Smart Cities – Adoption of Future Technologies

“Smart sustainable cities is a journey. Not a final destination”.

In collaboration with KPMG

January 2020
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  - Smart homes
  - Industry 4.0 in waste management
- Asia is moving fast on ICT & Digitally enabled Smart Cities
  - Indian Smart Cities
- However, there are concerns to be addressed…
- What it takes - the Way forward
As the world became more urbanized the challenges multiplied..

**Sewage**
- Sewage treated- 33% in middle income & 8% in lower income countries

**Pollution/ climate concerns**
- 20% of urban population live in areas with safe levels of PM 2.5 in air

**Affordable housing**
- 33% of urban population live in slums worldwide

**Data security**
- 0.5 mn traffic control sensors vulnerable to manipulation in mega cities

**Solid Waste**
- Cities in low income countries have waste collection rates around 45%

**Water supply**
- 4 out of 10 urban residents are affected by water shortage

**Transportation system**
- Peak hour travel times > 200 hours a year in large cities due to congestion

**Basic amenities**
- 60% South Asian and 42% Sub-Saharan Africa urban dwellers have access
Smart cities leverage digital intelligence to solve public problems and improve livability

Three layers of “smartness”:

- Adoption and usage, often leading to better decisions and behavior change
- Smart applications and data analysis capabilities
- The tech base includes networks of connected devices and sensors
- Traditional infrastructure (physical and social)
‘Digital Intelligence’ constitutes numerous technological applications to transform traditional urban infrastructure and services

<table>
<thead>
<tr>
<th>Energy</th>
<th>Mobility</th>
<th>Environment</th>
<th>Social</th>
<th>Workspace</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smart meter</td>
<td>Intelligent transport system</td>
<td>Smart water meter</td>
<td>E-health: Remote Patient Monitoring</td>
<td>Building automation</td>
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<tr>
<td>Demand response</td>
<td>Tolling and congestion charges</td>
<td>Smart disaster management</td>
<td>E-governance</td>
<td>Remote work station</td>
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<tr>
<td>Distributed generation and integration</td>
<td>Smart parking</td>
<td>Real-time air pollution monitoring</td>
<td>Remote social infrastructure</td>
<td>Smart consumer appliances and devices</td>
</tr>
</tbody>
</table>

**Smart City & Communication Infrastructure**

**Interaction layer (service delivery platform, integrated operations centre and government scheme applications)**

- Servers/ IoT
- Mobile technology
- Big data/ advanced analytics
- Cloud computing
- Artificial Intelligence

**User orientation & user participation**
Digital technologies are being deployed in cities around the world to improve urban services.

**Deployment of digital technology solutions**

**Case examples, not exhaustive**

**Boston**
- Sensors monitor energy usage across 350 facilities

**New York City**
- Sensors detect gunshots and detect them with 1m² accuracy

**Vancouver**
- >1m smart meter monitor energy usage and pinpoint outages

**Philadelphia**
- 500 solar trash compactors save city $1M annually in OpEx

**Chicago**
- Smart meters have reduced energy consumption by 10-15%

**Mexico City**
- Sensors detect earthquakes, giving residents 90 seconds to evacuate

**Rio De Janeiro**
- Command centre integrates cameras & sensors for emergency mgmt

**Port au Prince**
- Drones assess earthquake damage, identifying rubble with 92% accuracy

**Nairobi**
- 90K smart water meters combat theft and leaks

**Copenhagen**
- Road sensors detect approaching cyclists and switch traffic signal to green

**Lyon**
- 6M bike share trips are taken each year via 345-dock system

**Barcelona**
- 70K elderly residents have one-click access to health call-centres

**Hong Kong**
- 47 buildings connected to produce light and music shows each night

**Singapore**
- Solar-powered rubbish bins to serve as internet hotspots; with fill-level sensors and compactor
Examples of smart cities generating high SDG impact in developing countries by improving key Quality of Life indicators by 10-30%

<table>
<thead>
<tr>
<th>Areas</th>
<th>Impact</th>
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<tbody>
<tr>
<td>Faster, secure and affordable commuting</td>
<td>Commute time saved by 15-20%</td>
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<td></td>
<td>Commuting time for healthcare/government work reduced by 45-65%</td>
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<td></td>
<td>Reduce health burden by &gt;4%.</td>
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<td>Developing cities achieved 5% reduction in spread of infectious disease</td>
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<tr>
<td>Smarter and faster public health response</td>
<td>6% reduction in building emissions</td>
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<td>Reduce air pollution related negative health effects by 3-15%</td>
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<td>Water consumption reduction by 15% and loss reduction by 25%</td>
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<tr>
<td></td>
<td>Reduce unrecycled solid waste by 30-130 kg/person</td>
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<td>Cleaner and more sustainable environment</td>
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<table>
<thead>
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<th>Areas</th>
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<tbody>
<tr>
<td>Smart, affordable and sustainable access to energy</td>
<td>Reduce usage of carbon intensive ‘peak plants’</td>
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<td></td>
<td>Increased use of green energy</td>
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<td>Reduced power outage</td>
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<tr>
<td>Improved public safety and information security</td>
<td>Incidents of assault, robbery, burglary lowered by 30–40%</td>
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<td>Cut emergency response times by 20–35%</td>
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<td></td>
<td>Reduce traffic fatalities by &gt; 1%</td>
</tr>
<tr>
<td>Innovation and economic opportunities</td>
<td>Smart city technologies to boost employment by 1–3% by 2025</td>
</tr>
</tbody>
</table>

SOURCE: KPMG
What are enabling the ‘smart cities’ to transform lives?
There are as many as ~60 technology applications for smart cities most relevant until 2025

- Predictive policing
- Real-time crime mapping
- Gunshot detection
- Smart surveillance
- Emergency response
- Body-worn cameras
- Disaster early-warning systems
- Personal alert
- Home security
- Data-driven building inspections

- Teledicine
- Remote patient monitoring
- Lifestyle wearables
- First aid alert
- Real-time air quality information
- Infectious disease surveillance
- Data-based population health interventions: Maternal and child health; Sanitation and hygiene
- Online care search and scheduling
- Integrated patient flow management systems

- Building automation
- Home energy automation
- Home energy consumption tracking
- Smart lights
- Dynamic electricity pricing
- Distribution automation

- Water consumption/ quality tracking
- Leakage detection
- Smart irrigation

- Digital tracking/ payment for waste disposal
- Route optimization

- Real-time public transit information
- Digital payment in public transit
- Predictive maintenance of transport system
- Intelligent traffic signals
- Congestion pricing
- Demand-based micro transit
- Smart parking
- E-hailing
- Car sharing
- Bike sharing
- Integrated multi-modal information
- Real-time road navigation

- Digital business licensing and permitting
- Digital tax filing
- Online retraining programs
- Personalized education
- Local e-career center
- Digital land-use and building permitting
- Open cadastral database

- Local citizen engagement
- Local connection platforms
- Digital administrative citizen services
Internet of Things (IoT)

- Billions of physical devices around the world that are now connected to the internet, collecting and sharing data in real time.
- By end of 2020, internet connected things expected to outnumber humans 4-to-1.

![Forecasted Growth of Connected Devices (Billions)](image)

**Global trends depict a large share of IoT invested in Smart Cities**

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<tbody>
<tr>
<td>Smart Retail</td>
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<td>18</td>
<td>23</td>
<td>27</td>
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<td>43</td>
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<td>Connected Health</td>
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<tr>
<td>Connected Building</td>
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<td>Connected Industry</td>
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<td>Smart Energy</td>
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<td>Connected Car</td>
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<tr>
<td>Connected Industry</td>
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<tr>
<td>Smart City</td>
<td>34%</td>
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</tbody>
</table>

**SOURCE:** KPMG
### IOT application in Smart Cities - State-of-the-art air-pollution analytics & Decision Tool

**CASE EXAMPLE -1**

<table>
<thead>
<tr>
<th>Challenge</th>
<th>Intervention</th>
</tr>
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</table>
| Ambient air pollution was responsible for nearly 7 mn deaths - 10% of all-cause deaths in 2013 | - Air pollution monitoring and management:  
  - Leveraging satellite imagery to map out pollution change and forecast trends  
  - Sensor based low cost monitors across urban and rural scape to generate local data  
  - Structured and unstructured information gathered from citizen through Apps, Social Media  
  - Natural Language based Voice/ Chat Bots or IVRS receiving pollution information  
  - Downloadable Apps to capture pollution information, geo-tag and transmit  
  - Using Predictive Analytics to forecast pollution intensities over time and geography |
| Of the most polluted cities in the world, 22 are in India (2018)           |                                                                                                  |
| Air pollution in urban areas as a whole was 8% worse in 2013 than it was in 2008 |                                                                                                  |
| 98% of urban areas in “low- and middle-income countries” with populations of more than 100,000 fall shy of air quality standards |                                                                                                  |

#### Decision Support system for graded response

<table>
<thead>
<tr>
<th>Status</th>
<th>Air</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACCEPTABLE (but with unfavourable forecasts)</td>
<td>- Prior warning through social media</td>
</tr>
</tbody>
</table>
| MODERATE | - Critical monitoring of industrial corridors  
- Water sprinkling on sites |
| POOR | - Public transport increased  
- Traffic restrictions |
| SEVERE | - DG operations suspended  
- Parking fee increased and congestion charge imposed in urban pockets |
| EMERGENCY | - Commercial vehicles ban  
- Real estate construction suspended |

Source: WHO, The Economist
Decision Support System for real-time response to city-level air-pollution management

1. DSS receives air quality data from each AQM (A-F) and weather data from IMD
2. IMD forecasts wind movement from NW to SE
3. ‘Moderate’ air quality at ‘A’ may worsen with incoming traffic
4. Furthermore, prevailing wind will direct PM towards city centre if situation in ‘A’ worsens
5. **DSS proposes that vehicles trying to enter from ‘A’ should be diverted to enter through ‘F’ by evaluating multiple criteria:**
   a) Situation in B, C, D are worse than in A
   b) Entry through B is not preferred as winds will blow PM towards city
   c) Travel diversion for entering through ‘E’ would be more
IOT application is radically transforming the city level power-utility business

**CASE EXAMPLE -2**

### Production
- Today: Nuclear power station, Gas production, Coal/gas-fired power station, Hydro-electric power
- Scenario for tomorrow: Onshore and offshore wind, Storage, Solar
- Key changes:
  - Decentralized generation
  - New sources of energy production, changes in generation mix
  - Grid balancing critical due to higher RE share, enabled by various ICT measures

### Trading
- Today: Business unit trading businesses — local markets
- Scenario for tomorrow: Regional markets grow
- Key changes:
  - Increasing complexity and sophistication required to capture data from various demand-supply centres

### Distribution
- Today: Energy flows to users
- Scenario for tomorrow: Micro wind
- Key changes:
  - Smart meters and grids enable flow of energy to and from customers

### Metering
- Today: "Dumb" meter
- Scenario for tomorrow: Smart metering, EV
- Key changes:
  - Applications and solutions utilizing Smart technologies offer new sources of revenue

### Retail
- Today: Micro wind, Micro CHP, Solar water heating, Solar PV
- Scenario for tomorrow: Customers generate their own energy, Customer has more control; enabled by smart technologies
‘Smart-home’ is becoming an attractive proposition for real-time residential energy management

Why now?

- Regulation and Government Incentives: It ignites the growth of the smart home market
- Smart metering: It extends the utility’s reach into customer premises and introduces appliance-utility interaction
- Technological Change: Appliances are becoming smart and able to interact
- Consumer Expectation: Expect technologies to be interactive and to improve quality of life
- Competition: The smart home is the focal point for many industries

What it offers?

Energy Services
Security
EV Transport
Tele-health
Entertainment

Smarter Homes

“In the future, homes will interface with technology in a different and exciting way where domestic processes will be joined together in an interactive, data rich smart grid. Customers will look to the providers they know and trust to look after their whole smart house.”
Industry 4.0 application to disrupt and transform the municipal waste management

- **Waste prevention**
  - IoT → preventive maintenance to expand life cycle
  - Robotic recycling and sorting

- **Waste disposal**
  - Driverless compaction
  - Sensors to process/map the materials
  - Monitoring

- **Waste generation**
  - New e-waste streams
  - More complex waste
  - Waste Prevention

- **Waste treatment**
  - Fully automatic
  - Continuously adapting
  - Miniaturization
  - 3D printers

- **Waste collection**
  - On demand services
  - People-bins-vehicles-cloud
  - Driverless & robotic

- **Seville, Spain**
  - 66% reduced collection costs

- **Walsall, UK**
  - Has used AI to sort 15,000 ton of batteries

- **Bergen, Norway**
  - Uses digital platform to enable plug and play integration with several vendors of access controlled containers, vacuum systems, car weights and scanners.

- **Vikki, Helsinki, Finland**
  - Has a robotic waste sorting station - utilization of waste increased by 20%

- **Driverless sweeper/refuse trucks used in an industrial park in Shanghai**

CASE EXAMPLE - 4
## City-by-city solution suite for smart transportation system

### City 1 (e.g., North American City)
- Medium commute time baseline
- Metro is primary commute mode
- Medium congestion
- Low bus occupancy

### City 2 (e.g., South African city)
- Medium commute time baseline
- Bus is primary commute mode
- Medium congestion
- High bus occupancy

### City 3 (e.g., African city)
- High commute time baseline
- Bus is primary commute mode
- High congestion
- Low bus occupancy

### Decrease in average commute time by application

<table>
<thead>
<tr>
<th>Service</th>
<th>City 1</th>
<th>City 2</th>
<th>City 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Real-time public transit information</td>
<td>5.2</td>
<td>2.5</td>
<td>3.8</td>
</tr>
<tr>
<td>Predictive maintenance of transport system</td>
<td>2.3</td>
<td>1.4</td>
<td>1.1</td>
</tr>
<tr>
<td>Smart parking</td>
<td>2.2</td>
<td>2.7</td>
<td>0.6</td>
</tr>
<tr>
<td>Real-time road navigation</td>
<td>2.1</td>
<td>2.6</td>
<td>3</td>
</tr>
<tr>
<td>Bike sharing</td>
<td>1</td>
<td>1</td>
<td>0.1</td>
</tr>
<tr>
<td>Congestion pricing</td>
<td>0.6</td>
<td>0.5</td>
<td>0.1</td>
</tr>
<tr>
<td>Digital payment in public transit</td>
<td>0.4</td>
<td>0.4</td>
<td>0.5</td>
</tr>
<tr>
<td>Smart parcel lockers</td>
<td>0.2</td>
<td>0.5</td>
<td>0.3</td>
</tr>
<tr>
<td>Parcel load pooling</td>
<td>0.2</td>
<td>0.1</td>
<td>0.6</td>
</tr>
<tr>
<td>Integrated multi-modal information</td>
<td>0</td>
<td>0</td>
<td>0.6</td>
</tr>
<tr>
<td>E-hailing (private and pooled)</td>
<td>-0.1</td>
<td>-0.3</td>
<td>-2.2</td>
</tr>
</tbody>
</table>

1 Overlaps not considered  2 Includes informal buses  3 E-hailing assumed 50% private, 50% pooled

SOURCE: KPMG
## Smart Transportation Solutions for Thane Municipal Corporation, India

<table>
<thead>
<tr>
<th>Situation</th>
<th>Intervention</th>
<th>Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extreme traffic congestion due to private cars and poor traffic planning</td>
<td>Real time bus running information at bus stops and mobile apps</td>
<td>Reduction in congestion by 5-10%</td>
</tr>
<tr>
<td>Public transportation system poorly managed</td>
<td>Digital Command &amp; Control Center for disaster management and emergency response</td>
<td>More utilization of public transport due to ease of ticketing and efficient management</td>
</tr>
<tr>
<td>Purchase of tickets for public transport extremely time taking</td>
<td>Centralized fleet management system helps in planning driver and route schedule of buses in a convenient way</td>
<td>Digital advertising an addition to the revenue stream helping to further upgrade and improve services</td>
</tr>
<tr>
<td>Lower number of buses as compared to the city’s population</td>
<td>Analytics reports highlights KPIs and key areas of improvements.</td>
<td>Reduction in air pollution due to reduced congestion and more utilization of public transport</td>
</tr>
<tr>
<td>Electronic ticketing system, mobile ticketing system and cashless rides for commuters</td>
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</table>

**SOURCE:** KPMG
Concerns to be addressed...
## Challenges and Concerns

<table>
<thead>
<tr>
<th>Resource demand</th>
<th>Demand for raw materials (lithium, heavy rare earths) used in digital devices is posed to increase significantly – opening up questions regarding their availability</th>
</tr>
</thead>
</table>
| Data security and privacy | More vulnerable to hackers invading intellectual property as all processes are digitized and all devices/machines connected to the network  
Guarantee privacy of personal data of people, which is captured when constantly interacting with permanently connected devices |
| Overstraining of governments with creation of policy | Pace of digitization exceeds the speed at which policies and regulations can be formulated to govern digital and technology developments  
Policy making could become ineffective in impeding potential adverse effects, e.g. on privacy and data security, labor rights and conditions and the environment |
| Innovation race | Few top runners would get large economic influence and – if regulations are weak – power to lever out social and environmental standards  
Countries will be increasingly challenged to provide suitable framework conditions for innovation and to protect existing standards and to expand them to newly developing digital branches |
| Deepening global inequalities | Inequalities between the economic development of industrialized, emerging economies and developing countries could further deepen if under-developed countries cannot tap into digital development benefits |
| Job loss | 15-20% workforce could be laid off due to automation, robotics and artificial intelligence taking over manual labour  
Upgradation of skills needed especially for unskilled and semi-skilled labour |
Way Forward...
Leading smart-cities also strive to become ‘Innovation Hubs’ that create economic spillovers in addition to GDP and job creation

<table>
<thead>
<tr>
<th>Description</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>▪ In-depth research and innovation within an industry establishes widespread know how of best practices that can influence other industries</td>
</tr>
<tr>
<td>Technology</td>
<td>▪ Technologies are developed that increase productivity in the economy</td>
</tr>
<tr>
<td>Talent</td>
<td>▪ Concentration of talent spurs innovation and provides a talent base that can be utilized by other firms and industries</td>
</tr>
<tr>
<td>Entrepreneurship</td>
<td>▪ Innovation spurs willingness of individuals to form new businesses to take advantage of promising ideas</td>
</tr>
<tr>
<td>Reputation</td>
<td>▪ Intangible benefits of developing a reputation for high-tech innovation and home to leading global companies</td>
</tr>
<tr>
<td>Culture</td>
<td>▪ Constant social interactions in driving innovation shapes positive economic behaviors (e.g. meritocracy)</td>
</tr>
</tbody>
</table>

Examples

▪ Studies have shown that half of the aggregate impact of R&D is in the form of knowledge spillovers↑
▪ Studies confirm that the rapid growth in productivity in the US during the latter half of the 1990s arose from an increase in technological change
▪ Concentration of knowledge workers in Boston – 48% vs US average 40% – yielded 215 patents per 10,000 employees in 2006, above US average of 78
▪ Boston biotech hub has 16 of the top 20 US biotech companies, 23 filing for IPOs since 2000 with 13 listed
▪ Swiss BioValley cluster is home to world-leading pharma companies like Novartis and Roche; 40% of international pharma companies are located in the region
▪ “Connectedness and involvement in networks, ability to communicate efficiently as well as quick coordination and decision-making are major characteristics… of Silicon Valley” – Institute of International Economics
Success of digitally enabled smart cities will entail intense public-private collaboration among key stakeholders

**Academia**
- Use advanced technologies for theoretical verification of new ideas
- Use social network to collaborate with other institutions and business
- Develop patents on new technologies
- Establish policy incubators

**Business**
- Run commercial pilots on advanced technologies
- Horizontal collaboration with institutes/start-ups/other business
- Incubator alliance/industry alliance
- Facilitate industry growth forums
- Set-up investment funds
- Policy advocacy

**Civil Society**
- Leverage advanced technologies for skill training
- Use social network and technologies for innovative jobs
- Provide feedback on citizen services to the government

**International organizations**
- Knowledge transfer
- Technology networking, collaboration & partnership
- Transfer of best-practices on data/technologies policies and governance
- Facilitate network of experts

**Digitization Master Plan**
**City-level digital infrastructure**
**Big data/advanced analytics**
**Data protection regulations**
**Finance support for business**
Thank you
SECURITY
- Predictive policing
- Real-time crime mapping
- Gunshot detection
- Smart surveillance
- Emergency response
- Body-worn cameras
- Disaster early-warning systems
- Personal alert
- Home security
- Data-driven building inspections

ECONOMIC DEVELOPMENT
- Digital business licensing and permitting
- Digital tax filing
- Online retraining programs
- Personalized education
- Local e-career center
- Digital land-use and building permitting
- Open cadastral database

HEALTHCARE
- Telemedicine
- Remote patient monitoring
- Lifestyle wearables
- First aid alert
- Real-time air quality information
- Infectious disease surveillance
- Data-based population health interventions: Maternal and child health, Sanitation and hygiene
- Online care search and scheduling
- Integrated patient flow management systems

MOBILITY
- Real-time public transit information
- Digital payment in public transit
- Predictive maintenance of transport system
- Intelligent traffic signals
- Congestion pricing
- Demand-based micro transit
- Smart parking
- E-hailing
- Car sharing
- Bike sharing
- Integrated multi-modal information
- Real-time road navigation

ENERGY
- Building automation
- Home energy automation
- Home energy consumption tracking
- Smart lights
- Dynamic electricity pricing
- Distribution automation

COMMUNITY
- Local citizen engagement
- Local connection platforms
- Digital administrative citizen services

WATER
- Water consumption/quality tracking
- Leakage detection
- Smart irrigation

WASTE
- Digital tracking/payment for waste disposal
- Route optimization

SOURCE: KPMG