KPMG

cutting through complexity

Dubai - a new paradigm for smart cities

CONSULTING

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Contents

1. Preamble

The pace of urbanization globally is unprecedented and this trend is expected to continue in the future with nearly 66%* of the world's population predicted to be urban by 2050.

** Source: United Nations – World Urbanization Prospects - 2014*

The ability to effectively and efficiently manage rapid urbanization is critical. Cities must increase the efficiency of existing and new infrastructure and services to a level never previously achieved. This will require a step change in the integration of infrastructure management and operations. Today, the quality of life of city residents is influenced by the degree of smartness and user-friendliness of the various services that a city provides. Technology plays a major role in achieving this smartness and efficiency.

As smartphones become more ubiquitous and technology rapidly changes our lives, Dubai is marching towards a new era of improvement and embracing a higher quality of life. The smart city project has been conceptualized under the visionary leadership of His Highness Shaikh Mohammad bin Rashid Al Maktoum, Vice-President and Prime Minister of the UAE and Ruler of Dubai, and Sheikh Hamdan bin Mohammed bin Rashid Al Maktoum, Crown Prince of Dubai and General Supervisor of the Dubai smart city project.

Globally, there has been an incredible rise in smart cities with cities leveraging the power of wi-fi and communication networks to enhance daily life for residents and businesses and promote sustainability.

There has been an exponential increase in smart devices, with the UAE having one of the highest mobile penetration rates in the world.

According to Dubai's Telecom Regulatory Authority, Dubai had over 16 million mobile subscribers with a penetration rate of 193% in 2013. Dubai has recently embarked on a large scale transformation programme to become one of the smartest cities in the world. Dubai's smart city initiatives aim to improve the quality of life of its people by "*embracing innovation, and making Dubai more efficient, seamless, safe and delivering an enriched city experience through smart technology*".
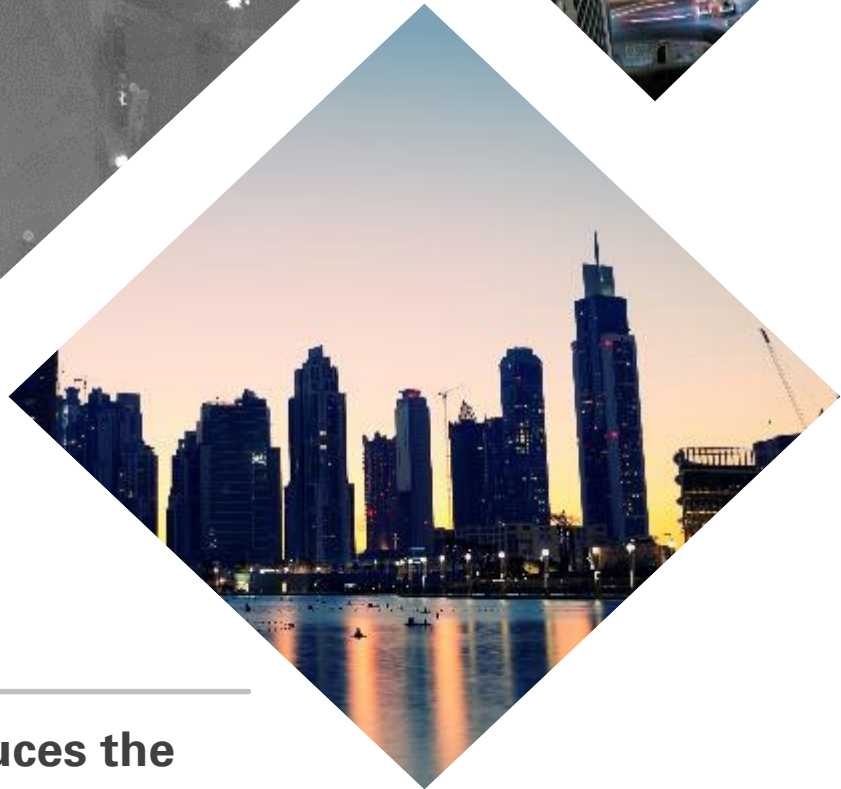
This paper introduces the concept of a smart city and illustrates how smart cities can help tackle the growing challenges of urbanization

While volumes of literature have been published about various smart city initiatives, this paper provides an overview of the key pillars of a smart city, some of its salient features and case studies of good practices from other smart cities. We also provide an overview of some of the smart initiatives both planned and underway in Dubai in specific areas, as well as the critical success factors which we believe are essential for Dubai to transform itself 'smartly'.

Dubai is one of the few cities in the world which has adopted a unique approach to evolve into a smart city. This aspiration is underpinned by three themes of communication, integration and cooperation. It is this integrated approach that will bear fruit and help it achieve its aspiration of becoming the first truly global smart city.

We would like to express our sincere thanks to Alan Mitchell, Executive Director in KPMG's Global Cities Centre of Excellence for providing his valuable inputs and critical feedback while writing this paper. We would also like to acknowledge our gratitude to the Smart Cities Readiness Guide publishing of the Smart Cities Council which has helped to shape our thoughts on the various sectors described in this paper.

2. Smart city drivers

"**Our goal is for the entire city's services and facilities to be available on smartphones. We want to provide a better quality of life for all.**"

- His Highness Shaikh Mohammad bin Rashid Al Maktoum, Vice-President and Prime Minister of the UAE and Ruler of Dubai
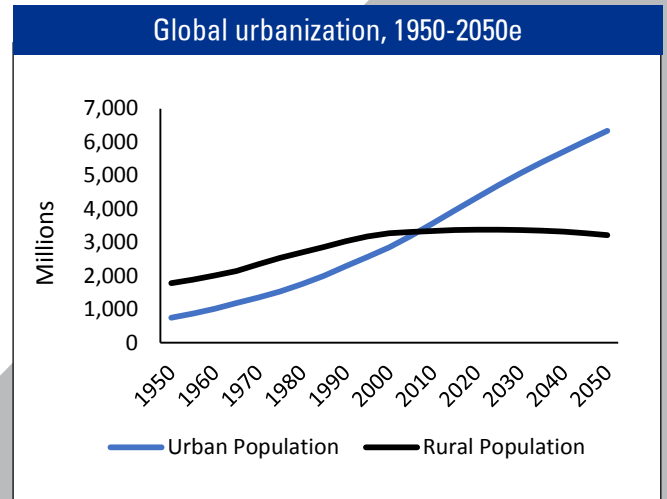
Urbanization – the century of cities

In recent decades, the world has witnessed a sharp increase in urbanization with the number of people dwelling in cities outnumbering rural population for the first time in 2007.

In 2014, according to the United Nations, 54% of the world's population lived in cities, compared with 30% in 1950. The trend of increasing urbanization is expected to continue with nearly 66% of the world's population predicted to be urban by 2050. Urbanization is not standardized across countries, so cities need to adapt differently to   meet the growing demands and unique challenges.

Urbanization has many positive effects. It increases economic and cultural activity, bringing together people and ideas. Bringing people closer reduces transport times and increases productivity. Environmentalists and others also believe that well planned cities offer benefits arising from lower fossil fuel usage for transportation and better utilization of land through increased development density.

However, urbanization also brings challenges. High population densities strain limited resources of land, clean water, food and energy. In order to promote a better quality of life and economic productivity, cities

Global urbanization, 1950-2050e

Source: United Nations - World Urbanization Prospects - 2014

### Population trends in select countries, 1960-2050e
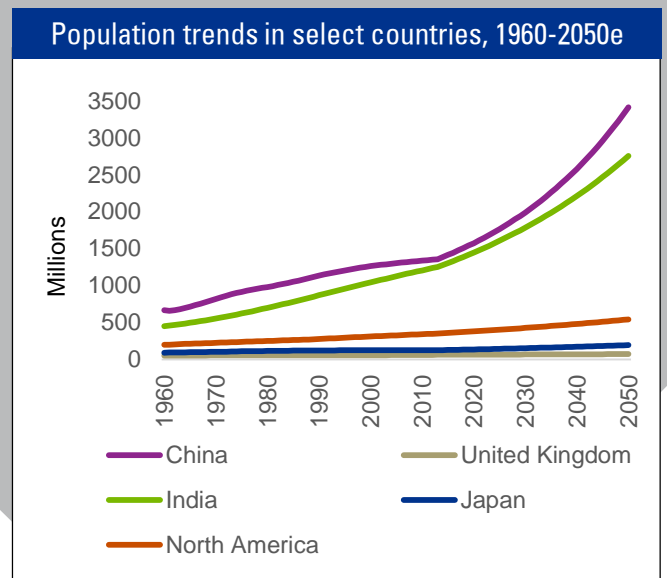
Source: World Bank - 2014

need systems that promote the efficient and sustainable use of resources. In the real world, limited capital and tight operating budgets must be shared amongst constantly growing populations and increasing demand for services.

Dubai – megacity ambition

Dubai is a fast-growing city that has developed as a global hub for business, trade and tourism over the last four decades. The population of Dubai grew from 0.6 million in 1993 to over 2.2 million in 2013, representing an annual growth rate of over 6.5%. Dubai is now a major tourist destination, playing host to over 11 million tourists in 2013. Hotel guest nights grew at an annual rate of 12.8% between 2003 and 2013.

Population of Dubai, 1950-2013e
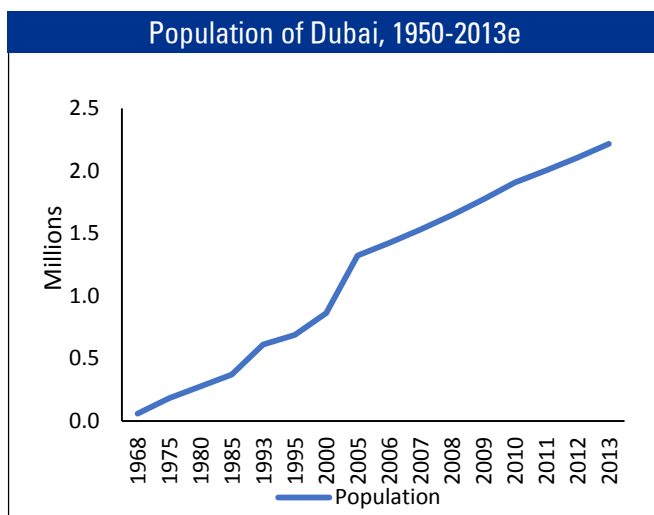
Source: Dubai Statistics Center - 2013

The Government of Dubai has built a city with world-class infrastructure and governance. However, as the city heads into its next phase of growth, several challenges lie ahead.

To address the challenges and realize the social, environmental and economic goals of Dubai Plan 2021, Dubai has launched its smart city strategy, aiming to transform itself into the smartest city in the world over the next few years.

The Dubai smart city project aims to encourage collaboration between the public and private sectors to achieve targets in six focus areas: **smart life, smart transportation, smart society, smart economy, smart governance** and **smart environment.**

Dubai - smart city strategy overview

Dubai's smart city strategy includes over 100 initiatives and a plan to transform 1,000 government services into smart services. The project aims to encourage collaboration between the public and private sectors to achieve targets in six 'smart' focus areas: **smart life, smart transportation, smart society, smart economy, smart governance** and **smart environment.** The strategy relies on three basic principles: **communication, integration** and **cooperation.**

Dubai Plan 2021

A city of happy, creative and empowered people

A smart and sustainable city

An inclusive and cohesive society

A pivotal hub in the global economy

The preferred place to live, work and visit

A pioneering and excellent government

Source: Dubai Plan 2021 website

3. Smart cities – an introduction

The concept of a smart and sustainable city is based on leveraging the power of data and the use of technology to minimize energy, waste and resource consumption; and to attain a higher quality of life by engaging more effectively and actively with residents.

Smart cities extensively use ICT to make traditional infrastructures more efficient, sustainable, livable and safe.

The success of a smart city depends on:

- The widespread deployment of all components of ICT

- Transparent, efficient and customer centric governance

- Informed, engaged and connected denizens

A smart city operates on a 4-step process:

1. Capture data

Smart devices at the ground level are responsible for collecting data and, as far as possible, doing this in real time. For example, sensors along roads can collect information about traffic congestion and road conditions, and smart meters in houses and offices can track electricity consumption dynamically. Recent technological advancements and the decreasing cost of devices have made it feasible to install millions of devices in cities. These devices form the basic backbone of a smart city.
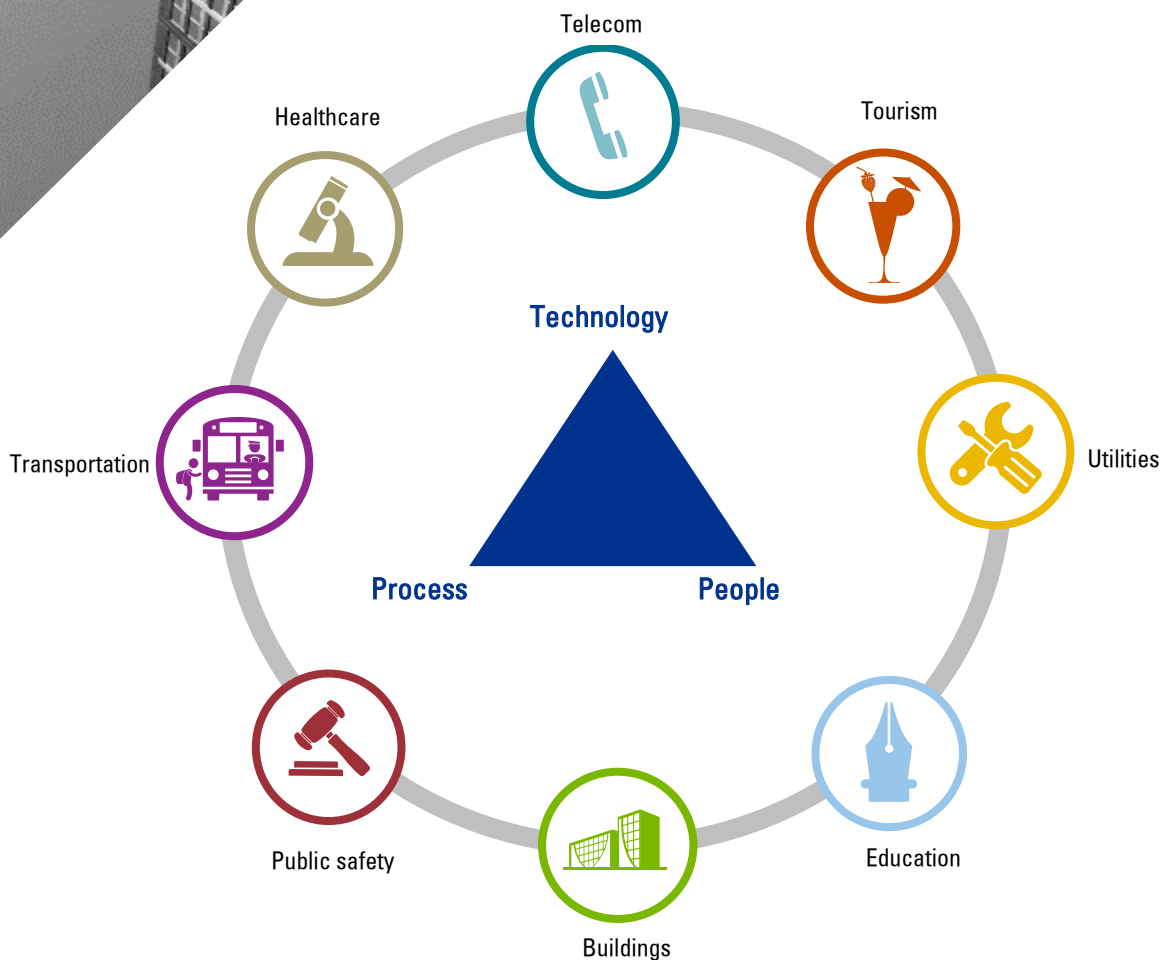
Smart city principle

1 Capture data

2 Communicate

3 Analyse

4 Act

Source: KPMG analysis-2015

2. Communicate

Data from smart devices and infrastructure needs to be communicated between servers and control centers. Smart cities need a communication layer that facilitates this interaction and connects various devices while ensuring interoperability, integrity, scalability and privacy. An integrated communications strategy must involve communication infrastructure providers, service providers, IT vendors and city governments.

Key pillars of a smart city

Telecom · Tourism · Utilities · Education · Buildings · Public safety · Transportation · Healthcare

Technology · Process · People

3. Analyse

Once data is collected centrally, the smart city needs to make sense of it to form actionable insights. This "data crunching" typically requires algorithms and computers that are capable of processing data and transforming it into intelligence. For example, data from traffic sensors could indicate congestion in certain areas, and alternative routes could be suggested.

4. Act

The final step is to use this analysis to make decisions or influence behavior. For example, a comprehensive electronic database of patient's medical records of patients captured by hospitals could be used to make strategic healthcare infrastructure decisions based on residents' demand for medical services.

We now analyze the key pillars of a smart city to understand some of their salient features and highlight examples of good practices from other countries in each of the areas. We also look at some of the initiatives undertaken by Dubai in each of these areas as part of its smart city strategy.

4A. Telecom

Telecom connectivity lies at the core and forms the backbone of a smart city.

Seamless, end-to-end connectivity is a key enabler for all aspects of smart cities. Cities need to implement high speed, reliable and high capacity networks.

Broadband and wi-fi access

Smart cities require ubiquitous broadband connectivity through a high speed fiber optic backbone and high bandwidth wi-fi networks. These networks facilitate consumer internet usage, as well as machine-to-machine and machine-to-human communications (also collectively known as the "internet of things") that smart cities depend on. According to Cisco, an estimated 50 billion devices will be connected to the internet globally by 2020, requiring fast and reliable network infrastructure.

Open standards

In order to enable interoperability of the huge number of devices connected to the internet, and to improve communication and understanding between the people and corporations involved in developing smart cities, there needs to be a set of shared international standards and reference architectures. The UK was the first country to publish a set of standards for smart cities through ther British Standards Institution (BSI) – the Publically Available Specification (PAS) 180 and PAS 181 standards.

Privacy and security

With the city collecting information related to the activities of its residents from various sources, privacy is an important concern. Cities need to create privacy governance policies that clearly lay out what data can be collected and stored, who can view which information, and what data rights and protections are afforded to the various parties involved.

With over 50 billion devices expected to be connected to the internet, another major concern is security. Not only does the system require network firewalls, but every end-device needs to be protected from attacks that could lead to data theft or malfunctions. Telecom providers, therefore, need to ensure that there are robust security policies in place, including risk management framework to continually assess risks, security controls, security analytics, and vulnerability management frameworks to push security patches to networks and devices.

Smart telecom in Dubai

According to Akamai's state of the internet report, UAE was ranked 58th globally in average internet speed at 4.3 Mbps, and recorded a decline in speed in 2013. Only 3.1% of the UAE's internet connections recorded speeds over 4 megabits per second, and only 0.7% of its connections are 4K ready (over 15 megabits per second).

In 2014, Du, a leading UAE telecom provider, announced that, as part of Dubai's smart city initiatives, it would create 5,000 hotspots to offer free wi-fi at 100 locations in Dubai and Abu Dhabi. Du promised to offer free, unlimited, fast access to government apps; low-bandwidth free wi-fi; and paid premium, high-bandwidth wi-fi.

World view: Google fiber

In 2012, Google implemented fiber-to-the-premises services in Kansas City that provided paid internet speeds of one gigabit per second (about 100 times faster than basic broadband speeds in the US) to homes. It also provided a free internet service of five megabits per second to all homes in the city. In 2014, Google announced that it was in discussions with 34 cities across the US to expand its Google fiber programme.

World view: Barcelona

In 2011, Barcelona launched the Barcelona wi-fi programme, and installed wi-fi routers across the city that provide free access to residents and tourists. There are currently over 400 wi-fi hotpots in the city. Barcelona City Council has announced that it will install over 1,500 new hotspots by the end of 2015 in restaurants, cafes and on streets.

Etisalat and Huawei recently signed a Memorandum of Understanding which will deepen the strategic partnerships in new areas such as Public Cloud, Software-Defined Networking (SDN), and Network Function Virtualization (NFV). This will assist in further developing new 'smart city solutions' for Dubai.

Although both telecom operators in Dubai are currently investing heavily in initiatives to ensure that the right infrastructure is in place to enable Dubai's smart city ambitions, the primary focus for Dubai should be on ensuring universal wi-fi access. This is a significant challenge and should be carried out in a phased manner by focusing on high footfall areas first. However, with widespread wi-fi, clear governance standards should also be developed and implemented to prevent cyber crime and protect the privacy and security of residents and tourists.

4B. Transportation

Transportation and mobility are key challenges for cities globally. Residents rely on transportation systems to commute, travel and transport essential goods.

Cities face multiple challenges related to transportation. Growing cities encounter congestion and longer trip times caused by overloaded infrastructure, while older cities suffer from ageing infrastructure. Transportation infrastructure is capital intensive and requires several years to build.

Smart traffic routing

Smart sensors placed in and along roads and at signals can be used to detect traffic flows. Back-end systems analyze traffic flows and determine optimum intervals for traffic signals in order to ease congestion. Traffic signals respond in real-time to improve mobility and trip times. Apps on smartphones provide real- time traffic updates to passengers. The TrafiCam x-stream system in Moscow is an excellent example of implementation of a smart traffic signal solution.

Smart parking

Wireless sensors are embedded in parking spots, and detect whether or not parking spaces are occupied. This data is transmitted to a central system which can send to the smartphones of users searching for parking spots. MobyPark in the Netherlands and Parker by Streetline in New York City are recent examples.

Smart infrastructure planning

A vast amount of data is collected through mobile phones, traffic sensors, smart cards, and parking sensors by city infrastructure planners. This data can be used for forecasting, simulations and predictive modeling to plan infrastructure developments. For example, Singapore Land Transport Authority's (LTA) Planet warehouse is used to formulate transport policies.

Smart transportation in Dubai

According to the Roads and Transport Authority (RTA), the number of vehicles in Dubai nearly doubled from 740,000 at the end of 2006 to 1.4 million at the end of 2014. This average annual increase of 8.2% is one of the highest in the world. The RTA has to focus on smart transportation solutions to deal with the increased demand on Dubai's transportation infrastructure. The RTA has been one of the pioneers in contributing to the Dubai smart city strategy. It has taken a number of initiatives to develop intelligent transportation systems and smart government mobile apps aimed at enhancing the transport network and services and delivering a truly integrated transportation experience for its customers. The RTA has recognized that integrating Dubai's various transport modes is critical in providing a seamless transportation experience to the customers.

Hence, the RTA has initiated a project to create the first multi-modal, multi-agency integrated command and control center in the region. It is establishing a center of excellence to oversee and manage a truly multi-modal city.

The RTA has recently announced the transition of all its applicable services to smart apps. With the help of nine mobile apps, RTA offers 173 services that help people complete transactions with a tap on their smartphone. The apps available on all smart phone platforms include Smart Drive, Wojhati, Smart Salik, Smart Parking, Smart Taxi, Drivers and Vehicles, Public Transport, Corporate Services and RTA Dubai.

As part of its effort to utilize the latest technologies, the RTA recently commissioned a study on using autonomous cars (driverless vehicles) in Dubai, hoping to pioneer this concept in the region.

World view: Autolib (Self service cars) in Paris

Autolib, an innovative rent-a-car service in Paris, allows people to a rent a car for a certain part of the day. Electric cars are parked at stations across the city. Customers can rent these cars and only pay for the time they use the car. This decreases traffic and makes travelling more efficient and easier. Autolib also brings environmental benefits as noise and air pollution are reduced.

World view: Santander

Santander has installed systems with over 12,000 sensors that help the city better manage traffic, power consumption, waste disposal and other issues. These sensors measure various factors such as temperature, luminosity, carbon emissions and road noise. Nearly 400 of these nodes are used as parking sensors accessible through smartphones. 60 devices are placed at entrances to the city which measure traffic volume, road occupancy and vehicle speed. This information enables the city planners to monitor road patterns, allowing them to control traffic lights and route traffic accordingly. Santander has also implemented a two year test programme with special acoustic sensors that help control traffic by listening to urban noises and managing traffic lights.

The RTA has identified the need to encourage transit-oriented, smart development around public transport stations by providing environmentally friendly pedestrian walkways and cycle tracks. The RTA has developed a bicycle master plan that covers 900 km of bikeways over the next few years. According to the master plan, a series of bikeways will be connected to mass transit systems to encourage greater integration.

Through these smart initiatives, the RTA seeks to provide a safe, reliable and sustainable transport environment for residents of, and visitors to, Dubai in keeping with the Dubai Plan 2021, Dubai's smart city strategy and Expo 2020 requirements.

Developing infrastructure and introducing leading practices to further automate ground transportation and providing an integrated and efficient public transport system will enhance the RTA's ability to achieve very high levels of customer satisfaction.

4C. Healthcare

Changing lifestyles and environmental conditions in the last few decades have been associated with an increase in the incidence of many chronic lifestyle diseases. Increasing population, escalating costs and tightening budgets are stressing cities' healthcare infrastructures around the world.

New technologies have the potential to change the delivery, efficacy and efficiency of healthcare services in cities. This could lead to longer and healthier lives for residents, improving overall wellbeing and happiness.

In a study published by Forbes in 2012, it was estimated that sick leave cost the United States economy around $576 billion every year. Cities that use ICT to highlight public health issues and promote remedies will optimize their citizens' well-being, leading to a more productive workforce and a stronger economy.

Consolidated digital health records

Electronic Health Records (EHR) should replace paper-based records and enable doctors and patients to access their complete history of diagnoses, laboratory tests, prescriptions and treatments online and on-demand. Smart cities with consolidated EHR systems that works across all hospitals, clinicians and government agencies make healthcare services more accurate and efficient. The eHealth Ontario programme in Canada is an example of a government body that is enabling physicians and health care providers to establish and maintain EHRs for all of Ontario's 13 million residents.

Telemedicine

Telemedicine, or remote healthcare, are services carried out off-location. Services typically include tele consultation and tele diagnosis, which lets experts perform diagnostics with medical instruments from a distance. Telemedicine enables nurses to monitor patients with chronic illnesses remotely (tele monitoring) and enables doctors to perform surgeries remotely through sophisticated mechanical and communication equipment. The University of Kansas has established a Center for Telemedicine and Telehealth and now has more than 100 telemedicine sites across the state.

Healthcare analytics

The large amount of healthcare data collected can be employed to improve healthcare and reduce costs. Hospitals and governments can use predictive analytics to assess patient risks for particular diseases. Cities can make strategic healthcare infrastructure decisions based on residents' EHRs. For example, Emory University Hospital in the United States conducts advanced analytics in real time to provide enhanced healthcare to patients.

Smart healthcare in Dubai

A growing population and a demand for advanced healthcare facilities will push Dubai to build additional healthcare infrastructure and adopt smart healthcare initiatives. In 2013, Dubai launched a smart healthcare project with three main initiatives - *smart applications, smart operations* and *smart hospitals*. Dubai is also

World view: Bristol

Bristol has made significant progress in implementing smart healthcare services for its approximately 400,000 residents.

SPHERE (Sensor Platform Healthcare in a Residential Environment) is an interdisciplinary research collaboration (IRC) led by the University of Bristol, together with the Universities of Southampton and Reading. SPHERE will develop sensor systems to monitor the health of people in their homes.

The sensors will gather health data and transmit it to a control system that will analyze this data to identify health issues, such as eating behavior, depression and anxiety. SPHERE will employ ultra low power wireless communications, on-body energy harvesting, and video analytics and extract meaning from complex datasets in order to serve healthcare needs.

planning to implement Electronic Medical Records and a Hospital Information System by 2015. These will enable easy electronic access to a patient's file, which contains all the details necessary to know the health status of the patient and the results of any tests, X-rays and records of doctors' visit. The system also enables doctors to send instructions and medical supplies to other sections of the hospital such as laboratories and pharmacies as the system interconnects all hospital departments and sections. This should eliminate paper work, reduce patient waiting time and provide a repository of accurate patient data, while cutting the time needed for procedures by half.

In the future, the Dubai Healthcare Authority (DHA) could also explore the possibilities of implementing telemedicine initiatives. This would involve developing electronic applications which allow patients to enter symptoms and get an idea of their health situation and issues. For certain medical conditions, doctors could provide e-consultations. This could shorten waiting lists in hospitals, increase patient satisfaction and improve diagnoses.

The DHA is studying a number of projects to encourage collaboration between the private and public sectors and enhance healthcare services in Dubai. In line with the vision of H.H. Sheikh Mohammed bin Rashid Al Maktoum, DHA is working hard to transform Dubai into the leading city in the Middle East for healthcare tourism.

4D. Buildings

Buildings are major consumers of energy and emitters of greenhouse gases in cities.

According to the World Business Council for Sustainable Development, buildings accounted for 32% of global energy and 19% of all carbon emissions in 2010. Under current trends, energy use could double by 2050.

Smart cities must adopt new policies and technologies to make buildings more energy efficient and environmentally friendly in order to improve their residents' health and quality of life.

Building Information Modeling (BIM)

BIM is revolutionizing how buildings, infrastructure and utilities are planned, designed, built, and managed. BIM is an intelligent, model-based process that provides insight to help plan, design, construct and manage buildings and infrastructure in a truly smart manner.

Wireless sensors

Smart buildings are fitted with wireless sensors and meters that collect information on various aspects of the building including energy consumption, lighting, HVAC, humidity control and ventilation. Sensors installed on components from fan blades to lightingfixtures regularly transmit data to a central server and help collect the required data.

Building Management Systems (BMS)

Data is used by a centralised building management system that performs complex analytics. Modem BMS learn and even predict preferences for light, temperature and other services. BMS aspects include:

- Centralized Lighting Control Systems (LCS) that manage lighting and enable daylight harvesting programmes that minimize the use of energy for lighting, using data such as shade position, light intensity and sun position

- Security Automation Systems (SAS) and Fire Automation Systems (FAS) that contain anti-theft security and alarm systems, access control, surveillance systems and fire monitoring and response systems.

- Energy Management Systems (EMS) that monitor energy usage in buildings and detect and eliminate energy wastage through the efficient management of climate control, security and lighting systems.

- Water Management Systems (WMS) that monitor and manage water usage while reducing loss through leaks. WMSs predict restroom traffic patterns and water usage patterns to determine water requirements and waste water generation.

Facility management systems

Smart buildings have integrated IT-enabled work order systems that can allow work order flows and enable analysis based on parameters such as building, space, personnel, labour, materials and costs.
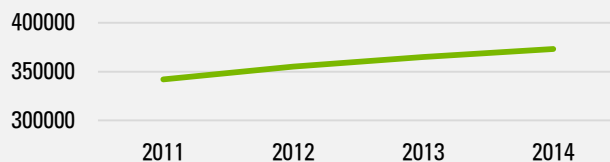
Smart buildings in Dubai

Dubai's built up commercial and retail stock grew at 5.8% CAGR and 2.8% CAGR by area between 2010 and 2014. Residential stock (in units) grew at 4.8% CAGR between 2010 and 2014.

The Green Building Council (GBC) ranked the UAE 9th globally in terms of cumulative gross square meters of space certified to LEED (Leadership in Energy and Environmental Design) standards, which certify buildings based on cost efficiency and energy savings. In the UAE, a building's energy consumption is a significant community issue. In 2010, the Dubai Municipality introduced a set of codes that promotes

Dubai's residential stock (units)

	2011	2012	2013	2014

(values: 400000, 350000, 300000)

World view: Seattle

Seattle's Office of Economic Development has been working with private sector participants since 2011 to implement smart buildings and drive energy efficiency throughout the city.
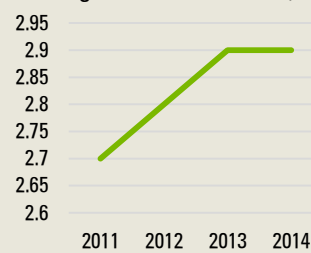
Seattle anticipates energy and maintenance savings of 10% to 25% as a result of this initiative. The city implemented a software solution that connects disparate building management systems and detects leaks and wasted energy.

Seattle is also home to the Bullitt Center, the greenest commercial building in the world.

Commercial stock (Hotel supply in number of keys)

(values: 65000, 60000, 55000, 50000, 45000 — 2011, 2012, 2013, 2014)
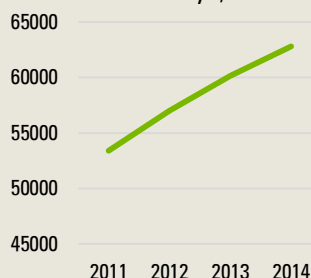
Retail stock (million square metre gross leasable area)

(values: 2.95, 2.9, 2.85, 2.8, 2.75, 2.7, 2.65, 2.6 — 2011, 2012, 2013, 2014)

Source: JLL - 2015

the use of energy saving systems, natural lighting systems and green building materials.

Dubai's Integrated Energy Strategy has an ambitious target of reducing energy and water demand by 30% by 2030. Reducing cooling requirements within buildings is a key focus area for the Dubai Electricity and Water Authority (DEWA) and Dubai Municipality.

Dubai, with its fast expanding property portfolio, should focus on smart buildings as a key lever in becoming a truly sustainable smart city.

4E. Utilities

Smart water

Water is one of the world's most precious resources. Many modern cities face water issues, including declining water quality, shortages and ageing infrastructure.

Smart cities can employ new technologies to enable better water and waste water management.

Water sensors around the city can measure pipe flow rates at different points in the water pipe systems to detect leakages. Meanwhile, other sensors can monitor water quality parameters such as pH, conductivity, oxidation reduction potential, dissolved oxygen and turbidity in hard-to-access locations. These sensors can transmit data in real-time over cellular or ZigBee standard networks to a central system.

The central water management system can use data from sensors to detect leakages and water pollution, which can be prioritized and fixed. The data can indicate problems with pipes, chemical spills, treatment plant issues or the performance of water sanitization systems.

Smart water meters can be installed in all households, allowing residents to see their water consumption in real-time and compare their usage with others in their neighborhood. Meters also transmit water usage information to water authorities to facilitate billing, eliminating manual meter readings every month.

Smart energy

Energy is a city's most basic and essential resource. Not only do cities need to cater to increasing demand for energy, but they also need to make energy sources green and more environmentally friendly.

At the center of smart energy initiatives is the implementation of smart meters and smart grids in cities. Smart electricity meters are sensor-based meters that monitor energy consumption in real-time and gives consumers information on their usage patterns. Smart meters installed in each home, office and factory transmit this usage information in real-time to smart grids.

A smart grid lies at the heart of a smart city's energy system.

A smart grid collects, and acts on, real-time information from energy suppliers and consumers. It provides real-time monitoring and reaction, anticipation and increased reliability.

Smart grids are self-healing and can rapidly isolate parts of the network that experience failure, preventing outages and blackouts. They can easily connect to renewable sources like solar plants, wind farms and hydro stations, facilitating the storage and distribution of energy through the city.

Smart utilities in Dubai

Dubai's peak power consumption grew to 6,857 MW between 2008 and 2013, representing 5.3% CAGR. Peak water consumption grew to 296 million gallons between 2009 to 2013, representing a CAGR of 2.3%. Dubai's growing population will demand more water and power in the run up to Expo 2020.

Electricity and water consumption (Dubai)

■ Electricity Consumption (in GWH)
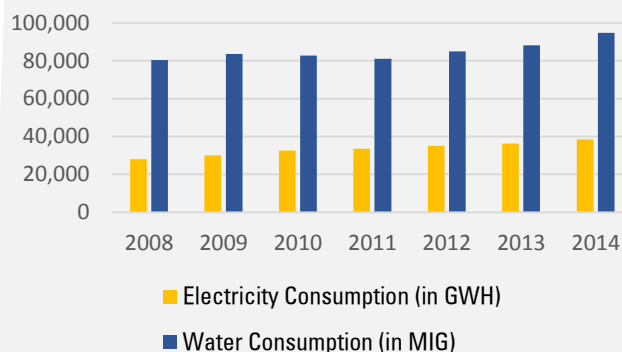■ Water Consumption (in MIG)

Source: DEWA - 2014

World view: Amsterdam and Florida

Amsterdam's New West district is served by a new smart grid. Sensors and computer systems monitor and control power systems in real-time and reduce power outages. Households monitor and offer the capability to connect renewable sources to the grid.

The city of Lakeland in Florida is deploying 54,000 digital water meters over the next six years at a cost of USD 57 million. The smart water meters will allow consumers to track their water consumption in real-time.

DEWA plans to install 250,000 smart meters in all residential, industrial and commercial properties by 2018 as part of Dubai's smart city initiative.

DEWA will deploy smart-grid to automate grid-control decisions and to deliver new services to consumers, allowing them to automate and control their power consumption.

DEWA plans to implement solutions for solar power in houses. It is also developing smart apps, building infrastructure and charging stations for electric vehicles. In October 2014, it signed an MoU with IBM to collaborate on smart grid technologies, innovation centers and research and development programmes and share industry knowledge and leading practices.

DEWA could play an active and 'smart role' in energy and water conservation and contribute to developing a sustainable city by informing people about their daily energy and water use using mobile apps, and reward consumers who contribute to conserving energy and water.

4F. Tourism

Tourism is an important source of income for many countries. Its importance was recognized in the Manila Declaration on World Tourism of 1980 as *"an activity essential to the life of nations because of its direct effects on the social, cultural, educational, and economic sectors of national societies and on their international relations".*

Smart tourism brings together a variety of smart city concepts and aims to promote tourism through the innovative use of ICT.

The technological advances in ICT have made a better understanding of the tourists' interests possible. They have also allowed tourists and tourist boards to optimize their choice of destinations and activities.

The internet of things

Smart tourism uses the "internet of things" concept which connects physical and real objects to the internet. For example, in Seoul, tourists can rent special smartphones installed with "i-Tour Seoul", an application based upon the Seoul tourism organization's official website. Operating in several languages, the application is everything from an electronic travel guide on the city to a real-time information service. The visitor is constantly updated on nearby points of interest, accommodation, dining options, weather and currency rates. Users can also point the camera at surrounding areas and i-Tour Seoul's augmented reality feature will quickly fill in the details, overlaying icons which explain precisely what they are looking at, whether it be a Starbucks or the ancient edifice of a UNESCO world heritage site.

Smart tourism destinations

As part of the end-user internet service system, ICT can also be used as a predictive tool to develop and manage tourism destinations in a smarter way. An example of this could be a "tourist tracking system" that could help to coordinate transport services in line with the number of tourists. For example, Stockholm uses a vehicle tracking system which optimizes transport services around tourist areas.

Devices such as Near Field Communication (NFC) tags can help tourists find nearby points of interest. Multilingual applications can be used to inform tourists about their route and suggest tour packages. In Paris, sensors were set beside monuments and a new device was implemented in 2012 with an application that would inform the tourists about the history of the monument while they sailed on a barge along the Seine.

A hypothetical case of the above example for Dubai would be to introduce chips/ smartphone applications for key tourist locations such as Burj Khalifa. Tourists could then be provided with personalized information about the site on their mobile phones or other hand held devices.

Cloud computing has permitted information sharing and diverse tour guides systems. These new guides benefit a considerable number of tourists without the application being installed on the tourist's personal devices.

The cities of Jinan and Wuhan in China started developing their smart tourism services in 2012 and many smart devices have been installed at various popular tourist spots.

Using these devices and a smart application, tourists can now obtain live footage of the tourist sites on their smartphones along with detailed tourist information about the sites. The smart application provides other information such as available promotional offers, discounts on main tourist areas and information on nearby hotels, resorts, restaurants, shopping centers and metro stations.

Smart tourism in Dubai

Dubai was the fifth most visited city in the world in 2014 with 11.95 million visitors. The city aims to welcome 20 million tourists annually by 2020.

Overnight visitors in Dubai (millions)
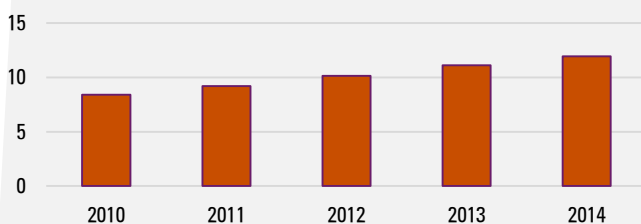
Source: Statista - 2014

To meet the growing challenges, smart tourism concepts have been adopted. An example of this is the tour guide system ''Nahaam', launched by the RTA, which gives tourists information about the landscapes and routes.

Another example is Dubai's smart gate system which has dramatically shortened immigration waiting time for passengers through electronic identification.

Dubai's Department of Tourism and Commerce Marketing (DTCM) has introduced e-Permit and e-Ticketing platforms to support and develop Dubai's growing events sector, a key pillar of the strategy behind the Emirate's tourism vision for 2020. e-Permit is an online system through which all procedures related to the application, processing and licensing of event permits are operated. e-Ticketing is a centralized platform for the sale and distribution of tickets for all events in Dubai. Both platforms speed up and simplify the entire events application, licensing and ticketing process. The electronic ticket distribution system is easier and more convenient for event attendees. Other benefits include the ability to collect big data for the purposes of city planning and crowd management. Statistics allow DTCM to optimize its events calendar and improve Dubai's events and destination offering.

There are still plenty of new opportunities for Dubai to transform its tourism sector and make it really smart by integrating it with other smart city components. A unified platform which hosts and engages with visitors offering location intelligence to ensure that the experience in Dubai is memorable is an immediate requirement especially as the city is expected to welcome over 20 million visitors for World Expo 2020.

4G. Education

A smart education system using technology helps open the door to richer learning tools and encourages more engaging teaching techniques.

Many countries are now trying to build technology into the school curriculum. Technology helps ease the burden on educators, freeing them to focus on what they do best. Technology advancement presents many advantages. Both students and teachers can benefit from better accessibility, collaboration, motivation and time efficiency through appropriate tools.

Accessibility

A smart education system permits increased accessibility to information anytime and anywhere, due to efficient interconnection achieved through modern technologies like cloud computing systems. For example, North Carolina State University provides 24x7 access to study materials and resources to schools and colleges throughout the state through its central shared server. Students, faculty and teachers have access to customized pages of their content that meets their personal learning needs.

Collaboration

A smart education system can provide everyone access to the same content. The system can be used to communicate with students, offering instant feedback, tips, results and educational content.

For example, the University of Nebraska makes use of collaborative technology to increase flexibility and productivity for students with recorded lectures, remote class sessions, and peer discussions. Expanding access to professors with "virtual office hours" helps improve communication between students and faculty.

Motivational

Multimedia resources integrated in smart educational systems can make learning fun, motivating students to study. In Australia, educational institutions have developed interactive learning environments to make learning science more engaging for students.

Time efficiency

With smart education systems, there is no need for students to be in the same place at the same time to attend lectures. In North Carolina, students now learn from professors, business leaders, and other guest lecturers from around the globe by meeting them face to face in the university's new "virtual lecture hall," powered by a Cisco TelePresence system.

Tools

A smart education system also provides tools to collect and submit accurate data, like grades, projects, essays and other involvement in different activities. The system can provide relevant information on a student's activities. Teachers and parents can use the data to assess and control the output and the efficiency of a student's educational progress.

World view: Singapore

In Singapore, Ngee Ann Secondary School is using web-based artificial intelligence chat bots to organize and analyze students' answers to identify leaning patterns and adjust to their needs accordingly. Every use by a student allows the system to collect more information and boost the existing database of resources. One of the school's goals is to help students with their critical inquiry skills through working with chat bots. Teachers use the tool to gain a greater understanding of students' learning patterns and needs.

Ngee Ann has also introduced a 'scaffolded algorithmic inquiry based learning system for its students. This system will test students with multiple-choice questions from a specific subject. Based on their answers, it will adjust the difficulty of the questions making sure all students are tested to an adequate degree of difficulty.

Smart education in Dubai

Realizing the growing importance of improving the education sector, UAE allocated AED 9.8 billion to the education sector in 2014. Around 35.7 % of 2015's total budget of AED 41 billion was allocated to social development including the education sector.

Dubai's Knowledge and Human Development Authority (KHDA) recently introduced a smart e-Services portal for universities and an updated system for schools and training institutes which allows its customers to connect directly to KHDA, saving time and paperwork and improving customer satisfaction. Universities will enjoy access to services such as online registration for both staff and students; certificate attestation; and permit renewal. Schools and training institutes are offered an updated version of the existing system to include smart services such as online payment, alerts on permit expiry, tracking of permit requests, email notifications and separation of services for amendment processes.

Dubai also launched a new smart learning initiative in 2012 that aims to transform classrooms as well as integrate teachers, students, parents and administrators into a single e-platform. The initiative, when implemented fully, will create a new learning environment in schools, by introducing 'smart classes' in all public schools and providing every pupil with a tablet PC enabled by high speed 4G networks. The system will also see students, teachers and parents interacting over every aspect of learning.

Education is the cornerstone of any country's growth and future. Dubai has to focus on ensuring wide modes of access to educational materials for students, making learning fun and motivational through the smart use of technology.

4H. Public Safety

Public safety involves preventing and protecting the general public from anything that could endanger their safety, be it man-made or natural. The rapid surge in technology has opened doors to new forms of crime, specifically on cyber platforms.

Changes in the external environment have led to the need for smart public safety using intelligence to help make informed decisions about general safety.

It is the government's responsibility to ensure that the necessary departments (such as the police, emergency medical services, fire department or cyber cells) are set up in order to satisfy this basic public need.

Access to, and integration of, multiple sources of data

By installing CCTVs and other optical sensors and devices, data and content from a wide range of sources and systems can be captured and integrated to create a trusted information base for enhancing public safety. Drancy, a suburb of Paris, has implemented a fiber network complemented by more than 300 CCTVs for city surveillance. This has helped increase efficiency dramatically with large amounts of data being captured and processed in digital format everyday and used for surveillance.

Scalability and compatibility

Any safe city setup has to be scalable in order to cater to the growth of a city. It has to be sufficiently upgradeable and versatile to incorporate new sensors and integrate with different functions such as healthcare, transportation, utilities and building management.

Proactive planning and decision making

Proactive planning permits make better use of available information and improve strategic and tactical decision making. Openly sharing information such as impending hazards or natural disasters can reduce causalities. San Diego has developed an app, *SD Emergency,* to provide a variety of information and services, including emergency maps, evacuation routes, Twitter feeds and checklists. This works across a range of mobile operating platforms and has led to a major reduction in casualties during emergencies such as severe fires.

Information sharing between relevant entities

Data collected to enhance public safety has to be shared across departments and jurisdictions, including those not directly responsible for activities, such as transportation, healthcare, weather services and utilities. This enables full situational awareness at the command center level to optimize responses. For example, data must be shared on a real time basis between a city's transportation operators, police and healthcare providers to optimize the response time for casualties following a road accident.

World view: Surat

Surat, a city in Gujarat, with a population of 2.4 million, has successfully completed the first phase of safe city project which includes the installation of 104 CCTV cameras, a command and control center furnished with a 280 square foot video wall, a data center with 200 TB of storage and an integrated physical security management system that supports an IP video surveillance network. The entire project, named 'Surat Safe City Project', consists of five phases. When all five phases are implemented and functional, it will involve a network of over 5,000 surveillance cameras spread across 500 locations covering a total area of 150 square kilometers.

Each of the requirements will have individual positive outcomes. However, if governments were to combine all of them, public safety would be taken to a whole new level.

Smart public safety in Dubai

Crime rates in the UAE have always been relatively low, especially when comparing to global averages. The UAE is known to be one of the safest countries in the Middle East. One of the many initiatives launched in Dubai include the Dubai Police app. This app has been highly successful and is one of the most popular government apps across Dubai. The app includes a handful of critical Dubai Police online services which can be accessed on a mobile phone. These services include customers accessing and paying their fines; applying for a good conduct certificate; reporting traffic violations or crimes to the police; providing a list of pharmacies which are open; and traffic services.

Dubai Police was one of the first organizations in the world to use Google Glass, allowing officers to identify road users who have outstanding warrants through their number plates. The use of Google Glass is part of Dubai Police's ambition to develop the 'smartest' police stations in the world by 2018.

Dubai Police plans to launch its first intelligent robot officer - Robocop - within two years. The humanoid officer will provide all Dubai Police services to the public in six languages, much like a human policeman. The robot will move around in public areas such as shopping malls, and will communicate with, and provide information to, the public without human interference. It will also be linked to a non-emergency call center.

Other smart initiatives include the sand storm and visibility system which is a new mobile application that consists of various features such as forecasting sandstorm and fog.

Dubai could implement a common, unified, connected communications platform that enables various safety and emergency services to share information and coordinate and collaborate on public safety issues.

5. Conclusions

There is no one clearly defined way for a city to evolve 'smartly'. Various cities around the world have approached the smart city concept in different ways and have evolved differently to suit their unique priorities and needs. All cities faced different challenges during their evolution and in many cases the smart city goals and objectives had to change frequently to align with the city's growth, priorities and interests.

Dubai has adopted its own a unique smart city approach. This aspiration is underpinned by the three themes of communication, integration and cooperation. It is this integrated approach that will bear fruit and help it achieve its aspiration of becoming a truly global smart city.

Based on the success stories and challenges of other global cities, we believe there are a few critical success factors, apart from setting up the requisite infrastructure, which we believe are essential for Dubai to transform itself 'smartly'.

1   **Leadership and vision** –The smart city transformation programme needs to have a long term vision and be supported by the Government. The current governance structure set up by the Dubai Government, along with higher committees to monitor progress in a coordinated manner, is a crucial driver for the success of this initiative.

2   **Policies and regulations** - Policies, regulations and legal frameworks provide a strong platform for all stakeholders and market players contributing towards the effective functioning of the smart city.

3   **Integration** – One of the most important factors influencing the success of this initiative will be the coordinated approach of government departments and authorities in offering smart services at the same pace. Government entities in Dubai have already started their journey towards this objective in an efficient manner.

4   **Innovation and agility** – The vision of a smart city requires government machinery to be agile and embrace innovation, particularly technological innovation, in order to improve its services and eventually the quality of life of its residents.

5   **Phasing** – Both the 'big bang' approach and the 'phased' approach have advantages and disadvantages to the implementation of projects under this initiative. Dubai must carefully observe and learn from the progress of other smart cities.

6   **Private sector partnerships** –The participation of the private sector has huge potential to deliver high quality infrastructure and services at lower costs, making them an essential element of Dubai's smart growth. The success of private sector partnerships will depend upon the ability to define concrete, measurable goals in mutually beneficial risk-reward relationships.

KPMG's Global Centre of

Excellence for Cities

KPMG delivers professional services to cities around the world, in all stages of evolution, and has hands-on experience and know-how to proactively assist city leaders to move successfully through the different city maturity stages.

City evolution maturity model

Cities are constantly changing, due to their economic base, migration, impacts of natural disasters and infrastructure development or decay.

Rapid urbanization and government incentives, such as development nodes, can also lead to new or emerging cities.

KPMG has identified five stages of maturity:

Each maturity stage presents opportunities and challenges. Examples of challenges that they may face include :

- What does it take to build a city from the ground up?

- How much pressure and where is population growth placing on existing and fragile infrastructure?

- Where will the city find the funding to finance new infrastructure?

- Does the city plan to maintain and replace infrastructure at appropriate intervals?

- How will the city cope with transport, water scarcity and food security?

- How dense does the city want to be, or does the city prefer satellites?

- How will the future city deal with additional waste? Will it be recycled or converted?

- Will there be enough energy and fuel for a growing population?

Reinvigorating cities

Decaying cities

Mature cities

Growing cities

New emerging cities
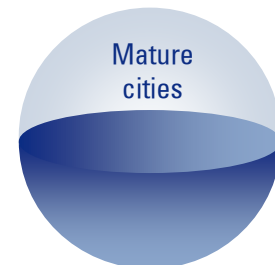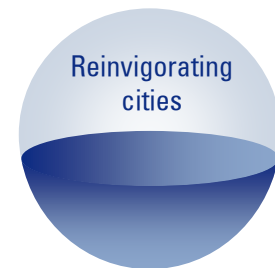
> **A great city is not to be confounded with a populous one.**
>
> - Aristotle

KPMG's Global Centre of Excellence for Cities (GCOEC) brings together subject matter experts and highly experienced professionals from around the world to share leading practices, knowledge and experience.

- KPMG advises and supports the sustainable development of cities and the effective provision of city services around the world.

- The GCOEC enables KPMG to offer a broad suite of services to clients, drawing upon the experience of subject matter experts to provide the advice needed to address a city's challenges.

- In doing this, KPMG professionals also have access to, and work across, a broad range of sub-sectors within KPMG's Global Government and Public Sector practice, including human and social services, education, infrastructure, healthcare and justice and security.

- We offer four broad services for cities:

  – Governance, risk and compliance

  – Business performance improvement and city specific solutions

  – Infrastructure development

  – Sustainability

Economic and financial modelling:
Providing economic, financial and tax modelling services to examine alternative revenue generation arrangements

Project support:
Providing ongoing management and oversight for large, complex projects to help cities reduce the risk of failure

ICT innovation:
Implementing the innovative business solutions required to carry out complex internal processes and provide electronic service delivery to customers

Diagnostic reviews:
Analysing and optimising service efficiency and effectiveness by examining service revenue and expenditure
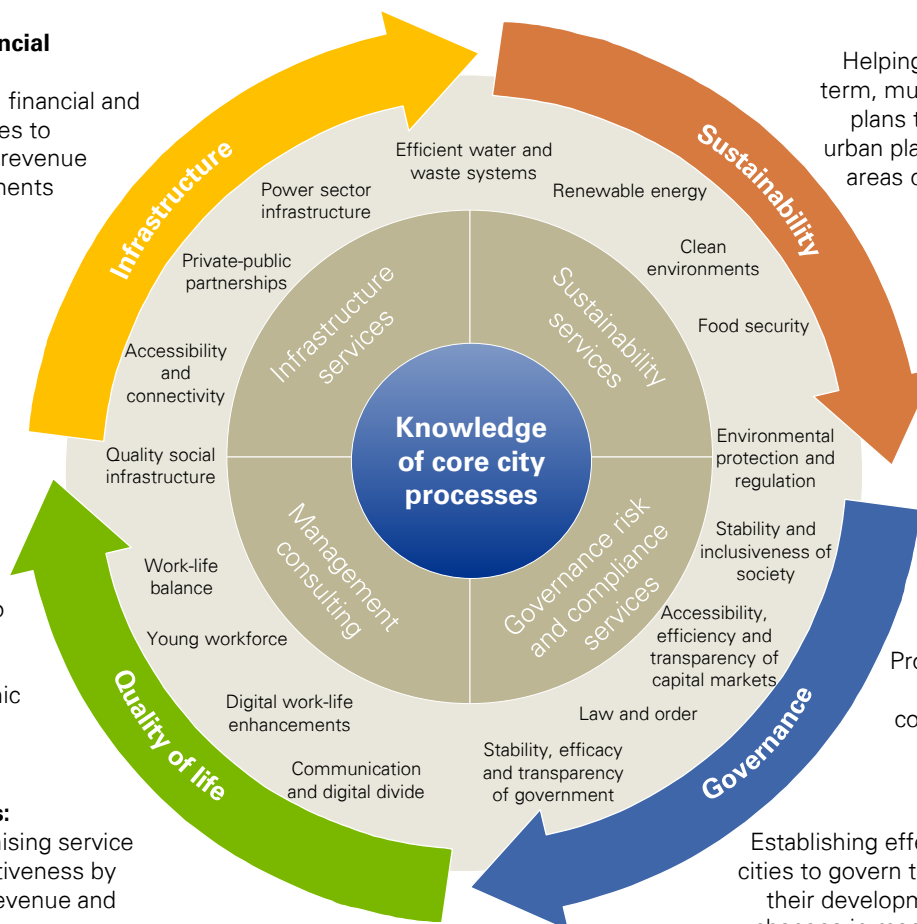
City master planning:
Helping cities to develop long-term, multidimensional strategic plans that combine traditional urban planning with programme areas critical to a city's overall sustainability

Resilience:
Assessing a city's risk profile to prevent, respond to, and recover from, natural crises and disasters, as well as socio-economic issues such as poverty, unemployment and crime

Executive counsel:
Providing senior municipal leaders with strategic coaching, mentorship and impartial advice

Effective governance
Establishing effective structures within cities to govern their organization during their development and in response to changes in mandates or reorganization

Infrastructure

Sustainability

Quality of life

Governance

Efficient water and waste systems

Power sector infrastructure

Renewable energy

Clean environments

Private-public partnerships

Food security

Accessibility and connectivity

Infrastructure services

Sustainability services

Quality social infrastructure

Knowledge of core city processes

Environmental protection and regulation

Stability and inclusiveness of society

Work-life balance

Management consulting

Governance risk and compliance services

Accessibility, efficiency and transparency of capital markets

Young workforce

Digital work-life enhancements

Law and order

Communication and digital divide

Stability, efficacy and transparency of government

KPMG's related thought leadership and publications discuss many pressing challenges faced by today's cities
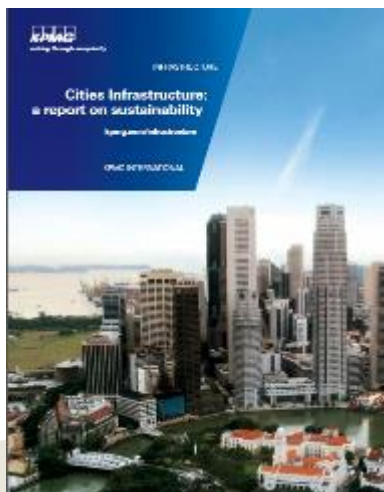
Selected publications

Tipping point: Striking the balance between urban and rural growth

Explores how governments can strike the right balance between rural areas and urban centers to create environments of inclusivity

Future State 2030

Explores how governments must respond to the global megatrends driving change into 2030

Cities infrastructure – a report on sustainability

Reviews urban infrastructure, key sustainability challenges and potential sustainability approaches

INSIGHT: Resilience

Reveals what infrastructure stakeholders are doing to manage risk and enhance resilience

Neeraj Dassani
Partner

Neeraj heads our Government and Infrastructure advisory practice. With over 25 years of consulting experience, he has worked with most major public and private sector clients across the region on large infrastructure projects, many of which are integral parts of smart cities. Neeraj has developed strategies and designed target operating models for multiple government authorities in the UAE and across the region.

Alan Mitchell
*Executive Director –
KPMG Cities Global
Center of Excellence*

Alan has over 30 years of experience of working for and with government organizations and agencies in a variety of capacities, including developing e-Government and e-Service solutions. He develops models to map the business of cities and local authorities. He has worked with approximately 40 international cities, supporting various transformation initiatives. Alan is one of the leading architects of the municipal reference model (MRM).

Dnyanesh Nirwan
Director

Dnyanesh leads KPMG Lower Gulf's infrastructure advisory practice. He has worked on a number of large-scale infrastructure programs for both public and private sector clients, and has a long-standing interest in smart cities and their evolution. Dnyanesh also has a deep understanding on how infrastructure and ICT underpin the smart city concept.

Gopalakrishnan Hariharan
Manager

A certified lean practitioner, Gopal specializes in business process management, process reengineering and developing policies and procedures, as well as process optimization. He has worked with government and private sector clients in the UAE, Oman and Saudi Arabia on a range of smart initiatives.

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