The rise of connected devices enables cities to take a holistic approach to address citizen issues from the municipal to the neighborhood level.

Data collected from devices can be used to create rich, virtual 3D views of cities and the way their systems interact.

Combining data from physical sources with virtual worlds allows city planners to predict and visualize system changes arising from the introduction of smart city projects.

This collection and combination of data enables cities to predict results, reducing negative outcomes and waste, helping to drive sustainable and resilient cities.
Cities are going through a period of profound change.

Demand for services continues to grow with urbanization.

The trend towards adoption of digital technologies provides a platform for change.

This combination presents opportunities to review long-term plans for addressing social, economic and environmental challenges to sustainability and resilience of cities.

**INCREASING URBANIZATION**
- In 1950, 30% of the world’s population lived in urban areas.
- Today, 55% live in urban areas.
- By 2050, this will rise to 68%.

**WASTE MANAGEMENT AND RECYCLING**
- Waste rates continue to rise. According to the World Bank, cities generated 1.3 billion tons of solid waste in 2012. Given population and urbanization trends, this is forecast to grow to 2.2 billion tons in 2025.

**WATER DISTRIBUTION AND RECLAMATION**
- Global demand for fresh water is expected to increase by around 55% by 2050.
- It is often cited that 80% of the world’s waste water is released into the environment without adequate treatment.

**ENERGY CONSUMPTION**
- Cities account for more than 75% of global primary energy use.
- The world’s energy consumption is set to rise 28% between 2015 and 2040.
Smart city initiatives will attract technology investment of more than US$81 billion in 2018.

Not just cities are involved. An increasing number of parties are addressing these challenges.

New business models are emerging — monetization of data, charging for services to influence behavior.

Cities can only become smart if they integrate and synthesize the data gathered and turn data into actionable intelligence that improves efficiency and quality of life for citizens.

**TOP 4 GLOBAL SMART CITIES STRATEGIC PRIORITIES**

2017-2021, COMPOUND ANNUAL GROWTH RATE

- **INTELLIGENT TRANSPORTATION**: 16% CAGR
- **PLANNING AND ADMINISTRATION**: 16% CAGR
- **ENERGY AND INFRASTRUCTURE**: 18% CAGR
- **ECONOMIC DEVELOPMENT AND CIVIC ENGAGEMENT**: 17% CAGR

**Compound Annual Growth Rate [CAGR]** = average annual growth rate over a specified time period greater than a year

Cities are increasingly using analytics to manage aspects of city operations (movement tracking for cars, asset management, air quality, etc.).

Cities are drawing this data together in a central hub, often supplemented by external data.
SMART CITIES ARE BUILT ON CONNECTING, AGGREGATING AND PRESENTING DATA TO DECISION MAKERS.

THE NUMBER OF CONNECTED DEVICES AND USE OF DIGITAL CHANNELS ARE INCREASING THE VOLUME, VARIETY AND VELOCITY OF DATA COLLECTED.

- IDC estimates that worldwide state, national and local government spending on modular/sensor devices will rise from US$8.4 billion in 2018 to US$13.9 billion in 2022. *

FINDING PATTERNS IN THE DATA QUICKLY DEPENDS ON HOW INTUITIVE INTERFACES ARE.

- IDC estimates that worldwide state, national and local government spending on analytical tools will be US$7.8 billion in 2018, rising to US$11.9 billion by 2022. **

THE END-USER NEEDS THE RIGHT TOOL TO VISUALIZE DATA AND KEEP IT FROM BECOMING AN INHIBITOR.

DATA VISUALIZATION.

- **Intuitiveness** — allows line managers and non-data scientists to interact with data.
- **Visual relationships** — easy to let city administrators explore data and see relationships.
- **Collaborative** — supports clarity of communication for ideas and facilitates working together.

**Source: IDC Worldwide Semiannual Internet of Things Spending Guide 2017H2
TECHNOLOGY ROADMAPS

USING THIRD-GENERATION PLATFORMS

Technology Roadmaps are required to guide organizations along the digital transformation journey.

Apply 3rd Generation Platform technologies to improve all aspects of society. For government bodies, this means:

- Use information to create an evidence-based culture. Government agencies should plan on doubling the productivity of their knowledge workers by using information more effectively.

- Use new sources of innovation and creativity to enhance experiences and improve financial performance. Simply modernizing the technology underpinning existing systems is not transformation.

- Use 3rd Generation Platform technologies (such as Cloud, Mobility, Big Data and Social), as well as Innovation Accelerators (including IoT, Robotics and 3D printing) to support change in how public services are delivered.

CONNECTED DEVICE GROWTH

Worldwide state, national and local government spending on augmented and virtual reality.

There is an expectation that this will grow as AR and VR technology is migrated. Worldwide state, national and local government spent US$37.8 billion on IoT in 2017.

Managing and monitoring environmental and infrastructure devices accounts for 38% of expenditure by use cases in 2017.

The most popular types of IoT data being collected are video, environmental (temperature, air quality, etc.) and geolocation.
### DATA VISUALIZATION CHALLENGES

**CITY PLANNERS AND ADMINISTRATORS ARE CURRENTLY UNABLE TO EXTRACT THE MAXIMUM VALUE FROM DATA DUE TO:**

<table>
<thead>
<tr>
<th>Challenge</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>The challenge of combining different types of data into a single view.</td>
<td>For example, merging static data (maps or images) with dynamic data (traffic flows or pedestrian footfall).</td>
</tr>
<tr>
<td>The challenge of visualizing data in a way for decision makers to understand intuitively and base decisions on.</td>
<td></td>
</tr>
<tr>
<td>The challenge of enabling users to query multidimensional data (such as traffic flow data) and relationships to other data (such as weather or sports events).</td>
<td></td>
</tr>
<tr>
<td>The challenge of relaying data to field workers, providing them with a real-world view of issues.</td>
<td></td>
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<tr>
<td>The challenge of building collaborative approaches to problem solving across departments due to issues of compatibility.</td>
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</tbody>
</table>
Collection of real-time data from sensors and connected devices across a range of city services.

Combining data to create a digital twin of the city and its 3D experience.

Analytics to plan and enable sustainable initiatives and avoid negative outcomes from future programs, such as impacting scarce resources, pollution from increased traffic and pedestrian flows around congested locations.

3D modeling that enables more robust civic engagement, as non-professionals can provide more input and feedback to city managers.

Modelling to create new possibilities over and above those in use today, such as — modelling for different economic groups or climate events to build sustainable and resilient cities.

Virtual Singapore, the first of its kind, is an initiative of the Singapore Government, creating a top to bottom 3D model of Singapore which not only provides a 3D model of the city, but also a platform for citizens, private enterprises, education institutions, and government to work collaboratively to address the long-term sustainability and smart city objectives of Singapore.
HOW DIGITAL TWINS CAN HELP CITIES

DIGITAL TWIN CITIES BENEFIT CITY PLANNERS AND DEVELOPERS BY:

- Overcoming the complexity of city ecosystems — city planners manage risk and the safety of citizens while improving performance and quality of systems, and especially gain oversight of the management of complex interrelated systems for scheduling and administration of maintenance and new site and building development.

- Extending the ecosystem of suppliers — a wider set of suppliers and partners providing and presenting design and operational services on top of infrastructure management.

- Presenting data at different levels of understanding — bringing together data from a range of sources in a way that is understandable to business managers, leaders and planners helps them gain a better understanding of territorial resources to ensure more sustainable and resilient urban areas.

- Creating a connected city — using IoT allows better asset management throughout the life of the asset, reducing citizen dissatisfaction with services, reducing costs and enabling management and maintenance, while reducing negative effects on business performance and urban experience.
Utilizing data to its maximum value is essential if cities are to maximize investments.

A wrong decision can cost or delay progress; visualization can help to make better choices.

Visualization tools require large amounts of data to be useful; this requires investment in sensors to generate data, storage capacity, data management tools, etc.

Digital twins can aid communication of events that are hard to visualize, aiding communication and decision making, leading to more resilient and sustainable cities.
For this report, IDC has drawn upon its library of research on Smart Cities, IoT and Government Insights to form a comprehensive view of the opportunities and challenges of Digital Twin and Visualization tools for the Smart City market.
ABOUT IDC

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