KHATIB & ALAMI

# MIDDLE EAST SMART CITIES ROADMAP

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Urban centers in the Middle East are facing the twin challenges of increasing population and scarce resources, leading to issues such as high rates of pollution, water and energy supply constraints, traffic congestion, lack of enough communication facilities, not enough space for residential and commercial areas, high rates of sickness and illness, and increased crime.

It is imperative that governments develop solutions that improve quality of living for their citizens while reducing resource consumption. Information and Communications Technology (ICT) offers many opportunities for governments to deliver city-wide transformations. To grasp these opportunities, they must develop a roadmap for building smart cities capable of leveraging and integrating ICT to create real economic opportunities and enhance the quality of their citizens' lives.

## EFFICIENCY

### PREDICTIVE LIFT MAINTENANCE
Enables the analysis of data recieved from sensors installed in lifts to predict breakdowns.

### SMART LIGHTING
Sensors and controllers in light fittings that allow light to dim if no presence is detected, saving energy and expenditure.

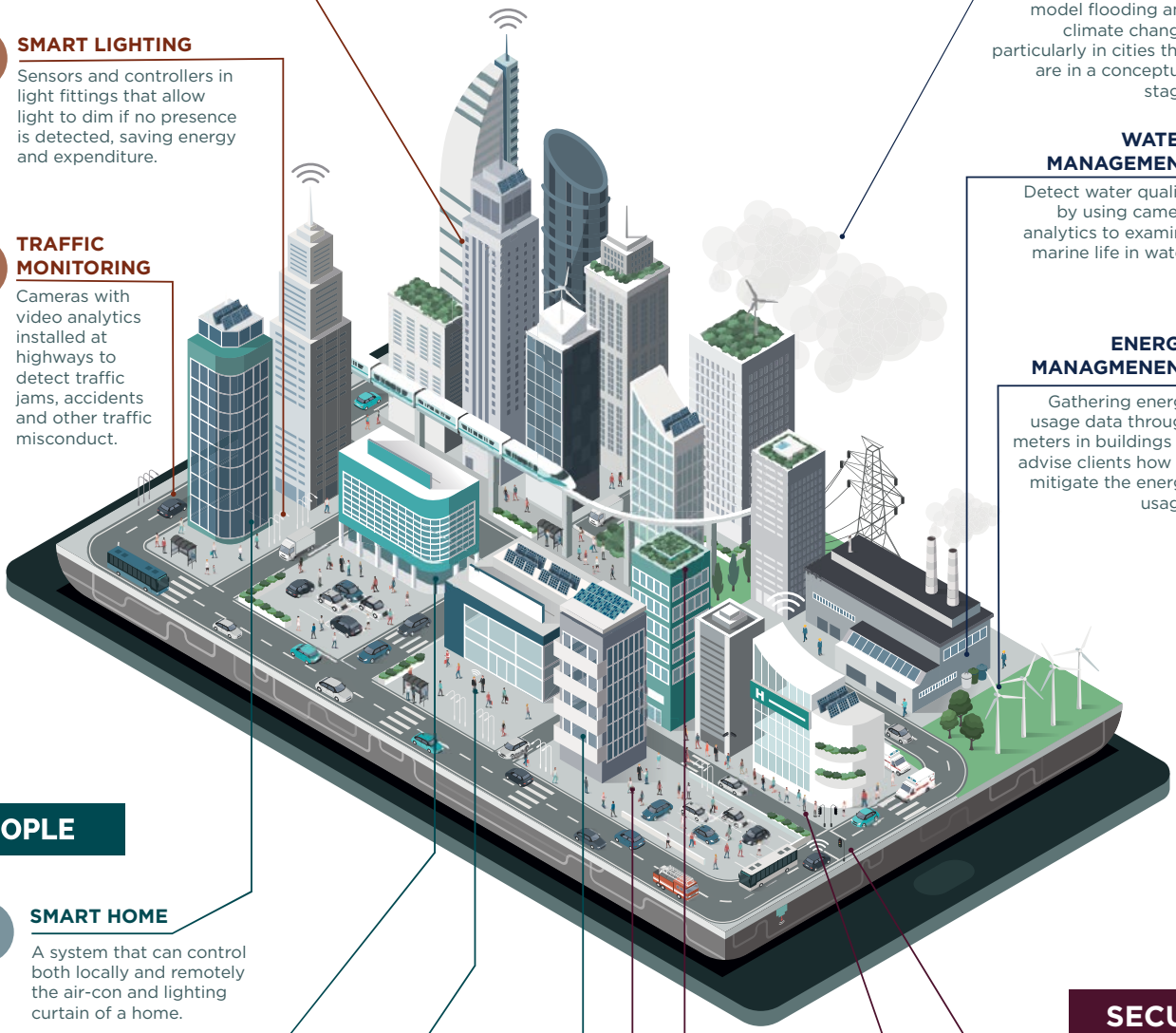
### TRAFFIC MONITORING
Cameras with video analytics installed at highways to detect traffic jams, accidents and other traffic misconduct.

## SUSTAINABILITY

### CLIMATE CHANGE & FLOOD MODELLING
Tool that allow users to model flooding and climate change, particularly in cities that are in a conceptual stage.

### WATER MANAGEMENT
Detect water quality by using camera analytics to examine marine life in water.

### ENERGY MANAGMENENT
Gathering energy usage data through meters in buildings to advise clients how to mitigate the energy usage.



## PEOPLE

### SMART HOME
A system that can control both locally and remotely the air-con and lighting curtain of a home.

### ITOWN
A mobile app allowing users to conveniently take pictures of defects and submit feedback to city councils.

### ELDERLY MONITORING
Installation of sensors in homes to detect the well-being of elderly persons and their movements.

### SMART TOILET
Sensors that detect if the toilet is wet or has run out of toilet paper, enabling the deployment of cleaners based on need rather than scheduled cleaning.

### FACIAL RECOGNITION
Cameras and laptops with stored data used to identify blacklisted individuals.

### FIRE & SMOKE DETECTION
Cameras and video analytics that detect fire and smoke.

## SECURITY

### SMART CCTV
Usage of cameras and video analytics to faciliate people-counting, illegal intrusion, objects left unattended and vehicle plate recognition.

### BEHAVIOUS ANALYTICS
Cameras that detect persons who may be drowning in a pool

**Figure 1:** *Smart City*

# TECHNOLOGY ENABLERS

There are six key technological enablers for smart cities:

- Low Power, Wide Area (LPWA) Networks
- Long Term Evolution-Machine type (LTE-M) including Enhanced Machine Type Communication (eMTC) used in cellular networks
- Narrow-Band Internet of Things (NB-IOT)
- Edge Computing
- Open-Source APIs
- Low-Cost Data Analytics make city infrastructure viable to connect

However, this large number of Low Cost Connected Sensors, actuators and switches, devices, machines, vehicles and appliances need a resilient high-speed backbone network built on optical fiber technologies.

# SMART CITY ICT REFERENCE FRAMEWORK

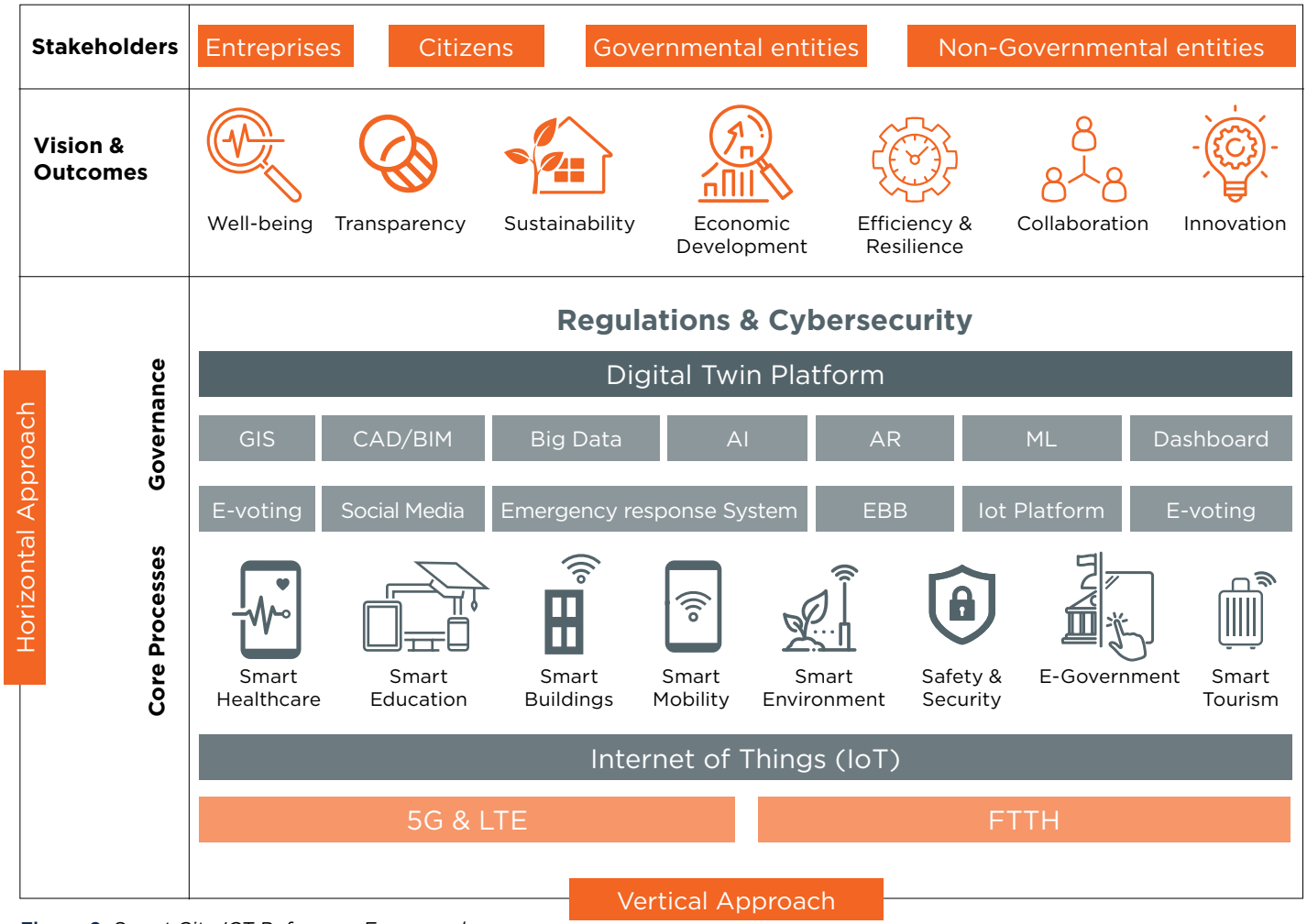



**Figure 2:** *Smart City ICT Reference Framework*

Smart city planners should take into consideration a broad area of factors including: the user experience; the expected outcomes; the control and awareness of all city functions; the city knowledge management; data and technologies; communications infrastructure; and security and regulations. Figure 2 illustrates the ICT reference framework of a smart city. The users served by the smart city ICT reference framework are enterprises, citizens, government entities and non-government entities. The motivation for making a city smart should be a result of a shared vision and a set of agreed outcomes from all the city stakeholders. The vision of a smart city is to deliver city services matching with city sustainability ambitions, transparently using collaboration and innovation approaches.

City outcomes are expected to improve the efficiency and resilience of city services and promote economic development activities that enhance the well-being of citizens.

**CORE PROCESSES** include the vertical approach processes to be integrated and be managed in order to deliver a smart city. Those include Smart Healthcare, Smart Education, Smart Buildings, Smart Mobility, Smart Environment, Safety & Security, E-Government, and Smart Tourism.

**SMART HEALTHCARE** is a health service system that uses technology such as wearable devices, IoT, and mobile internet to dynamically access information in order to connect people, materials and institutions related to healthcare. It then actively manages and responds to medical ecosystem needs in an intelligent manner.

**SMART EDUCATION** enables the city to provide the education and training that the citizens need to play an active and effective role in the economic and social life of the city, and provides local business and industry with the skills they need to flourish. This also includes the processes needed to ensure that all research into the needs and opportunities facing the city is effectively coordinated. It is accompanied by technology or by instructional practice that makes effective use of technology. It encompasses the application of a wide spectrum of educational practices, including hybrid, virtual and e-learning.

**SMART BUILDINGS** involve the installation and use of advanced and integrated building technology systems. These systems include building automation, life safety, telecommunications, user systems, and facility management systems.

**SMART MOBILITY** refers to the combined intelligent modes of transportation using connected sensors, big data and mobile apps, and the use of self-driven autonomous cars or electrical vehicles.

**SMART ENVIRONMENT** requires active inputs from the government and the people, and in any smart city their management calls for a synchronous combination of e-governance and IoT (Internet of Things) systems in a 24/7 framework, along with conventional resource management tools to achieve coordinated, effective and efficient management, development, and conservation that equitably improves ecological and economic welfare, without compromising the sustainability of development ecosystems and stakeholders.

**SAFETY & SECURITY** includes connected CCTV technologies and IoT sensors & devices to enable urban areas to deploy smart applications for crime detection and prevention. These applications are crucial to helping the police, medical teams and first responders make the best decision possible when dealing with emergency situations.

**E-GOVERNMENT** is the application of Information and Communication Technologies (ICTs) to government functions and procedures with the purpose of increasing efficiency, transparency and citizen participation.

**SMART TOURISM** can be said to inject revenues in the smart city economy, and to improve the efficiency of resource management, maximize competitiveness and to enhance sustainability through the use of technological innovations and practices. It is often associated with e-tourism as this will involve the use of web technology.

**GOVERNANCE** includes the horizontal-approach business processes that govern and manage the core processes of a smart city to produce the desired outcomes; leadership, stakeholders' engagement, sustainability & resiliency management, and external interface management.

- **The Smart City Leadership** process provides city leaders with the ability to bring together the city core processes by using Cloud Computing, Artificial Intelligence (AI), Augmented Reality (AR), big data analysis, Machine Learning (ML), Robotic Process Automation (RPA), IoT technologies and systems. Digital Twin technology on top of CAD, BIM and GIS will provide the visualization tool of this process.

- **The Stakeholder Engagement and Citizen Focus** process provides a platform for the exchange of ideas and for the sharing of information to make sure that the demands and ideas of citizens and other stakeholders are fully socialized, considered and discussed. It will enable the management and future plans for city development to be focused around the citizen, taking into account their requirements for city design, functions, services, etc. Using system engineering and system thinking, this process ensures smart city stakeholders are fully involved to minimize conflicts and unfulfilled requirements. Enabling platforms such as electronic bulletin boards (EBB), e-voting systems, or feedback/ monitoring systems using social media are used to enhance the stakeholder and citizen engagement.

- **Sustainability and Resilience Management** ensures that the city's carbon footprint and vulnerabilities to major disasters are thoroughly audited and that comprehensive. Multi-stakeholder plans are put in place to address these. This will include the identification and constant monitoring of KPIs related to sustainability and resilience and the review of all plans in light of the results using an emergency response system & dashboard.

- **External Interface Management** enables the city to interact with the wider city region and other cities, and to better manage the flow of people, goods and supplies coming in and out of the city. Arrangements should be in place to ensure that the city's needs for energy, food, clean water, etc. can be met from the wider region. The city's plans for transport and infrastructure are made in conjunction with plans for the wider regions.

Smart City planners should take into consideration the vulnerability of data flowing between IoT devices and the integrated processes in the core or in the governance layers to achieve the security goals that are confidentiality, integrity, availability, safety and resiliency. Therefore, they should plan for an integrated cyber security framework that can provide management principles comprising industry standards, legal and regulatory requirements to determine how cyber risks may affect all the ecosystem participants, as well as assess each system and asset's influence on each other. Such an integrated approach can enable city stakeholders to view threats and vulnerabilities in their entirety rather than react to specific services or operational impact.

# SMART CITY INFRASTRUCTURE

A smart city is defined as a city that is able to engage its citizens and has a high-speed data-driven resilient infrastructure to integrate and manage the city's multiple information systems and applications i.e., intelligent transportation, e-government, intelligent power utility, e-health, remote education, law enforcement and other community services.

A smart city infrastructure will be based on five pillars:

- A combined physical infrastructure using **high-speed fiber backbone** metro network and **LPWA** edge networks with **Sensors, DATA Centers and Apps**
- **Massive data collection** and storage for real-time data processing
- **Analytics** to obtain useful information for decision making
- **Data feedback** loop to ensure process optimization
- **Adaptability** to current and future demands.

Back to the Smart City index for 2021 published by the International Institute for Management Development (IMD), Riyadh, Abu Dhabi and Dubai are at the forefront of Smart City projects in the GCC.

In line with KSA's Vision 2030, NEOM mega smart city was launched in 2017 and is scheduled to be completed in 2025. It is a city with flying taxis, cloud seeding to make rain in the desert, robot maids, dinosaur robots, glow-in-the-dark sand, a giant artificial moon, and state-of-the-art medical facilities. In addition, KSA launched a Smart City project in Jeddah for light industries and car maintenance characterized by an integrated infrastructure and the use of digital and smart applications and technologies to provide automated services to customers. KSA has plans to implement 10 more smart cities in Mecca, Jeddah, Riyadh, Medina and Al-Ehsa up till 2027.

In 2015, Egypt launched the new administrative capital in Cairo, where people will be able to use a one-stop-shop mobile app to pay bills or submit complaints and reports to city officials. Meanwhile the city's public spaces and streets will be outfitted with IP CCTV**,** intended to "monitor people and vehicles to manage traffic and report on any suspicious activities". The city will install smart columns with sensors, public Wi-Fi, surveillance cameras, and smart lighting. Egypt has plans to build 17 new smart cities across the country.

In UAE, Abu Dhabi launched Masdar city in 2006 with the aim to reduce Energy and Water resources and optimize waste, and Zayed Smart City Pilot in 2018 (5-year project) using IoT and AI to manage infrastructure. As part of Dubai's plans to become a smart city leader, its government launched several smart city projects; Dubai Sustainable city in Dubai Land and Dubai Silicon Oasis aim to optimize the consumption of energy, while Dubai South District, the venue of Expo2020, emphasized the use of renewable energy and recycled materials in the expo buildings infrastructure. Desert Rose city was designed with the aim of reducing energy consumption and optimizing waste.

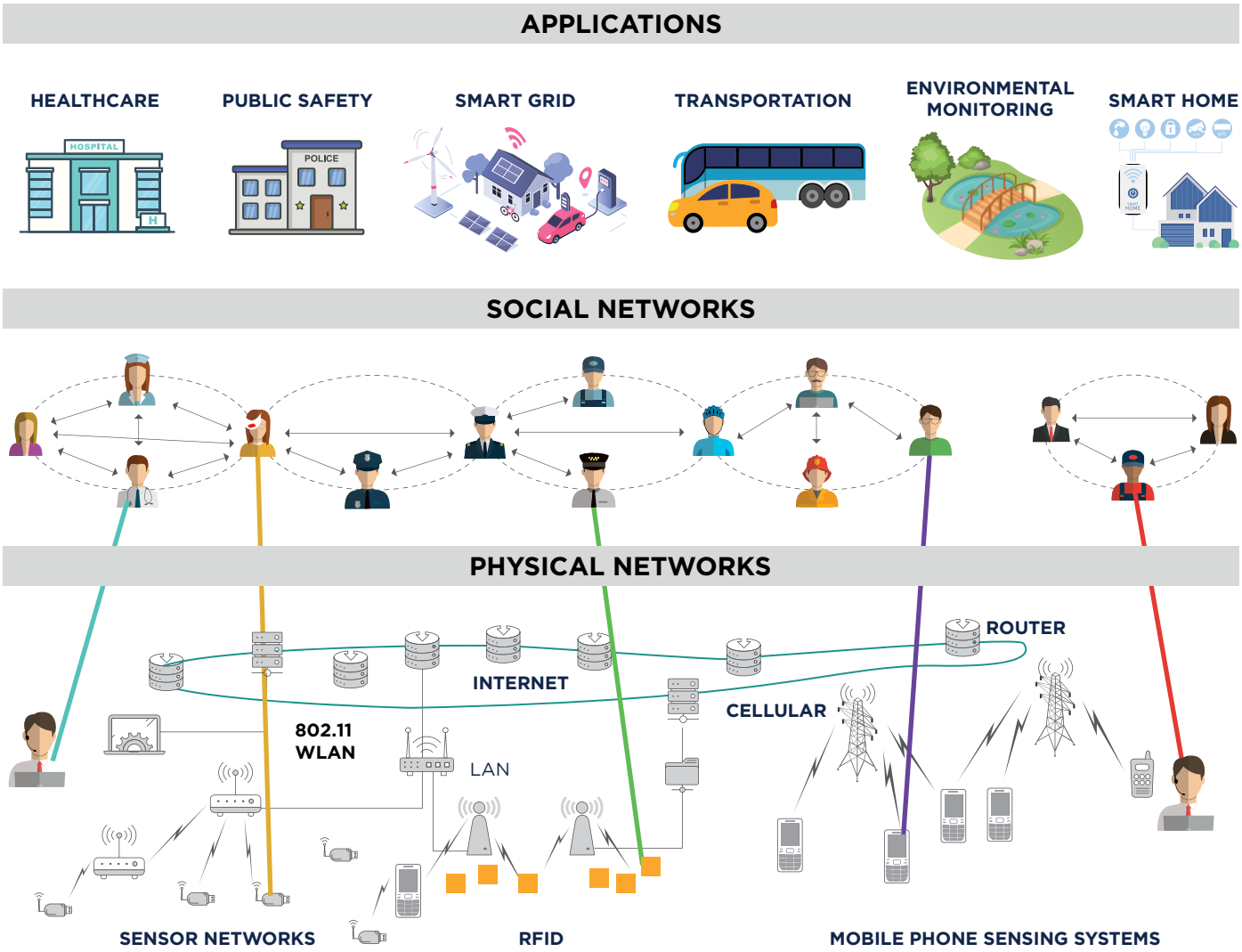



**Figure 3:** *Smart City Infrastructure*

Internet of Things (IoT) technology is used to increase sustainability, as well as to make quality-of-life improvements for citizens and visitors in smart cities.

Low power wireless sensors powered by batteries or solar cells, or even self-powered, can provide key data for such IoT networks, whether for water treatment, power utility and public lighting, smart buildings or logistics. Battery-backed sensors can be placed in many locations to provide as much data as possible and LPWANs provide a long-range link, with a battery lifetime of decades, which minimizes the cost of rolling out a monitoring network by avoiding the need for regular battery replacement cycles.

All of this data can be ingested into machine learning and artificial intelligence databases that can identify patterns, highlighting equipment that may be about to fail, and allowing resources to be provided more accurately. This is an essential element in optimizing the use of increasingly scarce resources and improving the quality of life of citizens in a city.

These sensor networks provide this actionable data across many parts of the smart city in several different ways. Early implementations have seen sub-GHz networks used for smart street lighting, air quality sensors and traffic monitoring. These sensors link to gateways that feed the data back into enterprise software systems via the cloud for real-time monitoring.

These networks are enabled by the long-range capabilities of 2.4GHz LoRaWAN versions, providing connectivity for local sensors and tracking for supply chain management across the smart city, while Sigfox, Zigbee, NB-IoT, LTE-M networks versions are helping to monitor and optimize the use of smart buildings.  LPWAN can be rolled out quickly and easily in convenient locations by city governments and network operators using 5G mobile broadband network and Gigabit internet access via Fiber networks.

# SMART CITY DEVELOPMENT ROADMAP

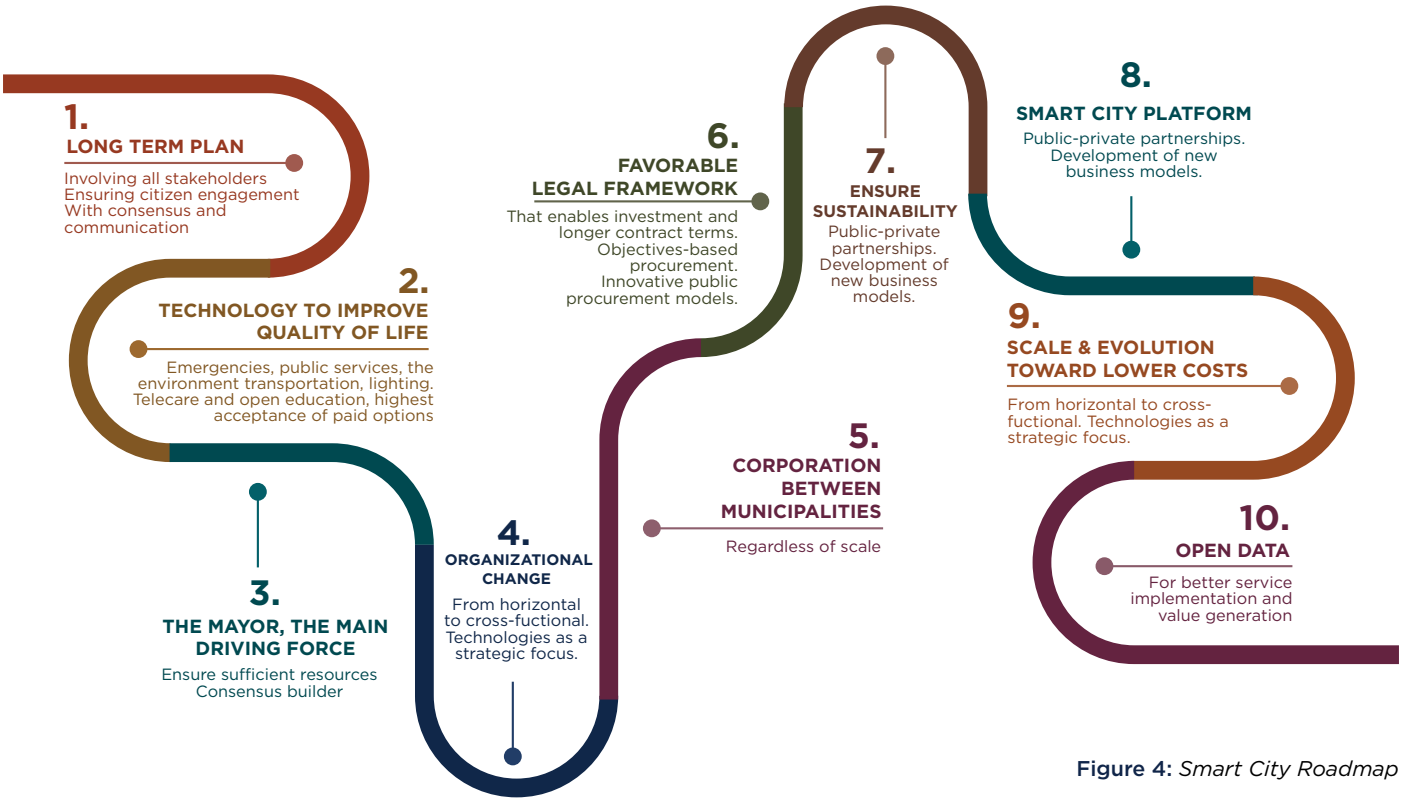



**Figure 4:** *Smart City Roadmap*

In order to build a smart city, a roadmap is required to be developed jointly by city officials and other stakeholders including citizens under PPP (Public-Private-Partnership) strategy. All parties should collaborate together to initiate and accelerate the smart city deployment process from innovation to deployment. Their goal is to be able to address all the challenges and problems facing their communities and develop creative and effective ICT solutions. The roadmap will comprise all the initiatives and priorities set for planned deployment projects with the aim of constantly updating and realizing the smart city goals.
This roadmap sets out the following steps approach *(figure. 4)*

**LONG TERM PLAN:** This includes empowering public and industry stakeholders' engagement to prepare the smart city master plan and address its challenges through public meetings and open house communications. The plan is formed based on benchmarking and best practices research. The outcomes of this step are a smart city framework and a policy to govern the planning process.

**TECHNOLOGY TRENDS ASSESSMENT:** It includes the definition of innovative technologies to be used to improve the quality of life in terms of emergencies, public services, environment, transportation, lighting, telecare, and open education and others..., the outcome of this step is to create a framework for digital transformation and digital connectivity infrastructure, processes and systems that span the city.

**SMART CITY GOVERNANCE:** It includes the engagement of city officials to lead the smart city efforts to develop creative and effective technology solutions to address the challenges. They will create and foster productive work teams, identify best practices, enhance service delivery, and implement citizens focused initiatives.

**ORGANIZATIONAL CHANGE:** To develop a smart city, municipalities and city administrators have to implement three strategies to change their organizations into flexible, agile and innovation-driven structures such as:

- **Collective Leadership** builds on a shared vision and goals, which fosters the development of a smart city as a key goal to follow in all strategies and policies of the city. It entails a balanced long-term perspective that is able to steer development towards long-term goals without compromising short-term benefits at the same time. Collective

leadership roots the development of a smart city within city stakeholders and networks and makes best use of the local innovation ecosystem.

- **Strategic Management** combines a long-term strategy with short-term investments. It uses indicators and performance monitoring systems to track progress and success. Technology-based management tools link processes across departments, provide efficient e-services and enhance overall efficiency of spending and activities. Cross-departmental organizations are needed to improve communication and management of increasingly interdisciplinary and cross-sectoral projects. This links the budget to the development goals and to strategic interests of the city and it applies innovative forms of procurement to link the local innovation ecosystem into the development process of the city.
- **Learning Organizations** with knowledge management systems that empower system-thinking, where city officials are enabled to understand the city as an integrated system, and employees are engaged in acquiring knowledge by staff training and continuous self-improvement.

**COOPERATION BETWEEN MUNICIPALITIES:** A smart city is a cross-cutting theme, where developments need to be planned, financed, built and operated across a range of departments and offices within the city administration. At the same time, becoming smart means to engage civil society, local SME's, research bodies and larger companies into the process of urban innovation. This needs a sound top-level organization, strategy-based decision making and the management and monitoring of a complex system, often in an iterative approach. It requires municipalities to depart from administration-focused institutions and become innovation-oriented organizations able to take risks, experiment, incorporate new solutions and processes, increase the speed of (re)action and drive change across a wide network of stakeholders from the private and public sectors. In today's world, all municipal staff need to engage in continuous learning and innovation processes to improve services, enhance efficiency and make best use of new and connected technologies.

**LEGAL FRAMEWORK:** It comprises the issuance of legislation that governs the construction of smart cities and assures the security and privacy of information and the protection against electronic crimes. For example, in Algeria, legislation for smart city construction, electronic crime protection, electronic signatures, and e-commerce was issued in 2006. In UAE, an e-commerce law was issued in 2002, Dubai E-government law in 2009, Digital Dubai Government in 2015. In Bahrain, an e-commerce law was issued in 2006, and e-government in 2007. This framework will be based on the following principles:

- **Participative governance**
- **Human resources development**
- **Sustainability**
- **Transparency**
- **Social Justice**

**ENSURE SUSTAINABILITY:** Establish and operationalize physical and virtual platforms for co-creation to which local citizens, social entrepreneurs, local business community, knowledge groups and the volunteer sector are invited to identify challenges and solutions. Link smart city strategies with Sustainable Development Goals and consider how new technology, new business models and co-creation can accelerate the 'green shift', while contributing to reducing the use of resources and making eco-friendly choices for people easier. Develop concrete measures and make the necessary adaptations to standards and regulations that, all in all, result in lower greenhouse gas emissions. This is to be done through more environmentally-friendly transport, new energy solutions and more energy-effective buildings.

**ESTABLISH A SMART CITY PLATFORM:** This open-source platform is a management tool to boost interoperability between different sectors, to promote participation, dialogue, innovation and collaboration between citizens and government, and allow citizens to benefit from intelligent surroundings. The tool also provides support to citizen-focused decision-making processes, allowing the city's situation and the needs of its citizens to be dealt with in an interactive and proactive manner, to provide better and more efficient services with sustainable development, and to make optimal use of available resources.

## About K&A:

Khatib & Alami is an international multidisciplinary consultancy comprised of architects, engineers, planners, project managers, technologists and other specialists. With around 7,000 experts in more than 30 international offices, we have vast experience of delivering complex projects which make a positive and sustainable contribution to our communities.

We work across a broad spectrum of sectors and disciplines, including: architecture and urban planning; transportation and urban mobility; water & environment; energy; program management; and digital services. In other words, our people are involved in enhancing infrastructure, creating new buildings, developing neighborhoods, protecting the environment, and reshaping entire cities.

We guide and support clients through the adoption of new technologies and integrated smart solutions which drive improvements across their projects and operations, including quality, productivity, risk and sustainability.

## About the author:

**Dr Houssam al Masri has more than 30 years' technical and management experience working with multidisciplinary teams on broadband communication networks and smart city infrastructure.**

As the FTTx project manager at Khatib & Alami, Dr Al Masri's current responsibilities include managing the supervision, validation and commissioning of Lebanon's FTTx project rollout. In his previous positions in the telecom industry in the MENA region, Dr Al Masri played an instrumental role in managing major telecommunication projects related to Smart cities and solutions, Smart Buildings and Smart Homes, Fiber to Homes and Broadband Access. He has led multiple project rollouts related to both the public and private sectors.

Dr Al Masri earned a PhD in Computer engineering from MIT. He is serving as a Chairman of the Smart City Opt. and App Committee for the FiberConnect Council MENA since 2019. He is a member of ESRI GIS community professionals, the IEEE IT society, and the Green Buildings Association.

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