



Internet
of Things

MAXIMISING THE SMART CITIES OPPORTUNITY:

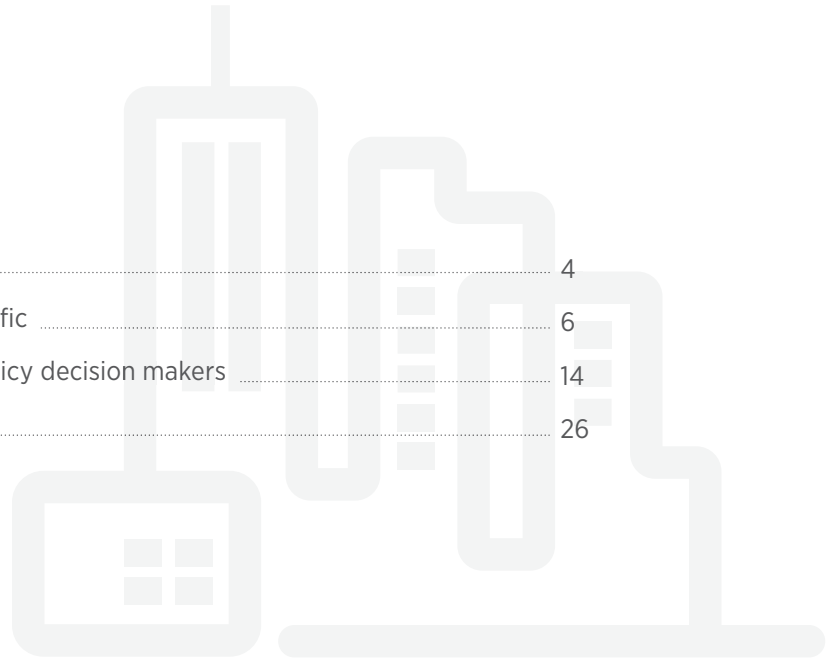
Recommendations for
Asia-Pacific policymakers

RECOMMENDATIONS FOR ASIA-PACIFIC POLICYMAKERS

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Executive Summary

Asian cities are facing pressing and complex challenges: reducing pollution and mitigating the consequences of climate change, efficiently managing economic resources, and improving the quality of life of citizens.

Air pollution, in particular, is a major health problem in Asian cities. Nearly 90% of air-pollution-related deaths occur in low-and middle-income countries, two out of three occurring in South-East Asia and Western Pacific regions.¹ As Asia has one of the highest rates of urbanisation in the world, its cities are increasingly congested: their transport and energy networks are under intense pressure. Cities in the region need appropriate infrastructure and services to attract and retain innovative businesses and highly skilled individuals.

City managers and local government decision makers can address these challenges and generate significant social and economic benefits for their citizens and businesses through well-conceived, designed and implemented smart city services. Internet of Things solutions, employing connected monitors, can save lives by enabling faster emergency services response, while minimising damage caused by flooding. Smart transport networks run more efficiently, reducing fuel costs and carbon emissions. Smart metering and smart buildings can save hundreds of GWh of energy in large Asian metropolis. Devising the right smart city policy can be challenging, as it can be difficult to quantify the tangible benefits of smart city solutions in the short-term. Moreover, policymakers need to raise the finance for projects, co-ordinate a number of

city departments, deal with legacy technology solutions and face questions on privacy and security risks.

Research by the GSMA, has identified seven key recommendations for municipalities looking to implement smart city solutions:

- 1.** Adopt an agile institutional framework and governance mechanisms: A smart city needs an institutional framework that ensures co-ordination and support throughout the lifetime of each project. The smart city agency will have to be agile and, ideally, independent from traditional city departments. It should, however, be accountable to a governance body on which the city institutions are represented.
- 2.** Appoint a CIO/smart city director with strategic vision: A strong vision and strategy is key to the success of smart city projects. A CIO/smart city director should be a project leader with cross-functional skills, capable of defining a long-term strategy. Rather than focusing on technology solutions, they will understand and analyse the city's needs and requirements. They will require appropriate authority to act efficiently, will have concrete objectives, and will be capable of bringing along those departments resisting innovation and change.

¹ WHO (2016)

3. Communicate effectively smart city project objectives and benefits: Establishing a dialogue with the local community is essential to ensure effective smart city services design and functionality. Digital media can help involve citizens in each step of the service lifetime and highlight tangible benefits that a smart city project will deliver.

4. Promote technology investment in open and scalable systems: A smart city should avoid relying on proprietary technologies tied to a single provider. Standards-based solutions are an essential foundation for the long-term evolution of a smart city. A city administration needs to think strategically and identify synergies: a new smart lighting system can be an opportunity to deploy additional services that use the same light poles, such as air pollution monitoring, the provision of Wi-Fi or security cameras.

5. Comply with privacy and security best practice, rather than defining new service-specific rules: To safeguard privacy and security, smart cities need to draw on industry best practice and comply with national laws. Having worked extensively in these areas, the GSMA makes available privacy tools, security guidelines and check lists to policymakers and industry players. Local city managers should resist the temptation to define their own data privacy and security standards for services they launch and adopt in their own city.

6. Make city data available to promote transparency and stimulate innovation: Cities generate a wealth of data related to transport, to the environment, health, demographics, and services accessibility. While protecting individuals' privacy, city managers should look to make data accessible to promote transparency and stimulate the creation of innovative services. Some cities already have portals that make data available in accessible formats.

7. Explore new models of funding: Smart city projects require significant initial investment. Smart city managers should explore public private partnerships or alternative finance mechanisms, such as municipal bonds, development banks or vendor finance.

Internet of Things technologies and smart city applications can generate substantial socio-economic benefits for citizens and businesses in Asia. Policymakers should make the most of this opportunity, by designing and implementing smart city projects with a long term vision, that are defined around citizens' needs, are managed through agile governance structures, are based on open and scalable systems and promote a culture of openness, innovation and transparency.

1. Introduction

There isn't a single definition of smart city. What is technologically 'smart' varies and develops over time, with regional and cultural sensitivity, the stage of development of the country, the citizens' level of education and technological competence.

Broadly speaking, most cities need to become more accessible, green, safe and liveable spaces. Traffic, pollution, security and access to public services are all areas where ICT technologies and Internet of things (IoT) solutions can make a major difference.

A myriad of applications already enable 'smart' interactions with city services. There are smart phone apps for mapping, transport, goods delivery, utility monitoring, ticketing and other aspects of urban life. However, a 'smart city' is a broader concept: Technological advances have enabled city administrators to implement a vision that profoundly transforms the functioning of a city and how people experience it.

The Wireless Broadband Alliance, for example, defines a smart city in terms of vision, as well as technology: "A smart city is an urban development vision to integrate IoT technology to manage assets, connect people and processes to improve efficiency, sustainability, citizens' quality of life and businesses and city agency performance, creating a safer environment and promoting socio economic development."²

For many years, the GSMA has been active in a programme aimed at developing and accelerating the deployment of mobile-based IoT solutions, including smart city services. It publishes a variety of material on the IoT and smart cities, including case studies, report and audio-visual material, which is all publicly available on the GSMA website³.

Representing over 800 mobile operators and more than 300 companies from the wider technology ecosystems, including vendors, technology providers, and system integrators, the GSMA understands the potential of technology to make urban development visions a tangible reality.

² Connected city blue print- (2016) connected city advisory board – Wireless Broadband alliance.

³ For more information please access the Smart city section <http://www.gsma.com/iot/smart-cities/>

Asia Pacific cities are becoming central nodes of global economic growth, but face increasing congestion and unprecedented environmental and resource management challenges. Smart cities that better allocate resources and improve the quality of life of citizens are likely to bring substantial socio-economic benefits both for the region and the world at large.

Mobile operators can be knowledgeable partners to Asian cities and are well positioned to understand local dynamics, as well as international best practices. Most operators have a local presence and run advanced, secure networks designed to scale and support innovative smart city services. Based on the GSMA's previous work, our members' experience in the field, and on extensive research, we have developed a set of specific recommendations for Asia Pacific

policymakers and regulators, both at a central and local level, to maximise the benefits that smart city projects can generate for their citizens and businesses. Where possible, these recommendations are corroborated with case studies.

The next section of this paper describes the three main challenges that Asian cities face, and how smart city projects can help to alleviate these burdens. The subsequent section then describes the key steps that policymakers should follow when undertaking a smart city project.

“ Smart cities that better allocate resources and improve the quality of life of citizens are likely to bring substantial socio-economic benefits both for the region and the world at large. ”



2. Priorities for smart cities in Asia Pacific

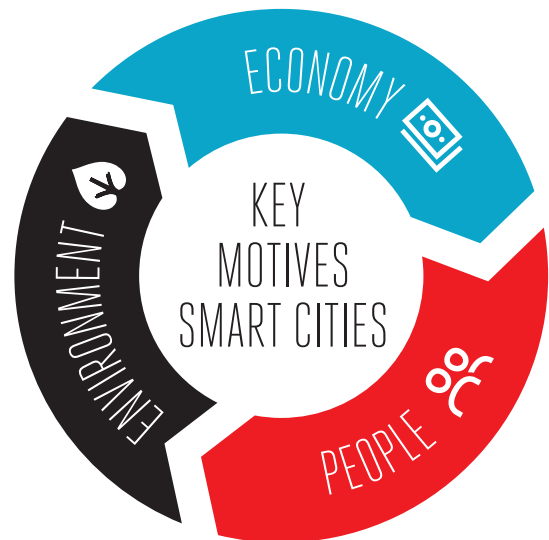
Asian cities typically have high-level priorities in three areas: environment, economy and people. In each of these areas, well-conceived and implemented smart city projects can make a real difference to Asian citizens and businesses.

Environmental priorities include reducing pollution and managing disasters, as well as containing energy consumption. Economic priorities revolve around the efficient management of public services. With respect to people, priorities include improving the quality of citizens' life by making cities safer and providing more accessible services.

Smart city solutions combining existing communication networks and innovative technology solutions can reduce the risk of loss of life and damage to property in natural disasters; minimise emergency services' response times, facilitate access to remote and risky locations, reduce traffic congestion and energy consumption, help design better public services, and make cities more attractive to businesses and high level professionals.

There is a strong inter-dependence across these three macro areas; a good quality of life, including

more efficient services and a healthy environment, draws talented people to the city. This human capital is one of the factors that businesses assess when selecting where to invest. Businesses and people, in turn, have an impact on the environment, which needs to be managed effectively.



ENVIRONMENT: REDUCING POLLUTION AND MITIGATING THE CONSEQUENCES OF CLIMATE CHANGE

Pollution

Air pollution is a major problem for Asian cities. In 2012, an estimated 6.5 million deaths globally (11.6% of all global deaths) were associated with indoor or outdoor air pollution. Nearly 90% of air-pollution-related deaths occur in low- and middle-income countries, with nearly two out of three occurring in South-East Asia and the Western Pacific region.⁴

Delhi in India has the highest level of PM10 (suspended particulate matter of 10 micrometres or less) in the world⁵. Nearly all the cities in South East Asia monitored by the World Health Organization have a level of PM (either PM 2.5 or PM10) above the WHO's air quality guidelines. Even more worryingly, the problem is getting worse: On average, pollution has increased over 5% over the past five years.

Major sources of air pollution include inefficient modes of transport, household fuel and waste burning, coal-fired power plants, and industrial activities.

Despite the threat to human health, the number of cities in South-East Asia in which air pollution is appropriately monitored is very low, when compared, for example, with American and European cities. Yet the availability of good quality air pollution data is required to devise effective strategies to address this problem.

Still, developing Asian countries, in particular, are moving environmental issues up the agenda. For example, Indonesia, Malaysia and the Philippines have all announced ambition emission reduction targets for 2020. Pollution, water management and deforestation are all critical issues caused by, or impacting, climate change⁶.

At the Paris Climate Conference in December 2015, 195 countries committed to reducing greenhouse gas emissions through nationally determined contributions. Asian countries have committed to either absolute reductions or reductions in the speed of growth of emissions⁷.

Disaster prevention

Cities worldwide are trying to build up resilience to natural disasters, such as extreme weather, flooding, heat and water stress, caused by climate change. South-East Asia, in particular, is highly vulnerable to climate change-related disasters, as a large proportion of the population and economic activity is concentrated along coastlines, which could be impacted by rises in the sea level. The region is heavily reliant on agriculture, natural resources and forestry; and the level of extreme poverty remains high.⁸

Technology is changing the way societies respond to natural disasters. Connected sensors can alert agencies across the globe, as soon as a natural disaster event is detected.

To obtain detailed local information and help manage the response to these kinds of events, cities and other agencies have deployed their own connected sensors and cameras using mobile technologies and services.

⁴ WHO (2016)

⁵ http://www.who.int/phe/health_topics/outdoorair/databases/AAP_database_summary_results_2016_v02.pdf?ua=1. PM10 refers to suspended dust particles of the size of a fraction of a human air. Exposure to high concentrations of PM10 can result in a number of health impacts ranging from coughing and wheezing to asthma attacks and bronchitis to high blood pressure, heart attack, strokes and premature death.

^{6&7} <https://www.adb.org/sites/default/files/publication/156203/adbi-wp348.pdf>

<https://www.adb.org/news/op-ed/how-will-asean-members-cope-their-climate-change-challenge>

<http://environment.asean.org/asean-working-group-on-climate-change/>

⁸ ASEAN - <http://environment.asean.org/asean-working-group-on-climate-change/>

TAINAN: CLIMATE CHANGE AND EXTREME WEATHER

The fifth largest city in Taiwan, Tainan is densely populated with about 1.9 million inhabitants. It is located at the confluence of several major rivers that flow through an extensive low-lying delta into the sea. Much of the newer parts of the city are built on reclaimed land and are vulnerable to flooding following extreme weather events. This volcanic, tropical island is also frequently hit by typhoons during the monsoon season that can deliver several hundred millimetres of rain in a single day, often many times in a single year.

Over the years, Taiwan has earned international recognition for its expertise in the forecasting of, and response to, extreme weather. As part of a government initiative to improve its extreme weather response, the national Water Resource Agency is working with the city of Tainan and mobile operator Far East Tone (FET) to develop capabilities to improve flood control and disaster recovery.

The partners are using high availability LTE mobile communication services, coupled with advanced monitoring devices and surveillance technologies, to deliver a comprehensive state-of-the-art solution. The high data throughput and low latency characteristics of FET's ubiquitous LTE network enable a range of low cost IoT technologies that can enable:

- **Near real time, data collection, data analysis and dissemination of results;**
- **Water resource monitoring, through real time pumping station and water level monitoring;**
- **Disaster awareness planning, through water level monitoring, analysis and flood prediction warnings;**
- **Emergency information broadcasts, through real-time flood warnings and information sharing via mobile applications;**
- **Distributed data backup, through distributed replicated data stores to provide high data availability at all times;**
- **Cross-agency integration of key data flows to deliver faster disaster response.**

With all this new data made available in real time, the Water Resource Agency and other agencies have better visibility of events as they unfold and are in a better position to plan and respond accordingly. Through this combination of advanced monitoring technology, high-bandwidth mobile communications and a dedicated, well-trained and well-managed workforce;

- **Emergency assets can be deployed faster, to where they can be the most effective;**
- **Flood prevention equipment can be accessed remotely, enabling faster response times;**
- **Flooding can sometimes be avoided or minimised;**
- **Water supplies and other utilities can be restored faster;**
- **The risk of loss of life is reduced;**
- **The risk of property damage is reduced.**

Source: GSMA smart cities guides: Water management
<http://www.gsma.com/iot/gsma-smart-cities-guide-water-management/>

ECONOMY: MANAGING RESOURCES EFFICIENTLY AND INVESTING IN CORE INFRASTRUCTURE

Asia is experiencing rapid and accelerating urbanisation. Many Asian cities were built on infrastructure that was designed for a population far smaller and less active than that they have today. The result is congested cities. With millions migrating to Asian cities each year, demand for energy, transportation and healthcare systems is rising dramatically.

To make the most of existing resources, it is important that cities get technologically smart as quickly as possible. Smart city solutions are the key to managing costs, increasing efficiency and reducing congestion.

In the transport domain, for example, the Chinese city of Zhenjiang reduced fuel costs by USD2.7 million and carbon emissions by 6,700 tonnes through the implementation of an IoT technology based control centre to monitor public buses⁹.

Having detailed insights on how demand for transport develops in a city over time and along which routes citizens move, can have a significant economic impact. A MasterCard demand management study for transport services found that for every one percent of passengers that a large city could divert to less busy routes at peak times, it would save approximately USD 30 million.¹⁰

Smart city projects can also improve energy efficiency and reduce emissions. China's 2011

five-year plan includes many smart city projects designed to help reduce China's carbon intensity¹¹ by 20%. The country's 2020 goal is to further reduce carbon intensity by 40–45%.

Smart grid and smart metering technologies are the key energy efficiency and management solutions used by smart cities. Smart metering technologies track power usage and can provide tips or notifications to help users reduce their utility bill, leading to lower total consumption. Businesses can also be incentivised to operate heavy electrical workloads during off-peak hours.

Siemens estimates that smart buildings can generate electricity savings of 15 GWh and heat efficiencies of 111 GWh¹² in a mega city of 10 million inhabitants. While up front capital investment can be daunting, the long term socio-economic benefits will far outweigh the costs.

Smart grid technologies improve the integration of irregular, renewable generation methods, such as solar and wind power, into the grid. Moreover, digital substations and high efficiency transmission solutions can better manage electricity generation and demand.

Effectively managing infrastructure lowers costs, increases productivity, helps environmental objectives, and improves competitiveness. To attract a skilled workforce, Asian cities need to provide developed infrastructure, including ICT, and a high quality of life. This in turn attracts new businesses and human capital and enhances the potential economic growth of the city itself.

⁹ <https://www.futurereadysingapore.com/2016/automating-asias-smart-cities.html>

¹⁰ MasterCard insight based on work with various cities. See for example UI Labs and Mastercard to inform better demand management here: <http://newsroom.mastercard.com/press-releases/mastercard-joins-ui-labs-city-digital-adding-new-data-analytics-capabilities/>

¹¹ Amount of carbon dioxide released for energy production.

¹² Julie Alexander - Siemens - presenting at Smart IoT presentation (2017) referring to savings that can be generated in a city the size of London. 15 GWh is enough to power 4,200 households for an entire year; 111 GWh is enough gas supply for 8,800 households for an entire year, in both cases assuming an average household consumption

UNITED NATIONS SUSTAINABLE DEVELOPMENT GOALS AND THE GSMA

Since 2016, the United Nations and the GSMA have been working together to increase awareness of the 17 UN Sustainable Developments Goals (SDGs). The GSMA is harnessing the capabilities of the mobile industry, which has the potential to accelerate awareness and adoption in a way that no other sector can, to advance progress towards the Goals.

The agenda set forth by the SDGs is far-reaching and ambitious, from ensuring healthy lives and promoting well-being for all, to achieving gender equality, to making cities and settlements inclusive, safe, resilient and sustainable, to helping to combat climate change and its impacts.

In February 2017, the GSMA launched the “Big Data for Social Good” initiative, which is leveraging mobile operators’ big data capabilities to address humanitarian crises, including epidemics and natural disasters. The impact of humanitarian crises such as epidemics and disasters is staggering. Each year, 15 million people die and millions more become seriously ill as a result of infectious diseases, which are spread through human contact as well as other sources, such as mosquitoes*.

The GSMA IoT programme has identified the mobile sector’s potential contribution to specific Goals related to smart cities, in particular SDG 11 on sustainable cities and communities:

📌 **SDG Target 11.2- By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons.**

The GSMA IoT programme has created a number of case studies on crowd and transport management. In Singapore, StarHub has deployed the Grid 360 service to enable the city to examine different data sets, as new transport options come online and routing options become more complex. These sets include aggregated and anonymous geo-location data to understand crowd densities, travel patterns and profiling of traveller groups.

📌 **SDG Target 11.5: By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global GDP caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations.**

By working with the cities’ health authorities, Far EasTone has been able to map the location of dengue fever cases reported at local health centres and identify the areas where most infections occur. Using this data, FET was able to work with cities to remotely track where mosquito repellent can be used to kill off the local mosquito population and prevent further spread of the disease.

*Sources:

GSMA press release: <http://www.gsma.com/betterfuture/wp-content/uploads/2017/02/GSMA-press-release-v15.pdf>

2016 Mobile Industry Impact Report: Sustainable Development Goals http://www.gsma.com/betterfuture/wp-content/uploads/2016/09/_UN_SDG_Report_FULL_R1_WEB_Singles_LOW.pdf

Project Grid 360: <http://www.gsma.com/iot/wp-content/uploads/2016/10/GSMA-Crowd-management-case-study-web.pdf>

Dengue Fever: http://www.gsma.com/iot/wp-content/uploads/2016/09/cl_tainan_cs_web_09_16.pdf

PEOPLE:

A HIGH QUALITY OF LIFE ATTRACTS AND RETAINS HUMAN CAPITAL

Whether a city is smart or not will ultimately be for its citizens to judge. Their level of satisfaction with the services they receive will be more important than any other indicator. Achieving a high quality of life requires easy and efficient access to public services, effective transport systems and health services. Asian cities are at the heart of the region's economic growth. They compete to attract the best professionals and businesses. Increasing quality of life, which will attract and retain human capital, should be a key priority for smart city strategies.

Cities pursuing this approach have made good progress. Hong Kong, Shanghai and Singapore have invested in telecom and ICT infrastructure to support smart city applications and services that have improved quality of life, attracting human capital and inward investment from existing and new businesses and increasing their competitiveness.

The availability of human capital is one of the criteria used by AT Kearney's Global¹³, and Citigroup's city indexes¹⁴ to rank cities worldwide. Public safety is another key criteria for attracting human capital. The Economist Safe City index measures, among other factors, infrastructure and personal safety to rank cities. On this index, Tokyo and Singapore ranked highest among Asian cities.

Technology is increasingly being used to improve urban safety. Data is being used to tackle crime, monitor infrastructure and limit the spread of diseases. In the developed world, cities are developing predictive capabilities, rather than simply reacting to crises. By contrast, the diversity of security threats and the lack of data in emerging markets could exacerbate the divide between developed and emerging economies.¹⁵

¹³ <https://www.atkearney.com/research-studies/global-cities-index>

¹⁴ <http://www.citigroup.com/citi/citiforcities/pdfs/hotspots2025.pdf>

¹⁵ <http://safecities.economist.com/report/safe-cities-index-white-paper/>

SINGAPORE IS IMPROVING URBAN LIVING STANDARDS TO ATTRACT NEW TALENT

An early adopter of smart city technologies, Singapore has sought to improve its quality of life and attract new talent to the country. In 2014, the prime minister launched the Smart Nation programme to coordinate and promote ongoing smart city projects. Now supporting 14 projects, the Smart Nation programme operates from the Prime Minister's office. The projects are led by the appropriate department of government, which for most smart city projects is the Housing and Development Board or the Land Transport Authority.

To improve quality of life and attract new talent, Singapore's projects focus on reducing the cost of living, and improving transport and commuting. For example, Singapore's Intelligent Transport System, which has been developed with open data, includes automatic accident detection, real time traffic information services and connected vehicles. The city is also planning an on-demand driverless car service for transporting passengers over the first and last miles of their journeys. Smart home projects have sought to reduce the cost of living by introducing smart electricity and water meters, and an elderly person monitoring system automatically provides notifications to caregivers, reducing the need for expensive care support.

Sources of funding are rarely announced, but most projects are likely to have been funded or heavily subsidised by the government. Singapore's national R&D spending is approximately 1% of GDP, while the Research, Innovation and Enterprise 2020 master plan set aside USD13.6 billion for innovation and technology adoption. Government departments have also announced their own innovation budgets, such as the LTA's USD35.8 million innovation fund for the development of new transport systems since 2006. In 2016, the Energy Market Authority made research grants totalling USD19.3 million for innovations in gas technology and smart grids.

Source: Smart Nation programme (Singapore, 2017), Why Smart Nation.
Available at <https://www.smartnation.sg/about-smart-nation>.

National Research Foundation (Singapore, 2016), RIE2020 Plan

Energy Market Authority (Singapore, 2016),
Available at https://www.ema.gov.sg/media_release.aspx?news_sid=20160318jXUXUoRhsvpQ.

SMART CITIES AND MOBILE: LPWA NETWORKS FOR THE MOBILE IOT

Mobile networks can enable secure, scalable and robust smart city solutions. As well as being well placed to understand both local city dynamics and international best practices, mobile operators typically have a commercial presence in the city and run advanced and secure networks that can scale easily.

But this is just a starting point. The mobile industry is now deploying networks specifically designed to support the Internet of Things (IoT). The GSMA IoT programme's Mobile IoT initiative is designed to accelerate the commercial availability of low power wide area (LPWA) solutions in licensed spectrum, which will be a key enabler for smart city applications. Mobile networks can now support these Mobile IoT technologies, following standardisation by 3GPP in June 2016. Vodafone, for example, has launched NB-IoT networks in Spain.¹

Mobile IoT technologies offer very low power consumption (with battery duration in excess of 10 years for some applications), very low modules costs, optimisation for the very brief messages typical of IoT applications, good indoor and extended outdoor coverage, scalability, security, easy maintenance and integration into unified IoT platforms.

Mobile IoT connectivity can enable simple on/off type applications, such as street lamp controls, air quality monitoring, and basic status updates for many types of sensors, including those that are battery powered and located in inaccessible places for many years.

In summary, Mobile IoT networks are ideal to connect parking sensors, streetlights, weather stations, and many other devices which enable smart city solutions.



3. Recommendations for smart city policy decision makers

Undertaking a new smart city project can be a daunting exercise for a mayor or a city manager, particularly in cases where resources are very limited, there is rigorous public scrutiny and pressure to deliver an early result. Most often, city managers face challenges related to the complexity of projects, the need to raise finance and orchestrate different divisions, and limits imposed by legacy equipment.

At the same time, studies quantifying the benefits of smart city projects conclude that investing in digital technologies can yield significant economic and financial gains¹⁶. A selection of projects in European cities assessed by Siemens, found that they can generate a significantly positive net economic value when assessed over a 35 year lifespan. Depending on the type of project considered, the payback period varies significantly, typically ranging between five and eleven years. That can be a long time and a risky exercise for an elected decision maker who wants to deliver results fast and has financial constraints.

City managers tend to have similar questions and face similar challenges: Will data be accurate enough to produce actionable information? Will it be secure? How will I ensure co-operation from every department in the municipality? How to pay for and support the IT infrastructure

installation and maintenance? What if I want to add more services in the future?

Based on our members' experiences in deploying real world smart city services and on our extensive research in the field, the GSMA believes that the impact of a smart city project can be maximised and city managers' anxieties appeased if a few, simple recommendations are followed.

Below are seven basic recommendations, supported by case studies where available:

1) Adopt an agile institutional frame work and governance mechanisms:



Realising the full potential of a smart city project depends upon alignment and co-operation between cities, government, local companies and

¹⁶ Julie Alexander - Siemens - presenting at Smart IoT London event (2017)

citizens. Defining the right framework and governance for the projects to ensure flexibility and accountability is an important initial step.

Interactions between central, local government and the private sectors vary across the Asia-Pacific region, and depend upon the size of the city or the nation where the smart city programme is being implemented.

In the case of India, for example, the government requires cities to create a private entity (known as a special purpose vehicle) to plan, approve, fund, implement, manage and evaluate smart city projects under the national framework (see box).

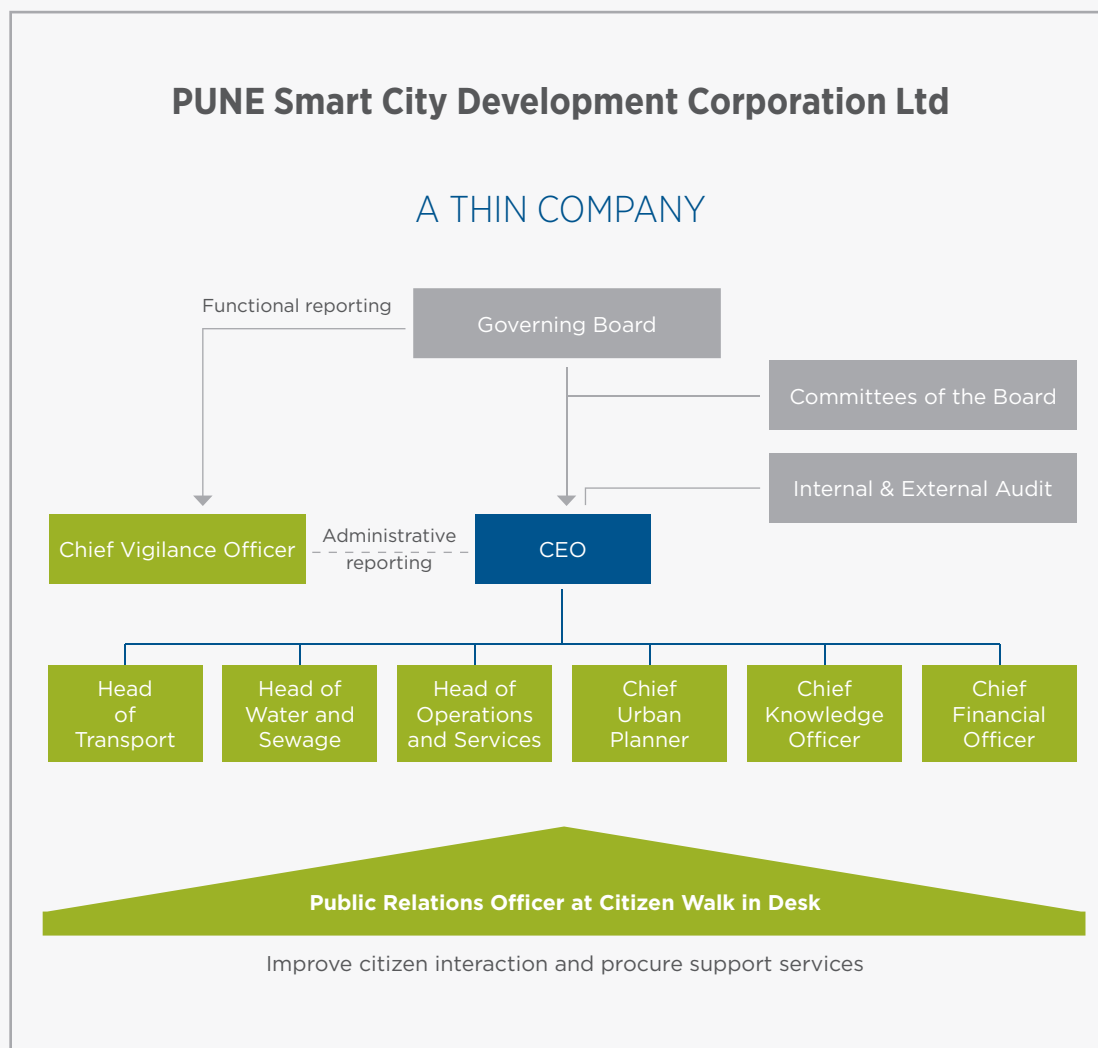
India: Special purpose vehicles for smart cities project

In 2015, India announced an ambitious smart city strategy; the government revealed plans to build 100 smart cities over the next five years. The Smart Cities Mission, a division of the Ministry of Urban Development, oversees the initiative and is responsible for the city selection process and the allocation of government funding. The Indian government has selected 97 smart cities to be developed over the next few years, after a rigorous 2 stage competition on various parameters and evaluated by experts.

As part of the process, each selected city is obliged to set up a special purpose vehicle (SPV) to develop, manage and implement the smart city strategy as well as taking responsibility for the release of funds. As of now, it seems 59 SPVs have been formed. The national government releases smart city funding for the SPV, which must be matched by the state and urban local body (ULB) governments. The state and the ULB

must take an equal share in the SPV, and they may invite private or financial investors to take an equity stake so long as the state/ULB retains a majority shareholding. The SPV will become a limited company and be registered under the companies' act.

The SPV can be a more efficient vehicle than state or local government for driving a new venture. New ventures, such as smart city projects, require a different and more agile approach independent from traditional government operations to expedite the smart city project. The SPV enables innovative approaches to raising financing and more flexible procurement processes than state-owned structures, which can be notoriously bureaucratic and time-consuming. A SPV can develop its own procurement methods aligned to the type and size of businesses that are typically involved in smart cities, many of which could be small start-ups.



The city of Pune's SPV - Pune Smart City Development Corporation Ltd. (PSCDCL) - has taken the innovative approach of creating a 'thin' structure. The organisational structure shown above includes head of various service departments, as well as a Chief Knowledge Officer and a Public Relations Officer at the Citizen Walk-In desk. At this initial stage, there is a strong focus on financing and the SPV's task of sourcing the funding for the projects. As the projects commence, there will be more focus on implementation.

Sources:

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- <http://www.punsmartcity.in>
- <http://www.makeinindia.com/article/-/v/internet-of-things>
- <http://indianexpress.com/article/cities/pune/pune-now-1250-eyes-to-watch-over-you/>
- <http://www.urbanaworld.com/google-bags-first-city-station-wi-fi-deal-from-pune-smart-city-development-corporation/>

2) Appoint a key stakeholder capable of delivering a holistic vision



It is widely viewed as best practice to appoint a key stakeholder (a CIO or smart city director) with the relevant authority to direct and oversee smart city projects across the municipal structure to avoid fragmentation or duplication of effort. This key stakeholder will require the appropriate level of authority to act efficiently, will be targeted with objectives such as resources or energy savings, and will report directly to the Chief Executive.

Most smart cities projects require co-operation between teams that do not typically work together, such as different regulatory bodies (e.g. telecom

and energy) or local divisions of the same city (e.g. in charge of street lights, waste management). Close collaboration to a common goal is vital to the success of the project. This should be one of the key responsibilities of the key stakeholder.

A CIO, for example, could produce a strategy capable of bringing along all agencies in a city, overcoming the lack of co-operation, the fear in exchanging data, the insufficient funding and ultimately the cultural resistance in the city's departments. Rather than a focus on the technology or the solution, the CIO needs to define and formulate the needs that citizens have, build an understanding of the various options and the long-term strategy, and be able to effectively communicate the benefits.

Smart city leaders

- ▲ **Singapore:** One of the most advanced smart cities in the world, Singapore has given its CIO responsibility for the GovTech agency formed to oversee innovation for the Smart Nation strategy. The CIO is leading a number of advanced smart city projects including Virtual Singapore, and Beeline, an app for citizens without easy access to public services, that crowdsources bus routes.
- ▲ **Hong Kong** is a developed smart city with some applications dating back to the start of the twenty-first century. Central to Hong Kong's smart city development is the Digital 21 strategy which focuses on cloud computing, IoT and big data and defines several smart city projects. The Hong Kong government's CIO is responsible for the policies, strategies and programmes encompassed by the Digital 21 Strategy.
- ▲ **Barcelona:** One of the most advanced smart cities in Europe, Barcelona has had a smart city co-ordinator for many years. Her objectives are to oversee smart city initiatives and coordinate them across departments and, most importantly, to define a long-term strategic vision for the city.

Sources:

<http://readwrite.com/2016/10/12/singapore-cio-smart-city-iot-cl1/>

Commerce and Economic Development Bureau (Hong Kong, 2013), Public Consultation on 2014 Digital 21 Strategy. Available at

<http://www.digital21.gov.hk/eng/relatedDoc/download/2014D21S-booklet.pdf>.

http://www.cisco.com/assets/global/ZA/tomorrow-starts-here/pdf/barcelona_jurisdiction_profile_za.pdf

What sets successful smart city projects apart is that they are based on a holistic vision and the leadership required to enable collaboration across government departments to develop a common and coordinated implementation plan. For example, in the case of Barcelona, one key step has been the establishment of a Smart City Strategy team within the mayor's office. The office is charged with promoting and coordinating smart city application development throughout the city organisation. This high-level political support has been crucial to the city's ability to develop smart city projects.¹⁷

3) Communicate to the local community the aim, benefits and challenges of smart city projects



Smart city projects are most likely to be successful if local stakeholders (e.g. citizens, local companies, utilities, hospitals, schools) understand the goals and can help shape them. The long term benefits and project challenges need to be explained. Citizens must be central to each project, as the projects are ultimately funded by taxpayers. Many cities use portals and apps to actively engage with their citizens to give them an opportunity to voice their opinions and feedback.

City portals, apps and stories

- ▲ **<http://www.smartcitybhubaneswar.gov.in>:** Bhubaneswar is the capital of the Indian state of Odisha and a centre of economic and religious importance in eastern India. Bhubaneswar has a well-established smart city programme. The city actively engages with its citizens to inform them of, and seek feedback on, its smart city proposals, respond to polls, participate in contests and discussion forums. Bhubaneswar is setting up smart city labs in colleges, universities and other public localities to engage with its citizens as well as using online and social media. It regularly polls its citizens on its proposals and services.
- ▲ **<http://pictureadelaide.com.au/>:** Picture Adelaide 2040 is an ambitious community engagement initiative undertaken by Adelaide City Council in Australia to inform the development of several plans for the city and its park lands. The portal enabled citizens to express opinions and describe their use of city infrastructure and facilities including parks.
- ▲ **OneService app:** Singapore has developed an app that enables citizens to report problems. The app enables geo-tagging and uploading of photos to help citizens report a problem without having to identify the government department responsible.

Sources:

<http://www.smartcitybhubaneswar.gov.in>
<http://pictureadelaide.com.au/>

¹⁷ http://www.cisco.com/assets/global/ZA/tomorrow-starts-here/pdf/barcelona_jurisdiction_profile_za.pdf

The box above outlines some examples where cities have adopted an open and effective communication channel with their citizens.

Soliciting feedback at the design stage, such as in the case of Adelaide, involves the community and helps implement services that are more in line with citizens' needs and expectations. However, effective communication should continue during each step of a city project: opportunities should be provided for citizens to comment and improve existing services, while results should be communicated on an annual basis.

Digital media provides multiple ways of engaging with citizens; it can be used to survey and understand citizen requirements, needs, and

feelings. In any case, citizens will use it to provide "feedback" on the city...solicited or not!

4) Promote technology investment in open, scalable systems



Cities contain hundreds of systems and services. Not all services have to become smart, but having them linked by a common infrastructure and standards-based technologies is an essential foundation based upon which the long-term evolution of a smart city can be built. As the deployed technology will need to last many years (often more than a decade), it must be cost-effective and flexible enough to support many services in the future.

One platform many services

- ▲ **AT&T and Current – powered by GE:** Smart lighting applications have the potential to go beyond energy savings. Lamp posts can also be used as a platform for other services. Since launching its Smart Cities organisation in 2015, AT&T has been using its resources and IoT expertise to develop impactful solutions for cities. By employing GE's Predix-based IoT platform, AT&T is using outdoor LED lighting in a city to create a digital infrastructure that helps improve traffic flow and optimise parking, detect gunshots on city streets, monitor air quality and warn of extreme weather. AT&T is working with the City of San Diego to upgrade thousands of the city's outdoor light fixtures to sensor-enabled LED technology. AT&T will provide highly secure connectivity for the San Diego deployment, which is expected to save the city approximately \$2.4 million in annual energy costs.

Source: GSMA



A city should avoid proprietary technologies that tie it into a single provider. Standards-based solutions provide more flexible options in the longer term and insulate the city from a key vendor running into financial or technical problems. Competition among different suppliers can also mean lower costs than proprietary solutions in the long term.

Besides, many components of a smart city solution (e.g. communication networks, cyber security, data analytics tools) can be applied and shared across a multitude of different services: from smart metering to traffic management, smart street-lights. Sharing components in this way should reduce set up and maintenance costs.



5) Comply with privacy and security as defined by central government rules and best practice



Privacy and security are of growing importance in an age defined by the rapid take-up of digital services. They will be critical in determining the success of all IoT services, including smart city applications. Widespread adoption of IoT solutions will depend on the trust and confidence people place in the providers and in the way they use private data.

The GSMA has conducted extensive research on individuals' attitudes towards privacy¹⁸, which confirms that privacy concerns can deter consumers from using mobile services. The same applies for IoT and smart city applications when the end user does not understand or trust the way their data is handled.

However, privacy and security rules cannot and should not be defined at a local level. Although CIOs, smart city managers and local government should take full account of privacy and security when designing their services, they should resist the temptation to define specific data privacy and security standards for the services they launch and adopt in their own city.

Data protection and privacy laws and regulations are generally defined at a national, rather than city, level. Cities need to ensure that they comply with national laws and regulations, as well as international industry best practice.

Equally in the case of security regulation, to avoid duplication, cities should comply with nationally-determined cyber security legislation and best practice.

The GSMA takes security and privacy very seriously and believes that smart city services should embrace these principles at the early stages of their design. To support such an approach, the GSMA has defined a set of 'Mobile Privacy Principles'¹⁹ and 'Privacy Design Guidelines for Mobile Application Developers'²⁰, as well as developing a decision tree tool to help organisations assess the way they should treat customer data (see box).



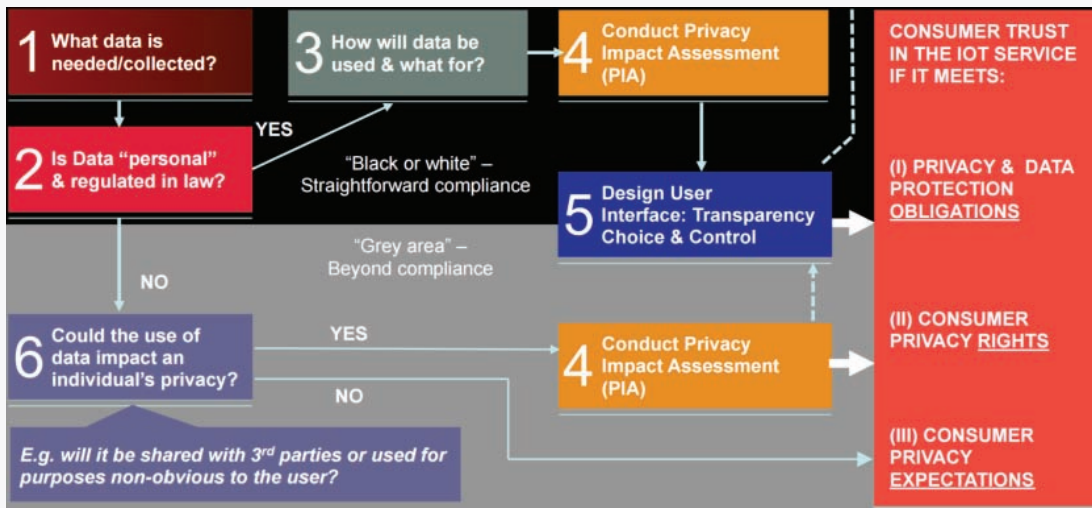
¹⁸ GSMA mobile privacy and consumer research (2014) <http://www.gsma.com/publicpolicy/mobile-privacy-consumer-research-insights-and-considerations-for-policy-makers>

¹⁹ GSMA (2012) Mobile privacy principles –Promoting consumer privacy in the mobile ecosystem http://www.gsma.com/publicpolicy/wp-content/uploads/2016/02/GSMA2016_Guidelines_Mobile_Privacy_Principles.pdf

²⁰ GSMA (2012) Privacy design guidelines for mobile application developers - http://www.gsma.com/publicpolicy/wp-content/uploads/2016/09/GSMA2012_Guidelines_PrivacyDesignGuidelinesForMobileApplicationDevelopment_English.pdf

The GSMA's IoT privacy-by-design decision tree

The GSMA's IoT privacy-by-design decision tree captures six core privacy principles that all entities dealing with consumers' data should consider before launching a service or product.



The decision tree is part of a set of tools that the GSMA has published to help organisations assess whether their services are capable of winning consumers' trust when it comes to privacy. To find out more about the GSMA and privacy, access the GSMA knowledge base on IoT/privacy and data protection.

Source: GSMA (2016) : <http://www.gsma.com/iot/wp-content/uploads/2016/09/IoT-%E2%80%98Privacy-By-Design%E2%80%99-decision-tree.pdf>

SECURITY

Security issues can be a significant inhibitor to the deployment of many new IoT services. Mobile operators have a long history of providing secure products and services to their consumers. To help ensure that IoT services coming to market are secure, mobile operators, together with their network, service and device suppliers, have built up significant security expertise that they can share with cities and services providers developing IoT solutions.

GSMA security guidelines and smart cities applications

Smart city applications raise the same kinds of cyber-security issues as those related to existing internet services, namely how to protect the availability, identity, privacy and integrity of the service components. One of the specific challenges of IoT services is how to secure devices that can be low complexity, low power, have long lifecycles and are physically accessible to attack.

For example, a connected parking meter in a smart city may need to be low cost, run on a solar powered power supply, be secure for ten years and be deployed on a public street which is accessible for 24 hours a day. Securely implementing such a product is non-trivial, as many physical and cyber security-related challenges will need to be addressed.

The mobile industry, which the GSMA represents, has a long history of providing secure products and services to its customers. To help ensure that new IoT services, including smart city services, coming to market are secure, mobile operators, together with their network, service and device equipment partners, have produced a set of security guidelines for service providers.

The GSMA guideline documents promote a methodology for developing secure IoT services to ensure security best practices are implemented throughout the life cycle of the service. The documents provide recommendations on how to mitigate common security threats and weaknesses within IoT services.

Source: The GSMA Security Guidelines are available at the following link: <http://www.gsma.com/iot/future-iot-networks/iot-security-guidelines>

6) Make city data available to promote transparency and stimulate innovation



Cities generate a wealth of data sets encompassing transport, the environment, health, demographics, services accessibility and other areas. While protecting privacy and maintaining public trust, city managers should make valuable data accessible so that it can easily be used by citizens and commercial entities to create innovative services.

As well as providing one-stop access to a city's information, sharing data helps communication and analysis, more transparent and efficient policymaking, and, most importantly, creates value by catalysing the development of innovative apps and services.

Some examples of well-established city "data stores" are:

- ▲ **Chicago:** offering open access to over 1,000 data series²¹

²¹ <https://data.cityofchicago.org>



City data is an incredibly important asset and is the foundation upon which smart cities vision will be built



▲ **London:** The Greater London Authority makes available 705 data sets on its London data store²²

▲ **Copenhagen:** The city data exchange provides a service for the sale, purchase and sharing of a wide variety of data from multiple sources between all types of users in a city – citizens, city government and businesses.²³

▲ **Singapore:** A central government initiative, 'Data.gov.sg',²⁴ was launched in 2011 as a one-stop portal for publicly-available datasets from 70 government agencies. More than 100 apps have been created using this data. Singapore's data sharing principles for open data are:

- Made easily accessible,
- Available for co-creation
- Released in a timely manner
- Shared in machine-readable format
- As raw as possible

▲ **Melbourne:** The city of Melbourne has built a portal²⁵ to make data available on a non-commercial basis. As in Singapore, the data is made available according to five open data principles:

- Available for open use
- Free
- In accessible formats and easy to find
- Released within set standards and accountabilities
- The community should have the opportunity to continuously engage with the city's open data programme.

▲ Melbourne is also making available a growing catalogue²⁶ of data sets grouped under assets and by category, such as infrastructure, economy and environment.

Whether used by decision makers, researchers, media, entrepreneurs, city event planners, or application developers, city data is an increasingly valuable asset that city managers can capitalise on:

"City data is an incredibly important asset and is the foundation upon which smart cities vision will be built. Providing efficient access to public and private sector and citizen's data has the potential to enhance and transform both government and businesses services, as well as stimulate innovation in city services to the benefit of everyone"²⁷.

²² <https://data.london.gov.uk/>

²³ Copenhagen city data exchange and Hitachi insight group <https://www.citydataexchange.com/#/dataset/about>

²⁴ <https://data.gov.sg/>

²⁵ <https://data.melbourne.vic.gov.au/about>

²⁶ <https://data.melbourne.vic.gov.au/browse>

²⁷ Suzuki, L.C.S.R. (2015) "Data as Infrastructure for Smart Cities", PhD Thesis, University College London'

7) Explore new models of funding



Smart city projects require significant initial investment. Even if the long-term financial benefits are clear, public authorities, be they government or local authorities, may struggle to raise the funds for the initial capital expenditure. Although some Asian city governments, such as Hong Kong, Shanghai and Singapore, have been able to fund their own projects, most cities need external sources of funding.

The Asian Development Bank (ADB) has estimated that spending on infrastructure will need to increase to USD1.7 trillion a year in developing Asia (USD26 trillion in total until 2030)²⁸ to maintain the current rate of growth. These figures include power, transport, telecommunications, water and sanitation infrastructure.

According to the ADB, the infrastructure investment gap is 2.4% of GDP for the 25 countries where data is available. As China's investment gap is 1.2%, the investment gap for the other 24 nations is closer to 5%. The same bank suggests that the private sector needs to increase substantially its contribution to USD250 billion per year between 2016 and 2020, up from USD63 billion.²⁹

An additional challenge is related to the long payback period of smart city projects. A selection

of projects assessed by Siemens³⁰ in European cities, shows that they can produce significantly positive economic value after thirty-five years. However the payback period varies significantly, depending on the type of project considered and can vary between 5 years up to 11 years or more. This can be a long time and a risky exercise for a policy maker who wants to deliver results fast and has limited financial capability.

Most smart city projects in developing Asia will depend on public-private partnerships. Many Asian nations already benefit from this funding model for infrastructure projects³¹.

PUBLIC PRIVATE PARTNERSHIPS

Public-private partnerships (PPPs) are and will be the main vehicle to obtain smart city funding. Most cities already work on this basis for many traditional infrastructure projects: PPP structures are used both to provide funding and for the expertise that they bring.

For example, in India, in the city of Pune, a PPP framework is used for waste management. The local municipality corporation partnered with a local cooperative, Solid Waste Collection and Handling (SWaCH)³², for the collection and disposal of solid waste. The municipality remained responsible for the infrastructure investment, while the partner was responsible for design and



²⁸ <https://www.adb.org/news/asia-infrastructure-needs-exceed-17-trillion-year-double-previous-estimates>

²⁹ <https://www.adb.org/news/asia-infrastructure-needs-exceed-17-trillion-year-double-previous-estimates>

³⁰ Julie Alexander – Siemens (2017) presentation at Smart IoT London

³¹ <http://ppi.worldbank.org/-/media/GIAWB/PPI/Documents/Data-Notes/SAR-Update-2015.pdf>

³² <http://timesofindia.indiatimes.com/city/varanasi/Pune-model-of-municipal-solid-waste-management-socially-relevant-says-study/articleshow/15526303.cms>

operations. The operator generates revenue from the sale of recyclable material and electricity. This type of model is likely to play a role as Pune transitions to smart technologies.

However, employing PPP may require legal changes by central governments when arrangements are not in place for PPP models. Moreover, PPP models are not 'problem free' in their deployment. As the World Economic Forum identified in its report, 'Reforms to accelerate Indian smart cities'³³, there are risks that need to be managed, such as changes in scope, market distortion, community risks and breach of contracts. These challenges can be addressed by following PPP preparation best practices. Again, the World Economic Forum' guide - Strategic Infrastructure: Steps to Prepare and Accelerate Public-Private Partnerships conveniently identifies them.³⁴

ALTERNATIVE FINANCE MECHANISMS

Alternative financing mechanisms for smart city project include municipal bonds, bilateral or multilateral banking arrangements and vendor financing:

- ▲ **Municipal bonds:** municipal bonds are financial instruments that enable debt to be raised directly by the municipality. In India, the city of Pune is considering municipal bonds to raise finance for its smart city projects³⁵
- ▲ **Development funds:** Institutions, such as the World Bank, Asian Development Bank (ADB), or the JICA, provide development funds. For example, the ADB has agreed USD1 billion in funding to help developing

nations mitigate the consequences of climate change. The Indian government has already announced plans³⁶ to support cities by approaching these institutions for smart city funding.

- ▲ **Vendor finance:** Technology vendor finance could also be used to support a smart city project. Vendors fund the capital outlay for the project in return for the opportunity to showcase their technologies and benefit from the revenue streams associated with operating the smart city services.



³³ http://www3.weforum.org/docs/WEF_Reforms_Accelerate_Development_Indias_Smart_Cities.pdf

³⁴ World Economic Forum, Strategic Infrastructure: Steps to Prepare and Accelerate Public-Private Partnerships, 2013

³⁵ <http://www.financialexpress.com/india-news/municipal-bonds-can-pune-smart-city-be-trailblazer-on-sourcing-funds/478527/>

³⁶ <http://smartcities.gov.in/content/>

CONCLUSIONS

IoT and smart city applications can generate substantial socio-economic benefits for citizens and businesses in Asia. Policymakers should make the most of this opportunity, by designing and implementing smart city projects with a long term vision, that are defined around citizens' needs, are managed through agile governance structures, are based on open and scalable systems and promote a culture of openness, innovation and transparency.

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GSMA Internet of Things Programme

Our vision: To enable the IoT, a world in which consumers and businesses enjoy rich new services, connected by an intelligent and secure mobile network.

Our aim: The GSMA Internet of Things programme is an initiative to help operators add value and accelerate the delivery of new connected devices and services in the IoT. This is to be achieved by industry collaboration, appropriate regulation, optimising networks as well as developing key enablers to support the growth of the IoT in the longer term.

To find out more visit: www.gsma.com/loT

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