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SMART MOBILITY

Smart Cities: Mobility ecosystems for a more sustainable future

Navigating converging social, economic, and technological trends requires rethinking your ecosystems strategy.

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After years of trial and error, municipal leaders are realizing that "smart" mobility strategies require more than just technology adoption. Real "smartness" means purposefully combining data and technology to create affordable, inclusive, safe, and sustainable mobility solutions that help people make better decisions and that deliver a better quality of life. Yet, for many leaders, the goal of fostering a truly smart city remains frustratingly out of reach.

We studied a sample of 28 cities worldwide and found that most municipal leaders are struggling in different ways to solve mobility challenges in five areas: congestion, environmental sustainability, affordability of public transit, road safety, and financing of infrastructure for so-called active mobility (e.g., walking and cycling; see figure, next page). The cities in our sample vary in terms of geography, land mass, population size, and stage of economic development as measured by per capita gross domestic product (GDP). We divided these cities into three broad categories of readiness (see figure, page 4).

In emerging cities such as Lagos (Nigeria) and Bogotá, for example, the absence of an affordable and reliable public transportation system has forced residents to rely on automobiles and other motorized forms of public transit such as motorbikes and minibuses. Given the average one-way commute time of almost an hour, these cities are among the most congested in the world. The levels of fine particulate matter of 2.5 microns or less in diameter (PM 2.5) in Bogotá and Lagos are three and 14 times the recommended World Health Organization (WHO) limit, respectively.

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The top mobility challenges facing today's cities and the data parameters used to measure them

Mobility challenge: Congestion

Data parameters:

Congestion level: % delay in a 30-minute trip compared to baseline uncongested conditions

Average one-way time to commute to work (minutes)

Inefficiency index: Inefficiency caused by use of cars over public transit

Mobility challenge: Environmental sustainability

Data parameters:

CO_2 emissions due to traffic (in grams)

Annual average PM 2.5 levels ($\mu g/m^3$)

Annual average PM 10 levels ($\mu g/m^3$)

Mobility challenge: Affordability of public transit

Data parameters:

Spend on public transit: % monthly income spent on one-month public transit pass

Spend on taxi: % monthly income spent on 1km taxi ride

Mobility challenge: Road safety

Data parameter:

Traffic fatalities (per 100,000 population)

Mobility challenge: Insufficient infrastructure for active mobility

Data parameters:

Share of walking: % modal share of walking

Share of cycling: % modal share of cycling

Cities fall into three broad categories of mobility readiness

Characteristic	Category 1 cities	Category 2 cities	Category 3 cities
Severity of mobility challenges	Low	Medium	High
GDP/capita	High	Medium	Low
City size	Compact	Large	Compact
Population density	High	Low	High
Public transit maturity	High	Low	High
Modal split	Public and nonmotorized	Private vehicles	Public and nonmotorized

Yet even some cities with robust public transit systems remain fraught with congestion. In London and Paris, the average one-way commute takes longer than 40 minutes, with freight vehicles accounting for one-third of the traffic in Central London during morning peak hours. In both cities, parking remains a problem: Paris, for instance, can accommodate parking for only 1 million vehicles, yet more than 1.5 million vehicles enter the Paris central business district every day. This results in illegal parking on the city's narrow streets, increasing congestion (see figure, next page).

Some other key findings of our study:

- Residents of the sample cities spent an average of 111 hours idling in traffic annually. Assuming a 45-hour workweek with 48 working weeks in a year, that equals up to 5% of one's total working hours spent stuck in traffic. In Istanbul, for example, people spend almost 200 hours in traffic annually. Those in Amsterdam and Chicago fared relatively better, at 64 hours.
- In all 28 cities we studied, the average annual PM 2.5 concentration exceeded the WHO's air quality guideline for particulate matter, 5 micrograms per cubic meter. That is an alarming statistic for environmental sustainability and the health and safety of citizens. In Beijing and Mumbai (India), two fast-growing cities, those levels are 16 and 13 times the safe WHO limit, respectively.

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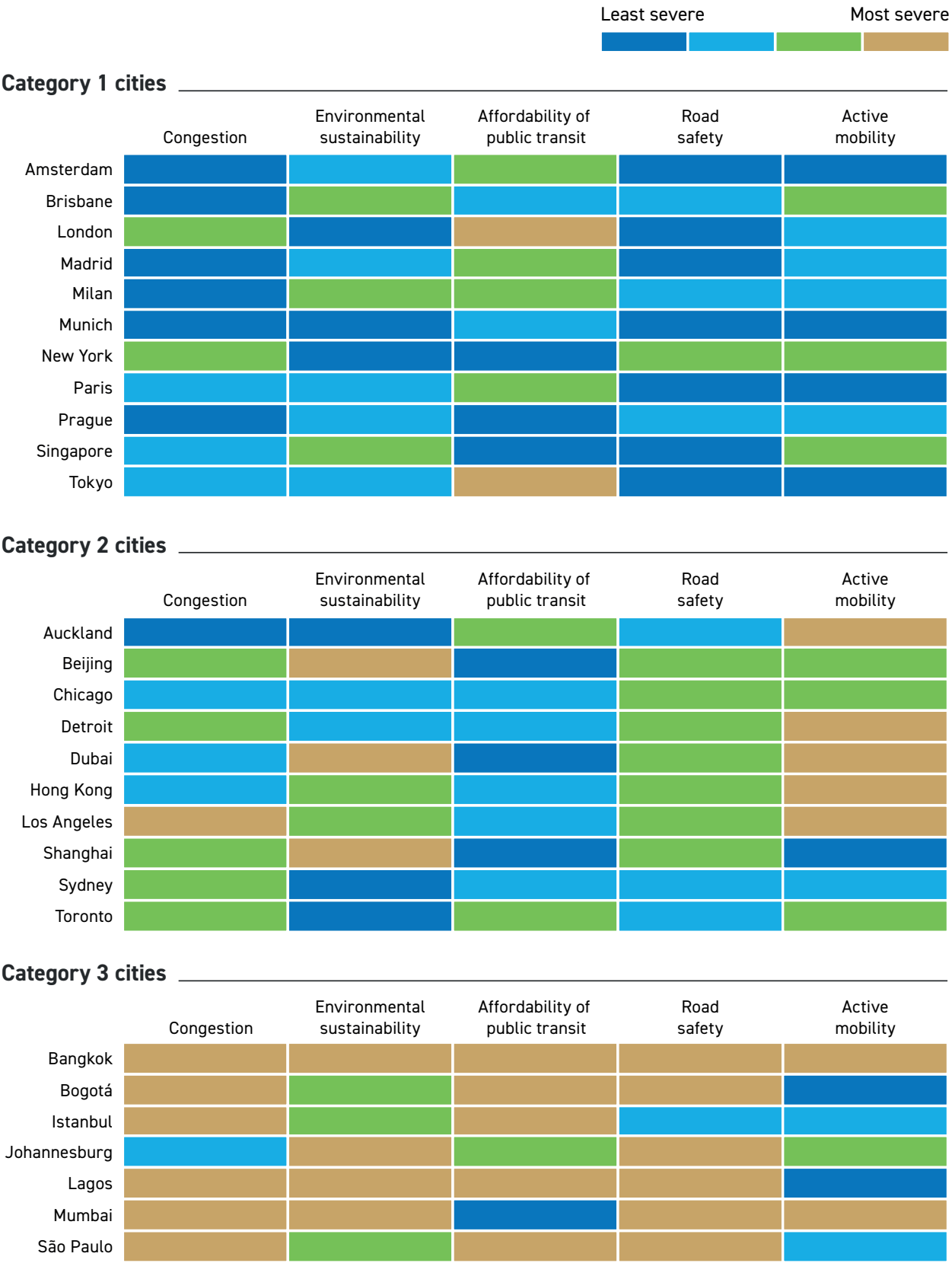
The severity of conditions affecting city mobility



- On average, residents spend almost 4% of their net monthly income on public transportation passes. In São Paulo and Lagos, commuters have to spend, on average, 11% of their net monthly income on such passes.
- In ten of the 28 cities, the average number of traffic-related fatalities each year exceeded the global 15-year average of 18 deaths/100,000 population, with cities such as Johannesburg (25.9 deaths/100,000 population) and Bangkok (33 deaths/100,000 population) having very high incidences of such fatalities.

Embracing a sustainable ecosystem strategy

Although every city is different, leading cities are becoming smarter through their participation in large, complex, digitally enabled ecosystems. The question for many urban leaders, however, is how to engage with them effectively.

Our experience in working with large transportation and communications clients yields a multilayered model and approach to guide the design and management of urban mobility systems. Given the interconnected nature of the building blocks of mobility, each layer—demand, supply, and foundational—is critical (see figure, next page). Cities must understand and manage all the interactions and interdependencies. For example, demand for different forms of transportation (e.g., public transit and freight delivery) is enabled via available modes of transit and supporting infrastructure (e.g., electric vehicle [EV] charging and parking). None of these would be possible without regulations, financing, insurance, and innovation.

Three different cities we studied illustrate the power of this multilayered ecosystem approach.

Singapore: Singapore's officials have said they want it to be a "45-minute city"—meaning that people can travel from their home to their place of work in less than 45 minutes. The government has built infrastructure for bus rapid transit (BRT), light-rail transit (LRT), and mass rapid transit (MRT). (Because sustainability is a key goal, municipal leaders have committed to having a 100% clean energy public bus and taxi fleet by 2040.) Singapore also has collaborated

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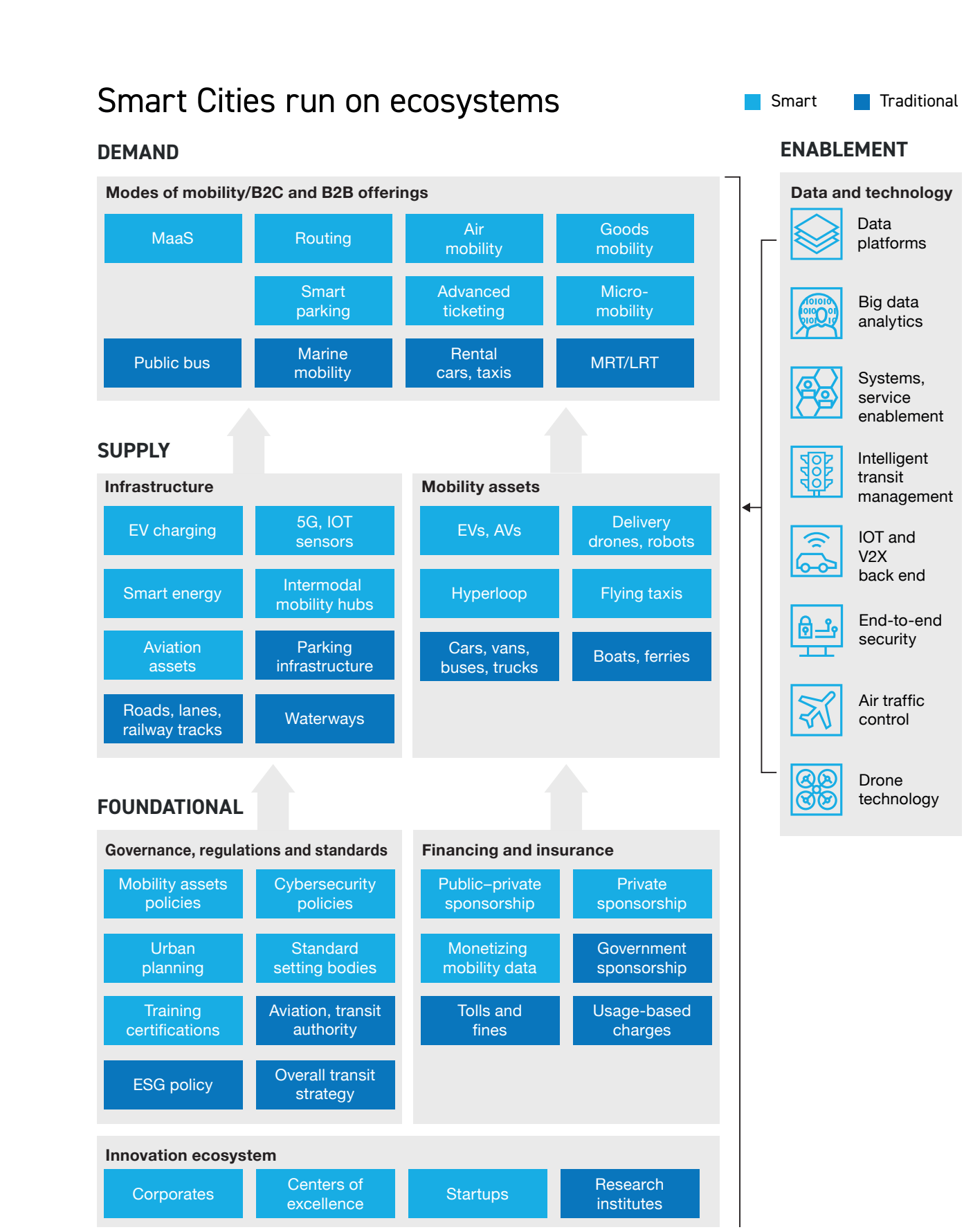
Smart Cities run on ecosystems



Key considerations for mobility ecosystem stakeholders

1. **City mayors, policymakers, and transit authorities**

- Is there a smart citywide ecosystem plan and road map that integrates mobility, sustainability, socioeconomic development, and spatial plans?
- If so, do these plans and road maps anticipate policies to reflect social needs such as fare affordability and access to low-density neighborhoods, to ensure a holistic mobility ecosystem?
- Have the roles of private-sector players—including mobility solutions providers and investors—been considered, to encourage their participation? Also, how effectively do leaders seek their inputs while formulating policies and incentives?
- Are procurement regulations transparent and flexible enough to encourage the early participation of the private sector as new business models and financing options for innovative mobility solutions are being developed?

2. **Real estate developers**

- Can developers provide visibility on future projects (residential, commercial, and industrial) to city administrators so that the city urban planning ecosystem can ensure sufficient mobility solutions to serve the demand from future urban growth?
- Do developers consider a life-cycle/total cost of ownership approach to residential and commercial developments to encourage adoption of innovative solutions, including micromobility options, in their projects?
- Will developers be able to share data from their developments with city planners and mobility operators to encourage and support innovative mobility solutions, including mobility-as-a-service?

3. Vehicle providers

- Do original equipment manufacturers (OEMs) and other providers understand the city's future needs (such as communications, data, fuel efficiency, sustainability, and energy/renewables) and consistent standards (such as size and safety) as they design future private transit vehicles (including bikes, cars, and boats, both hydrocarbon-based and clean/EVs)?
- Are vehicle providers able to get good data and insights on factors such as city layout and requirements (city archetype, maturity, and budgets), routing and traffic management (e.g., fixed versus flexible routes for trams or buses), digital operations (information access, integrated mobility, etc.), and city sustainability goals?
- How effectively do OEMs and their affiliates prioritize the types of vehicles that can best meet the current and future requirements using considerations such as vehicle footprint (e.g., large buses versus minibuses), ease of operations (uptime and maintenance), and carbon footprints (internal combustion engine, hydrogen, or EV buses)?

4. Transit operators and infrastructure developers (public and private)

- How effective is collaboration with city administrators, urban planners, real estate developers, and other stakeholders in the effort to adapt policies and standards that can enhance the "performance" of the city?
- Are business models designed and managed such that they can be effective today as well as in the future, considering factors such as traffic volumes, "last mile" transit, vehicle types, congestion, use of data, sustainability, plans for chargers or other infrastructure, and integration and interoperability with other transit modes as well as parking?
- Do public and private infrastructure developers (including those for roads, light rail, metro, stations, and parking garages) undertake

upgrades or new projects considering future use cases, communications and connectivity, data models, use of sustainable materials, energy conservation, and embedded utilities such as EV charging, while leveraging government grants and public–private partnerships?

5. Adjacent providers

- How effectively do mobility providers consider adjacent "heavy" users and providers in their analyses, offerings, and capacity planning? Examples include schools (with busing and related requirements), logistics companies (including FedEx, Amazon, and UPS), and core public safety providers such as ambulance, police, and fire services.
- Do mobility providers coordinate with transit and other agencies (e.g., roads and communications providers) regarding maintenance requirements; energy utilities regarding energy usage and rates (especially as the proportion of EVs increases over time); and other forms of infrastructure?
- Is there a plan to conduct joint studies and analyses with such ecosystem-adjacent players, and even to partner with some of them in innovative ways?

6. Financial organizations and investors

- Do investors engage early with the city's ecosystem and entities to contribute to the development of bankable innovative mobility solutions?
- What approach to total impact assessment and environmental, social, and governance (ESG) issues do investors, banks, and rating agencies take when assessing the returns from financing mobility projects?
- Do investors and the city consider new funding models and instruments—as well as appropriate incentives—to encourage the development and financing of bankable innovative mobility solutions?

7. Research and academic institutions

- Do research and academic institutions proactively engage with the city's ecosystem and entities to provide new ideas for the development of innovative and sustainable mobility solutions?
- Have institutions developed multidisciplinary programs and incubators that encourage research and student-led startups to develop practical and innovative mobility solutions?
- Do these institutions work closely with private-sector mobility solutions providers to propose new ideas and innovative concepts that can be commercialized?

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with French transportation company Bolloré to develop an electric car–sharing program, called BlueSG.

Meanwhile, the Singapore Economic Development Board, through various public–private partnerships, is working to create an innovation pipeline to take advantage of new mobility offerings such as on-demand autonomous shuttles—in collaboration with Alliances for Action (AfA), an industry-led coalition—and air taxis, in collaboration with Volocopter. Already a technology leader among cities, Singapore has been using advanced tech, including smart sensors, connectivity, and cloud computing, to enable a centralized bus fleet management system, which has improved service efficiency.

What the city is doing well: To achieve its vision of becoming a 45-minute city, Singapore is focusing on building its infrastructure (e.g., it is building intermodal mobility hubs to allow commuters to move seamlessly from one mode of transportation to another). The city is developing a robust innovation ecosystem, collaborating with many private-sector players. Singapore has proactively shaped both the demand side (e.g., congestion fines, vehicle quotas) and the supply side (e.g., nonmotorized transportation policy), and has provided guidance for forward-looking technologies (e.g., technical references for autonomous vehicles).

Istanbul: The city is focused on providing citizens with multiple ways to travel efficiently (MRT, LRT, and BRT), while expanding roads, highways, and bridges. It is experimenting with technologies such as an electronic tolling system, and is even looking into the possibility of developing flying cars. By adopting an ecosystem approach, the city has made inroads into tackling its mobility challenges.

What the city is doing well: Istanbul is focusing on its modes of mobility/B2C offerings and mobility assets to provide multiple options to its citizens (e.g., MRT, LRT, and BRT). To tackle its unique traffic challenge—the Bosphorus Strait separates the city's Asian and European sides—Istanbul is building underground road tunnels as well as an underground metro line to mitigate congestion on bridges (the infrastructure layer). It has used the financing and insurance layer to finance capital-intensive infrastructure projects through public–private partnerships.

Brisbane, Australia: On average, Brisbane residents travel farther for work than they do for any other purpose—in fact, double the distance. To alleviate this burden on commuters, the city is developing a new public bus network of more than 1,200 vehicles and 6,200 stops. Queensland is currently trialing hydrogen fuel cell buses, which local authorities want to become as ubiquitous as mobile phones. Through an investment of AU$5.4 billion (US$3.8 billion), the Queensland Government is working on a new high-speed, high-frequency rail link, the Cross River Rail. The in-progress metro project and a provision for water taxis, coupled with the existing shared mobility and micromobility modes—such as electric bikes and scooters—aim at making the city highly accessible and connected.

Brisbane places great importance on improving technology and developing infrastructure. The Brisbane Metropolitan Transport Management Centre, operated in partnership with the Queensland Government, provides real-time monitoring and operation of the city's road and busway networks. Smart parking and smart traffic lights, along with an integrated payment system, is helping it move ahead on the path of smart mobility. To support these smart mobility initiatives, the Brisbane city council aims at harnessing innovation by bringing together government, industry, research partners, and the private sector to share ideas, technologies, and data.

What the city is doing well: Brisbane is prioritizing its mobility infrastructure

via an extensive network of high-frequency buses along major routes that connect the city with the outer suburbs. Brisbane is also focused on enhancing the modes of mobility/B2C offerings and the mobility assets, developing multiple modes of public transit such as rail, metro, and water ferries to make the city accessible and connected. Finally, Brisbane is employing data and technology enablement (e.g., one payment method that can be used across all public transit modes).

Implications for ecosystem participants

In applying this framework, we have identified essential activities for both city authorities and the private sector (see "Key considerations for mobility ecosystem stakeholders," page 8).

City authorities and regulators: Above all else, local governments should enable the creation of a citywide ecosystem that fully integrates mobility, sustainability, socioeconomic development, and spatial plans, drawing on the participation of the private sector, local investors, real estate developers, and academics for input and support. Regulations, policies, and incentives should strive to be politically agnostic and draw support from the evolving mobility industry. Cities should encourage the early participation of the private sector in designing sustainable mobility solutions through enhanced and transparent procurement regulations to develop new business models and financing options.

Mobility and infrastructure providers and local businesses: To succeed in their missions, local officials need visibility into future construction projects, mobility solutions, and innovations. That's why private-sector providers should work with city administrators, urban planners, real estate developers, and other stakeholders to define policies and standards that accomplish two goals: improving the city's quality of life and furthering the goals of mobility. They should also develop and adopt business models that anticipate new trends. Transit infrastructure providers have a particular responsibility to consider future needs such as EV charging, parking, communications, and renewable energy in their designs.

Real estate developers and adjacent investors: Real estate and infrastructure should use data to anticipate the growth and evolution of the communities for which they're building. They should integrate mobility into their development

If traditional stakeholder categories are stripped away, what roles are possible to play in making cities safer, cleaner, and more sustainable?

plans and coordinate proactively with city authorities. Investors and financial advisors also have a responsibility to take a comprehensive and fact-based approach to creating viable and bankable projects.

Ecosystems represent a fundamental strategic choice of the future. If traditional stakeholder categories are stripped away, what roles are possible to play in making cities safer, cleaner, and more sustainable? What previously unseen opportunities are created within and outside traditional spaces, and where can innovation arise? On the city side, leveraging ecosystem thinking will help catalyze innovation across various industries. Private-sector providers, including investors, can move from a traditional lens to an ecosystem lens, and in so doing, create a frame through which to innovate. All stakeholders can develop the ability to identify new sustainable opportunities for growth and collaborative connections to accelerate results. +

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