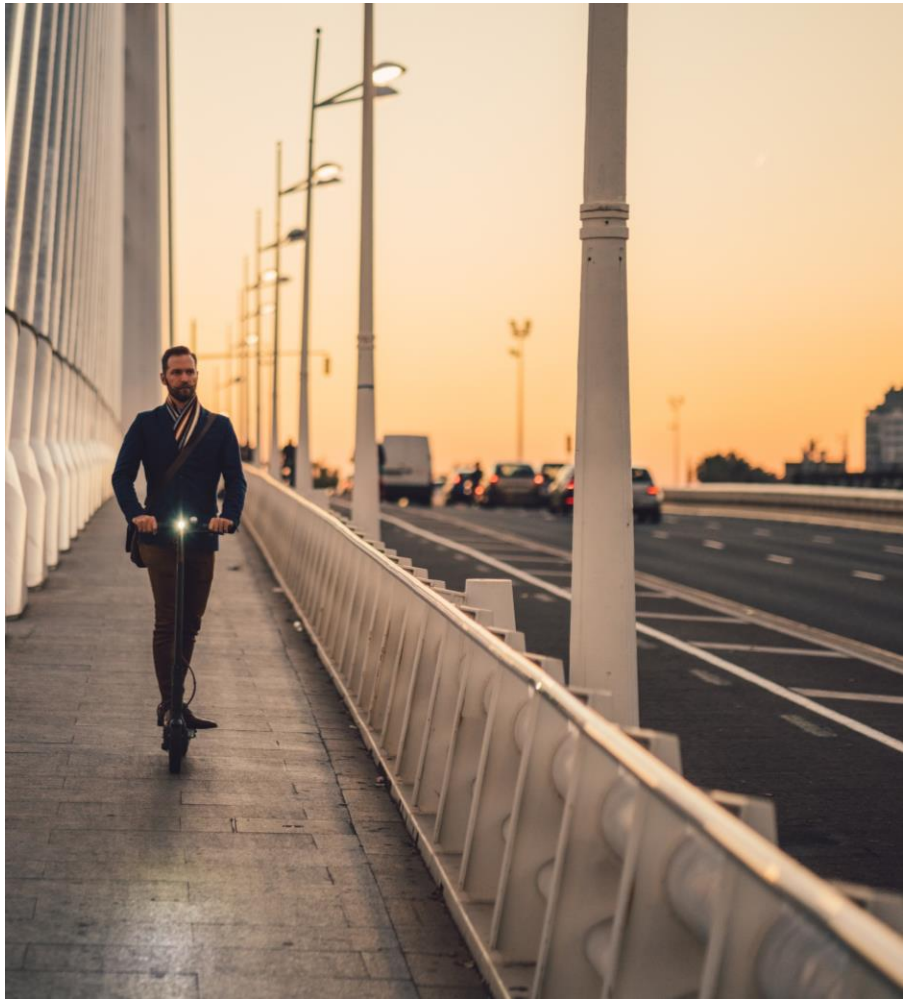
Beyond pipes and roads

How cities can rethink infrastructure for sustainable growth

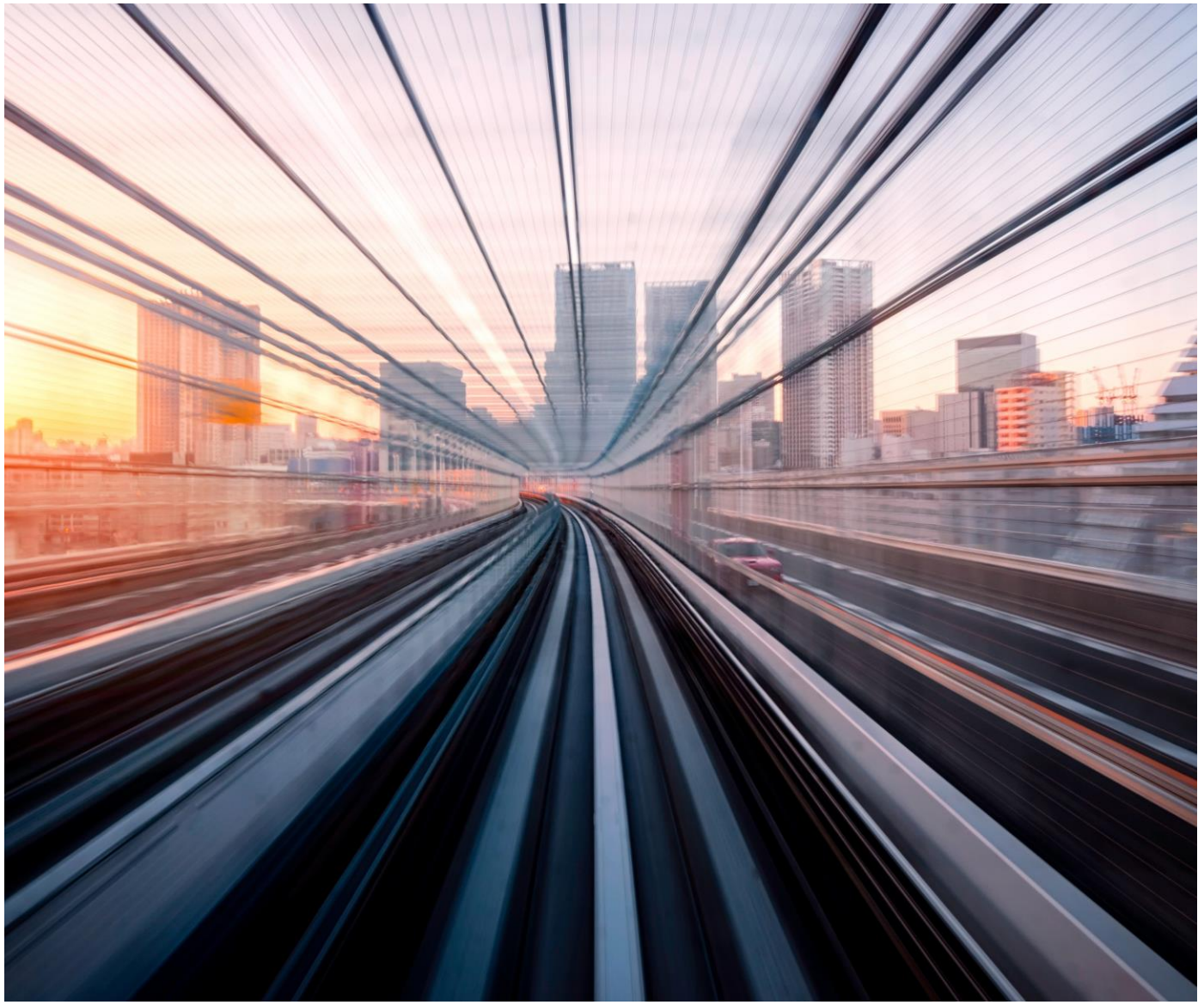
Table of contents



Introduction

City infrastructure has long been seen as a way to deliver essential services, keeping water flowing, lights on and transportation systems running. But its impact goes far beyond functionality. Infrastructure is considered one of the key catalysts to city growth across a multitude of dimensions, ranging from economic growth, mobility, sustainability, social equity, innovation and enhanced governance. Across its economic dimension, a World Bank review of over 100 academic studies finds that infrastructure investment typically carries a fiscal multiplier of around 1.5 within two to five years – meaning every dollar invested generates approximately US$1.50 in economic return.[1]

The GCC's project pipeline exceeds the US$1.5trn[2] mark, shaped by a rapid adoption of AI-driven planning and modular construction across capital projects[3]. In cities around the world, infrastructure has often been shaped more by national priorities than local needs, limiting its ability to drive meaningful economic and social growth. To unlock its full potential, modern cities must move beyond reactive maintenance and adopt proactive, integrated strategies that position infrastructure as a strategic enabler of development, sustainability and resilient, smart urban ecosystems.



From passive to proactive infrastructure

Most city authorities focus on maintaining existing infrastructure, addressing needs as they emerge and responding reactively to challenges. Cities that thrive in the future will be those that proactively shape their infrastructure to unlock and maximise economic opportunities.

Cities are rapidly evolving and as a result, infrastructure planning and implementation must also evolve.

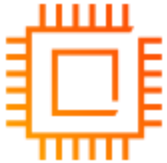
Forward-thinking cities are adopting:

Integrated infrastructure planning:

Moving away from siloed decision-making and adopting cross-sectoral planning that ensures transportation, energy, water and digital infrastructure work in synergy.

Resilient and sustainable policies:

Implementing policies that promote resilient and sustainable systems such as green infrastructure, circular water use, district heating and cooling systems, natural drainage and renewable energy.



Data-driven decision-making:

Smart city initiatives using real-time data, predictive analytics and AI to improve infrastructure performance, by reducing water loss, enhancing traffic flow and optimising maintenance cycles.

Public-private partnerships (PPPs) and innovative financing:

Increasingly looking at alternative funding models such as land-value capture, infrastructure bonds and PPPs to accelerate investment.

Equity and inclusivity in infrastructure:

Ensuring all residents have access to essential services is increasingly becoming a core focus of urban policies, aiming to address disparities in water, transport and digital connectivity.

Breaking down silos: A holistic approach

Infrastructure planning and execution is often fragmented across agencies, leading to inefficiencies and missed opportunities. An integrated approach that combines transportation, energy, water and digital infrastructure creates synergies that enhance both functionality and economic impact. Leading cities are shifting focus from sector-specific strategies to comprehensive city-level plans with clearly defined priorities. This integrated approach ensures the alignment with citywide priorities to further drive socio-economic growth and improve quality of life. Typically, as much as 25% of optimisation can be achieved with better coordinated infrastructure planning.[4]

25%

of optimisation can be achieved with better intergrated and coordinated infrastructure planning.

Moving towards an autonomous and regenerative infrastructure

Future cities will rely on a well-developed foundational infrastructure, which will determine the city's future readiness. The infrastructure can be defined by key guiding principles forming the I-CORE framework. This framework ensures that infrastructure addresses not only current demands but also the needs for future readiness in an ever-changing world.

What is I-CORE?

I-CORE is a framework, developed by PwC, that governs the future of infrastructure based on five key development principles.

I Integrated

Holistic and multi-dimensional

Future infrastructure planning should adopt a holistic approach that includes coordination across the various sub-sectors and scales ranging from district to city to national levels. It should also balance both short- and long-term perspectives. This integrated approach enables greater efficiency and resilience allowing urban systems to evolve in sync rather than in isolation.

C Connected

Smart and linked

Future cities will be hyper-connected, harnessing IoT, AI, and digital twins to automate operations and enable real-time monitoring of critical infrastructure. This data-driven approach supports seamless urban ecosystems, where infrastructure and public services communicate effectively, creating responsive accessible and intelligent cities.

O Optimised

Efficient and sustainable

Future infrastructure will be designed for maximum optimisation and efficiency through automation, predictive maintenance and innovation to reduce waste and enhance performance. Regenerative materials and self-sustaining solutions will further optimise city operations towards minimal consumption with maximum output.

R Resilient

Strong and climate-adaptive

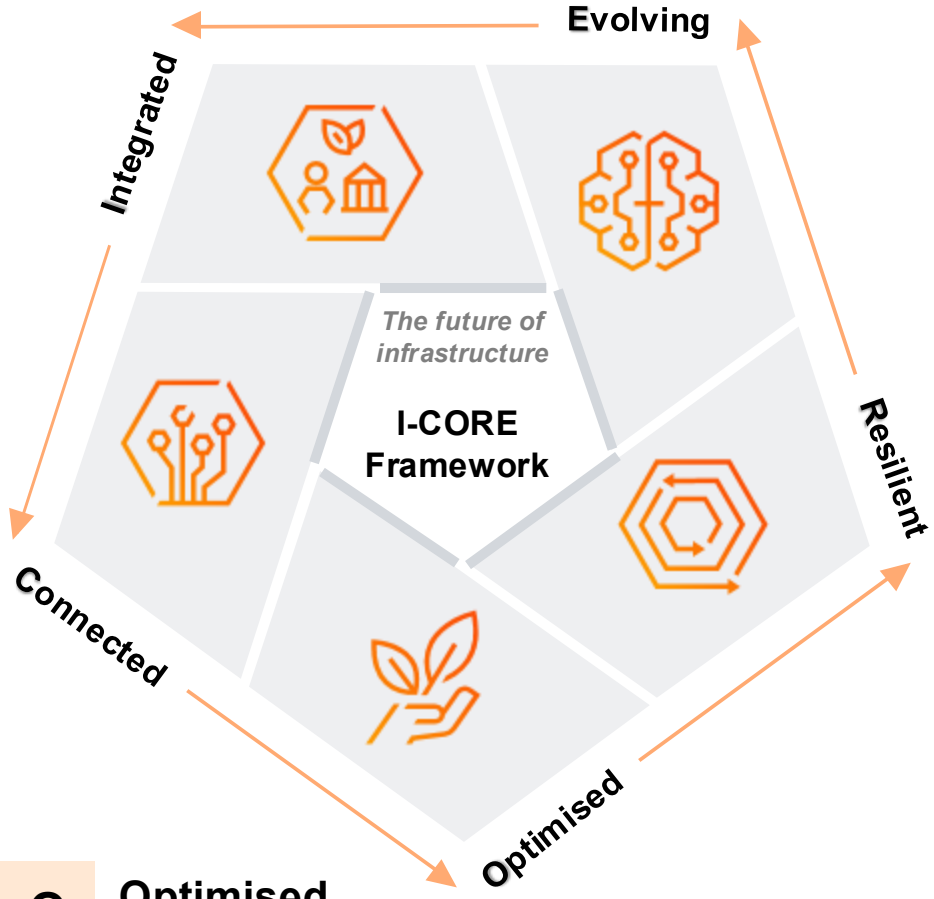
Future cities are designed for agility to withstand disruptions from climate change, and cyber threats, and infrastructure failures. Solutions include flood-resistant infrastructure, earthquake-safe developments, self-healing materials, cyber-industrial digital twins and decentralised energy systems.

E Evolving

Future-proof and adaptive

The agility of future cities will involve not only enhancing resilience but also allowing cities and their infrastructure to adapt continuously to societal changes, new technologies, and environmental demands. Modular, flexible and upgradable infrastructure will enable the integration of innovations and technology.

I-CORE Principles



I Integrated

Holistic and multi-dimensional

- Planned as an interconnected ecosystem, moving beyond siloed approaches and KPIs
- Seamless coordination across sectors such as energy and water
- Planned across district to city to national level, ensuring long-term vision matches short term needs and vice versa
- Data-driven urban planning using real-time data for optimised decision making

C Connected

Smart and linked

- AI, IoT and 5G enable real-time monitoring, automation and efficiency
- Digital twins simulate and optimise urban planning
- Autonomous mobility networks including self-driving transport, hyperloop and drones
- Seamless, interconnected infrastructure of energy, water, waste and logistics

O Optimised

Efficient and sustainable

- Smart energy grids maximise renewable energy use and reduce waste
- AI-powered predictive maintenance prevents failures before they occur
- Self-sufficient buildings adjust climate, lighting and energy dynamically
- Circular economy design – recyclable materials, waste-to-energy solutions

E Evolving

Future-proof and adaptive

- Designed for continuous innovation (modular, scalable and upgradeable)
- Policy and AI-driven governance to adapt to societal and environmental shifts
- Flexible spaces that transform for new needs (e.g., hybrid digital/physical workspaces)
- Next-gen mobility and resource systems that grow with cities

R Resilient

Strong and climate-adaptive

- Disaster-proof urban design – floating districts, underground reservoirs, storm-resistant infrastructure, etc
- Cybersecurity-first infrastructure to protect digital and physical assets
- Self-healing materials and climate-adaptive buildings
- Decentralised energy and water systems to ensure sustainability and reliability

Where do cities in our region stand today?

Cities that prioritise infrastructure performance and further adopt the I-CORE framework will be ready for the future achieving higher efficiency, sustainability and economic growth. Here are some key performance metrics from Middle Eastern cities linking to the I-CORE principles.

Progress made and areas for further improvement in the region

1

Treated sewage effluent utilisation rate and water losses:

Leading cities like Singapore reuse 100% of their wastewater,[5] setting a benchmark for water sustainability. Dubai's rate is approaching 90%,[6] demonstrating commitment to water management. Meanwhile other leading cities in the region have established plans to enhance their water reuse capabilities with current rates averaging around 13%[7]. Cities in developed economies such as Toronto maintain water losses below 15%.[8]

In the Middle East, cities like Abu Dhabi have implemented advanced water management systems which have helped reduce NRW[9]. This is a commendable achievement, however other regional cities still experience major losses in the network[10], resulting in significant financial and environmental costs.

2

Power grid efficiency and resiliency:

Cities like Tokyo[11] and Berlin[12] maintain efficient power grids, with losses kept under 5%. Tokyo additionally demonstrates exceptional grid resiliency, with average interruption durations of only six minutes and frequencies around 0.06 interruptions per customer per year[13].

In the Middle East, cities like Riyadh have invested in modernising their power infrastructure, reducing losses to approximately 10%[14]. Despite these efforts, regional cities still report relatively low resiliency indicators, with average interruption durations of 40-4515 minutes per customer per year and interruption frequencies ranging from 0.8 to 1.8[15] per customer per year, highlighting the need for further improvement.

3

Urban mobility quality:

PwC's Sustainable Mobility Readiness[16] Index evaluates the readiness of metropolitan areas to embrace sustainable mobility solutions. These include key factors such as infrastructure, policy frameworks, innovation and environmental impact. Cities such as Singapore and London score high at 7.6 and 8.3 respectively.

In the Middle East, cities like Dubai lead the region with a score of 6.5. Despite significant investments made in improving mobility infrastructure, opportunities for further improvement remain, such as access to public transit networks to ease private vehicle dependence.

4 Quality of life and urban green space per capita:

Quality of life in cities is strongly dependent on good service accessibility including green spaces that support health, wellbeing and social cohesion[17]. The World Health Organization recommends 9m² of green space per person.[18] Leading cities, like Vienna and Stockholm, provide over 50m²,[19] significantly enhancing residents' well-being and air quality.

Some regional cities such as Abu Dhabi has made notable progress, providing over 17m²[20] of green space per capita, however many others still fall short of the recommended levels with figures as low as 1-3m². On the service accessibility front, the percentage of the population with access to clean water, sanitation, electricity and broadband varies widely. Typically, developed economies have achieved complete inclusive coverage of essential utility services. Riyadh, Dubai and Abu Dhabi have over 90%[21] coverage for essential services such as power and potable water, whilst others in the region still have areas for development such as in efficient stormwater network coverage.

5 Strategic readiness and resilience:

Poor resilience planning can leave cities vulnerable to failure in major events and unforeseen stresses. Natural or manmade disasters or even hosting large-scale events such as an expo or the FIFA World-Cup can all test a city's infrastructure limits and adaptability. While cities like Dubai and Doha have strengthened their resilience, via hosting major global events and overcoming major shocks, others in the region still face gaps. For instance, Dubai invested US$8.2bn in enhancing its rainwater drainage system by 700% after being hit by the biggest rainstorm in 75 years in April 2024.[22] Dubai's Future Readiness Index,[23] highlights its commitment to resilience through adaptability and scenario planning. Other cities in the region, however, still require significant investment to enhance their resilience and readiness for both large-scale events and potential disruptions.

A call to action

The cities that will lead in the coming decades are those that treat infrastructure not as a cost centre but as a platform for growth. This requires a fundamental shift in mindset – from reactive to proactive, from siloed to integrated and from maintaining the past and reacting to the now to building for the future.

To achieve this transformation, cities must embrace the principles of the I-CORE framework with innovative strategies and tools that drive integration, efficiency, sustainability and economic development. Viewing infrastructure as a catalyst for growth can enable cities to access new opportunities, attract businesses and enhance the quality of life for residents.

Our role in this journey

We have partnered with key cities in the region to modernise infrastructure strategies, ensuring they are future-ready, efficient and built for economic expansion.

Our expertise covers urban infrastructure planning, digital transformation and infrastructure finance

Infrastructure city planning

Developing cross-sector integrated city infrastructure strategies and governance frameworks that align infrastructure with long-term economic growth goals. Our approach ensures that infrastructure plans are strategically planned and executed, creating sustainable development and enhancing residents' quality of life.

Digitally transformed and informed

Our tools such as our Geographic Information Systems, help cities simulate scenarios to prepare for future demand and challenges. These tools provide data driven insights into infrastructure requirements, enabling cities to make informed decisions and optimise resource allocation and planning at the outset.

Next-gen and future-proof systems

Conducting comprehensive studies to identify next-generation and future-proof infrastructure systems and assess their adoptability and scalability.

Public-private partnership structuring

Creating innovative funding models to attract private sector investment while aligning with government fiscal policies.

By reimagining infrastructure as a dynamic enabler of inclusive growth, sustainability and resilience, urban leaders can transform their cities into engines of opportunity. The I-CORE framework provides a roadmap for this transformation – where infrastructure is not just built but smartly orchestrated. And not just sustained but continuously evolved. The cities that embrace this future-ready mindset will not only meet the needs of today's residents but also lay the foundation for generations to thrive. The challenge is complex, but the opportunity is profound – and the future will reward those who choose to lead, innovate and invest confidently.

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