



The Benefits of Safe Cities

Safer Cities Creating a Better Life



Table of Contents

Part 1: Executive Summary	3
Part 2: Safe Cities Create a Better Life	4
Part 3: Quantifying the Benefits of Safe Cities.....	7
Part 4: Safe City Case Studies	9
4.1 Singapore.....	9
4.2 London	11
4.3 Dubai	12
4.4 Nairobi.....	14
Part 5: Key Enabling Technology: the Cornerstone of Safe City Construction	16
Part 6: Development Strategy	19
Appendix.....	21

Part 1: Executive Summary

For the first time in history, there are more people around the world living in cities than there are living in rural areas. While this global migration to urban areas is improving the living standards, health, and financial prosperity of these citizens; it also brings challenges to a city's infrastructure, resources, security procedures, and emergency response systems. Meeting these challenges will be critical to the success of cities in the decades that follow.

The safe city concept has been developed precisely to help government stakeholders, city mayors, and police departments mitigate these challenges. Leveraging the internet of things (IoT) and the connectivity now found in core security and safety technologies, safe city solutions are providing a range of systems including predictive analytics and big data, real-time response procedures and emergency response systems. These solutions are enabling governments and police departments to better protect their citizens from everything from terrorist attacks to natural disasters. They are also supporting wider city organizations, such as public health, fire and rescue, border control and social services to better serve their citizens.



The Benefits of Safe Cities white paper measures how government investment on safe city technology and solutions impacts the safety result and the associated social and economic benefits. While various studies surrounding the 'safest' cities have been produced, this study is the first of its kind evaluating key safe city initiatives globally and quantifying the impact of these projects.

The aim of the study is to help government officials, and other key stakeholders, to understand the benefits and challenges of safe city projects, including:

- Quantifying the safety result, social benefit and economic benefit created by safe city investment and how this impacts cities at different stages of the investment cycle.
- Discussing the important safe city technologies and Information and Communications Technologies (ICT) required in successful safe city projects.
- Providing guidance to city leaders on how to approach a safe city project, including best practice to deliver an effective solution.

Part 2: Safe Cities Create a Better Life

The safe city concept is based on a consolidated ICT platform which combines public-safety information of different types and from different sources, obtained through sensors and multi-agency collaboration.

Safe cities are an essential pillar supporting the development of smart cities throughout the world. They provide the security and safety required to protect citizens from crime and terrorism as well as mitigate, as much as possible, the impact of natural disasters and other threats. A successful safe city solution should support a city's security agencies, fire and rescue departments, public health and social service departments before, during and after an event and integrate the disparate technologies and government departments responsible for citizen safety.



- **Prevention:** provide reliable and comprehensive security measures to predict threats and hazardous situations.

City authorities must be able to take measures to prevent threats from occurring in the first place. Simulation and forecasting technology, based on big data mining, can help the relevant authorities to predict public threats and support police and military assets to prevent the event before it begins.

- **Detection:** aid public-safety organizations in collecting, sharing and analyzing data more effectively to provide early warnings and raise situational awareness.

Sensor systems in the city will proactively gather information. These sensors may include video surveillance cameras, CBRNE (Chemical, biological, radiological and nuclear) sensors, gunshot-detection sensors, and weather sensors. The type of sensor used is determined by the scope of the safe city project and how much interoperability is required. Information can be used to provide early detection and alerts when events occur. Increasingly, sensors include “listening” to social media for relevant postings by netizens.

- **Response:** enable the key organizations in the city to react to security threats in real time.

City authorities must be able to prevent an adverse event from escalating. Safe city projects enable an effective response by using a consolidated ICT platform to provide a common operational picture to all relevant agencies, including law enforcement, public health, fire and rescue services; and to allow the critical communication systems of these agencies to interoperate. This helps to raise the situational awareness for each of the responding agencies, and their command, control and coordination.

- **Recovery:** provide post-event examination and analysis, identify victims and provide assistance in rescue actions.

After an event, city authorities must be able to quickly examine and analyze all data received from the relevant sensor systems. This supports the subsequent search for suspects as well as the process of building a case based on incriminating evidence. Information can also be used to facilitate rescue actions, and the identification and assistance processes for both victims and survivors.

Integration

The safe city concept typically promotes interoperability across law enforcement, emergency services and other government agencies (public health, border control, social services) to streamline operations and provide ‘situational awareness’ to all stakeholders involved in the management of a city’s security. This approach fosters better cooperation and sharing of intelligence.

While much of the emphasis of the ‘safe city’ discussion involves security technology implementation and investment, the operational procedures and ICT backbone are just as important in the solutions ultimate success or failure. This reality means that ICT and security agencies must work together for the greater good of the safe city project. One cannot exist without the other.

The size of the city does not impede its ability to be considered a “safe city”, but differing city sizes require different levels of technology investment, stakeholder ‘buy-in’ and planning. Safe city solutions are often layered on top of legacy infrastructure that is in place. Overall, detailed planning around the use of legacy technology and the need for new infrastructure are key considerations when deploying safe cities.

Market drivers

There are a number of market drivers that government agencies need to consider when deciding how to proceed with a safe city project. These can be broadly grouped as safety drivers, social drivers and economic drivers, and government investment in safe cities has a positive impact on each of them.

- **Safety drivers:** at its core, a safe city addresses issues related to crime and terrorism. Often, these types of incidents cause regulations surrounding data privacy and national security to shift. For instance, after the September 11th attacks, the United States Congress passed the Patriot Act, which set up fusion centers to surveil and aggregate vast amounts of data, including video surveillance streams, social media, arrest records, warrants and even mug shots. These centers, now known as “Intelligence Fusion Centers,” are becoming increasingly important, as agencies emphasize predictive policing.
- **Social drivers:** political motives are a key driver of safe city projects. Politicians can use safe city initiatives to generate support in their campaigns with citizens who are concerned about terrorism or high crime rates. A safer city also increases retail spending, means citizens are more likely to visit leisure and sports facilities and generally improves the happiness of people living in the city. Furthermore, a safer city may see fewer citizens migrating out due to security and safety concerns.
- **Economic drivers:** it is evident that there are economic benefits to safe city solutions. These include savings from the reduced impact of crime and terrorism; promoting business and commercial opportunity; mitigating costly natural disasters and generally increasing the productivity and wellbeing of citizens. A safer city also attracts foreign investment and tourism. On top of promoting business, safe city initiatives allow a city to save on technology operational costs. Sharing and re-using optimized infrastructure across agencies helps a city to eliminate repeated spend on technologies. There is also a return-on-investment (ROI) opportunity for cities, in particular from traffic violation fines. Automatic number plate recognition can be used to identify and fine cars driving in car-pool or bus lanes and video analytics can be used to recognize when parked cars have exceeded a designated length of stay and issue a penalty notice charge.

The role of governments in safe cities

Government stakeholders typically manage the safe city initiative and make the final decisions with regard to technology investment. Stakeholders include government employees, law enforcement, public health, fire, rescue, border control and social services. It is the government's job to give the security consultants and technology providers a comprehensive scope of the goals the city would like to achieve. Enough time must be allocated for these steps so that the thought processes of both the city and the technology experts can align.

Governments must also determine how the initiative will be funded initially and what revenue streams will be leveraged to support the project. Safe city projects are 'living', and as such require a continuous stream of revenue. One of the best things a government can do with regard to leadership and 'driving' the safe city project is to build a steering committee. This committee would include representatives from various agencies across the city who might be stakeholders. Additionally, the committee can include experts from consultancies or technology providers, who can provide guidance.

For positive reasons Safer Cities intrude on the privacy of citizens. To avoid concerns about privacy negatively impacting on achieving the best safe city result, Governments should be open and honest about the nature of the intrusion. This will include capturing and storing data about citizens as they go about their daily lives. Most citizens will be satisfied to know that first, the data has been collected and securely stored only for legitimate reasons related to making their city safer, and second that there is a clear policy on how long that data will be kept before it is deleted.

The role of technology providers in safe cities

Technology providers play a major role in safe city initiatives. Ultimately, their solutions will be brought together to create an advanced security solution. However, there are no comprehensive safe city technology standards. Instead, each technology type has its own set of standards and regulations, and these often change between vertical markets. For this reason, integrators, consultants and technology suppliers and their concepts and technologies must be vetted heavily to determine if they work together effectively. Technology suppliers must gain a deep understanding of what the government is trying to accomplish, and how they will achieve key performance indicators with their safe city initiative.

The role of the maintaining service providers in safe cities

Safe city projects are not just about building a system; running the system successfully is also very important. Therefore, maintaining service providers play a key role. These organizations upgrade and maintain the security equipment – important given much of it is installed outdoors – and have professional ICT skills to maintain the back-end systems. In most cases, the government will outsource the maintenance to either a system integrator or a dedicated maintaining service provider.

The role of citizens in safe cities

Citizens are critical to the safe city project. While citizens may not directly affect decision making around the technologies or operational processes, their engagement with the government and emergency services is important for the success of safe city projects. Allowing citizen's to share information means they will be more engaged in the project and will feel a civic duty for reporting crime or providing crowd sourced evidence. Governments who deliver successful, effective safe city projects can also enhance their reputation as leaders who have improved the quality of life of their citizens.

Part 3: Quantifying the Benefits of Safe Cities

3.1 Evaluating the impact of safe city projects

The benefits of safe city projects can be broad and difficult to quantify. Often, the goals of “safe city” projects range from reducing crime rates and improving public safety to driving economic growth and improving general citizen wellbeing.

Based on primary discussions with executives from leading safe city security firms, city officials and other industry experts, IHS Markit identified four indexes to measure the success or failure of a project. These indexes use an aggregation of public data, IHS Markit research data and an IHS Markit commissioned citizen survey, and measure the government investment, safety result, social benefit and economic benefit of safe city projects in key cities across the world.

Each index is comprised of either six or seven primary indicators which are used to review how safe city projects are influenced over a set period of time. The purpose of analyzing multiple indicators in one index is to take into account the wide range of project aims and challenges. The Indexes and their constituent indicators are defined in full in the appendix but are summarized below:

- **Government investment:** measures the level of a government or city administration’s continued commitment to spending on safe city ICT equipment as well as the level of ICT competence, the police resource allocated to public safety and the coverage of physical security and critical communications equipment.

- **Safety result:** measures the level of crime, the risk to individuals and property from riots, protests, terrorism, and kidnapping as well as the public’s perception of crime and the police department’s ability to respond to events quickly and effectively.
- **Social benefit:** measures social benefits such as the ability to enjoy entertainment, leisure and sporting events safely, the public’s appreciation of the government and police force based on their response to security and whether talented employees are moving to the city.
- **Economic benefit:** measures economic benefits such as personal wealth and prosperity, spending on tourism and retail, employment rates, city investment and the risk and prevention of serious economic challenges happening in the short-term.

Each index has been compiled from a series of 26 primary indicators. Weightings have been applied to differentiate between indicators and reflect their importance on the overall category. A score of between one and five has been allocated to represent the level of commitment, spending or risk for each category. A score of 5 relates to the most positive impact and a score of 1 to the least positive impact. Index data has been sourced from IHS Markit research and public resources.

IHS Markit Safe City Indexes

1. Government Investment

Country ICT development index

Safe city ICT spend commitment

Police investment

Video surveillance coverage

Command and control coverage

Critical comms coverage

2. Safety Result

Criminal activity prevention

Serious crime rate

Individual risk prevention

Property risk prevention

Citizen perception of crime

Emergency response time

Police conviction rate

3. Social Benefit

Government appreciation

Police appreciation

Leisure activity rate

City recommendation

Talented workforce

Population growth

Citizen happiness

4. Economic Benefit

Economic prosperity

Tourism

City investment

Retail spend

Economic risk prevention

Employment

Source: IHS, Further definitions are available in the appendices

3.2 Summary of key points for global safe cities

The safety result, social benefits and economic benefits generated by a safe city project are greatly dependent on the government investment. The figures show that government investment has a direct relationship on the benefits of a safe city project; however, the impact is different depending on the stage of government investment. There are three distinct stages of government investment that impact the safety result and social benefit of a city.

Government investment versus safety result

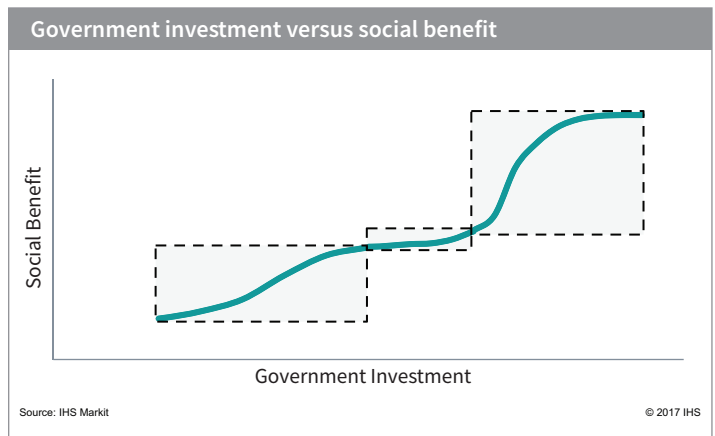
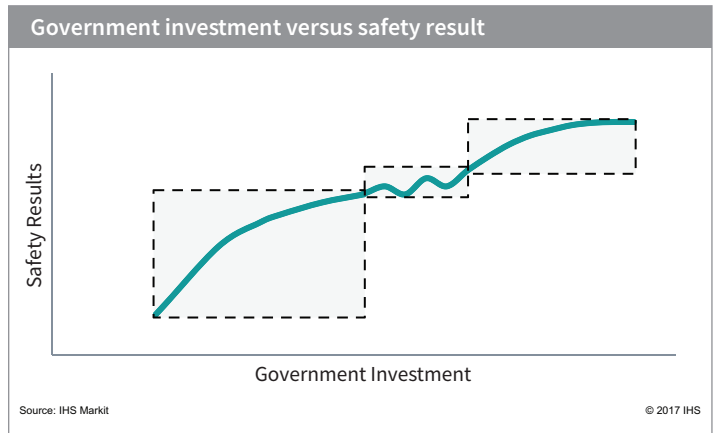
The initial government investment in a safe city project is primarily about security and can drive a large increase in the safety result. As much of the security infrastructure and technology is not deployed, the required government investment is high. At this stage, only the city's critical locations are covered by video surveillance cameras, basic command and control equipment is in place, and the government begins to build the ICT infrastructure. Maximizing these security technologies can drive a 25% increase in the safety result score, with significant improvements in property and individual risk levels, police conviction rates and emergency response times.

Once the initial safety result improvements have been achieved the projects can often become more challenging. Continued investment does not have the same impact on the safety result as many of the primary risks have been mitigated. This is called the second stage of government investment. At this stage, the city has better video surveillance camera coverage of key and secondary locations. The city also has the advanced security technology in place to start to deploy big data and intelligent analysis. Additionally, these cities often have more stakeholders involved following the initial government investment which makes it more difficult to agree on the projects direction.

If a city has the capital resources to continue investing in these projects, the third stage of deployment is to leverage opportunities such as big data analytics and predictive crime centers. At this stage, the city has almost full video surveillance camera coverage. The city also emphasizes more on data sharing, predictive technology and other intelligent analysis than physical security equipment. Furthermore, the city's resources can be used more effectively through the deployment of a safe city. The key benefit is the reduction in the operational costs for the city without impacting the security level. At this stage of government investment the safety result shows a slight increase and then tends to be stable.

Government investment versus social benefit

At the initial investment stage in a safe city project, the primary focus is on improving the safety result. That being said, the city can generate an increase in the social benefit score as citizens begin to appreciate the government and police force's efforts to make their city safer, and generally feel happier living and working in the city. In fact, the safety



result is a critical foundation to the social prosperity at this stage of project deployment.

The second stage of government investment typically results in a lower increase in the social benefit score. The social benefit does not change dramatically here, and the limited deployment of leading-edge technology does not generate as much appreciation of city leaders or impact the citizens' lifestyle.

If the safety result benefits most from the initial government investment, the social benefit score improves most in the third stage of government investment. A key component of the social benefit score is citizen feedback on the government and police, and the general happiness of citizens living in the city. The security and safety improvements made during the initial investment take time to make an impact, but ultimately drive an increase in the social benefit score. Citizens appreciate the value of innovative solutions that are making them safer, which is reflected in their appreciation of the government and police force.

Overall, a 20-25% increase in government investment can result in a 35-40% increase in the social benefit score of the city at this third stage. The government appreciation and police appreciation scores can increase by over 50%; citizens in connected cities value the impact safe city projects have on their city environment and way of life.

It is clear that safe city deployments have a positive impact on many of the key indicators of a successful city. That being said, there is no one size fits all solution. Projects need to address the unique threats of a city and focus on the areas of opportunity. This could be crime prevention in cities where government investment has historically been low or tourism and citizen happiness for cities that have already made significant investment. They also need to take into account the ICT environment to maximize the opportunity to improve the safety result, social benefit and economic benefit.

IHS Markit has analyzed four safe city case studies to measure and quantify the benefits of safe city deployments. The case studies investigate cities of various classifications and located in different geographic regions in order to present the full range of benefits and opportunities associated with these projects. They also provide insight into the aims of the project, the implementation and the key benefits achieved by the city. Please note that there are many factors that will impact the safety score that are outside the influence of safe city solutions and technology.

Part 4: Safe City Case Studies

4.1 Singapore

Singapore, one of the world's most economically developed countries, deploys a safe city solution to bring its law enforcement capabilities in line with its position as one of the most 'tech-ready' nations

In 2013, the Ministry of Home Affairs (MHA) and the Singapore Economic Development Board (SEDB) embarked on a "Safe City Test Bed" project. The aim of the project was to test advanced technologies and improve public safety. Fundamentally it was part of an overall project to realize the city's vision: making Singapore "a Liveable and Endearing Home". The venture involved enabling government agencies to integrate and analyze data collected from existing sensors and networked systems by using advanced analytic and information sharing tools. The government appointed four consortia to develop potential safe city solutions that would maximize its agencies' situational awareness and response capacity, streamline its manpower requirements, address operational challenges, and overcome infrastructural and technical constraints.

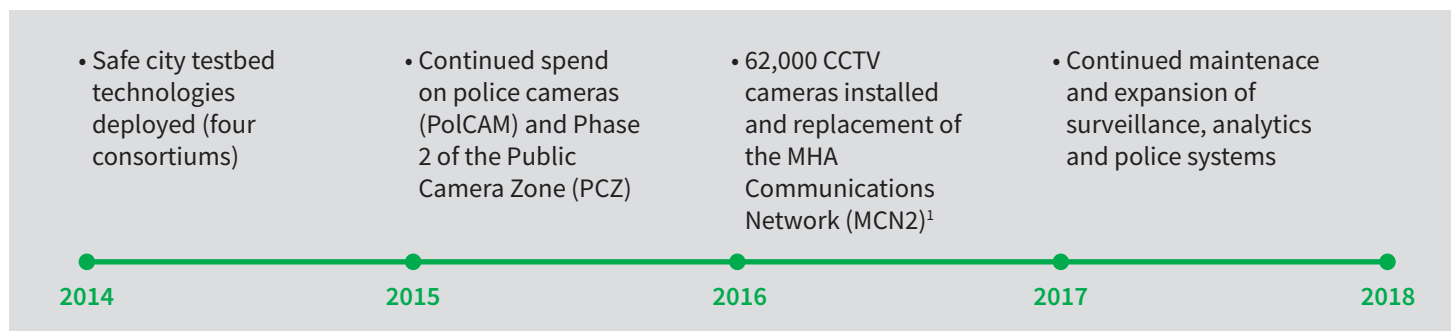
Why Singapore deployed a safe city solution

While Singapore is one of the most stable countries globally, both politically and economically, the government realized many benefits could be achieved with enhancements to their security systems. Because the city has developed exponentially over the past few decades, it needed to address a number of challenges including population density, a lack of space, rising costs of living and increasing immigration. The deployment also helped maintain Singapore's leading position within public safety and as a city at the forefront of technology.

The safe city deployment: leading the technology evolution for safe cities and public safety

In June 2014, the four consortia showcased their solutions at the World Cities Summit 2014. The technologies have helped the government agencies involved to improve their operations and reduce resource requirements.

- Government investment included multi-million USD investments in ICT equipment, a crime control system and police cameras (PolCAM) and surveillance costing \$142 million (SGD)².
- Predictive analytics were deployed to detect where security issues might occur, supported by social media intelligence, behavioral analysis software, crowd size analytics and face recognition. Acoustic and mobile phone sensors were also deployed.
- Key developments in crowd simulation models for indoor environments such as metro, rail and transit stations were developed. When applied to emergency and evacuation scenarios, this solution uses real-time crowd counting techniques to help officers predict crowd behavior and movement. The simulation can also help in crowd control for major events where a high volume and density of people are expected.
- A video analytics solution was developed that is capable of detecting abnormal scenarios like traffic congestion, abandoned objects and rubbish buildup. A combination of rule-based algorithms and machine learning can allow agencies to analyze large amounts of data to provide meaningful insights to the public and private organizations. Moving forward, the government has confirmed that public-private partnerships will remain a key strategy in developing their safety and security roadmap.



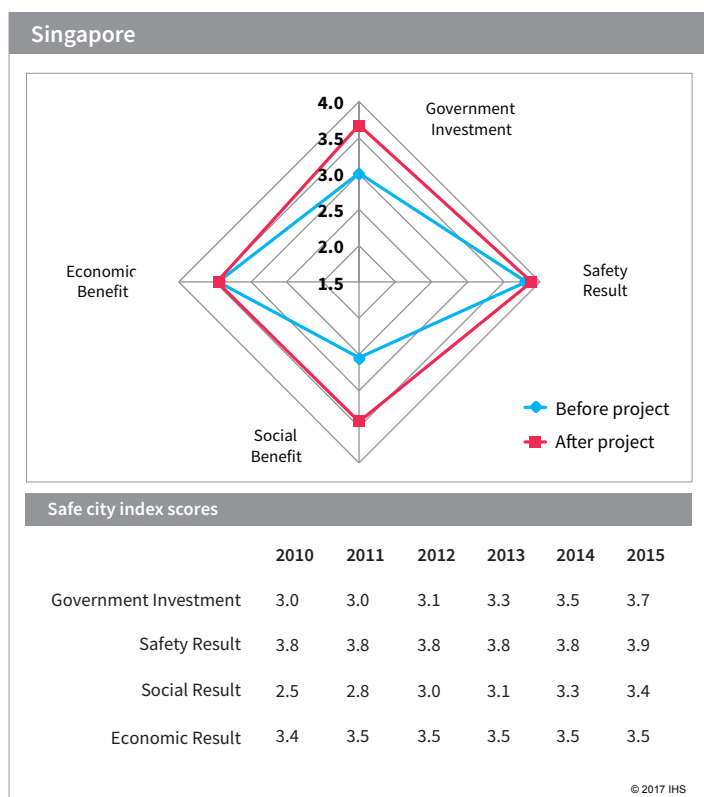
Quantifying the safe city

Prior to the safe city projects, Singapore already had a relatively high safety result and improving this was not one of the primary drivers of the government investment. The main areas of focus related to safety were to leverage the large number of IoT sensors and predictive analytics deployed and make most efficient use of the city's resources enabling operators to make smarter decisions in real time. Overall, the government investment increased Singapore's safety result score by 2%.

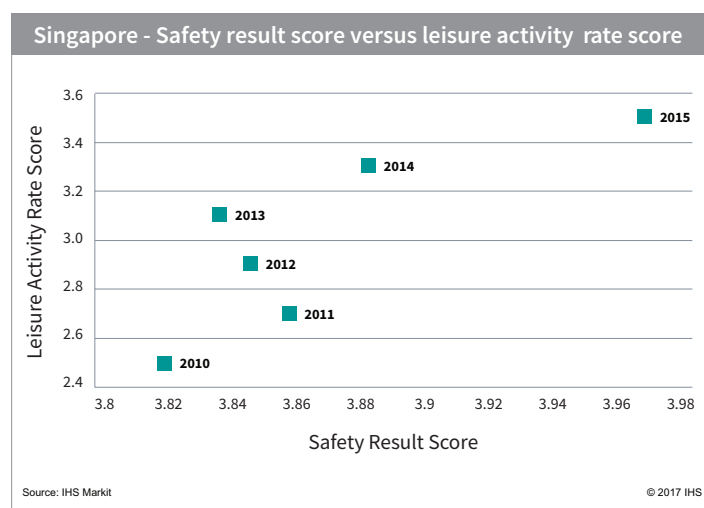
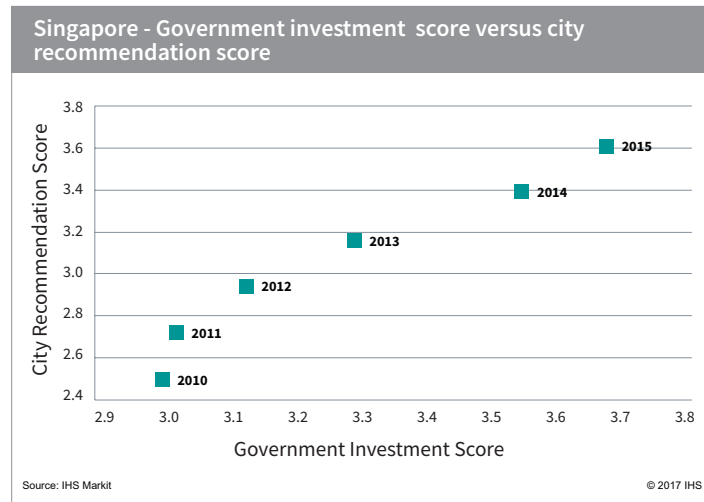
However, the area of greatest improvement has been the social benefit of the city which increased by 35% following the government's investment. Key social benefit indicators have increased such as the government appreciation score which increased by 54%; the police appreciation score which increased by 49% and the citizen happiness score which increased by 47%.

Furthermore, the city recommendation score improved by 44% (see figure) based on the IHS Markit citizen survey. Citizens were asked whether they would be more or less likely to recommend living and working in their city to a friend or family member compared with five years ago. People living in Singapore were already supportive of the city so this increase is a significant achievement.

The figures also show the leisure activity rate was another social benefit indicator which saw an improvement following the safe city investment. An increase in the government investment score of 22% meant citizens were 40% more likely to spend on entertainment and visit an entertainment, sports or leisure facility more than twice a month, as measured in the citizen survey.



Singapore has also seen its economic prosperity rise. Return on investment can materialize as both direct cost saving efficiencies as well as improved economic conditions. For example, operational efficiencies brought about by increased spending on safe city ICT technology meant that reductions in Singapore's police investment (a decline of 8%) had no impact on the overall safety result. The focus on a safer city has also helped drive an increase in tourism; with 1.5 million more annual international visitors in 2015 when compared with 2010³.



Conclusion and summary

Crime in Singapore has been consistently low. However, the Singapore safe city projects are about more than protecting its citizens from criminals. The projects position Singapore at the forefront of public safety technology, taking data and information from IoT sensors and applying algorithms to make smarter decisions in real time. The safe city project has also had a positive impact on the city's social benefit indicators such as the appreciation of the government and police force, the leisure activity rate and citizen happiness.

While indicators, such as crime rate, may not show much impact from the safe city projects, operational efficiency with regard to emergency response is extremely high. Furthermore, Singapore's experience in this safe city Test Bed will provide valuable insights on how technology and

analytics can aid urban management and public safety in other cities around the world and much of this insight was shared at the World Cities Summit in 2014.

4.2 London

London, one of the original safe cities, continues to invest in its surveillance and emergency response systems to gain additional efficiencies and improve collaboration across law enforcement agencies.

London was one of the first cities to implement an advanced emergency response and command & control system. A series of terrorist attacks in the 1980s and 1990s meant the government reviewed its security equipment deployment and initiated the investment in safe city technologies. The resulting C3i control room project remains one of the most successful command & control projects in Europe. Since the mid 90s, the Metropolitan Police have been running a highly successful patrol and review strategy, called Operation Benbow, using CCTV as a cornerstone technology.

Why London deployed a safe city solution

Although London had a substantial police force and a large video surveillance infrastructure, the Metropolitan Police and city leadership realized significant efficiencies could be gained within the emergency response system. At one point, London had over 30 police control rooms, and a major goal was to reduce this number to save on costs and improve efficiency across the city. The ability to provide multi-agency collaboration as well as free up police officers was also important. Additionally, the city sought to implement an incident tracking system to track emergency call taking costs versus the dispatching costs. This is where the C3i program was implemented reducing the control rooms to just three (plus back up), a system that proved resilient during the 2012 London Olympics.

The safe city deployment: building on an already secure safe city infrastructure

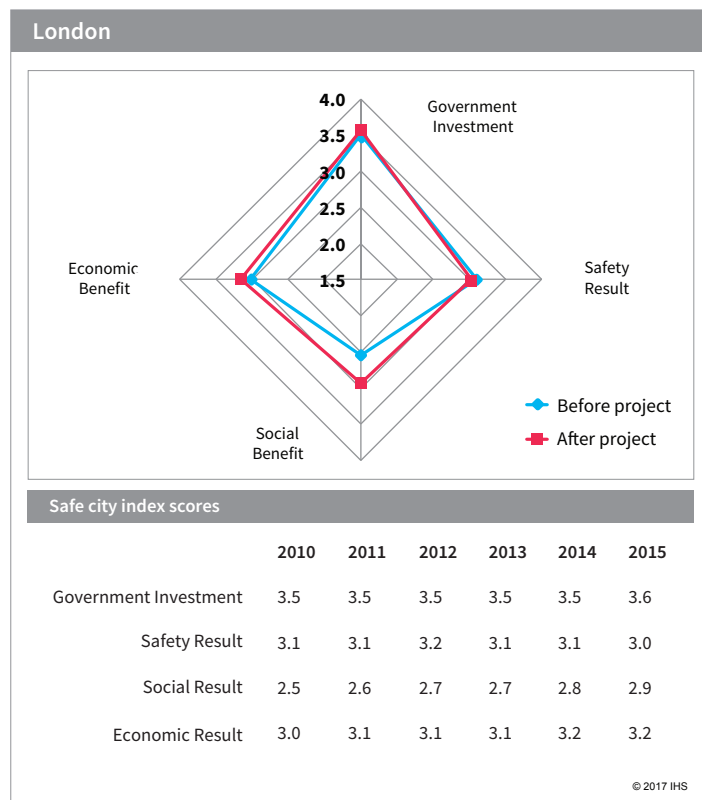
- An integrated control system was deployed with three new command & control centers and one special operations room with fall back capability. Video surveillance cameras were installed in new locations and integrated into these command & control rooms.
- Mobile data terminals were fitted to police cars and 22,000 body-worn cameras were issued to police officers⁴. A

TETRA radio communications system was deployed with third party enhancements to the computer aided dispatch (CAD) system and new GIS (Geographical Information System) mapping system developed.

Quantifying the safe city

London had already invested heavily in safe city technology prior to 2010. Consequently, the government investment and safety result did not change dramatically between 2010 and 2015. Most of the safety result improvement is in operational efficiency. For example, despite London's police investment declining by 10%, the criminal activity prevention score actually improved by 0.5%. This suggests that the city's resources were optimized more effectively.

It is clear from the government investment score that London is in the third stage of safe city investment where there are typically small increases in the safety result, but large increases in the social benefit score can be achieved. This is borne out in London's social benefit score which increased by over 15%.



• Installation of CCTV Cameras throughout London

• Introduction of C3i Command & Control Room Upgrade Programme (New police control rooms with TETRA and CCTV Integration)

• C3i Command & Control Room programme complete moving from 32 control rooms to 3 control centers⁵

• Upgrade of the ICCS system and CAD applications to successfully support the 2012 Olympic Games

1980s

2002

2007

2012

2018

A major driver of this positive movement was from the citizen survey analysis. 83% of citizens surveyed stated that they would be the same or more likely to recommend their city to live and work in when compared with five years ago. Additionally, 78% of respondents stated that they would recommend the police force based on its response to crime the same or more now compared with five years ago, highlighting the positive feedback that police officials and government stakeholders can receive from successful safe city deployments.

Continued government investment in safe cities helped drive a 21% increase in the citizen happiness score showing the positive social benefits of these projects. London also saw positive economic benefits from continued safe city investment, with an overall increase in the economic benefit score of 4%. Given the economic downturn in Europe, London still saw economic growth: a great achievement supported by strengthened safe city operations. There was also a 14% increase in the retail spend score and the economic prosperity score grew in line with government investment. Finally, as shown below, the employment score, a measure of unemployment in the city, improved by 15% over the time period bringing with it economic benefits.

Conclusion and summary

The London safe city project has a number of innovative additions planned such as the new nationwide Emergency Services Network, which will upgrade all communications from the legacy TETRA radio system onto a 4G broadband LTE (Long-term Evolution) network. Other upgrades to the safe city project will include minor video surveillance enhancements, potentially CAD system upgrades and further collaboration between the British Transport Police and the Metropolitan Police. While the need for the safe city project was different to other cities profiled in this report, London was able to gain noteworthy efficiencies by optimizing their control room and emergency response systems.

In addition, the social benefit and economic benefit scores increased following continued deployment of safe city technology. The citizen's appreciation of the government for its efforts in responding to crime was a particular success story, and economic indicators such as the retail spend score and the employment score have also increased. Overall, London's continued investment in safe city technology is benefiting the social and economic position of the city.

4.3 Dubai

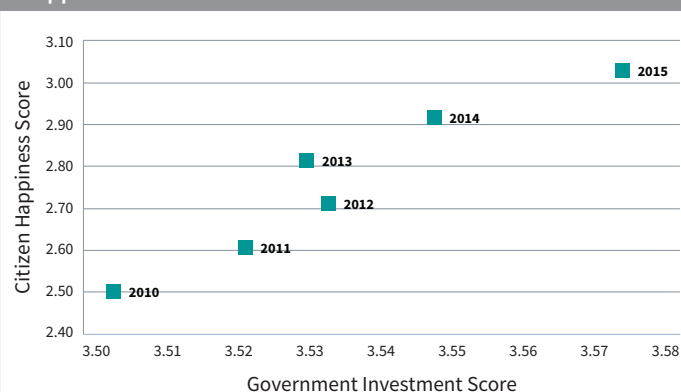
The government of Dubai is determined to showcase itself as a world-leading smart city. To achieve this goal the government has launched hundreds of on-going smart city projects and services under the "Smart Dubai" initiative. Many of these initiatives directly encompass safe cities technologies.

Safe city technology is helping Dubai to achieve its aims of fostering a diversified economy, increasing tourism, attracting higher skilled workers and preparing for the 2020 World Expo event. The Smart Dubai initiative, set out by the government in 2014, includes a rollout of over 500 projects and services relating to a smarter city. Most projects are to be delivered by the end of 2017 as a result of public-private partnerships. Eight different government entities, such as the police department or transport authorities, are managing specific projects from the government across six dimensions: smart economy; smart living; smart mobility; smart governance; smart environment; and smart people. The initiative highlights smart ICT infrastructure as the underlying "transversal dimension" which enables the six dimensions.

Why Dubai deployed a safe city solution

The Smart Dubai initiative is aimed at increasing citizen happiness and showcasing Dubai as a world-leading smart city in preparation for its hosting of the 2020 World Expo. The government wants to demonstrate it can improve the lives of its citizen using technology whilst making significant cost savings across the city. Prior to the Smart Dubai initiative the city already had extensive public safety technology installed. Sensors included video surveillance cameras, fixed-speed radars, 3G traffic signal control and traffic data sensors fitted on the city's 8,000 taxis⁶. When it comes to the safe city elements of the Smart Dubai initiative the projects are about connecting the existing systems and enabling future expansion.

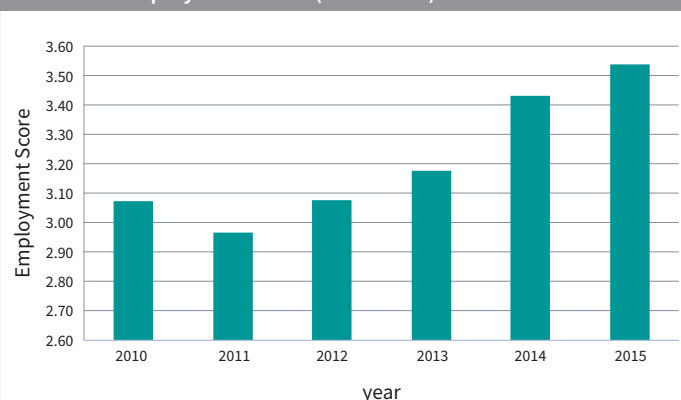
London - Government investment score versus citizen happiness score



Source: IHS Markit

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London - Employment score (2010-2015)



Source: IHS Markit

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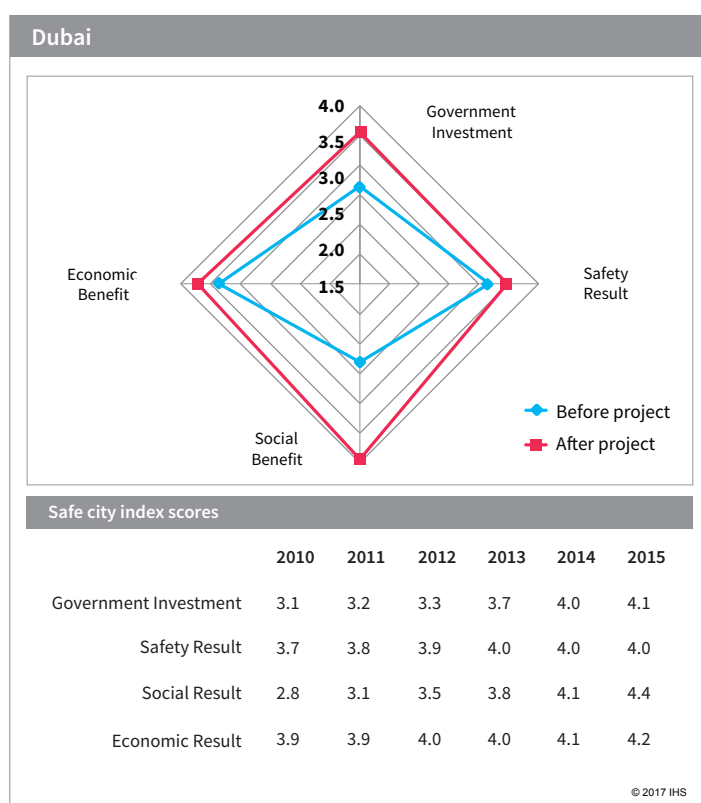
Historically Dubai has had low overall crime rates. Consequently, crime was not a key project driver. Dubai has also not had a single all-encompassing safe city project but over the last two decades has continually upgraded. This has resulted in several expansions and iterations of safe city capabilities via new or expanded control centers, ICT infrastructure upgrades and new sensors.

The safe city deployment: safety through smarts

- Installation of new government owned city and traffic cameras as well as cameras on Dubai's police vehicles taking the total camera count to multiple thousands. Police also linking to private cameras. The UAE national TETRA radio communications system was also used as part of Dubai's safe city projects.
- A new roads and transit authority (RTA) enterprise command and control center which provides an integrated control unit linking to the individual control centers of the various transit authorities such as the Dubai metro, traffic systems or taxi dispatch.
- Deploying a 5G ready high-bandwidth network for voice, video and other data applications used for mission-critical services and connecting Internet of Things (IoT) sensors.
- Traffic control centers deployed with live traffic analysis, a 3G network to control traffic signals and electronic road signs. It has also implemented a traffic application, providing the ability to report incidents, and a police application, which supports crime reporting, video evidence submission and SOS alerts.

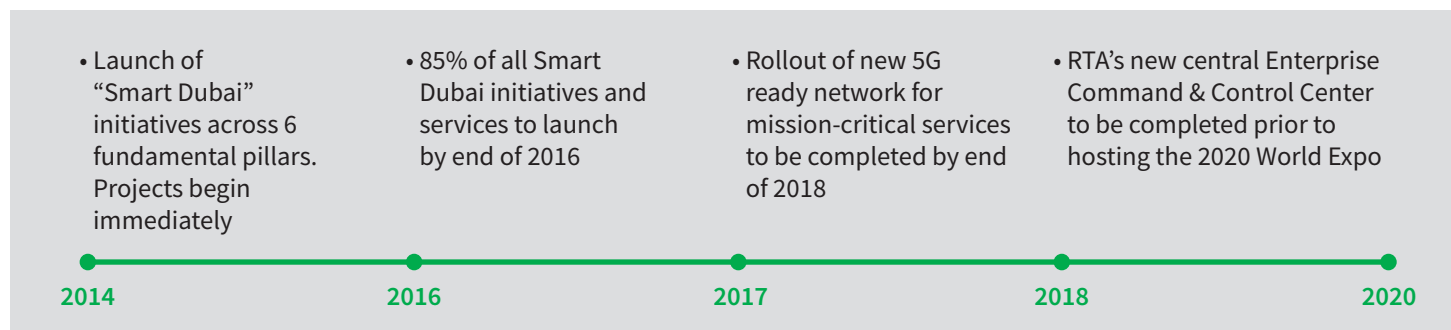
Quantifying the safe city

The Dubai government's primary focus in the safe Dubai initiative has been to increase citizen engagement and happiness. Similar to Singapore and London, the government investment score by 2015 shows that Dubai is in the third stage of safe city investment. However, it has managed to achieve a greater increase in the safety result when compared to the other two cities. In quantitative terms, an increase in the government investment of 29% has resulted in an increase in the overall safety result of 8% and helped ensure citizens are safer from individual risk and property risk by 3% and 31%, respectively.

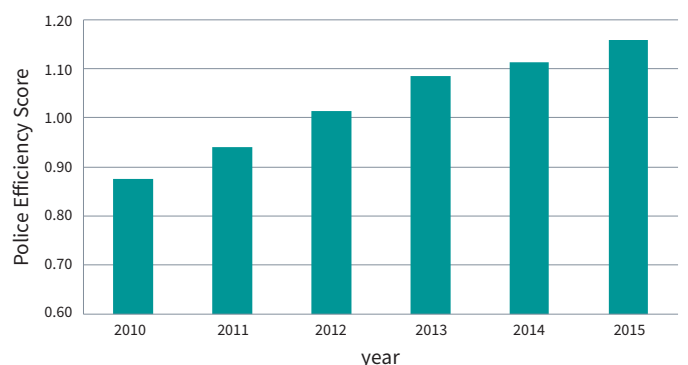


Another interesting development is the optimization of resources following the deployment of advanced ICT technology. As shown in the figure (following page), the police efficiency score has increased between 2010 and 2015. This is a measure of the safety result divided by the police investment and shows that despite fewer police resources, the city is utilizing these resources better to improve the safety result.

Midway through many of Dubai's projects (2015) there is a strong correlation between increased government investment and the social benefits the projects have brought to the city. As mentioned, this is to be expected in the third stage of safe city investment. An increase in the government investment score of 29% resulted in a 58% increase in the social benefit score. Government investment also had a positive impact on the citizens' appreciation of both the government and the police department and an increased proportion of citizens stated they would recommend living and working in their city.



Dubai - Police efficiency (2010-2015)
Police efficiency score: safety result/police investment



Source: IHS Markit

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In fact, 77% of respondents in the IHS Markit citizen survey stated that they would be more likely to recommend living and working in the city. There was also a positive story in the leisure activity rate with 70% of citizens surveyed more likely to visit entertainment facilities more than twice a month when compared with five years ago. Dubai has also improved on its economic indicators. As shown in the figure, the tourism score has increased by 16% as the safety result increased by 9%. There was also an increase of 11% for the city investment score, a measure of foreign investment, and a 20% increase in the retail spend score. Overall, Dubai improved in all three categories following the government's investment in safe city technology.

Conclusion and summary

The Smart Dubai initiative is a huge undertaking and it will be hard to quantify the full benefits until all the elements are completed between 2020 and 2021. However, it is clear from the index analysis that the government investment in the safe city project has impacted the safety result, the social benefit and the economic benefit in the city. The positive approval for both government and police agencies is another benefit for government stakeholders looking to apply these types of projects.

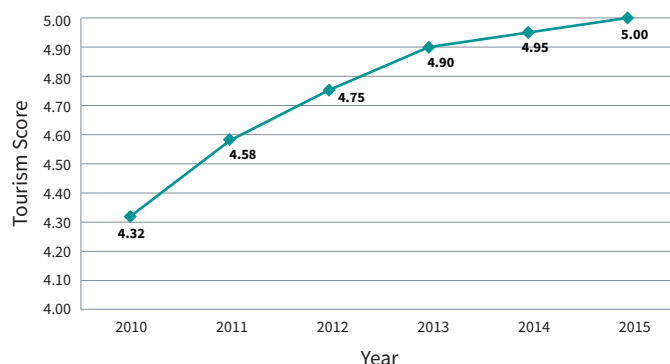
Dubai - Safety result score versus city recommendation score



Source: IHS Markit

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Dubai - Tourism score (2010-2015)



Source: IHS Markit

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4.4 Nairobi

Nairobi, with limited existing infrastructure and an increasing crime rate deploys a safe city solution to reduce its crime rate, increase its economic stability and improve general citizen wellbeing.

To ensure Nairobi's continued economic development and social growth the Kenyan government has focused on infrastructure improvements. Enhanced urban safety is an important component to urban infrastructure alongside power, sanitation, transportation and connectivity. Nairobi has leveraged technology to enable safer, sustainable urban living for its citizens and visitors. The safe city project's main goal was to make Nairobi a safer place to live; a fundamental building block to the economic and social aspirations of the city.

Why Nairobi deployed a safe city solution

Prior to the deployment of its safe city project, the Nairobi Police and Kenyan National Police Service used critical communications based on outdated analog technology which were unreliable and unsecured. As the threat of robbery, burglary, vehicle theft and homicide increased in the late 1990s and early 2000s, these systems were hindering the authorities' ability to make the city safer and reduce crime. Furthermore, since 2011 the terrorist threat from jihadist groups, most notably from Al-Shabaab, increased sharply and mitigation of this greater terrorist threat became a priority. From a command and control standpoint, there was little linkage between officers on the ground and the main control centers. Public engagement with the police force was also low. The lack of an efficient call taking and dispatch system, and the subsequent resources to run an aging system, meant Nairobi's 999 emergency number had remained switched off for fifteen years from 1998. With the increased terrorism risk and an element of public disengagement the Kenyan Government decided to act to empower its authorities to protect its citizens.

The safe city deployment: new public safety solutions to meet the emerging security challenges

- The first stage of Nairobi's safe city project centered on the complete overhaul of its public safety systems: upgrading aging or non-existent infrastructure to enable a holistic solution. A new Integrated Emergency Command Centre for management of the public emergency call system was installed. This included upgrades to the CAD and GIS mapping systems. A unified communications system to increase sharing of information through reliable, secure digital communication between command and emergency responders was also deployed.
- An eLTE trunking network including hundreds of nodes was installed around the city. Over 1,800 surveillance cameras⁷, a video management and storage system, and ANPR (Automatic Number Plate Recognition) analytics integrations were also part of the upgraded solution.
- The speed and scale of project implementation created a number of challenges for this safe city project. The first phase deployment was completed in around four months and required project managers, engineers, systems integrators and installers to work around the clock. During this time there were over 200 new technological updates and revisions. On-going training programs have been implemented to support operators, dispatchers and police officers to maximize the functionality of the safe city solutions.

Quantifying the safe city

Nairobi had very little infrastructure to support security operations prior to its safe city project and invested substantially to ensure that it had the required infrastructure. The figure shows that an increase in the government investment of 87% resulted in an increase in the safety result of 24%.

The primary objective of the Nairobi project was security and this investment was necessary to meet the projects objectives. With previously high crime numbers Nairobi's investment has already yielded strong results with the city seeing a 46% reduction in crime since deploying its safe city solution. Citizens are now safer from individual risk and property risk by 42% and 34%, respectively, and the increased investment has resulted in a 31% increase in the conviction rate score.



Nairobi has moved through the first stage of safe city government investment which typically results in lower improvements for both social and economic benefit. However, there have been some success stories in both these indexes.

On the social benefit indicators, the safe city deployment has been extremely positive for both government and police force appreciation. The 24% increase in safety result has seen a 21% increase in the number of citizens that have a positive image of the police force and a 36% increase in the number of citizens that have a positive image of the government based on their responses to crime. This analysis was measured from the IHS Markit citizen survey of residents in Nairobi. Furthermore, almost half of survey respondents were more likely to recommend working and living in Nairobi when compared with five years ago.

Another social benefit indicator to improve has been the leisure activity rate, which has increased by 32% following the safety result improvement. It can be inferred that citizens are more likely to go out and enjoy living in the city following a safe city deployment as they feel more confident of their surroundings.

- Overhaul of critical communications as well as the public safety call taking and dispatch system

- Deployment of video surveillance, command and control, and ANPR (Automatic Number Plate Recognition)

- Implementation of video analytics and other safe city systems

- Proposed project expansion to incorporate other cities and the creation of a national command centre

2014

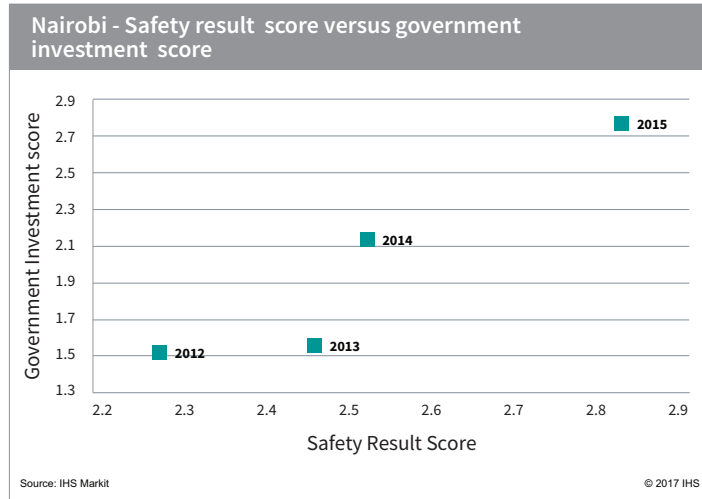
2015

2016

2017

2018

On the economic benefits, the improved safety result has supported a 29% improvement in the economic risk prevention score. There has also been a 50% increase in the city investment score and citizens are more comfortable spending money with the retail spend score increasing by 35%. There has also been a significant increase in tourism numbers in the first half of calendar year 2016



Conclusion and summary

The Nairobi safe city project is an example of a full deployment having a significant impact on the security situation in a city. In this project, the government's aim was clear: reduce the crime rate and make the city safer. This was achieved; however, other benefits are also emerging. The citizens are happier with their government as a consequence of the project and 2016 is seeing positive moves in tourism and other economic and social indicators. Fundamentally, this project shows what can be achieved despite limited existing infrastructure with a well deployed safe city project.

Part 5: Key Enabling Technology: the Cornerstone of Safe City Construction

While safe city projects typically integrate a large number of security and communications technologies, there are a few critical segments and emerging applications that are extremely relevant to the future success of safe cities.



Enabling the detection: video surveillance and video analytics

Video surveillance is a critical element of a safe city. Security cameras provide the “eyes” for all other operations and collect information remotely for live operations and forensic investigations. Each video surveillance scenario and camera site is different. Video surveillance deployments used in safe city projects can be especially challenging due to the size of the geographic area of coverage, the number of cameras integrated into a single system, and the range of conditions and operational purposes for each individual camera.

Video surveillance cameras can fulfill various functions in a safe city project including: general security monitoring of public spaces; suspect tracking; forensic investigations and evidence gathering following an incident; traffic monitoring and enforcement; and number plate recognition.

The video surveillance industry has undergone a transition from analog to network products. Picture quality has many components but the higher resolution in network cameras has driven adoption. To cope with the largely outdoor deployments and large variance in environmental conditions the use of wide dynamic range, high color fidelity and advanced low light technologies has increased. Furthermore, high resolution and panoramic cameras have the ability to cover wide-areas from a single vantage point meaning objects within wide urban areas can be recognized and identified.

The video management element of a safe city video surveillance system critically allows operators to collate all live video inputs to build a picture of current scenarios. Underlying ICT platforms and the use of cloud management enable a large system to be managed on a single platform through distributed multiple control rooms (potentially with varying levels of authority). A flexible cloud infrastructure allows for seamless resource (transmission, analytic processing or storage) sharing across the network. Another of the trends in video surveillance technology is the evolution from an “information island” to the “cloud”, which could raise working efficiency, advance data sharing and big data analysis, maximizing the benefits of video surveillance, and reducing the cost caused by repeated construction.

Developments in the field of video content analysis (VCA) are most crucial to enabling the next-generation of safe city capabilities. Video analytics technology is now able to characterize the entire environment captured by a video surveillance camera, allowing the system to interpret the relevant information from the video. Truly providing “eyes” and a “brain” to an entire safe city system by analyzing live and recorded video streams to detect, classify and track predefined objects or behavioral patterns. These technologies are used as a means to automate the video monitoring process and can be particularly effective in proactively identifying events as they happen and extracting information from recorded video. The latest deep-learning analytics are able to more accurately recognize detail, objects and behaviors. In a crucial difference to rule based analytics, once “trained” – analytics using deep-learning technologies have the potential to continue learning from their training, gaining accuracy and efficiencies as a human operator would.

Increasingly a hybrid approach is being deployed where analytics workloads are more distributed using a powerful mix of smart cameras at the edge combined with centralized server and/or cloud based analysis. This means some analytics can be run at the camera, for example crowd monitoring and counting, but more powerful centralized analytics could be used to run processor intensive applications such as face recognition against a nationwide-shared suspect database.

A significant element of the deep-learning analytics revolution is the potential for multi-use and big data applications of video based metadata. The data which can be leveraged from surveillance cameras using analytics is not limited to security purposes. The potential for operational data relating to crowd management, sanitation, public transport and traffic monitoring amongst other examples can be leveraged – meaning potential for the integration of safe city technologies into a smart city.

Enabling the quick responses: internet of Things (IoT) and connected devices

The IoT is not a specific device or technology – it is a conceptual framework, driven by the idea of embedding connectivity and intelligence in a wide range of devices. IHS Markit defines an IoT device as a device which has some form of embedded connectivity that allows the device to be directly connected

to the internet (i.e. IP addressable), or allows the device to connect (tether) to an IP addressable device. This connectivity can be wired or wireless.

These devices can include a range of sensors as well as some type of user interface (UI), but neither sensors nor a user interface is required under this definition. The ability to collect vast amounts of data in near real-time from this broad range of intelligent connected devices is the foundation of the IoT. This data can then be accessed directly, or via the cloud, and unique value propositions can be created through the application of complex analytics and big data techniques.

IoT is an important trend, especially within the safe city space. With more connected devices comes more data, which when combined with strong analytics, can provide intelligence that decision makers can use to preemptively alert to attacks, improve responses in real-time and speed up forensic analysis. Connected devices specific to the public safety sector can be connected to a control room or storage platform via a sensor. In the case of law enforcement, one such application could be a firearm connected with a sensor. The agency could gather data from this sensor such as drawing of the gun, firing of the gun, and time and locations where the gun is drawn.

Analytics can be run on the data collected to identify the city-sectors most likely to result in a drawn weapon and officers who are more likely to draw the weapon. These types of sensors are the future of public safety and ‘safe city’, but many challenges surround the use of these systems. While this market is in an ‘early-days’ phase, it is evident that these technologies offer significant benefits to government agencies. In order to leverage these opportunities, governments should build up dedicated IOT for their safe city projects. LPWA (Low Power Wide Area) networks such as NB-IOT technology could be leveraged to realize the full city IOT coverage.

Enabling the efficient policing: mobile policing

The transition from narrowband communications such as licensed mobile radio to broadband communications such as LTE is expected to be a facilitator to communications used as part of safe city initiatives. These networks will be able to carry high-speed data, location information, images, and video to provide first responders with enhanced ‘situational awareness.’ LTE is well placed to meet all the critical communication demands in various scenarios enabling data-sharing and collaboration across agencies and districts to improve the coordinated response to emergencies, which are chief goals of safe city initiatives. The implications of the network for safe city projects are tremendous. Vastly more and ‘heavier’ information can be sent over a broadband network. Additional access to data means more options, which can be analyzed in control rooms and disseminated into the hands of field personnel.

Various programs such as the United States’ FirstNet and the United Kingdom’s ESN have made plans to migrate the countries’ emergency communications networks onto broadband. While these transitions will take time, and will work with mobile radio networks concurrently during the

transition, it is evident that broadband will be the future of emergency communications.

Enabling the integration: control room consolidation and resource sharing

A significant trend impacting public safety and law enforcement control rooms, especially in North America and Europe, is the consolidation of single-agency control rooms to form large multi-agency control rooms. This trend is driven by control rooms attempting to manage increasing budget restrictions, to improve efficiency and to improve interoperability between different agencies.

Consolidation depends heavily on the productivity metrics that a control room uses. The agency must evaluate call-taking and dispatching capabilities and processes. A typical consolidation might include rolling up city control rooms into a more regional entity. This task will encounter different local processes and it is therefore an opportunity to introduce best practice process across all agencies.

Physically combining control rooms into one large unified control room is not necessarily the only way in which this consolidation is happening. With the increasing pressure to budgets and also in an effort to increase data sharing, it is becoming more common for several control rooms in a region to issue a joint tender for a single platform to be shared by each agency. There are several benefits to this shared purchasing process. There is a cost benefit, but it also enables control rooms to design emergency management systems to their own needs as well as expand their cooperation with geographically separate control rooms, leading to considerably improved resource management. There is also a benefit in the integration of voice, video and other data; the integration of video surveillance, video conference and narrowband/broadband trunk.

Enabling the prevention: predictive crime centers and big data analytics

A number of police departments around the world are placing more importance on predictive crime centers. After the September 11th attacks, the Department of Homeland Security provided US states with funding to facilitate collaboration and information sharing among law enforcement agencies. As a result, “fusion centers” were developed as part of counter terrorism analysis. Today, there are 78 fusion centers across the United States, which range in size from staffs of three to 250, including officers, analysts and agents.

Fusion centers are slower time analysis units which look at big data sets from both traditional police data and many other sources. These can include video surveillance streams, social media, arrest records, warrants and mug shots. Fusion centers can provide intelligence packages for patrol briefings and operations as well as support real time intelligence cells. These real time intelligence cells are typically attached or embedded into control rooms to provide intelligence supporting either command and control decisions or deployed officers. Furthermore, LTE networks have the potential to

support richer data and image packages. These centers will become increasingly important as agencies place an emphasis on predictive policing.

Departments, including the Houston Police Department, are hiring specialized analysts to review social media during major criminal incidents to gather and send out data to officers in the field. This allows resources to be dispatched in a more focused manner saving time and cost. Predictive crime centers like the one in Austin, Texas, provide information including traffic camera data to the police force to facilitate investigations. The future of analytics will shift from a data sharing approach to a data mining approach, with the purpose of intelligence gathering, and disseminating those results across relevant agencies. Predictive analytics are typically deployed from traditional intelligence units and sometimes from Fusion centers. It is important to note that these systems require a significant amount of data to work effectively and even advanced city deployments remain in the early stages of what is possible.

Enabling the sustainability of safe cities: cloud and SaaS solutions

Cloud services can be defined as convenient, on-demand services provided over the internet by a third-party provider. Rather than committing upfront to a fixed cost, platforms, hardware (servers, storage, etc.), applications and software are provided as a service. The payment is typically on a periodic basis and based on usage. Consequently, cloud networks are designed to be scalable, rapidly elastic, and require minimal management, allowing increasing demand to be met dynamically.

On the flip side, if a user or enterprise starts to downsize, usage and payments for cloud services can be scaled back, allowing the consumer to save money. Data stored in the cloud can also be accessed anywhere and shared seamlessly with other qualified users at any time across multiple devices. One of the factors hindering adoption of safe city projects is financing. As these projects are a capital expenditure (CAPEX), a city has to fund this type of project through some form of local, state or federal government funding. For small and medium-sized cities, typically without access to significant funding, this can be a great impediment to initiating these projects. The city can also be stuck with obsolete technology that it cannot afford to upgrade.

Cloud based technology has the potential to alter the way safe city projects are funded by changing the projects from a CAPEX model to an operational expenditure (OPEX) model. OPEX typically covers the day to day costs of running a city and includes rent, payroll, utility bills and maintenance. Two benefits of an OPEX model versus CAPEX model are that cities can deploy safe city projects in a more incremental fashion and there is no long-term commitment.

A further benefit of OPEX models that cloud-based technology provides is that it shifts responsibility and risk away from the city itself and onto the provider of the technology. One

issue cities have faced in the past has been continuing to fund safe city projects after the initial funding had run out. As the project shifted from a depreciating capital expenditure to an ongoing operational expenditure, the city had to find money again to continue the project.

Safe cities are living projects, which means that even after extensive video surveillance infrastructure, a centralized command center, advanced analytics platforms and a robust storage system have been installed, the technologies and platforms used as well as the operational procedures employed will continue to evolve.

Multiple technologies and trends are shaping what safe cities will look like in the future, but the reality is that each city will have a unique solution based on their needs and the goals they are trying to achieve. Increasingly, cities will rely less on hardware and will instead rely more on software based applications. Infrastructure such as cameras will remain in place, but software will be used to access relevant data from systems across a city. Collaborative software systems will be used to disseminate this data to each agency involved in emergency response or security incident management. The future of safe cities is in the platform and solution rather than the equipment and technology.

Part 6: Development Strategy

The safe city represents the intersection of ICT and security technology. However, there is no “one size fits all” when it comes to implementing and deploying a safe city solution. The key success factors can differ dramatically depending on the city’s specific security threats, government investment, existing infrastructure and the roles of the stakeholders involved in the safe city initiative. That being said, a number of strategic recommendations can be made based on the government investment stage of the city which will help to ensure a more successful safe city deployment.

First stage of government investment

In the first stage of government investment, the city typically needs to replace outdated security technology and critical communications systems. While this stage involves the largest capital expenditure, it also generates the largest improvement in the overall safety result. Furthermore, the implementation is more straightforward than at other stages, with higher resolution video cameras, LTE networks, IoT sensors, and command centers all likely to be deployed around the city. Given the limited existing infrastructure in place, the city can make a dramatic impact by reducing emergency response times for police, fire, and rescue services and lowering the overall crime rate through the safe city deployment.

Second stage of government investment

The second stage of government investment is more challenging. The safety result benefits generated in the first stage of investment have already been achieved and many of the social and economic benefits associated with the project will not be achieved until the government investment

reaches the third stage. At this stage, the government should set targets and expectations for the third stage of government investment focused on the social and economic benefit improvements required. It should also build and motivate the project team to deliver on these targets. Furthermore, the government should start to build advanced data sharing platforms and continue to invest in ICT to maximize the safety result of the city and work towards the next stage of government investment. In the second stage of investment it is important to manage expectations and ensure that the city exploits the benefits of the project through continued spending to progress through to the next stage of investment.

Third stage of government investment

By the third stage of government investment, cities already have a mature physical security and ICT infrastructure. Consequently, much of the additional planning and investment in these cities surrounds the integration of existing systems, setting up collaborative or data sharing platforms and building advanced analytics solutions, which can mine data across the legacy systems. Project leaders need to ensure they work well with technology suppliers, systems integrators and security consultants to leverage the best of breed solutions available. Citizens should also be involved in the overall safe city project. Ultimately, the safety result, social benefit and economic benefit should work for the citizens and it is important that they are involved in the project and see the benefit. While improvements in the safety result are possible, the main improvements will be found in the social and economic benefit of the city; citizens will be happier to live and work in the city, and the economic environment will be more favorable for growth. In comparison to earlier stages of government investment, the third stage safe city solution is more likely to be bespoke, designed for the dedicated needs of the city.

Key elements of successful safe city projects

It is evident that the approach to deploying a safe city is challenging. For this reason, planning and discussion between stakeholders is important regardless of the city size or development stage. The projects which have been successful had one major element in common: the various stakeholders worked together and constructed a consolidated project team and dedicated safe city initiative. Projects fail because the different agencies do not identify unified objectives, are unwilling to collaborate, or do not engage the city’s citizen stakeholders effectively. A few components are critical:

- **Steering committee:** a group which takes the lead on the safe city initiative. Their responsibility surrounds securing funding and establishing stakeholder partnerships. There has to be a clearly defined lead agency or person and an agreed definition of what success looks like.
- **Identified funding source(s):** this may take the form of a wider federal grant, but also from private sources such as a foundation or local businesses.
- **Strong partnerships with a range of agencies:** police departments, transit organizations, universities, public

health, social services, and business stakeholders need to work together. It is also important that the city's citizens embrace the safe city concept.

- **Project goals:** specific targets with regards to the security needs to be addressed and technologies to be implemented.

Benefits of a dedicated 'safe city' initiative

There are several benefits to establishing a wide-scale safe city initiative. Firstly, it involves a greater range of stakeholders, which means that there is not only more publicity, but greater potential for 'buy-in' amongst city agencies and other organizations. The greater range of stakeholder involvement brings with it a larger pool of financial resources. For example, if only the police are involved in a safe city initiative, it is likely that only their budget could be used to finance the project. However, if transport, police, public health, fire and rescue, border control, social services and private organizations are involved, budget availability becomes larger. Multiple agencies working together do present additional challenges. However, it is for this reason that the steering committee is set up. This organization would ideally have an awareness of the technological needs of each of the different agencies and work to address those needs in the planning stage.

Conclusion

The safe city is ultimately a government-driven approach to security. However, multiple stakeholders must be involved. The continuous evolution of technologies, city structure, and security requirements, means a broad range

of expertise is needed to make safe city projects a success. Strong government support facilitates these projects, but ultimately a collaborative approach between the government stakeholders, including public health, fire and rescue, and social services, its citizens, and technology firms will provide the best opportunity for successful safe city projects.

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Indicators

Index and indicator definitions

Each index is created from six or seven indicators weighted based on their importance to the overall index. The following figures show the constituent indicators, their definitions, an explanation of the calculation and the associated weighting.

1. Government Investment				
Primary Indicator	Weight (%)	Definition	Calculation	Source
1.1 Country ICT development index	15%	Ranking of overall ICT development level of the country	ICT development analyst assessment from public data; score of 1 refers to almost no ICT development, 2=basic/evolving ICT development, 3=existing/not advanced ICT development, 4=strong ICT development, 5=highest level of ICT development.	ITU IDI Report
1.2 Safe City ICT spend commitment	25%	Ranking of the continued commitment to Safe City ICT spending	Based on IHS Markit research; score of 1 refers to no ICT investment; 2=limited continued investment, 3=some continued investment to support core security equipment, 4=continued investment for analytics and big data applications, 5=full continued investment.	IHS Markit data
1.3 Police investment	15%	Ranking of Police officer numbers and resources	Number of active police officers per 100,000 citizens; score of 1 refers to less than 200 officers, 2=400 officers, 3=600 officers, 4=800 officers, 5=1,000 officers or more.	Public city police data
1.4 Video surveillance coverage	15%	Ranking of city surveillance camera coverage	Installed base of cameras per capita ranked against major capital cities; score of 1 refers to 0% percentile city; 2=25% percentile, 3=50% percentile, 4=75% percentile, 5=100% percentile.	IHS Markit data
1.5 Command and control coverage	15%	Ranking of command and control seats per capita	Installed base of command and control seats per capita ranked against major capital cities; score of 1 refers to 0% percentile city; 2=25% percentile, 3=50% percentile, 4=75% percentile, 5=100% percentile.	IHS Markit data
1.6 Critical communications coverage	15%	Ranking of critical communications coverage	Installed base of critical communications infrastructure per capita ranked against major capital cities; score of 1 refers to 0% percentile city; 2=25% percentile, 3=50% percentile, 4=75% percentile, 5=100% percentile.	IHS Markit data
5=most positive score; 1=least positive score				

2. Safety Result

Primary Indicator	Weight (%)	Definition	Calculation	Source
2.1 Criminal activity prevention score	10%	Ranking of the overall crime rate	Crime numbers per 1,000 citizens ranked against major capital cities; score of 1 refers to 0% percentile city (highest crime rate); 2=25% percentile, 3=50% percentile, 4=75% percentile, 5=100% percentile (lowest crime rate).	Public city crime statistics
2.2 Serious crime rate score	10%	Ranking of serious crimes as a percentage of all reported criminal cases	Serious crimes as a percentage of all crimes; score of 1 refers to a rate of over 90%, 2=70%, 3=50%, 4=30%, 5=less than 10%.	Public city crime statistics
2.3 Individual risk prevention score	20%	Ranking of the likelihood for citizens or foreign travelers to be killed, injured or kidnapped	IHS Markit risk ratings ranked against major capital cities; score of 1 refers to 0% percentile city (highest risk); 2=25% percentile, 3=50% percentile, 4=75% percentile, 5=100% percentile (lowest risk).	IHS Markit data
2.4 Property risk prevention score	20%	Ranking of the risk that protests, riots and terrorism could damage property	IHS Markit risk ratings ranked against major capital cities; score of 1 refers to 0% percentile city (highest risk); 2=25% percentile, 3=50% percentile, 4=75% percentile, 5=100% percentile (lowest risk).	IHS Markit data
2.5 Citizen perception of crime score	20%	Ranking of the perception of crime by a survey of citizens	Citizens asked to rank how safe and secure they feel in their city; score of 1 refers to regular threats/ineffective government, 2=regular threats/partially effective government, 3=occasional threat/partially effective government, 4=occasional threat/effective government, 5=little threat/effective government.	IHS Markit survey
2.6 Emergency response time score	10%	Ranking of the average time for police officers responding to emergency callouts	Average police emergency response time (minutes); score of 1 refers to over 120 minutes, 2=less than 120 minutes, 3=less than 60 minutes, 4=less than 15 minutes, 5=less than 5 minutes.	IHS Markit research
2.7 Police conviction rate score	10%	Ranking of the conviction rate of criminal cases charged	Convictions as a percentage of all charged crimes; score of 1 refers to 0% conviction rate, 2=25% rate, 3=50% rate, 4=75% rate, 5=100% rate.	Public city conviction statistics
5=most positive score; 1=least positive score				

3. Social Benefit

Primary Indicator	Weight (%)	Definition	Calculation	Source
3.1 Government appreciation score	20%	Ranking of the appreciation level of the government's response to crime by a survey of citizens	Citizens asked whether they are more or less likely to approve of the government based on its actions to combat crime compared with five years ago; score of 1 refers to 100% of respondents less likely, 2=50% less likely, 3=no change, 4=50% more likely, 5= 100% more likely.	IHS Markit survey
3.2 Police appreciation score	20%	Ranking of the appreciation level of the police force by a survey of citizens	Citizens asked whether their general perception of the police force has improved or deteriorated compared with five years ago; score of 1 refers to 100% deteriorated, 2=50% deteriorated, 3=no change, 4=50% improved, 5= 100% improved.	IHS Markit survey
3.3 Leisure activity rate score	15%	Ranking of the regularity of leisure activities that citizens participate in each month	Citizens asked whether they would be more or less likely to visit a leisure, sports, or entertainment facility twice a month compared with five years ago; score of 1 refers to 100% of respondents less likely, 2=50% less likely, 3=no change, 4=50% more likely, 5=100% more likely.	IHS Markit survey
3.4 City recommendation score	15%	Ranking of the likelihood of citizens to recommend living and working in the city	Citizens asked whether they would be more or less likely to recommend living and working in their city to a friend or family member compared with five years ago; score of 1 refers to 100% of respondents less likely, 2=50% less likely, 3=no change, 4=50% more likely, 5=100% more likely.	IHS Markit survey
3.5 Talented workforce score	10%	Ranking of the wealth creation per employee	GDP to employed labor force (USD) ranked against major capital cities; Score of 1 refers to 0% percentile city (lowest talent); 2=25% percentile, 3=50% percentile, 4=75% percentile, 5=100% percentile (highest talent).	IHS Markit
3.6 Population growth score	10%	Ranking of the city's population growth rate	Percentage increase in the total population of the city; score of 1 refers to less than 1% year-on-year (YoY) growth, 2=2.25% YoY growth, 3=3.5% YoY growth, 4=4.75% YoY growth, 5=over 6% YoY growth.	Public data provided by city/country on population
3.7 Citizen happiness score	10%	Ranking of citizen's happiness level	Number of respondents that posted a positive score in three of the four IHS Markit survey questions included in the social benefit score. Score of 1 refers to 100% of not positive in three of four questions, 2=50% not positive, 3=no change, 4=50% more positive, 5= 100% more positive.	IHS Markit survey
5=most positive score; 1=least positive score				

4. Economic Benefit

Primary Indicator	Weight (%)	Definition	Calculation	Source
4.1 Economic prosperity score	20%	Ranking of the economic wealth per citizen	GDP per capita (USD) ranked against major capital cities; Score of 1 refers to 0% percentile city (lowest wealth per citizen); 2=25% percentile, 3=50% percentile, 4=75% percentile, 5=100% percentile (highest wealth per citizen).	IHS Markit
4.2 Tourism score	20%	Ranking of international visitors numbers	International visitor numbers (minimum one night stay) per capita ranked against major capital cities; Score of 1 refers to 0% percentile city (lowest tourism rate); 2=25% percentile, 3=50% percentile, 4=75% percentile, 5=100% percentile (highest tourism rate).	Public international visitor data - city tourism website
4.3 City investment score	20%	Ranking of the amount of annual foreign investment	Foreign investment (USD) as a percentage of total GDP; score of 1 refers to less than 2% ratio, 2=5% ratio, 3=10% ratio, 4=20% ratio, 5=over 30% ratio.	IHS Markit estimate
4.4 Retail spend score	20%	Ranking of the growth in retail spend	Retail spend (USD) indexed in 2010; score of 1 refers to a 0% increase from base year, 2=10% increase, 3= 20% increase, 4= 40% increase, 5=60% increase or higher.	IHS Markit
4.5 Economic risk prevention score	10%	Ranking of the economic risk of a severe recession and market slowdown	IHS Markit economic risk ratings ranked against major capital cities; score of 1 refers to 0% percentile city (highest risk rate); 2=25% percentile, 3=50% percentile, 4=75% percentile, 5=100% percentile (lowest risk rate).	IHS Markit
4.6 Employment score	10%	Ranking of the employment rate	City employment rate ranked against major capital cities; score of 1 refers to 0% percentile city (lowest employment); 2=25% percentile, 3=50% percentile, 4=75% percentile, 5=100% percentile (highest employment).	IHS Markit
5=most positive score; 1=least positive score				

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