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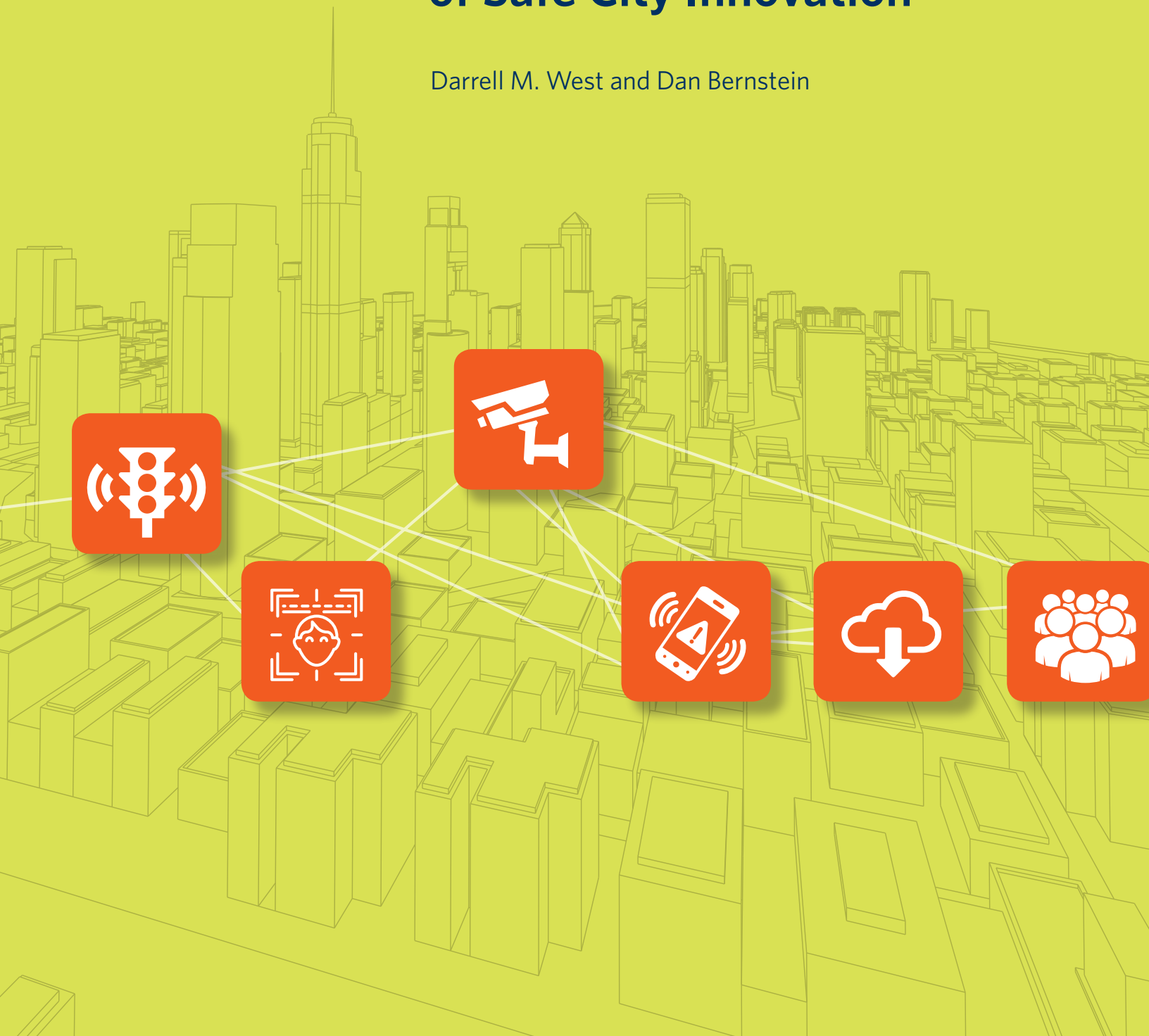
Benefits and Best Practices of Safe City Innovation

Darrell M. West and Dan Bernstein



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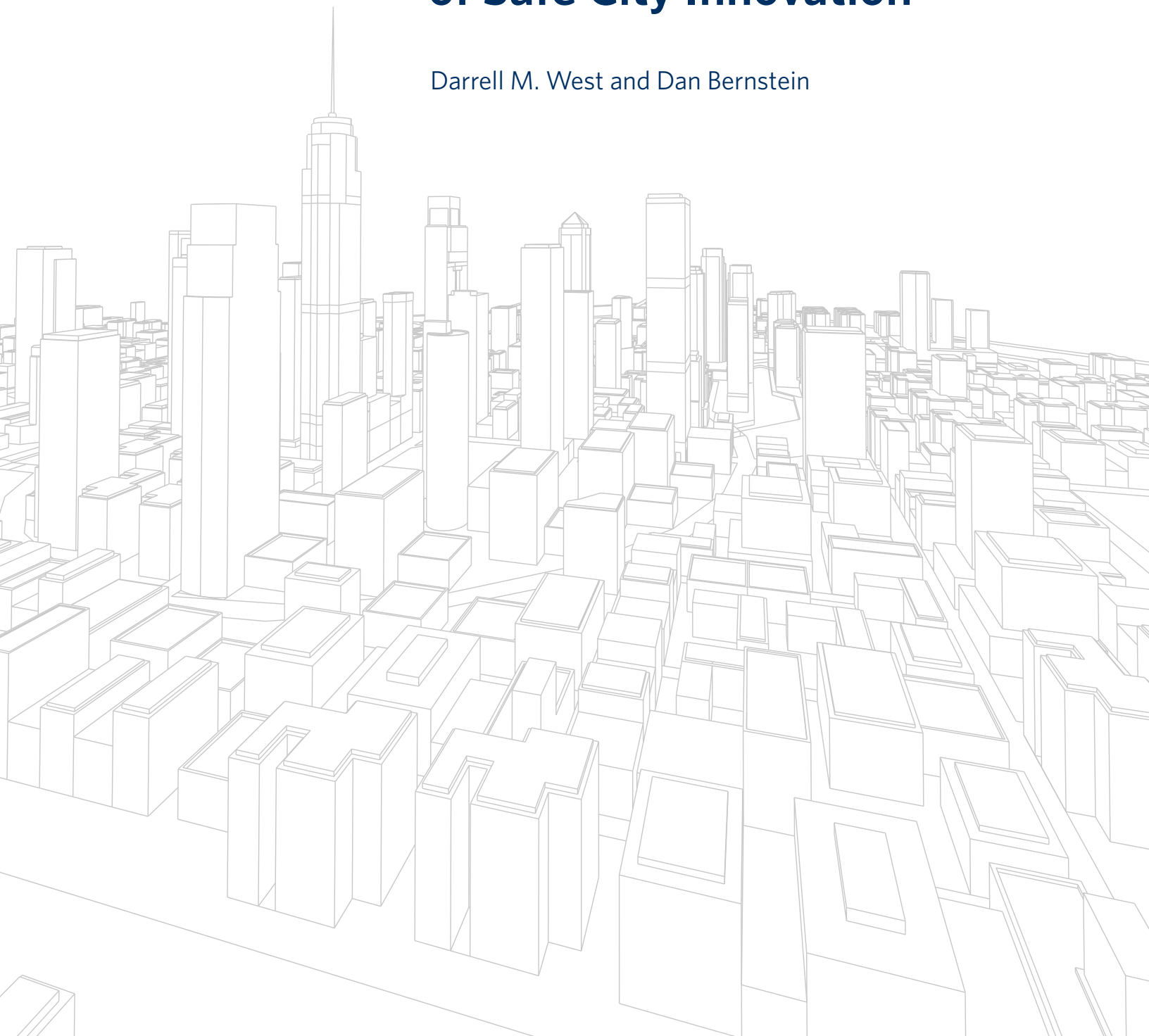

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Executive Summary

Public safety is an important aspect of contemporary life. In a world that is chaotic, dangerous, and volatile, it is hard for there to be economic prosperity and social cohesion without some degree of safety. People need security in order to live day-to-day and undertake business and communications. This is especially the case in regard to cities. According to UNICEF, 70 percent of people around the world will live in cities by the year 2050. This trend toward urbanization will necessitate new operating models and pose challenges in terms of how to protect residents.

Digital technology represents a novel way to improve public safety, promote stronger ties between law enforcement and the community, integrate solutions such as video, data, and analytics into effective solutions, and give security officials stronger tools for outreach and coordination. According to a Composite report, many police departments around the world are incorporating social media, mobile technology, and digital tools in their operations. They are setting up Internet platforms, leveraging the wisdom of the crowd, and expanding their community policing initiatives.

Law enforcement officials see value in terms of integrated, visualized, and collaborative command centers that provide real-time analysis. There are solutions that promote shared infrastructure, multi-agency collaboration, real-time information through sensors, video surveillance, facial recognition, and data analytics, and automated processing of information. Public officials need reliable and up-to-date communications in order to make informed decisions on emergency responses, resource allocation, and priority-setting.

In this paper, we examine the ways that digital technology, mobile networks, and integrated solutions help officials in 17 cities manage public safety and law enforcement. The locales include New York City, United States; Washington, D.C., United States; Paris, France; London, United Kingdom; Amsterdam, Netherlands; Madrid, Spain; Copenhagen, Denmark; Bangkok, Thailand; Kuala Lumpur, Malaysia; Jakarta, Indonesia; Singapore, Riyadh, Saudi Arabia; Kuwait City, Kuwait; Abuja, Nigeria; Cairo, Egypt; Astana, Kazakhstan, and Bogota, Colombia. We chose these places to reflect geographic diversity, representation both in the developed and developing worlds, having large populations, and in most cases serving as the capital city of a country.

As documented in this report, there is considerable variation from city to city in implementation progress and adoption of best practices. Singapore, Copenhagen, and London top the list of public safety innovators, while Abuja, Nigeria, Cairo, Kuwait City, and Astana, Kazakhstan lag the top performers. The former are places that have a clear vision, significant financial resources, a strong infrastructure, generate positive safety outcomes, the use of data analytics, and community engagement to improve ties with the general public, while the latter have not implemented many best practices and have resource limitations that so far have precluded significant progress.

Public safety innovation is important because it is a major contributor to economic development. According to research studies reviewed by Cardona, Kretschmer, and Strobel in the journal of *Information Economics and Policy,* "a 10% increase in ICT investment leads to a .6% increase in growth." That benefit has grown overtime and appears in a number of different countries.

In addition, social connectivity represents a way to improve law enforcement. It helps officers keep in touch with the community and improve its accountability. For example, cities that utilize body cameras on police "saw an 88% decline in the number of complaints against officers and a 60% reduction in incidents involving a use of force over the next year," according to an Equities report. RAND furthermore found that a "10% increase in the size of a police force decreases the rate of homicide by 9%, robbery by 6% and vehicle theft by 4% each year."

Cities face a variety of implementation challenges, such as poor funding, infrastructure difficulties, public resistance, a lack of technical expertise, and privacy and security concerns. Implementation of public safety solutions represents a major challenge in many different places, and it is crucial for leaders to overcome these barriers in order to achieve the benefits of public safety innovation. Solutions such as CCTV cameras, police body cameras, integrated command centers using broadband trunking, social media safety alerts, and predictive data analysis show great promise as tools for law enforcement.

Many factors affect technology innovation in the public sector. This includes the level of financial investment, crime rates, safety considerations, openness to technology solutions, and the strength of the digital infrastructure in particular countries. But government policy is especially important because officials make investments that enhance the efficiency and effectiveness of public sector operations. The way in which they handle modernization strategies matters a lot in terms of innovation and service delivery.

There are many opportunities for cities to build their economies and promote social inclusion through public safety innovation. Cities can encourage greater innovation by increasing budget investments in digital infrastructure, building public support, using crowd-sourcing platforms to encourage citizen participation, breaking down organizational stovepipes through technology, overcoming organizational resistance, making data openly available, deploying data analytics, integrating solutions, figuring out how to balance privacy and security concerns, and identifying opportunities for improvement.

Below we explain why these important steps will encourage best practices and enable cities to take advantage of digital technology (see Conclusion for additional details).

Increasing budget investments in digital infrastructure — Investing financial resources in digital infrastructure and solutions pays off in improved productivity, competitiveness, and innovation. Many developing nations suffer from limited internet access and few wi-fi hotspots. This makes it difficult for people to take advantage of mobile solutions and new digital tools for public safety. Cities need to upgrade their telecommunications facilities so their residents and law enforcement can gain the benefits of technology innovation.

Overcoming funding challenges — The biggest difficulty in most municipal areas is funding. Budgets are strained in most cities as they confront rising populations, public discontent, community disorder, and organizational dysfunction. Law enforcement has to balance demands from a number of different sources and figure out ways to become more efficient and effective. Understanding how digital technology improves the efficiency of operations is important for city officials.

Implementing integrated command centers — Public officials need reliable and up-to-date information regarding law enforcement and public safety. Broadband trunking systems help agents integrate information from voice, data, and collaboration. Using broadband that brings together material from many different sources improves response times and public safety protection.

Boosting government efficacy and transparency — Digital and mobile technologies offer the opportunity to improve efficacy and transparency in law enforcement. This includes mobile apps for residents to communicate with law enforcement, the use of data analytics to improve decision-making, the deployment of emergency alerts, and the employment of sensors and cameras to detect criminal activities.

Building public support — Law enforcement needs help from the community in order to solve crimes and prevent disruptive behavior. Yet in many neighborhoods, residents are skeptical of the police. They worry that law enforcement is unfair, unresponsive, or even discriminatory in their regular practices. What is needed is a community engagement strategy that builds rapport with local residents. Having a regular means of communicating with the general public is crucial to building the support that law enforcement requires.

Using crowd-sourcing platforms to encourage citizen participation — Crowd-sourcing has the potential to improve public engagement with law enforcement.

Social media sites represent a way for the police to get useful information and to test particular products before they are released to the general public.

Breaking down organizational stovepipes through technology — Many police systems are decentralized and fragmented, and not very good at sharing information with other jurisdictions. The result is organizational inefficiencies and a lack of effectiveness at protecting public safety. Digital technology represents a way to break down these stovepipes and create more integrated solutions. Collaboration creates possibilities in terms of information-sharing and tackling crime networks.

Overcoming organizational resistance — People like to follow set routines and sometimes resist efforts to change their behavior or introduce new procedures into the agency. In order to adopt new practices, organizations have to create strong training programs and incentives to handle things the proper way. This can involve awards for effective performance and professional development opportunities where the police are exposed to new ideas. Top-performing departments are not content merely to repeat traditional behaviors, but seek to encourage best practices and changes in daily routines.

Using police body cameras and CCTV cameras improves accountability — The use of police body cams and CCTV cameras help citizen complaints go down. If officers and community members think the record of their encounter will be available publicly, it promotes honesty on both sides of the engagement. Figuring out ways to balance consumer rights with law enforcement is crucial to moving ahead with this innovation.

Making data openly available and deploying data analytics — Open data improves transparency in law enforcement and promotes greater accountability and responsiveness. Researchers can identify crime patterns and help the police do a better job. Being able to see what is happening and how resources are being deployed builds public confidence in law enforcement.

Integrating solutions — There are many new solutions that are popular such as sensors, video surveillance, facial recognition, and data analytics. But what is needed are automated processing of information so that officials have the data they need instantly in order to make informed decisions. Every day, law enforcement agents require solutions that integrate information from a variety of sources. Material that takes hours or days to process is not very helpful when they have to figure out how to handle a domestic problem, neighborhood dispute, or criminal activity.

Figuring out how to balance privacy and security concerns — Privacy is a challenge in many places, and figuring out how to balance privacy protection with public safety is crucial. Authorities must determine how to maintain the confidentiality of public information while also keeping people safe. The public places a high value both on privacy and security.

Identifying opportunities for improvement — Many cities are working to improve their safe city practices, but need to embrace ideas such as mobile policing, police body cams, video surveillance, data analytics, and integrated solutions that help them visualize crime patterns or prioritize their budget resources. Building their digital infrastructure would help them improve their crime-fighting capabilities. They need to adopt best practices that help them fight crime and become more proactive at dealing with law enforcement problems.

Rating Cities on Public Safety Innovation

Cities vary greatly in the extent of their public safety innovation. Some have substantial financial resources and political leadership, and are in a position to implement the latest solutions, while others lack the fiscal means or leadership capabilities to try new approaches. Instead, they prefer to rely upon traditional approaches to law enforcement.

In order to measure public safety innovation from leading cities, we undertook a detailed assessment of six broad dimensions of public safety innovation. This included emphasizing a metropolitan vision on public safety, having a sufficient digital infrastructure, showing evidence of public safety effectiveness, adopting new public safety features, using data analytics to improve decision-making, and engaging in community outreach through law enforcement.

Developing a clear vision is crucial to resource allocation and organizational prioritization. Cities that make innovation a priority generally do a better job of implementing new features. Having a strong digital infrastructure enables innovation and provides a robust platform from which governments and businesses can promote new products. Being effective in producing positive outcomes suggests law enforcement is generating meaningful results. Implementing new public safety features is a sign that civic leaders are willing to try new approaches and adopt solutions with the potential to improve public safety. Employing data analytics helps cities make use of digital information and improve decision-making in real-time. Reaching out to the community and engaging them in meaningful ways increase the odds of success by making residents feel a part of the process.

In this analysis, we assessed public safety innovation on a 120 point scale using 24 different indicators. As described in greater detail in Appendix I, for metropolitan vision, we look at factors such as having a city goal of public safety innovation, making a management commitment, establishing financial priorities, and having a public safety planning board. Digital infrastructure is assessed through having reasonable internet access, mobile technology availability, having wi-fi access, and having a safe city web platform. With public safety effectiveness, we examine crime perceptions, safety perceptions, number of homicides per 100,000 residents, and crime incidence rates. For public safety features, we investigate whether cities have adopted tools such as mobile policing, body cams for law enforcement; video surveillance, and emergency alerts. The use of data analytics is assessed through having data center facilities, open data access, employing predictive analytics, and making use of digital information for social inclusion and economic development. Community engagement measures consultation with key stakeholders, providing citizen feedback mechanisms, having public-private partnerships, and having an outreach budget.

After compiling this information, we rated the cities overall as well as on the six broad dimensions of safety innovation. Following this ranking, we undertake several case studies, provide examples of notable innovations, describe the vertical industry that facilitates public safety innovation, outline implementation challenges, and make recommendations regarding best practices.

Table 1 shows how major cities performed on public safety innovation (Appendix II lists the specific numbers for each place). Singapore was the most innovative city, followed by Copenhagen and London. These places rate highly on indicators of metropolitan vision, digital infrastructure, public safety effectiveness, public safety adoption, data analytics, and community engagement.

As an illustration, Singapore had a perfect score of 120 points. It launched the Smart Nation effort to test new urban living technologies. Its Programme Office guides collaboration among agencies and private corporations. Through this, the Singapore Police leverages digital technology in their planning and implementation. This includes an i-Witness, where citizens can send vital counterterrorism information in texts, pictures,

TABLE 1 **Public Safety Ratings of Major Cities**

City	Total Score	Metro Vision	Digital Infrastructure	Public Safety Effectiveness	Public Safety Adoption	Use of Data Analytics	Community Engagement
Singapore	120	20	20	20	20	20	20
Copenhagen	116	20	20	20	16	20	20
London	114	20	20	14	20	20	20
Amsterdam	112	20	18	18	16	20	20
Madrid	112	16	20	16	20	20	20
New York	112	20	20	12	20	20	20
Paris	108	18	20	10	20	20	20
Washington, DC	106	18	20	8	20	20	20
Riyadh	102	20	14	16	16	20	16
Bangkok	96	20	18	14	12	12	20
Bogota	94	20	14	4	16	20	20
Kuala Lumpur	94	20	16	6	12	20	20
Jakarta	90	20	10	8	12	20	20
Astana	86	20	14	12	16	8	16
Kuwait City	86	20	12	14	12	12	16
Cairo	82	20	10	8	12	12	20
Abuja	68	16	8	4	12	8	20

Source: Compiled by authors using methodology described in Appendix I.

or videos, and a Community Policing System, which automates services at police stations, enabling officers to redeploy law enforcement resources into the community.

Copenhagen ranked second with 116 points and featured a number of new initiatives. It has a strong digital infrastructure and ranks highly in terms of public safety effectiveness. City officials rely upon data analytics and its police department has asked private surveillance system owners to register the location of their systems in order to allow law enforcement to contact individuals with useful footage is necessary. This voluntary pilot program began in 2016, although a majority of parliament members favor a mandatory registry, along with fines as punishment for failure to register.

London earned 114 points for its public safety activities. The city features advanced mobile services and data analytics that are integrated into its resource management. Its Legacy Development Corporation is developing Queen Elizabeth Olympic Park into "an inclusive community, a thriving business zone and a must-see destination". This area features a robust digital infrastructure, public safety innovation, and substantial community outreach.

Just below these global leaders came cities such as Amsterdam (112 points), Madrid (112 points each), and New York (112 points). These locales did well on vision, data analytics, and community engagement, but not as well on adding new safety features. New York also suffered on public safety effectiveness as judged by crime

and safety perceptions as well as measures of homicides and crime incidence.

The next level included places such as Riyadh (102 points), Bangkok (96 points), Kuala Lumpur (94 points), and Jakarta (90 points). These cities articulated a vision and generally had strategies for community engagement, but performed less well on digital infrastructure and public safety adoption. The Riyadh site highlights milestones by various agencies towards smart solutions and it has plans to implement LED street lights with a Remote Control and Monitoring System that adjusts lighting during the course of the day.

At the bottom of the list are cities such as Abuja (with a score of 68), Cairo (82), Kuwait City (86), and Astana (86). Each of these places display a metropolitan vision, but rank lower on digital infrastructure, safety effectiveness, public safety implementation, and use of data analytics. Astana has the goal through its Smart Astana project of moving Astana into the top 50 smart cities in the world and hosting the 2017 World's Fair EXPO. Its initiatives through JSC Astana Innovations include the smart school project which installs video surveillance and security systems that control building access and send SMS notifications to parents about student attendance, a smart street lighting project that installs LED-lamps programmed to dim to the time of day, and an Wi-Fi project that provides 24 Wi-Fi hotspots in public places, such as main cultural features or transportation centers. But despite its laudable hopes, execution has been limited and has not achieved all its objectives.

Public Safety Budgets

Financial considerations are an important aspect of the ability to innovate. Table 2 compiles information on public safety budgets, the percent of the total budget devoted to public safety, and spending per resident in a few selected places where information was available. It is difficult to compare public safety budgets across city governments. Municipalities do not classify public safety expenditures in the same way and have differing mixes of national and local revenues. Some focus on operating expenses, while others include development or capital funds in their local budgets.

But as seen in the tabulation, municipalities that performed well on innovation devoted billions of dollars to public safety. London, for example, spends $5.47 billion on safety, which is 6.4% of its budget, while New York City devotes $5.1 billion, Singapore, spends $4.1 billion, and Washington, D.C. spends $1.3 billion on safety.

In breaking public safety expenditures by city resident, London spends $6.30 per resident, compared to $6.00 per resident for New York City, $7.41 per resident in Singapore, and $19.34 per resident in Washington, D.C. With a relatively small population of 672,228, Washington spends a lot per person, compared to places such as London (with a population of 8.6 million), New York City (with a population of 8.5 million), and Singapore (with a population of 5.5 million).

For all these cities, high levels of law enforcement expenditures enable them to build advanced digital infrastructures, adopt new technology products and services, support law enforcement, and engage with the general community. All of those things position these places for leadership when it comes to digital innovation.

A breakdown of the $5.1 billion New York City Police Department budget in Table 3 of this document shows that the city derives the bulk of its revenues (95 percent) from city taxes. The rest comes from intra-city or federal funding. This means that the bulk of New York's innovation funding comes from government sources.

In Singapore, the largest revenue sources include the corporate income tax ($13.6 billion), goods and services tax ($11.2 billion), and personal income tax ($10.7). Taken together, these taxes comprise over half of the total revenue. Other prominent sources include the vehicle quota premiums, assets taxes, and motor vehicles taxes.

TABLE 2 Public Safety Budgets in Selected Cities

City	Total Budget (in billions of dollars)	Public Safety Budget (in billions of dollars)	% of Total Budget Devoted to Public Safety	Public Safety Spending Per City Resident
London	$84.86	$5.47	6.4%	$6.30/resident
New York City	84.7	5.1	6.0	$6.00/resident
Singapore (national government)	53.8	4.1	7.6	$7.41/resident
Washington, DC	7.6	1.3	17.1	$19.34/resident

TABLE 3 **Breakdown of New York City Public Safety Revenue Sources**

Revenue Source	Amount
City Funds	$4,862,524,000
State Funds	732,000
Federal Funds	28,762,000
Intra-City Funds	258,920,000

TABLE 4 **Breakdown of Singapore Revenue Sources**

Revenue Source	Amount
Corporate Income Tax	$13.6 billion
Personal Income Tax	10.7
Withholding Tax	1.3
Statutory Boards	0.2
Assets Taxes	4.4
Customs and Excise Taxes	3.1
Goods and Services Taxes	11.2
Motor Vehicles Taxes	2.7
Vehicle Quota Premiums	6.5
Betting Taxes	2.7
Stamp Duty	2.7

The Number of CCTV Cameras

An innovation that is popular in many places is closed-circuit television (CCTV). Table 5 shows the total CCTV cameras and the number per 1,000 residents in selected cities around the world where data are available. The tabulation shows that Beijing has 470,000 cameras, compared to 420,000 in London, 30,000 in Washington, DC, and 17,000 each in Chicago and Houston. However, when incorporating population size by looking at CCTV cameras per 1,000 people, London has the highest ratio at 48.4 cameras per 1,000 people, followed by Washington, D.C. (44.6) and Beijing (21.9).

Interest in video surveillance has grown in many places around the world. In a report, the Beijing Public Security Bureau noted that "the number of cameras in Beijing streets soared by 29 percent last year." It claimed that "thanks to surveillance cameras, officers detained 5 percent more suspects this year compared with last year."

A study by IHS estimated there are 245 million video surveillance cameras globally. Using data from companies regarding their "installed base of security cameras," this firm found that 65 percent of the cameras were in Asia. The largest vendors for these cameras were Hikvision, Samsung Techwin, and Axis Communications.

Video surveillance is seen as a deterrent to crime and as an aid to identifying criminals once infractions have taken place. When cameras are present, many people feel they should be on good behavior and not break the law. For those who do not share those sentiments, cameras help the police find law-breakers by making their identities known to police and the larger community.

TABLE 5 Number of CCTV Cameras in Selected Cities

City	Total Number of CCTV Cameras	CCTV Cameras Per 1,000 Residents
Beijing, China	470,000	21.9
London, United Kingdom	420,000	48.4
Washington, DC	30,000	44.6
Chicago, United States	17,000	6.3
Houston, Texas	17,000	7.7

Source: Compiled by authors.

Safe City Projects and Initiatives

There are a number of new projects and noteworthy initiatives around the world. Local authorities deal with crime by trying new approaches, integrating solutions, aggregating information, and breaking down the silos between government agencies. The most successful cities place a premium on innovation because they want to do a better job protecting their city residents.

Analysts have estimated that the value of the "safe city" market was $5.6 billion in 2015 and it is expected to rise to $8.5 billion in 2019. Some of the most popular initiatives involve integrated and collaborative systems for tools such as video surveillance, remote sensors, data analytics, social media monitoring, body cameras, facial recognition, and license plate readers. Each of these techniques helps officials make resource decisions using the most up-to-date information.

Some of the new projects involve infrastructure development that creates platforms for digital communication and public engagement. As an illustration of this approach, New York City unveiled LinkNYC, a public gigabit Wi-Fi hotspot system, in 2016 that provided rapid and widespread internet access. It had the goal of connecting 7,500 police stations around the city through tablets for internet browsing or a mobile means of contacting law enforcement. Since then, wi-fi access has expanded greatly, with over 500 stations becoming operational. This gives poor people access to internet platforms and allows them to report crimes or other types of problems, even if they lack computer devices of their own. Wi-fi hotspots help the public work with law enforcement and bridge the divide that exists in many place between the police and local residents.

Many countries, especially in the developing world, have innovated through new communities they have constructed. These places represent a growth area for safe city applications since it is easier to innovate in new as opposed to existing areas. A number of developing nations have devoted substantial resources to new urban developments. One example is in Kuwait where the government in conjunction with Korea's Land and Housing Corporation signed a memorandum of understanding to develop Saad Al-Abdullah into a smart, eco-friendly city along the lines of Masdar City in Abu Dhabi. A joint committee with the Kuwaiti Municipality was formed and implementation begins this year to build 30,000 housing units that leverage mobile technology connected with infrastructure for more efficient policing and service delivery.

Madrid has established a Smart Lab center to provide incubation and training to entrepreneurs to accelerate innovative solutions to implement smart solutions to urban safety issues. The city partnered with Ferrovial Services, a Spanish multinational urban development company, to administer the urban challenge and implement the incubation and training. One of the winning projects was "Mejora Tu Ciudad" (Improve Your City), an open communication platform to facilitate direct communication between citizens and municipal government.

The Bangkok Metropolitan Authority (BMA) meanwhile is developing applications to ease traffic congestion and identify neighborhood crime problems. The YouPin app makes it easier for citizens to send their complaints to law enforcement and generate data for analysis. However, developers report a lack of readily available data has hindered app development. A report written by the Authority's Policy and Planning Department states that the BMA is establishing Bangkok's Public-Private Cooperation Council, which brings together stakeholders from the community and business to improve community development.

Technology creates the potential to use new applications to improve public sector responsiveness. For example, Jakarta's Qlue program has developed a solution for citizen participation. It works with the city's Smart City Unit to monitor data in traffic, floods, and dengue fever to predict and mitigate dangers. An app called CROP with the English translation of "rapid response to public opinion" allows government employees to directly respond to reported problems. When launched, Jakarta's governor said they would use CROP data to monitor employee response time and use it to fire people who react too slowly to citizen complaints.

The Royal Malaysian Police piloted a Self-Monitoring Analytics Reporting Technology (SMART) Lock-Up system in a city police station in 2016 that uses gait analysis to alert officers to suspicious activity, prevent jailbreaks, and stop violence among inmates. The program was expanded to 58 prisons and there are plans to expand to the rest of the country soon.

The Use of Police Body Cams in Amsterdam

To illustrate an example of safe city solutions, we looked in greater depth at the use of police body cameras in the Netherlands. Amsterdam Smart City (ASC) serves as a platform to connect companies, individuals, and municipalities to accelerate innovative solutions for issues in the Amsterdam Metropolitan Area. ASC has at least 100 partners involved in more than 70 initiatives, with special emphasis on open-source data and open application programming interfaces (APIs).

One of its more popular initiatives involves the use of body cams. These video cameras worn by law enforcement agents are designed to provide a video record of interactions between citizens and law enforcement. These materials can be used either to defend police against unfair charges or help citizens who feel law enforcement has encroached on their rights.

Dutch interest in body cams goes back to 2009, when some of its law enforcement agents visited Nottingham in the United Kingdom. The British force was an early adopter of body cams and had gotten good results for their implementation. The London Metropolitan Police Service began outfitting frontline officers with body cameras in October 2016 and plans to achieve full deployment of 22,000 officers across all London boroughs by Summer 2017. The Mayor's Office for Policing and Crime (MOPAC) awarded 3.4 million pounds to Axon Public Safety UK Limited to supply the body cameras.

Seeing the positive consequences of this implementation, the Amsterdam police decided to deploy them as well. A Dutch company called Zepcam developed a wearable camera for the police based on its high-end sports cameras and sold them to a number of departments in the Netherlands. According to an analysis by researcher Tjerk Timan in *Surveillance and Society* magazine, the goals of these body cameras were five-fold: "reducing violence against the police, and recording of violence against the police; recording of offences, as well as registration and identification of suspect(s); registering disturbances to public order; promoting a sense of security for the police; and using captured images as supportive evidence in criminal investigations."

Critics worried that body cameras would produce a "mission creep" that increased surveillance against private citizens. Rather than serve merely as a technical platform for recording infractions, some feared that police would use the technology surreptitiously or covertly, and therefore erode public rights. Their concern was that images captured by the cameras would be used to invade people's privacy or entrap bystanders into illicit actions.

However, controlled trials of the technology supervised by Barak Ariel, William Farrar, and Alex Sutherland have found positive results. A study that compared police use of force in situations with and without the body cameras demonstrated that "the likelihood of force being used in control conditions [without cameras] were roughly twice those in experimental conditions [with cameras]" and that "the number of complaints filed against officers dropped from 0.7 complaints per 1,000 contacts to 0.07 per 1,000 contacts."

These types of benefits are especially important in a city such as Amsterdam. According to its Smart City website, the place is one of the densest around the world, with around 5,065 people per square kilometer. In addition, the city is home to people from over 180 different nationalities, which makes conflict resolution a very high priority for urban law enforcement. Keeping the peace in a situation where there are individuals from many different backgrounds is crucial. Body cams help hold the police accountable and promote more trusting relationships between citizens and law enforcement.

The positive results achieved by the Amsterdam experience have served as an encouraging example for other locales. New York City recently purchased 5,000 cameras for police from the Seattle company Vievu. This is

the first time that locality has implemented body cams and there is great attention to how that project goes. The city's hope is to improve accountability among law enforcement and provide better documentation of interactions between officers and the community. Police leaders plan to roll out body cameras to all of the 23,000 officers in the New York Police Department by 2019.

Table 6 shows the number of police body cameras for selected cities where data are available. London police reported 22,000 body cameras, followed by Los Angeles with 7,000 cameras, New York City with 5,000, Houston with 4,100, Washington, DC with 2,600, France country-wide with 2,600, Sacramento with 890, and Denver with 800.

On a per capita basis, Washington, D.C. had the highest percentage of police body cameras at 3.87 per 1,000 residents. This was followed by London at 2.54, Sacramento at 1.84, Houston at 1.83, and Los Angeles at 1.78. According to a market survey by Vivian Hung, Steven Babin, and Jacqueline Coberly, prices for cameras ranged from $199 to $2,000, with the average cost being $570.

TABLE 6 Number of Police Body Cameras in Selected Cities

City	Number of Police Body Cameras	Police Body Cameras Per 1,000 Residents
London	22,000	2.54
Los Angeles	7,000	1.78
New York City	5,000	0.58
Houston	4,100	1.83
Washington, DC	2,600	3.87
France (country-wide)	2,600	0.04
Sacramento	890	1.84
Denver	800	1.20

Source: Compiled by authors.

Integrated Command Centers in Lijiang and Nairobi

Integrated command centers help local and regional communities secure their communications networks. Using broadband trunking systems, these solutions help agents integrate information from voice, data, and mobile units. In law enforcement and emergency response, the police need quick, reliable, and secure communications channels that enable them to respond quickly and effectively to possible threats.

In their comparative study of smart cities in Europe and China, researchers at the China Academy of Information and Communications Technology found that a number of places are implementing safe city solutions. Many communities have CCTV cameras, social media feeds, data from remote sensors, and channels for communication. Yet these channels must be integrated in a manner that provides actionable intelligence and multimedia dispatch. If there is not a means to bring this information together in a secure and timely manner, it will be difficult to make proper use of the materials.

One place that has had success in implementing innovative solutions is Lijiang, China. It is located in the northwest part of Yunnan province and has a "golden waterway" in the Li River, picturesque mountains, and a UNESCO Heritage Cite in its Old Town. With the increase in tourism in recent years, the city faces substantial challenges in law enforcement and public safety. There are difficulties in managing large crowds, supervising the sale of local goods and services, and ensuring there is not over-fishing in the river. Law enforcement resources are stretched thin and it is hard to know how to prioritize personnel and the safety budget.

Broadbank trunking helped authorities cope with the demands in their city. They implemented a high-speed eLTE wireless broadband sytem covering video, voice, and digital data services. According to a research report, "high-resolution cameras are used in key areas for real-time monitoring. Meanwhile, multimedia video trunking is employed to allow visualized dispatching, accurate decision-making, quick police operations, and task-specific deployment. The network permits the command boat to communicate with the onshore control center and patrol boats on the river, which helps Lijiang Police to provide joint, quick responses."

The head of the local police praised the deployment of this system. After its rollout, he said "our system is so beneficial that we can conduct both onshore and offshore monitoring to reduce illegal and criminal acts and enhance law enforcement. Now we employ less than 60 people to secure up to 83 km of Li River waterways." His office estimates that accidents have "dropped by 50 percent and emergency response efficiency rose by 30 percent" since the implementation.

Other communities have found similar results. Police stations in Nairobi, Kenya have added emergency communications networks with advanced features such as "video dispatching, video surveillance, and high-speed data backhaul services." Their system uses the Safaricom mobile network along with ICT terminals to integrate command centers and individual police cars. High-definition videos taken in various places around town feed into a command center through trunking handsets. According to analysts, "the command center can then deliver these videos to police cars equipped with voice-and-video stations. As a result, all on-duty personnel at headquarters, the command center, and in police cars can conduct a visible, coordinated, three-dimension operation." All this has improved the efficiency of police operations and the effectiveness of emergency responses.

Social Media Safety Alerts in Bangkok

Some communities use social media to inform residents about safety issues. The Bangkok municipal government has deployed an emergency alert system using Facebook's safety check alerts to deal with emergencies. When an incident happens such as gun violence, a bombing, or a natural disaster, people can go to the social media homepage and tell others that they are safe. This lets friends and family members know in real-time the status of people in the affected area and whether specific individuals have been hurt.

The company used to trigger the alerts internally when it decided that a disaster had occurred and that people needed a platform to inform others about their status. That happened 39 times in 2015 and 2016. Alerts typically were triggered by bombings or natural disasters in particular areas.

Starting in June, 2016, though, the government has crowd-sourced this innovation and let people in the community trigger alerts. If internal algorithms based on social media activity indicate that an alert is needed, one is triggered automatically even without independent verification of what happened. That allows community members to decide whether a safety check is needed. These kinds of alerts happened over 300 times in the last six months of 2016, according to an article in the *Malay Mail*.

Other municipalities prefer to house social media alerts on their own platforms. Cities can host these types of alerts on their own websites or through their own mobile networks. All it takes is a mechanism for deciding what triggers the alert and a means to deliver alerts to the broader community. Each of those systems can be implemented on city government networks, which gives local officials the means to disseminate their own alerts.

Some observers worry that social media algorithms are not reliable. False triggerings based on untrue reports or inaccurate community rumors might generate fear among the general public. Critics argue that collaborating with local authorities would improve the reliability of these tools. Working closely with local leaders would build confidence in municipal alert systems that inform the public when catastrophes take place.

Predictive Data Analytics in Bogota

Predictive data analysis is another strategy for improving law enforcement. In Bogota, for example, there is considerable interest in predictive capabilities for crime prevention using crime, transportation, and housing data. These models are designed to anticipate criminality and prevent violence in local neighborhoods.

An illustration of this took place when the Data-Pop Alliance investigated crime in the Bogota challenge at PeaceHack. The exercise asked stakeholders to predict "crime hotspots" using crime and transportation data. According to the Data-Pop Alliance, "team members had access to hourly data on crimes (from the police) and transport (from Transmillenum). Through analysis of this data, they tried to understand if and how public transportation affects crime."

Using these kinds of geo-location information, researchers were able to pinpoint when crimes were most likely to take place. For example, their analyses revealed that the greatest number of crimes took place at the end of the workday (around 5 to 6 p.m.). That is when people are traveling and therefore vulnerable to criminal activities. This information helped city planners determine ways to anticipate crime and reduce crime levels through enhanced enforcement.

Based on these insights, community leaders developed strategies that were pro-active in reducing crime. That included re-deploying law enforcement resources in places and during times of greatest crime risk. They also thought about the impact of transportation systems on criminality, and how population density protects people from illegal activities.

Predictive analytics is a growing area of innovation for many cities. Accenture Analytics equipped London police with predictive analytics to produce risk scores based on the likelihood that an individual linked to a gang would commit a crime. This was the first attempt in the United Kingdom to predict violent crime using data analytics.

IBM subsidiary INSA meanwhile has partnered with the City of Madrid in a $20 million deal to deploy data analytics to pay service providers based on service levels. Leapcraft has partnered with the city of Copenhagen, Cisco, and the Danish Technical University to mine anonymous data from geo-located wi-fi devices to improve public safety. Singapore held a Safe City Test Bed, where government agencies worked with four private organizations (Accenture, AGT International, Airbus Defense and Space, NEC Asia Pacific) to combat crime issues through data analytics and machine learning. These examples demonstrate the interest in many cities in using big data to improve crime prevention.

The Industry Supporting Safe City Solutions

As listed in Table 7, there are a number of commercial firms that support safe city solutions. In general, most cities use local firms that specialize in particular products or services. Relying upon local companies allows the police to build ties with the community and support local businesses. However, in some cases, departments utilize services from national or international providers that have a demonstrated track record and provide excellent customer service.

In Amsterdam, Incentro provides fire risk profiles for the Amsterdam Fire Brigade using incident data to identify high-risk environments and firefighters can view relevant information remotely while on route to an incident. Hitachi Insight Group developed the Copenhagen City Data Exchange to produce a single platform for accessing public and private data from the region to reduce barriers to producing smart city solutions.

Video surveillance is a popular crime-fighting solution. SICE installed 47 surveillance cameras in Madrid, including 10 "electronic eyes" with analytical software capable of detecting odd behavior and alerting police.

The Malaysia Digital Economy Corporation, a government organization established in 1996, undertakes planning and implementation of the special economic zone, MSC Malaysia. It has supported the development of Cyberjaya, the country's global tech hub that is near Kuala Lumpur. Cyberjaya is positioned to be the first LoRa (Low-Power Wide-Area Network) City in Southeast Asia after a partnership with Atilze, an Internet of Things supplier. In safety, the city has the Malaysian Emergency Response System (MERS) 999 CCTV system. It fully integrates CCTV with their emergency response system in order to support the goal of becoming a smart and safe city with zero crime.

In Paris, Teleste began a 10-year public-private partnership with the Paris Police Department to upgrade to high definition video surveillance and integrate more cameras into the Paris metro surveillance system and videos for the French national railway company.

Maintaining digital infrastructure often is out-sourced to private companies. True Internet (a subsidiary of True Corp) installed and maintains the public Wi-Fi infrastructure for the Bangkok Metropolitan Authority (BMA). True Internet is the largest broadband supplier in the country, even though there are many complaints in that city concerning service outages and performance failures.

In the Middle East, the Saudi government chose Mobilaris as the provider for a SMS emergency alert system that uses mobile device GPS location to notify individuals near an emergency. In Kuwait, the Wireless Mobile Data Company (WiMD) is a privately-owned Internet Service Provider that will launch a free, national wi-fi service. The rollout will begin in Kuwait City, working in conjunction with the State Minister for Cabinet Affairs and support from the Director of Public Authority for Communications. Harassmap, an Egyptian anti-sexual harassment campaign, unveiled Ushahidi, an open source platform to report and visualize sexual harassment in 2015.

These illustrations along with the list shown in Table 5 demonstrate the growing market for safe city solutions. Companies that offer products such as video surveillance, body cameras, and data analytics are in hot demand. Local governments are looking for firms that can integrate information quickly and visualize data in a graphic form that is readily accessible and helps authorities make decisions quickly. In the law enforcement area, conditions change rapidly. Leaders often have to make decisions instantaneously so they need information in real-time that comes from a variety of different sources: videos, sensors, and maps. Having the ability to analyze data and integrate solutions is a vital part of the opportunities that are present in many places.

TABLE 7 Companies Providing Public Safety Solutions

City	Company	Solutions
Abuja	Suburban Broadband Limited	WiFi service
Amsterdam	Incentro	Fire risk profiles
Amsterdam	Zepcam	Police body cams
Bangkok	True Internet	WiFi service
Bogota	Telephone Company	Intelligent transportation
Cairo	Ushahidi	Open source platform to report sexual harassment
Copenhagen	Hitachi Insight Group	City data platform
Copenhagen	Leapcraft, Cisco, and Danish Technical University	Data mining for traffic and public safety
Kuala Lumpur	Digital Economy Corporation	Tech hub
Kuwait City	Wireless Mobile Data Company	Wifi service
London	Accenture Analytics	Data analytics
London	Axon Public Safety	Police body cams
London	Cloud	WiFi service
London	Panasonic	Tablets for police
Madrid	INSA	Data analytics
Madrid	SICE	Video surveillance
New York City	Qualcomm, Titan, Control Group, Comark, Transit Wireless, and Antenna Design	Wifi service for LinkNYC
New York City	Vievu	Police body cams
Paris	Teleste	High definition video surveillance
Riyadh	Mobilaris	SMS Emergency Alerts
Singapore	Accenture, AGT International, Airbus Defense and Space, NEC Asia Pacific	Data analytics
Washington, D.C.	Shotspotter	Gunshot sensors
Washington, D.C.	Raheem	Data analytics for social media

Source: Compiled by authors.

Cities in the upper half of the safe city index already have adopted many of these tools and are using them to generate meaningful results. Places such as Singapore, Copenhagen, London, Amsterdam, Madrid, New York City, Paris, and Washington, D.C. are quite advanced in their best practices and adoption of new technologies. They have found local or national firms that help them pilot new projects and bring them to the marketplace. A number of these locales have made progress on outcomes such as safety and crime perceptions, homicide rates, and incidence levels.

But there are many other areas that lag the adoption rates of these global cities. Metropolitan communities such as Riyadh, Bangkok, Bogota, Kuala Lumpur, Jakarta, Astana, Kuwait City, Cairo, and Abuja have not innovated at the same levels and therefore need help in their innovation practices. Some of these places suffer from budget limitations that make it difficult to finance new solutions or don't have the digital infrastructure to support advanced products. These cities need to place a higher priority on best practices. Their leaders have to understand that innovation pays off in higher economic growth, competitiveness, and productivity as well as lower crime incidence.

Communities such as Bangkok, Kuala Lumpur, Jakarta, Kuwait City, Cairo, and Abuja are at the low end of public safety adoption practices. They have not embraced new law enforcement ideas such as mobile policing, police body cams, or video surveillance. In many cases, they also have not adopted integrated solutions that help them visualize crime patterns or ways to prioritize their budget resources.

Cities such as Astana and Abuja are weak on data analytics and have a digital infrastructure that lags other global cities. They need to adopt best practices that help them fight crime and become more proactive at dealing with potential problems. With more modern tools, they could generate higher effectiveness on public safety outcomes and put themselves in a stronger position to protect their residents.

The Economic Benefits of Public Safety Innovation

There are many economic benefits of public safety innovation. Digital technology contributes to society through direct spending, indirect improvements in supply chains, benefits to worker productivity, and gains in national competitiveness. Table 8 lists the demonstrated benefits, and there are a number of important gains associated with technology investment. For example, research by Cardona, Kretschmer, and Strobel finds that "a 10% increase in ICT investment leads to a .6% increase in growth." That contribution has increased overtime and is found in a variety of different countries.

There also are benefits in terms of productivity, innovation, and national competitiveness. A Huawei report found that each percentage point increase in a country's digital connectivity score was strongly correlated to an increase in productivity by 2.3 percent, innovation by 2.2 percent, and national competitiveness by 2.1 percent. These are impressive technology benefits for economic development.

Within the United States, telecommunications companies are expected to invest $275 billion in broadband infrastructure and experts expect this to create 3 million jobs and add $500 billion to that country's Gross Domestic Product. Accenture analyzed smart city spending in American cities and found clear economic benefits. In Chicago, smart city technology will create 90,000 jobs, add $14 billion to the city's economic growth, and provide $5 billion in smart grid and transportation benefits. In San Francisco, the adoption of sensors measuring gunshots has reduced gun violence by up to 50 percent.

The Kazak Vice Minister for Emergencies announced a planned SMS-based emergency alert system that would be completed in several years. A similar mobile alert system has been operating in Almaty, the former capital city, since July 2012.

TABLE 8 Benefits of Technology Investment and Public Safety Innovation

Benefits	Technology Investment
Economic Growth	A 10% increase in ICT investment leads to a .6% increase in growth
Productivity	Each percentage point increase in digital connectivity is associated with a productivity increase of 2.3 percent
National Competitiveness	Each percentage point increase in digital connectivity is associated with a 2.1 percent boost in competitiveness
Job Creation	An investment of $275 billion in broadband infrastructure is expected to create 3 million jobs and add $500 billion to Gross Domestic Product
Innovation	Each percentage point increase in digital connectivity is associated with a 2.2 percent gain in innovation
Reduction in Police Complaints	Investing in police body cameras reduce citizen complaints by 88 percent and cuts police "use of force" incidents by 60 percent
Reduction in Crime Incidence	Increasing police force by 10 percent cuts homicide by 9 percent, robbery by 6 percent and vehicle theft by 4 percent each year
Increase in Housing Values	Cutting homicides by 10 percent increases housing values by 0.83 percent

But these gains are not limited to the United States. Research on Korean smart cities also has found a number of benefits in terms of economic growth. In looking at smart city investments of 17 billion Korean won (around $15 million) at, economists estimate economic gains of 33.5 billion Korean won (around $29.2 million). This means that investments produce growth almost double the original investment.

There furthermore are benefits in terms of personal safety. Digital innovation in the public safety area promotes better community relations. For example, according to an Equities report, communities that deployed body cameras on police "saw an 88% decline in the number of complaints against officers and a 60% reduction in incidents involving a use of force over the next year." Researchers concluded that people were "better behaved when they knew the camera was recording them."

The U.S. National League of Cities undertook case studies of Chicago, Illinois, Philadelphia, Pennsylvania, Charlotte, North Carolina, San Francisco, California, and New Delhi, India. Through a report entitled "Trends in Smart City Development," it found that the introduction of "smart policing" enabled Philadelphia to lower its crime rate and do a better job of protecting its residents. Through new development, community engagement, and law enforcement training, it strengthened its law enforcement capacity and made its data widely available.

RAND found that a "10% increase in the size of a police force decreases the rate of homicide by 9%, robbery by 6% and vehicle theft by 4% each year." Its researchers computed that crime reductions of this magnitude would save about $475 million annually. Another study undertaken by Larry Samuels demonstrated that "if a city has a reduction in crime of 10%, then 2% of total patrol officer time will be recouped in the form of available officer time."

Not only was their clear evidence of a substantial investment rate of return, analysis found that police departments could save millions in legal fees and court settlements over police brutality and the use of force. As an illustration of the large amount of money that major cities spend in this area, the city of New York spent $735 million on settlements in 2011, while Los Angeles spent $54 million. Body cams protect both police officers and private citizens during enforcement encounters.

Research from the Center for American Progress demonstrates social and economic benefits from reducing violent crime. In a study of eight American cities, economists Robert Shapiro and Kevin Hassett found that violent crimes cost Americans $42 billion in direct costs per year. That includes "the associated costs of police, courts and correctional institutions, out-of-pocket-medical expenses borne by victims, and lost earnings by both victims and perpetrators who are arrested and convicted." These writers document that "a 10 percent reduction in homicides should lead to a 0.83 percent increase in housing values the following year." Public safety is an area where budgetary investments pay off in economic growth, crime reduction, and community integration.

Implementation Challenges

Implementation of public safety solutions represents a major challenge in many places. There are problems in terms of insufficient funding, infrastructure deficiencies, public resistance, a lack of technical expertise, and privacy and security concerns. We detail these at greater length in the sections below.

Poor Funding

Poor funding is the biggest problem in many places around the world. For example, the Nigeria government has had problems delivering on the 30-year National Integrated Infrastructure Master Plan (NIIMP) it announced in 2014. The plan was poised to draw together the plans from various departments to provide a single, comprehensive national plan, with much of the funding allocated towards road infrastructure investment and mobile network capacity. However, annual funding for the plan has been extremely low and government officials have complained that other concerns have become more important to the administration.

This is not an isolated problem. Many cities do not place a sufficient priority on investments in digital solutions. Money for policing competes with housing, transportation, income support, energy, and other community needs. And in the law enforcement area, officials devote the bulk of their funding to personnel and beat officers, and therefore are not in a strong position to invest in information technology. That limits their ability to innovate and prevents them from deploying the most up-to-date solutions for fighting crime.

Poor investment is short-sighted because the economic case for putting money into public safety innovation is clear. As noted earlier in the paper, there are positive returns on investing in this area because additional funding improves productivity, innovation, competitiveness, and crime-fighting ability. In addition, public safety innovation has social payoffs in terms of improving governance, promoting transparency and accountability, and increasing the quality of life in metropolitan areas. Even in countries with limited budgets, there are economic and social benefits of technology innovation.

Infrastructure Deficiencies

Many countries have infrastructure problems that make it difficult to implement digital solutions. As an illustration, Abuja has struggled to deliver infrastructure enhancements to the public, including simple wi-fi improvements. A $5 million partnership between the Federal Capital Territory Authority and Suburban Broadband Limited to deliver six, free wi-fi hotspots in the capital city failed to perform satisfactorily. Automated traffic lights also have fallen into disrepair and humans have returned to regulate traffic at congested intersections.

It is crucial to strengthen digital infrastructure because of the increase in crime using technology. According to an analysis by Knoo Boon Hui and Koh Hong Eng, "about 42% of vehicles stolen in London were not by traditional brute force, but through digital hacking!". Hacking, identity theft, ransomware, and online scams are growing in number and posing serious threats in many communities. Without new solutions, it will be hard for law enforcement to keep up with criminals who use technology to ensnare innocent victims.

Public Resistance

Some Internet policies have incited public resistance from the community at large. In January 2017, the Kazakhstan government passed a law to require internet users to register on website with their phone numbers before they can post comments. Critics there feared that the measure would help authorities to identify individuals posting comments that are considered inflammatory or disruptive. Since 2016, internet users must install a "national security certificate" allowing authorities to scan communications and block website access.

Using Twitter in Spain also has led to some arrests, but there is legal uncertainty in how aggressively Spanish police should use social media to release information pertaining to active cases to find missing and wanted individuals. Some officials are reluctant to reach out to the public for help in solving crime due to public sensitivity about law enforcement practices. Their fear is that aggressive policing will spark a community backlash and make it more difficult to fight crime.

Lack of Technical Expertise

A lack of technical expertise complicates innovation in many cities around the globe. Most government agencies lack detailed expertise in public safety innovation. They do not have skilled information technology personnel and it is hard to recruit such people given the high salaries that technology experts can earn in the private sector.

The result is that most agencies rely upon private contracts to build infrastructure, supply wi-fi services, and provide innovation solutions through mobile devices. In some places, there are public-private partnerships that support implementation, while in other places new solutions are developed exclusively by private businesses.

Privacy Concerns

The New York Domain Awareness System (DAS) and LinkNYC have drawn privacy concerns as well with individuals citing DAS as a violation of the fourth amendment protecting against unreasonable search and seizure. In addition, there is concern over LinkNYC turning over copious amounts of personal data to private providers. Predictive policing furthermore has raised concerns about bias in the software resulting from over-policing of low-income minority communities. The fear is that these algorithms will include unfair criteria and be used aggressively against minority residents.

Security and Ransomware Problems

A major ransomware attack in May, 2017 highlighted the security challenges facing Internet platforms around the world. Over 200,000 networks in 150 countries were afflicted with malware intrusions. Hackers locked computers and threatened to destroy data if money was not paid.

This was just one of many such intrusions that have plagued the world. When the White House launched a collaboration between Washington, D.C. and twenty other cities in September 2016, a ransomware hack of the Metropolitan Police Department CCTV in January 2017 demonstrated there were major security problems. Similar difficulties have emerged in China, Russia, and many parts of Europe. British regulators, for example, have called for that country to adjust to accelerating technology development in automated surveillance so that it can balance "smart" technology with individual security and privacy. The Dutch Government meanwhile changed its stance on hardware backdoors in order to help authorities understand cyberattacks. These are just some of the ways that security concerns have complicated the task of fighting crime.

The Role of Government in Technology Innovation

Many factors affect public safety innovation: budgetary considerations, crime rates, openness to technology solutions, and the strength of the digital infrastructure in particular places. As noted earlier, having sufficient resources is crucial for law enforcement. Suffering from high crime rates or safety risks in a community can increase the desire for new crime management solutions. How open officials are to new technologies conditions their willingness to try different things. And the scope of their digital networks affects the ability to implement new approaches.

But one important factor in innovation is the role of government policy. From a governmental perspective, officials make investments they believe will enhance the efficiency and effectiveness of public sector operations. They realize the need to modernize government and adopt new approaches to service delivery. People are accessing personal information and services online, and they need to deliver public sector services in integrated and collaborative ways.

Digital technology improves the efficacy of government operations. Many public agencies are inefficient in the way they function. They don't work well with other departments, have difficulty sharing information, and do not collaborate very effectively. Those tendencies make it difficult to integrate their databases and take advantage of shared insights.

Table 9 shows how law enforcement in a number of cities is using digital and mobile applications to improve the efficiency of their operations. For example, Astana uses SMS to notify parents of their children's school attendance. Kuala Lumpur has integrated CCTV into its command center to improve response times. In Singapore, citizens can send texts, pictures, or videos to police to warn them about possible counterterrorism threats.

These places were able to overcome funding limitation, infrastructure issues, and lack of technical expertise by prioritizing the innovation and using technology to save money. They studied how other cities have innovated and drew on the lessons. Generally, their initiatives involved relying upon outside firms that had the knowledge to build the application within the confines of the available budget.

Many governments rely upon outside firms because they lack the in-house technical expertise needed to overcome public opposition and implement new digital solutions. Agencies often have people who have been in

TABLE 9 Ways Law Enforcement is Promoting Efficacy and Transparency

City	Promoting Efficacy
Astana	Authorities can send SMS notifications to parents about the school attendance of their children
Kuala Lumpur	Its Emergency Response System fully integrates CCTV in order to increase police responses
Kuwait City	New housing units incorporate mobile technology connected with community infrastructure in order to promote more efficient policing and service delivery
Nairobi	High-definition videos taken in various places around town feed into police command center to give it up-to-date information on community activities
New York City	Mobile tablets for police enable real-time notification of alerts or problems
Singapore	Citizens can send texts, pictures, or videos to police to warn about possible counterterrorism threats
Washington, D.C.	Shotspotter sensors detect gunshot locations in order to improve police response times

the public sector for a number of years and are not well-trained in technology innovation. For that reason, they contract with leading firms to develop new products and services in the law enforcement area.

As the world moves to digital platforms, officials can blend digital solutions with traditional approaches to law enforcement. This includes mobile apps for residents to communicate with law enforcement, body cameras that protect both police and private citizens, the use of data analytics to improve decision-making, the deployment of emergency alerts, and the employment of sensors and cameras to detect criminal activities.

Some communities focus on sensors to combat specific urban problems. In Washington, D.C., for example, Shotspotter has detected over 39,000 gunshots since installing a network of 300 sensors. The system monitors for gunshot noises, which are analyzed by ballistics experts at the company's headquarters, and notifies police with location information to enable quicker responses. Seventy-five U.S. cities currently have installed Shotspotter networks and integrated the data emanating from these sites into crime prevention.

In assessing smart city implementation, government leaders look at several different criteria. Since there are many untested solutions, working with companies that have a demonstrated track record of success matters a lot. Firms that have deployed innovations in other cities have a credibility that is very important because it offers confidence that the new approach will deliver the promised results.

In addition, governments prefer solutions that are scalable in nature. Cities often start with small, pilot projects to make sure the invention works well. After seeing positive results, they then want firms that can scale up quickly to the entire metropolitan area, and be in a position to serve millions of residents. This means that firms must be able to operate both at small and large scales.

Cities prefer solutions that integrate well with existing platforms and can be updated as new models or software packages are developed. Digital technologies change fast and companies need a capacity to improve their offerings and roll them out to interested customers. Having help desks and strong maintenance and upgrading staffs gives governments confidence that firms can adapt quickly as knowledge improves.

The New York Police Department meanwhile has equipped 6,000 police cars with tablet computers and provided 35,000 handheld devices to enhance NYPD's mobile technology platform. The mobile policing gives officers access to the portable Real Time Crime Center, all investigative databases, and real-time notification capabilities for alerts or counterterrorism issues. Its Domain Awareness System (DAS) in New York City combines 911 call information with data from 9,000 CCTV cameras, 500 license plate readers, 600 radiation and chemical sensors, and ShotSpotter audio gunshot detectors to enhance police activity. Originally financed by the Counterterrorism Bureau, the system was given automated pattern recognition in 2011 and predictive policing capabilities in 2014.

Recommendations and Best Practices for Improving Public Safety Innovation

There are a number of ways to encourage best practices and facilitate safe city development. This includes investing in digital infrastructure, crowd-sourcing through citizen participation, building public support, breaking down organizational stovepipes, overcoming organizational resistance, using police body cameras and video cameras to improve accountability, taking advantage of open data and open platforms, deploying data analytics and social media to fight crime, and balancing public safety and personal privacy. In this section, we explain how these recommendations help promote public safety.

Investing in Digital Infrastructure

One recommendation involves investing greater resources in digital infrastructure and mobile solutions. Many developing nations suffer from limited internet access and few wi-fi hotspots. This makes it difficult for people to access mobile solutions and take advantage of new tools for public safety. In this situation, neither law enforcement nor the public in general are able to make much progress in public safety innovation. This frustrates all involved and makes it difficult to show progress.

To deal with this, both governments and businesses need to invest in improving infrastructure. This includes internet service delivery, mobile networks, and the emerging Internet of Things. With some countries poised to roll out new 5G networks in the next few years, it is crucial that global cities not be left behind. They need to upgrade their telecommunications facilities so their people can gain the social and economic benefits of technology innovation.

Overcoming Funding Challenges

The most important challenge in most cities is funding limitations. Law enforcement officers have to balance demands from competing areas and figure out how to become more efficient and effective. As illustrated in this paper, digital technology represents a way to improve law enforcement operations. Facial recognition software can help agents identify particular individuals and therefore help them make use of high-definition videos. Data analytics enable them to target their scarce resources in neighborhoods most at risk from criminality. And police body cameras can reduce citizen complaints and promote greater accountability with the general public.

Much of the current way in which cities finance public safety comes from government sources. This includes channels such as a corporate income tax, personal income tax, goods and services tax, assets taxes, and motor vehicles taxes. In many places, these sources provide the bulk of government funding.

But another way that some municipalities are using to raise funds is through public-private partnerships. The Houston Police Department, for example, partnered with the Greater Houston Retailers Association on an initiative designed to reduce vehicle thefts around retail stores. In conjunction with the police, the Association ran a billboard and social media campaign called "Making Convenience Stores Safe in Houston" and pushed for legislation that supported video surveillance, trespassing enforcement, panic alarms, and safety training for store workers. According to a report, "murders dropped 70 percent, sexual assaults by 75 percent robberies by 71 percent, assaults by 59 percent, burglaries by 72 percent, and thefts by 82 percent" following this campaign.

A World Economic Forum project examined public-private partnerships and recommended that businesses and government join forces to fight cybercrime. They could do this through sharing information, developing computer emergency response teams to coordinate public safety campaigns, improve encryption efforts, identify best practices, and engage in other initiatives

that would reduce crime. Its analysts argued that this represented a way to marshal additional resources for law enforcement and public safety.

Implementing Integrated Command Centers

Public officials need reliable and up-to-date information regarding law enforcement and public safety. Broadband trunking systems use broadband that brings together material from many different sources to improve response times and protect public safety. This involves merging information from voice, data, mobile, and video sources, among others.

The challenge in this area is integrating information from diverse inputs and putting them into a form that is actionable for police officers. Overcoming interoperability challenges is a major issue in most countries. It is difficult to get systems designed with different operating systems to work together and share information. Data can come both in structured and unstructured formats, and there needs to be a means to analyze each type of information.

There also can be problems in making use of non-text information such as high-definition video. Advances in facial recognition software help in this area because it can identify particular individuals who are known to authorities. That helps law enforcement specify certain threats and protect the general public.

Best practices today involve integrated, visualized, and collaborative systems that provide real-time analysis. There are many new solutions that are popular such as sensors, video surveillance, facial recognition, and data analytics. But what is needed are automated processing of information so that officials have the data they need instantly in order to make informed decisions on resource allocation and priority-setting.

Every day, law enforcement agents confront complicated problems and they need solutions that integrate information from a variety of sources and make that material available to them when they need it. Information that takes hours or days to process is not very helpful when they have to figure out how to handle a domestic problem, neighborhood dispute, or criminal activity. Placing data at their fingertips in a rapidly changing world is of high priority to law enforcement.

Boosting Government Efficacy and Transparency

Most public agencies are inefficient in the way they function. As noted earlier, they don't work well with other departments, have difficulty sharing information, and do not collaborate very effectively. Those features make it difficult to integrate their operations and scale up enforcement activities. In addition, community residents don't understand how law enforcement operates or prioritizes various activities. A number of them feel it is difficult for ordinary residents to get basic information on policing efforts.

Digital and mobile technologies offer the opportunity to improve efficacy and transparency in law enforcement because officials can blend digital solutions with traditional approaches. This includes mobile apps for residents to communicate with law enforcement, body cameras that protect both police and private citizens, the use of data analytics to improve decision-making, the deployment of emergency alerts, and the employment of sensors and cameras to detect criminal activities. Adopting these kinds of applications and integrating them into their command centers would help law enforcement become more effective in its operations.

Crowd-Sourcing Through Citizen Participation

Another way to improve public safety innovation involves crowd-sourcing through citizen participation. For example, the Singapore Government Technology Agency has run numerous trials using social media applications to encourage citizen participation. The Agency uses an online group of citizens to test products before releasing them to the general public. Some noteworthy examples include OneService, where citizens send municipal issues to city authorities and myResponder, which notifies volunteers within 400 feet of a Cardiac Arrest case to respond until emergency services arrive. This helps ensure that public safety innovation corresponds to initiatives are welcomed and accepted by the general public.

Singapore is not alone in doing this. The Egyptian Information and Decision Support Center released an app, Positive, in January 2017 that allows citizens directly to send their complaints to authorities with photos and videos. Around 16,000 people have used the app and initial app ratings are favorable, with 500 people giving the app 4.5 out of 5 stars.

The Amsterdam Smart City program meanwhile is a private-public partnership that has garnered a lot of attention as a model for innovative, sustainable city development. It relies heavily on citizen input to make sure that its initiatives are accepted by the general public. A Leapcraft project called Copenhagen Sense (CPH Sense) meanwhile helps officials monitor and analyze trends in air quality. This sensor system relies upon remote sensors to gather information and provide data analytics to city officials.

It is the kind of network that is applicable to public safety as well. Law enforcement agents can monitor gunshots, analyze crowd gatherings, and mine aggregate crime information to determine areas where crime likely will occur and determine what that means for resource allocation and crime-fighting. Involving people in their own law enforcement increases the odds of public safety effectiveness.

Building Public Support

In an environment where law enforcement needs help from the community in order to solve crimes and prevent disruptive behavior, it is important to innovate in ways that build public support. In many neighborhoods, residents are skeptical of the police. They worry that law enforcement is unfair, unresponsive, or even discriminatory in their regular practices. They feel detached from the police and do not offer the support and engagement that law enforcement needs. It is hard for authorities to identify criminals without information provided by the general public.

What is needed is a community engagement strategy that seeks to build rapport with local residents. Law enforcement should see people as partners in crime-fighting, not adversaries. Police officers should set up mechanisms for public participation and public feedback. No organization functions perfectly and there has to be a means for ordinary folks to file complaints and offer advice on policing priorities. Having a regular means of communicating with the general public is crucial to building the support that law enforcement requires.

Breaking Down Organizational Stovepipes

Many police systems are decentralized and fragmented, and not very good at sharing information with other jurisdictions. Each unit protects its own information and it often is difficult to get different divisions to share information and collaborate on law enforcement. The result is organizational inefficiencies and a lack of effectiveness at protecting public safety.

Digital technology represents a way to break down these stovepipes and create more integrated solutions. General Raymond Odierno and Michael O'Hanlon of the Brookings Institution undertook an innovative report on "Securing Global Cities." They argue that "collaboration is needed to share intelligence and to address cross-jurisdictional threats particularly for the purposes of stopping terrorism, but also for taking on organized crime and transnational criminal networks." Institutionalizing patterns of cooperation across divisions and geographic units is essential to effective law enforcement. Technology represents a way to further collaboration and get people across an organization to work together.

Overcoming Organizational Resistance

Members of organizations are not always eager to embrace change. People like to follow their set routines and sometimes resist efforts to change behavior or introduce new procedures into the agency. This is especially the case with police because officers have considerable independence in their day-to-day actions. They have to make split-second decisions in situations that can be quite dangerous. Many law enforcement agents feel most comfortable handling things they way they always have done them. The familiar often drives out the new practice or the new approach to doing things.

In order to adopt new practices, organizations have to create strong training programs and incentives to handle things the proper way. This can involve awards for effective performance and professional development opportunities where the police are exposed to new ideas and new ways of handling their daily responsibilities. Top-performing departments are not content to repeat traditional behaviors, but seek to encourage best practices and changes in daily routines. They look to cities that have achieved positive results and try to learn what those departments are doing that generated favorable outcomes. Overcoming resistance and learning new approaches is vital to police success in crime-fighting.

Using Police Body Cameras and Video Cameras to Improve Accountability

The use of police body cameras demonstrates that citizen complaints go down when police are equipped with video cameras. Having an audio or video record of interactions with the community increases transparency and encourages both law enforcement and the general public to be on good behavior. If people think the record of their encounter will be available publicly or in a court of law, it promotes honesty on both sides of the engagement.

The major question concerning body cams and video cameras is the scope of usage and rules for engagement. The Urban Institute examined state-level rules in the United States for police body cameras, and showed that American states vary considerably in their legal requirements. Table 10 shows the types of rules that have been adopted in a number of places. Among the legal principles that officials are utilizing include whether two-party consent is required for filming, there are restrictions on recording when privacy is reasonably expected, police recordings are exempt from public records requests, and how long videos are kept in storage. Balancing consumer rights with law enforcement is crucial to moving ahead with public safety innovation.

Taking Advantage of Open Data and Open Platforms

Having open data is a way to gain the benefits of information sharing. It aids the research community in formulating models of crime prevention and resource allocation. And it improves the ability to collaborate and overcome organizational fragmentation and decentralization.

As an example, the Jakarta Open Data website contains participatory budgeting proposals submitted by citizens. The Regional Development Planning Board has pushed to increase transparency in budget changes allowing citizens to give feedback, with significant pushback from departments that only choose to publish final budgets. People appreciate the chance to provide input into decisions about which they care.

Kazakhstan was the first central Asian country to release an Open Data platform and continues to lead Central Asia in implementing e-government initiatives after approving the Information Kazakhstan 2020 in 2013. The Sinar Project in Kuala Lumpur meanwhile is a volunteer organization funded by numerous open data organizations, uses open source technology to produce apps that promote open government and citizen involvement.

TABLE 10 Legal Considerations with Police Body Cameras

Is two-party consent required for filming?
Are there restrictions on recording when privacy is reasonably expected (such as inside a home or residential building)?
Are police recordings exempted from public records requests by the media or general public?
Does the police department have rules on where and when cameras can be used?
How long are videos kept in storage?
Under what conditions can the media or public request access to footage?

Singapore's urban planning model is admired because government officials and other stakeholders, such as India and China, use its model to develop sustainable solutions. The explicit use of experimentation allows it to pilot various solutions and determine what works best in particular neighborhoods.

While the Thai government maintains an open data web platform, a 2016 Machina Research and Nokia report states that the open data available to citizens and developers have not moved beyond basic weather information. The capitol city still is in an early stage in smart city development, and working on efficiency and scalability of smart technologies. Its report states that open data is an easy way for Bangkok to catch up to other regional cities with more advanced smart city technologies. While Bangkok scored 3 out of 5 in both smart and safe metrics, the city received a 1 in sustainable metrics because they have not undertaken any initiatives in that area.

Government open data is also extremely limited in Riyadh. The city website only includes building permitting and excavation datasets. Saudi Arabia ranked #103 out of 122 countries in the 2015 Global Open Data Index, failing to deliver any open data in important areas, such as election results and government spending.

The Nigerian government has not undertaken a large-scale open data initiative, but the World Bank has supported the first Nigerian Open Data portal in Edo state. This is similar to what other organizations, such as the African Development Bank, have done to fund the Nigeria Data Portal and college students who founded the Nigerian Open Data Access platform.

In general, cities that do not share information perform less well on crime prevention and law enforcement. In our index, for example, places that emphasize open data did better on public safety effectiveness and adoption of new policing approaches. Having the information with which to discern underlying patterns puts city agencies in a stronger position to be effective in their law enforcement activities.

Deploying Data Analytics and Social Media to Fight Crime

Data analytics represent an interesting way to deploy technology to fight crime. In order to boost public safety, a number of New York Police Department precincts have conducted a pilot trial of Hunchlab, a tool to determine whether predictive policing enhanced crime prevention. This system uses past behavior to anticipate which people and areas of the city are most at risk of safety problems. This tool helps law enforcement identify problems before they become severe and helps them be proactive at dealing with these issues.

Raheem meanwhile is a Facebook Messenger chatbot established by D.C. developers that collects and aggregates police interaction with the public. The project is in the beta stage and the data collected are compiled into "the first national database on police performance open to the public". This helps law enforcement track public responses to crime and natural disasters.

Balancing Public Safety and Personal Privacy

Privacy is a challenge in many places, and figuring out how to balance privacy protection with public safety is crucial. A report from Citizen Lab at the University of Toronto uncovered government surveillance malware disguised as a local news app for the Qatif Governate, an eastern Saudi region that experienced large protests during the Arab Spring.

There are numerous reports of police surveillance in Colombia operating outside of a legal authority. Privacy International has released two reports, "Demand/Supply: Exposing the Surveillance Industry in Colombia" details the unlawful surveillance of journalists, activists, and government actors, while "Shadow State: Surveillance, Law and Order in Colombia" looks at the mass, automated technologized used and the international corporations providing the systems, including notorious groups, such as Hacking Team. While public revelations about police corruption has led to some police officials stepping down or being removed, these

instances often lead to further illegal surveillance of the private individuals who instigated the revelations, like radio stations.

Data collection in policing is currently controversial in some nations. A Danish court is expected to reintroduce session logging surveillance, despite evidence that the practice has not aided policing and calls from privacy groups to roll back surveillance. The reintroduction was postponed by the Minister of Justice in 2016 because of prohibitive costs, though they intend to explore cheaper options that avoid the surveillance pitfalls that hurt session logging in the past. The previous session logging law went beyond the European Union Data Retention Directive and the EU Parliament advocates for a single EU law to protect privacy and reduce costs in law enforcement.

Conclusion

To summarize, there has been considerable progress made in public safety innovation. Among the new initiatives include developments such as the use of data analytics, body cameras, video surveillance, gunshot sensors, license plate readers, and community engagement. These features help cities integrate data and collaborate with one another. It is a way to use digital technology to protect public safety and encourage people to lead safer lives.

However, many cities face a variety of implementation challenges, such as poor funding, infrastructure difficulties, public resistance, a lack of technical expertise, and privacy and security concerns. They are not able to take advantage of existing technologies, even though public safety innovation is a significant contributor to job creation and economic development.

Major cities can encourage greater innovation by increasing budget investments, using crowd-sourcing platforms to encourage citizen participation, making data openly available, and figuring out how to balance privacy with security concerns. If they can make progress in these areas, they can bring the benefits of digital technology to a greater number of their residents.

Appendix

Note: We want to thank Niam Yaraghi for his comments on an earlier version of this paper. His suggestions were very helpful. Hillary Schaub also provided research assistance on this project.

I. METHODOLOGY

We assess public safety innovation using 24 different indicators. For metropolitan vision, we look at factors such as having a city goal of public safety innovation, making a management commitment, establishing financial priorities, and having a public safety planning board. Digital infrastructure is assessed through having reasonable internet access, mobile technology availability, having wi-fi access, and having a safe city web platform. On public safety effectiveness, we look at crime perceptions, safety perceptions, homicide rates, and crime incidence. For public safety adoption, we investigate whether cities have adopted features such as mobile policing, body cams for law enforcement; video surveillance, and emergency alerts. The use of data analytics is assessed through having data center facilities, open data access, employing predictive analytics, and making use of digital information for social inclusion and economic development. Community engagement measures consultation with key stakeholders, providing citizen feedback mechanisms, having public-private partnerships, and having an outreach budget.

For each of the cities in this study, we compile data on these indicators and use them to assess the degree of public safety innovation on a 120 point scale. After compiling this information, we rate the cities overall as well as on the six broad dimensions of safety innovation. Following this ranking, we provide examples of notable innovations in these cities, describe the vertical industry that facilitates public safety innovation, outline implementation challenges, and make recommendations regarding best practices.

For factors having an ordinal scale, we applied a 1 for a low performance, 3 for medium performance, and 5 for high performance. This included items such as city goal, management commitment, internet access, mobile penetration, wi-fi access, crime perceptions, safety perceptions, homicide rate, and crime incidence. All other indicators were coded on a 1 (no) to 5 (yes) scale, meaning the cities either had or used the item or did not employ it.

We employ a variety of materials in order to assess public safety innovation. As noted in Appendix II, we looked at metropolitan police websites, government and company press releases, news stories, non-profit organization reports, and online sources of information about what each city was doing. Throughout our report, we linked particular sources of information to the text through underlined web-based hyper-links. This allows readers who seek more detailed information to go directly to the source of the material.

METROPOLITAN VISION

1. **city goal:** 1=low; 3=medium; 5=high
2. **management commitment:** 1=low; 3=medium; 5=high
3. **financial priority:** 1=no and 5=yes
4. **planning board:** 1=no and 5=yes

DIGITAL INFRASTRUCTURE

5. **Internet access:** 1=low; 3=medium; 5=high (using country-level internet penetration data at http://www.internetlivestats.com/internet-users-by-country/, we define 0-40% penetration as low; 41-67 as medium, and 68-100 as high)
6. **mobile penetration:** 1=low; 3=medium; 5= high (using country-level mobile cellular subscriptions per 100 people at http://data.worldbank.org/indicator/IT.CEL.SETS.P2, we define 0-60 as low; 61-99 as medium, and 100-200 as high)
7. **wifi access:** 1=low; 3=medium; 5=high
8. **safe city web platform:** 1=no and 5=yes

PUBLIC SAFETY EFFECTIVENESS

9. **crime perceptions:** 1=negative; 3=medium; 5=positive (using 2017 crime perceptions index developed by Numbeo at https://www.numbeo.com/crime/rankings.jsp, we define 51-100 as negative, 31-50 as medium, and 0-30 as positive)
10. **safety perceptions:** 1=negative; 3=medium; 5=positive (using 2017 safety perceptions index developed by Numbeo at https://www.numbeo.com/crime/rankings.jsp, we define 0-50 as negative, 51-65 as medium, and 66-100 as positive)
11. **homicides:** 1=many murders; 3=medium murders; 5=low murders (using homicide rate per 100,000 people compiled by United Nations Office on Drugs and Crime, we define 10 and above as many murders, 5-9 as medium, and 0-4 as low murders)
12. **crime incidence:** 1=low; 3=medium; 5=high (using crime statistics compiled by the Economist Intelligence Unit, we define 0-60 as low, 61-79 as medium, and 80-100 as high)

PUBLIC SAFETY ADOPTION

13. **mobile policing:** 1=no and 5=yes
14. **body cams for law enforcement:** 1=no and 5=yes
15. **video surveillance:** 1=no and 5=yes
16. **emergency alerts:** 1=no and 5=yes

DATA ANALYTICS

17. **data center facilities:** 1=no and 5=yes
18. **open data access:** 1=no and 5= yes
19. **predictive analytics:** 1=no and 5=yes
20. **use of digital information for social inclusion and economic development:** 1=no and 5=yes

COMMUNITY ENGAGEMENT

21. **consultation with key stakeholders:** 1=no and 5=yes
22. **citizen feedback mechanisms:** 1=no and 5=yes
23. **public-private partnerships:** 1=no and 5=yes
24. **outreach budget:** 1=no and 5=yes

II. INFORMATION SOURCES AND DATA FOR EACH CITY

Abuja, Nigeria

City Website http://www.abujacity.com/abuja_and_beyond/

Police Website http://www.npf.gov.ng/vision_mission.php

Articles Premium Times, Eight public facilities that have gone extinct in Abuja, 30 Aug 2012.

Daily Trust, Francis Arinze Iloani, FG Dumps N398 TR Infrastructure Master Plan, 10 Jul 2016.

Metropolitan Vision	
City Goal	5
Management Commitment	5
Financial Priority	1
Planning Board	5

Digital Infrastructure	
Internet Access	3
Mobile Penetration	3
Wifi Access	1
Web Platform	1

Public Safety Effectiveness	
Crime Perceptions	1
Safety Perceptions	1
Homicides	1
Crime Incidence	1

Public Safety Adoption	
Mobile Policing	5
Body Cams	1
Video Surveillance	1
Emergency Alerts	5

Data Analytics	
Data Centers	5
Open Data	1
Predictive Analytics	1
Inclusive Development	1

Community Engagement	
Consultation	5
Feedback	5
Public-Private Partnerships	5
Outreach Budget	5
Total Score	**68**

Amsterdam, Netherlands

City Website http://www.iamsterdam.com/en/

Police Website https://translate.google.com/translate?hl=en&sl=nl&u=https://www.politie.nl/&prev=search

Articles Randy Lippert, Bryce Clayton Newell, The Privacy and Surveillance Implications of Police Body Cameras, Surveillance & Society, 2016.

Metropolitan Vision	
City Goal	5
Management Commitment	5
Financial Priority	5
Planning Board	5

Digital Infrastructure	
Internet Access	5
Mobile Penetration	3
Wifi Access	5
Web Platform	5

Public Safety Effectiveness	
Crime Perceptions	3
Safety Perceptions	5
Homicides	5
Crime Incidence	5

Public Safety Adoption	
Mobile Policing	5
Body Cams	1
Video Surveillance	5
Emergency Alerts	5

Data Analytics	
Data Centers	5
Open Data	5
Predictive Analytics	5
Inclusive Development	5

Community Engagement	
Consultation	5
Feedback	5
Public-Private Partnerships	5
Outreach Budget	5
Total Score	**112**

Astana, Kazakhstan

City Website http://astana.gov.kz/kk/

Articles Astana takes the path of Smart City

News Desk Media, Invest in Kazakhstan 2015 briefing.

Integrated Life Sustenance Assurance System, Mayor's Office of Astana (outline of surveillance).

Metropolitan Vision	
City Goal	5
Management Commitment	5
Financial Priority	5
Planning Board	5

Digital Infrastructure	
Internet Access	3
Mobile Penetration	5
Wifi Access	5
Web Platform	1

Public Safety Effectiveness	
Crime Perceptions	3
Safety Perceptions	1
Homicides	5
Crime Incidence	3

Public Safety Adoption	
Mobile Policing	5
Body Cams	1
Video Surveillance	5
Emergency Alerts	5

Data Analytics	
Data Centers	1
Open Data	5
Predictive Analytics	1
Inclusive Development	1

Community Engagement	
Consultation	5
Feedback	5
Public-Private Partnerships	5
Outreach Budget	1
Total Score	**86**

Bangkok, Thailand

City Website http://www.bangkok.go.th/main/index.php?&l=en

Police Website http://www.royalthaipolice.go.th/index.php

Articles Facebook Safety Alerts Like Bangkok to be Triggered More Often, The Malay Mail, 30 Dec. 2016.

Pattramon Sukprasert, Apps and sites take edge off daily stresses of living in the capital, Bangkok Post, 28 Jan 2017.

Privacy International report on social surveillance in Thailand.

The Smart City Playbook: smart, safe, sustainable (Sponsored by Nokia) compares 22 cities in their attempts to become smart, safe, and sustainable cities using IoT implementation.

Metropolitan Vision	
City Goal	5
Management Commitment	5
Financial Priority	5
Planning Board	5

Digital Infrastructure	
Internet Access	3
Mobile Penetration	5
Wifi Access	5
Web Platform	5

Public Safety Effectiveness	
Crime Perceptions	3
Safety Perceptions	3
Homicides	5
Crime Incidence	3

Public Safety Adoption	
Mobile Policing	5
Body Cams	1
Video Surveillance	5
Emergency Alerts	1

Data Analytics	
Data Centers	5
Open Data	5
Predictive Analytics	1
Inclusive Development	1

Community Engagement	
Consultation	5
Feedback	5
Public-Private Partnerships	5
Outreach Budget	5
Total Score	**96**

Bogota, Colombia

City Website http://www.bogota.gov.co/

Police Website https://www.policia.gov.co/

Articles

David Luna Sanchez (Colombian Minister of Information and Communication Technologies), A country in a digital transformation, New Europe, 8 Jan 2017.

Ed Buckley, 1,000 Free Wi-Fi Hotspots to connect Colombia by 2018, The City Paper – Bogota, 22 Apr 2016.

Privacy International, Shadow State: Surveillance, Law and Order in Colombia, Aug 2015.

Mauricio Trujillo Uribe, ICTs for social inclusion in Bogota, Bogota Office of Information and Communication Technology, April 2015.

Metropolitan Vision	
City Goal	5
Management Commitment	5
Financial Priority	5
Planning Board	5

Digital Infrastructure	
Internet Access	3
Mobile Penetration	5
Wifi Access	5
Web Platform	1

Public Safety Effectiveness	
Crime Perceptions	1
Safety Perceptions	1
Homicides	1
Crime Incidence	1

Public Safety Adoption	
Mobile Policing	5
Body Cams	1
Video Surveillance	5
Emergency Alerts	5

Data Analytics	
Data Centers	5
Open Data	5
Predictive Analytics	5
Inclusive Development	5

Community Engagement	
Consultation	5
Feedback	5
Public-Private Partnerships	5
Outreach Budget	5
Total Score	**94**

Cairo, Egypt

City Website http://www.cairo.gov.eg/CairoPortal/default.aspx

Articles Patrick Kingsley, A new New Cairo: Egypt plans £30bn purpose-built capital in desert, The Guardian, 16 March 2015.

Metropolitan Vision	
City Goal	5
Management Commitment	5
Financial Priority	5
Planning Board	5

Digital Infrastructure	
Internet Access	1
Mobile Penetration	5
Wifi Access	3
Web Platform	1

Public Safety Effectiveness	
Crime Perceptions	1
Safety Perceptions	1
Homicides	5
Crime Incidence	1

Public Safety Adoption	
Mobile Policing	5
Body Cams	1
Video Surveillance	5
Emergency Alerts	1

Data Analytics	
Data Centers	5
Open Data	5
Predictive Analytics	1
Inclusive Development	1

Community Engagement	
Consultation	5
Feedback	5
Public-Private Partnerships	5
Outreach Budget	5
Total Score	**82**

Copenhagen, Denmark

City Website	http://international.kk.dk/
Police Website	https://www.politi.dk/en/About_the_police/
Articles	Torbin Olander, In Denmark, Online Tracking of Citizens is an Unwieldy Failure, Tech President, 22 May 2013.
	Copenhagen Solutions for Sustainable Cities, State of Green report
	Danish Smart Cities: Sustainable Living in an Urban World, Copenhagen Cleantech Cluster

Metropolitan Vision	
City Goal	5
Management Commitment	5
Financial Priority	5
Planning Board	5

Digital Infrastructure	
Internet Access	5
Mobile Penetration	5
Wifi Access	5
Web Platform	5

Public Safety Effectiveness	
Crime Perceptions	5
Safety Perceptions	5
Homicides	5
Crime Incidence	5

Public Safety Adoption	
Mobile Policing	5
Body Cams	1
Video Surveillance	5
Emergency Alerts	5

Data Analytics	
Data Centers	5
Open Data	5
Predictive Analytics	5
Inclusive Development	5

Community Engagement	
Consultation	5
Feedback	5
Public-Private Partnerships	5
Outreach Budget	5
Total Score	**116**

Jakarta, Indonesia

City Website http://www.jakarta.go.id/

Police Website https://www.polri.go.id/

Articles Tomas Holderness and Etienne Turpin, How tweeting about floods became a civic duty in Jakarta, The Guardian, 25 Jan 2016.

Indonesia publishes long-term plans (20-year increments), mid-term plans and evaluations (5-year), and yearly monitoring reports on the implementation of national priorities. There were issues and priorities specific to Jakarta outlined in the ASEAN Indonesian Master Plan 2011–2025.

Metropolitan Vision	
City Goal	5
Management Commitment	5
Financial Priority	5
Planning Board	5

Digital Infrastructure	
Internet Access	1
Mobile Penetration	5
Wifi Access	3
Web Platform	1

Public Safety Effectiveness	
Crime Perceptions	1
Safety Perceptions	1
Homicides	5
Crime Incidence	1

Public Safety Adoption	
Mobile Policing	5
Body Cams	1
Video Surveillance	5
Emergency Alerts	1

Data Analytics	
Data Centers	5
Open Data	5
Predictive Analytics	5
Inclusive Development	5

Community Engagement	
Consultation	5
Feedback	5
Public-Private Partnerships	5
Outreach Budget	5
Total Score	**90**

Kuala Lumpur, Malaysia

City Website http://www.dbkl.gov.my/index.php?lang=ms

Police Website http://www.rmp.gov.my/

Articles Dean Koh, Managing Government Projects and Public-Partnerships for Greater Economic Growth, PEMANDU, 11 June 2016.

Social inclusion activities: https://www.unicef.org/malaysia/media_news2015-social-inclusion-a-priority-for-every-child.html#.WJIvJ4MrLcs

Operational Plan: https://www.adb.org/sites/default/files/institutional-document/33671/ppp-operational-plan-2012-2020.pdf

Avanti Kumar, Cyberjaya touted as Southeast Asia's first LoRa smart city, MIS Asia, 23 Aug 2016.

Metropolitan Vision	
City Goal	5
Management Commitment	5
Financial Priority	5
Planning Board	5

Digital Infrastructure	
Internet Access	5
Mobile Penetration	5
Wifi Access	5
Web Platform	1

Public Safety Effectiveness	
Crime Perceptions	1
Safety Perceptions	1
Homicides	3
Crime Incidence	1

Public Safety Adoption	
Mobile Policing	5
Body Cams	1
Video Surveillance	5
Emergency Alerts	1

Data Analytics	
Data Centers	5
Open Data	5
Predictive Analytics	5
Inclusive Development	5

Community Engagement	
Consultation	5
Feedback	5
Public-Private Partnerships	5
Outreach Budget	5
Total Score	**94**

Kuwait City, Kuwait

City Website https://www.baladia.gov.kw/sites/ar/MunicipalityCouncil/Pages/default.aspx?menuItem=item1

Police Website https://www.moi.gov.kw/portal/venglish/

Metropolitan Vision	
City Goal	5
Management Commitment	5
Financial Priority	5
Planning Board	5

Digital Infrastructure	
Internet Access	3
Mobile Penetration	5
Wifi Access	3
Web Platform	1

Public Safety Effectiveness	
Crime Perceptions	3
Safety Perceptions	5
Homicides	5
Crime Incidence	1

Public Safety Adoption	
Mobile Policing	1
Body Cams	1
Video Surveillance	5
Emergency Alerts	5

Data Analytics	
Data Centers	5
Open Data	5
Predictive Analytics	1
Inclusive Development	1

Community Engagement	
Consultation	5
Feedback	1
Public-Private Partnerships	5
Outreach Budget	5
Total Score	**86**

London, United Kingdom

City Website https://www.cityoflondon.gov.uk

Safe City Partner Website https://www.cityoflondon.gov.uk/services/community-and-living/safer-city-partnership/Pages/default.aspx

Articles James Temperton, One Nation Under CCTV: The Future of Automated Surveillance, Wired, 17 Aug 2015.

Leo Kelion, London Police Trial Gang Violence 'Predicting Software', BBC, 29 Oct 2014.

Annual Monitoring Report on The London Plan: https://www.london.gov.uk/what-we-do/planning/implementing-london-plan/monitoring-london-plan

2016 City Plan: https://www.london.gov.uk/sites/default/files/the_london_plan_malp_final_for_web_0606_0.pdf

Metropolitan Vision	
City Goal	5
Management Commitment	5
Financial Priority	5
Planning Board	5

Digital Infrastructure	
Internet Access	5
Mobile Penetration	5
Wifi Access	5
Web Platform	5

Public Safety Effectiveness	
Crime Perceptions	3
Safety Perceptions	3
Homicides	5
Crime Incidence	3

Public Safety Adoption	
Mobile Policing	5
Body Cams	5
Video Surveillance	5
Emergency Alerts	5

Data Analytics	
Data Centers	5
Open Data	5
Predictive Analytics	5
Inclusive Development	5

Community Engagement	
Consultation	5
Feedback	5
Public-Private Partnerships	5
Outreach Budget	5
Total Score	**114**

Madrid, Spain

City Website http://www.madrid.es/portales/munimadrid/en/Home?vgnextfmt=default&vgnextchannel=1ccd566813946010VgnVCM100000dc0ca8c0RCRD&idioma=en&idiomaPrevio=en&combo=1

Police Website http://www.madrid.es/portales/munimadrid/es/Inicio/Ayuntamiento/Emergencias-y-Seguridad/Policia-Municipal-de-Madrid?vgnextfmt=default&vgnextoid=1b5abbc29b9ac310VgnVCM2000000c205a0aRCRD&vgnextchannel=d11c9ad016e07010VgnVCM100000dc0ca8c0RCRD

Articles Paul Mason, We Can't Allow Tech Giants to Rule Smart Cities, The Guardian, 25 October 2015.

Metropolitan Vision	
City Goal	3
Management Commitment	3
Financial Priority	5
Planning Board	5

Digital Infrastructure	
Internet Access	5
Mobile Penetration	5
Wifi Access	5
Web Platform	5

Public Safety Effectiveness	
Crime Perceptions	3
Safety Perceptions	5
Homicides	5
Crime Incidence	3

Public Safety Adoption	
Mobile Policing	5
Body Cams	5
Video Surveillance	5
Emergency Alerts	5

Data Analytics	
Data Centers	5
Open Data	5
Predictive Analytics	5
Inclusive Development	5

Community Engagement	
Consultation	5
Feedback	5
Public-Private Partnerships	5
Outreach Budget	5
Total Score	**112**

New York, New York

City Website	http://www1.nyc.gov/
Police Website	http://www.nyc.gov/html/nypd/html/home/home.shtml
Articles	Gerald Schifman, After Controversy, LinkiNC Finds Its Niche, Crain's, 15 Feb 2017.
	Aaron Shapiro, Reform Predictive Policing, Nature, 25 Jan 2017.

Metropolitan Vision	
City Goal	5
Management Commitment	5
Financial Priority	5
Planning Board	5

Digital Infrastructure	
Internet Access	5
Mobile Penetration	5
Wifi Access	5
Web Platform	5

Public Safety Effectiveness	
Crime Perceptions	3
Safety Perceptions	3
Homicides	3
Crime Incidence	3

Public Safety Adoption	
Mobile Policing	5
Body Cams	5
Video Surveillance	5
Emergency Alerts	5

Data Analytics	
Data Centers	5
Open Data	5
Predictive Analytics	5
Inclusive Development	5

Community Engagement	
Consultation	5
Feedback	5
Public-Private Partnerships	5
Outreach Budget	5
Total Score	**112**

Paris, France

City Website http://www.paris.fr/

Police Website http://www.prefecturedepolice.interieur.gouv.fr/

Articles Michael Fitzgerald, Data-Driven City Management: A Close Look at Amsterdam's Smart City Initiative, MIT Sloan Management Review, 19 May 2016.

Smart and Sustainable Paris: A View of 2020 and Beyond, Marie de Paris, June 2015.

Metropolitan Vision	
City Goal	5
Management Commitment	3
Financial Priority	5
Planning Board	5

Digital Infrastructure	
Internet Access	5
Mobile Penetration	5
Wifi Access	5
Web Platform	5

Public Safety Effectiveness	
Crime Perceptions	1
Safety Perceptions	1
Homicides	5
Crime Incidence	3

Public Safety Adoption	
Mobile Policing	5
Body Cams	5
Video Surveillance	5
Emergency Alerts	5

Data Analytics	
Data Centers	5
Open Data	5
Predictive Analytics	5
Inclusive Development	5

Community Engagement	
Consultation	5
Feedback	5
Public-Private Partnerships	5
Outreach Budget	5
Total Score	**108**

Riyadh, Saudi Arabia

City Website http://www.arriyadh.com/eng/

Police Website www.moi.gov.sa

Articles Technology drives economic, social changes in Saudi Arabia, Arab News, 9 Jan 2017.

Philippa Wilkinson, Saudi Arabia's Prince has put his political weight behind reforming the country's economy, but can he pull it off?, The Independent, 27 Jan 2017.

Morgan Marquis-Boire, et al., Police Story: Hacking Team's Government Surveillance Malware, Citizen Lab (University of Toronto), 24 June 2014.

Metropolitan Vision	
City Goal	5
Management Commitment	5
Financial Priority	5
Planning Board	5

Digital Infrastructure	
Internet Access	3
Mobile Penetration	5
Wifi Access	5
Web Platform	1

Public Safety Effectiveness	
Crime Perceptions	5
Safety Perceptions	5
Homicides	5
Crime Incidence	1

Public Safety Adoption	
Mobile Policing	5
Body Cams	1
Video Surveillance	5
Emergency Alerts	5

Data Analytics	
Data Centers	5
Open Data	5
Predictive Analytics	5
Inclusive Development	5
Community Engagement	
Consultation	5
Feedback	5
Public-Private Partnerships	5
Outreach Budget	1
Total Score	**102**

Singapore

City Website https://www.gov.sg/

Police Website http://www.police.gov.sg/

Articles Matt Hamblen, Singapore's 'city brain' project is groundbreaking but what about privacy? Computer World, 12 Dec 2016.

Singapore speeds towards its Smart Nation vision, Smart Cities World, 12 Jan 2017.

Metropolitan Vision	
City Goal	5
Management Commitment	5
Financial Priority	5
Planning Board	5

Digital Infrastructure	
Internet Access	5
Mobile Penetration	5
Wifi Access	5
Web Platform	5
Public Safety Effectiveness	

Crime Perceptions	**5**
Safety Perceptions	5
Homicides	5
Crime Incidence	5

Public Safety Adoption	
Mobile Policing	5
Body Cams	5
Video Surveillance	5
Emergency Alerts	5

Data Analytics	
Data Centers	5
Open Data	5
Predictive Analytics	5
Inclusive Development	5

Community Engagement	
Consultation	5
Feedback	5
Public-Private Partnerships	5
Outreach Budget	5
Total Score	**120**

Washington, D.C.

City Website https://dc.gov/

Police Website https://mpdc.dc.gov/

Articles Clarence Williams, Hackers hit DC police closed-circuit camera network, city officials disclose, Washington Post, 27 Jan 2017.

Metropolitan Vision	
City Goal	5
Management Commitment	3
Financial Priority	5
Planning Board	5

Digital Infrastructure	
Internet Access	5
Mobile Penetration	5
Wifi Access	5
Web Platform	5

Public Safety Effectiveness	
Crime Perceptions	1
Safety Perceptions	1
Homicides	3
Crime Incidence	3

Public Safety Adoption	
Mobile Policing	5
Body Cams	5
Video Surveillance	5
Emergency Alerts	5

Data Analytics	
Data Centers	5
Open Data	5
Predictive Analytics	5
Inclusive Development	5

Community Engagement	
Consultation	5
Feedback	5
Public-Private Partnerships	5
Outreach Budget	5
Total Score	**106**

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