



**WITHOUT  
LIMITS**

**AECOM**

# THE FUTURE OF INFRASTRUCTURE VOICE OF THE PEOPLE

Over 10,000 citizens from 10 major cities share their views on how satisfied, safe, inspired and engaged they are with their infrastructure networks and services

## **LONDON EDITION**

### **EVERYONE'S BUSINESS**

An informed, engaged public is key to modernizing infrastructure

### **ENGAGEMENT**

Five steps to working closer with communities

### **ACCELERATED DELIVERY**

Adopting the Lean process to save time and money

### **RESILIENCE**

Using a simulation exercise, Houston takes a cyber stress test

### **INNOVATION**

How MaaS could revolutionize the way cities are planned and run

**2019**

[infrastructure.aecom.com](http://infrastructure.aecom.com)

# THE FUTURE OF INFRASTRUCTURE VOICE OF THE PEOPLE

## FOREWORD

Welcome to AECOM's latest *Future of Infrastructure* report.

For this year's edition, we reached out to more than 10,000 people in 10 major global cities to ask about their everyday experiences with infrastructure services. How satisfied and safe do they feel with their roads and bridges, rail services and utilities? How engaged are they in the decision-making processes for new projects that can improve lifestyles and drive new economic growth?

We found that while every city has its own distinct story, there are shared views and experiences that people have around the world. This includes frustration with public transportation and a desire for cities to be greener, safer and better connected. They also share an interest in how infrastructure systems are planned, paid for, developed and operated.

We spoke with senior industry and government leaders about their work to meet these challenges. What we confirmed in this process is that infrastructure is everyone's business — no matter whether you live in Los Angeles, London, New York, Hong Kong, Riyadh, Sydney, Chicago, Mumbai, Singapore, or Toronto.


The report is rich with findings and insights. And we believe these will be useful in advancing public engagement, leading to progress in modernizing the infrastructure systems that power economies and improve lives.



There are articles, too, addressing many of the issues raised around funding, stakeholder engagement, resilience, accelerated project delivery, the next-generation workforce and infrastructure innovations that will impact and shape our cities of the future.

Our new *Future of Infrastructure* report marks the beginning of a series of important conversations involving the public and private sectors, governments, and the people they serve in cities around the world.

AECOM is uniquely placed to respond to the challenges identified in this report. Our engineers, builders, planners and other professionals are already delivering compelling solutions as we help to improve quality of life for all.

Thank you for being a part of this important conversation. 

**Michael S. Burke**  
Chairman and Chief Executive Officer



**Infrastructure is everyone's business.  
Discover the unique stories of 10 cities by visiting:  
[infrastructure.aecom.com](https://infrastructure.aecom.com)**

# LDN LONDON CITY FACT FILE

A global leader, with a colorful past, vibrant culture and growing population, ambitious for its future.

16

## Executive Summary A TALE OF 10 CITIES

Is anyone happy with their infrastructure? It's the big question we asked more than 10,000 people across 10 major cities. Our findings show that while every city has its own distinct story, there are also shared experiences around the world.

22

## Part One INFRASTRUCTURE IS EVERYONE'S BUSINESS: WE WANT MORE SAY

With quality of life and quality of infrastructure services being inextricably linked, our survey respondents make it clear that they want to be part of the infrastructure debate. In several cities, more than half of the people say they have not had the opportunity to comment on public transportation.

30

## Part Two SMART, CONVENIENT, DATA DRIVEN

Many respondents believe there is considerable innovation around infrastructure and services. Overall, citizens are 'moderately satisfied' on this count as we all witness big changes including autonomous cars and delivery drones.

36

## Part Three FUTURE PRIORITIES: MAKE IT GREEN, EFFICIENT, FLEXIBLE AND SAFE

Two priorities stand out for residents of our 10 cities when thinking about future infrastructure: they want to see work upgrading public transportation and enhancing environmental sustainability.

42

## Part Four CALLS TO ACTION

Infrastructure users have provided many useful pointers to help guide future projects, including the public's desire for greater involvement in decision making, and a willingness to share data in exchange for infrastructure improvements.

44

## Insights FUNDING AND FINANCING: AN INFORMED, ENGAGED PUBLIC IS KEY TO MODERNIZING INFRASTRUCTURE

Infrastructure occasionally falls short of what we need, but it doesn't have to be like this. AECOM Chairman and CEO Michael S. Burke believes the public can be a key partner in delivering modern infrastructure. *Specialist consultant Clive Lipshitz contributed to this article.*

48

## Insights ENGAGEMENT: HOW WELL DO YOU KNOW YOUR COMMUNITY?

People around the world say they feel excluded from discussions and decisions around their infrastructure services. To get projects delivered on time and to budget, it is essential to work in partnership with communities writes stakeholder engagement champion Kelli Bernard.

52

## Insights MAKING CITIES RESILIENT: HOUSTON TAKES A CYBER STRESS TEST

For the first time in the U.S., a major city has undertaken a live twin-disaster-simulation exercise to help forge plans to strengthen the resilience of critical infrastructure. Leading participants from the City of Houston describe the highlights and learnings.

58

## Insights ACCELERATED DELIVERY: OLMSTED DAM AND MAKING MODERN AMERICA

The latest upgrades to the Ohio River's locks and dams have been delivered ahead of time and below budget by using innovative ways of working explain Lean specialist Sue Ann Averitte, productivity manager Brad Bell and project director Kevin McLaughlin.

62

## Insights INNOVATION: RIGHT HERE, RIGHT NOW: THE FUTURE IS MOBILITY AS A SERVICE

Innovation specialist Veronica Siranosian and Stephen Engblom, global cities leader, discuss the potential for Mobility as a Service to transform urban spaces, improve citizens' lives and revolutionize the way cities are planned and run.

68

## Insights SKILLS AND TALENT: ALL CHANGE? INFRASTRUCTURE'S NEXT-GENERATION WORKFORCE

How will infrastructure's workforce transform the industry? Human resources leader Mary Finch explores the potential for change and we hear from young professionals around the world about their hopes and aspirations.



# LDN

## LONDON

### A GLOBAL LEADER, WITH A COLOURFUL PAST, VIBRANT CULTURE AND GROWING POPULATION, AMBITIOUS FOR ITS FUTURE

#### Introduction

London is a city that has always been defined by its openness — to people, investment and ideas. We see this openness running throughout the London-focused results of AECOM's second global *Future of Infrastructure* report.

For this research, we asked over 1,000 people in London for their views on city infrastructure and their ambitions for its future evolution. What we found is that citizens recognise the innovative steps city leaders are taking to bring London's infrastructure up-to-date, for example, revolutionising how we plan and pay for our travel.

But they also understand the challenges that the city's transport systems and utilities face. They are keen for action to build a greener, safer, digitally driven and better-connected London equipped to succeed in the years ahead.

For Londoners, smarter, faster, better infrastructure is a team effort. Citizens want to have more say on infrastructure issues such as planning. They're open to greater private sector involvement in infrastructure development and also show a willingness to pay higher taxes to fund infrastructure improvements, for example, in return for better quality, more reliable and resilient systems.

AECOM has extensive experience of working in London and other major global cities. With our network of planners, designers, engineers and management professionals, we have the knowledge and reach to develop and deliver innovative infrastructure solutions that improve lives and connect communities.

#### David Barwell

Chief Executive,  
UK and Ireland, AECOM

London is in an elite club; it's one of only two cities in the world to be given an Alpha ++ global ranking by the leading ranking organisation, Globalization and World Rankings Research Institute.<sup>1</sup> The other is New York. London's competitive edge is built around its openness, connectivity, flexibility and diverse population.

To continue its success, London must think big. International influence is moving eastwards and London needs to secure its place in a post-Brexit world. The city, along with the rest of the UK, also faces a series of tough challenges around housing, employment, the environment and delivery of infrastructure. The city's ambitions to remain a world leader are unequivocal, and Londoners recognise the need for greater collaboration, smarter thinking and engagement to realise them.

#### Big plans, but room for improvement

Greater sustainability, digital resilience and transport connections — these are three of the big infrastructure issues topping Londoners' future wish lists, and align with the mayor's ambitions for a greener, smarter city.<sup>2 3</sup>

Reinforcing #LondonIsOpen to investment and collaboration, 57% of citizens agreed that the private sector should be more involved in infrastructure development.<sup>4</sup>

Although many find London's transport systems and utilities to be reliable and affordable, others highlight challenges. Nearly two-thirds of our survey respondents agree that using the city's public transport is becoming more stressful.

Citizens don't think that the politics involved in infrastructure helps or that their voice counts. But they are prepared to play their part, 39% agree that they would be willing to pay higher taxes to fund infrastructure improvements and 47% would be happy to share their personal data with city authorities to deliver better infrastructure.

<sup>1</sup> <https://www.lboro.ac.uk/gawc/gawcworlds.html>

<sup>2</sup> <https://www.london.gov.uk/what-we-do/environment/london-environment-strategy>

<sup>3</sup> <https://www.london.gov.uk/press-releases/mayoral/mayor-launches-smart-london-plan>

<sup>4</sup> <https://www.london.gov.uk/what-we-do/arts-and-culture/london-open>



CITY RANKING 3/10



### Satisfaction

What is residents' experience of core infrastructure — utilities (water and electric power) and transportation (rail, bus, roads, ports, etc.) in the city where they live?

6.8

6.4

SATISFACTION

GLOBAL AVERAGE

CITY RANKING 3/10



### Engagement

How much do residents engage with city authorities and infrastructure providers?

3.3

3.3

ENGAGEMENT

GLOBAL AVERAGE

CITY RANKING 2/10



### Innovation

What is residents' experience of innovative technologies in their city?

6.7

6.2

INNOVATION

GLOBAL AVERAGE

CITY RANKING 9/10



### Resilience

How confident do residents feel about their city's ability to protect infrastructure from natural disasters, cyberattacks, terrorism and other external hazards?

5.3

5.7

RESILIENCE

GLOBAL AVERAGE

CITY RANKING 2/10

4.34

4.12

OVERALL

GLOBAL AVERAGE

**The Infrastructure Satisfaction Index** draws on responses to selected questions from a global online survey of 10,750 people residing in 10 cities: Los Angeles, London, New York, Hong Kong, Riyadh, Sydney, Chicago, Mumbai, Singapore, and Toronto. Scores for satisfaction, engagement, innovation, and resilience are based on a 1–10 scale, with four bands:



10–7.6  
Very satisfied



7.5–5.1  
Moderately satisfied



5.0–2.6  
Not very satisfied



2.5–1.0  
Dissatisfied



# 39% OF LONDON RESPONDENTS WOULD BE WILLING TO PAY HIGHER TAXES TO FUND IMPROVEMENTS TO INFRASTRUCTURE OVERALL.



## SATISFACTION

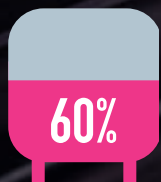
**The vast majority of Londoners we spoke to (70%) use public transport as their primary method of transportation. But 60% are finding it increasingly stressful to travel that way.**

Crucially, 39% of London respondents would be willing to pay higher taxes to fund improvements to infrastructure overall.

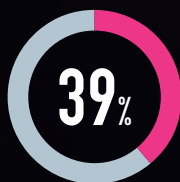
Of the 10 major cities surveyed, London ranked third (behind Hong Kong and Singapore) in terms of citizens' satisfaction with infrastructure. But a closer look highlights areas for improvement.

Most respondents found their water and electricity services to be affordable (58% and 47% respectively) and reliable (62% — no water outages/56% — no power cuts). Fewer than a quarter, however, feel that the service they've received from their water (22%) and electricity (23%) providers has got better in the last 12 months. For the majority of users, these services have either not changed or got worse compared to the previous year.

Some respondents faced major problems: 11% said that they or a neighbour had experienced three or more power cuts to their home in the past 12 months, with 12% of users citing three or more instances of water outages or restricted supplies to their property across the year.



**60 percent** of respondents find public transport an increasingly stressful way to travel.



**39 percent** of London respondents would be willing to pay higher taxes to fund improvements to infrastructure overall.

High fares, busy trains and delays could be contributing to some people's dissatisfaction.<sup>5 6 7</sup> Over one-third of respondents (38%) describe public transport in London as unaffordable, showing the most concern — alongside Riyadh — about this issue compared to other major cities. London Mayor Sadiq Khan is taking steps to address this, freezing TfL fares for the third year in a row, in 2019, and introducing new weekly capping to help Oyster card users.

Almost one-quarter (23%) of citizens rate the reliability of public transport in London as 'poor/very poor'. And only 25% of respondents overall would be willing to pay even higher fares for public transportation in the future.

London's roads are also a concern, 75% believe that the state of the roads has worsened or not changed in the last 12 months.

<sup>5</sup> <https://www.bbc.co.uk/news/uk-england-london-39806865>

<sup>6</sup> <https://www.capgemini.com/gb-en/2016/05/just-how-overcrowded-has-transport-in-london-become/>

<sup>7</sup> <https://www.theguardian.com/uk-news/2018/nov/19/london-waterloo-commuters-told-not-to-travel-due-to-engineering-delays>

<sup>8</sup> <https://www.bbc.co.uk/news/uk-england-london-40921373>





## ENGAGEMENT

**Infrastructure is everyone's business, but many Londoners feel shut out of the conversation. Over half (55%) say that they haven't had the chance to feedback on transport services during the past year, and 46% on public infrastructure projects more generally.**

Almost one-quarter of respondents (23%) feel that city officials are not clear about the ways to submit their views on infrastructure. And, crucially, 50% of those questioned think that, when they are asked to feedback, it is too late in the process for their voice to be heard or to have an impact.

Giving people more interactive ways to engage (e.g. via virtual reality, interactive plans and digital channels) could help, with 36% of respondents saying that city authorities are making it easier for them to contribute through social media.

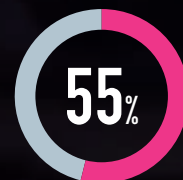
This perceived lack of engagement, along with recent controversies

surrounding some proposed projects such as the Garden Bridge, could be informing Londoners' dissatisfaction with infrastructure management and delivery.<sup>8</sup>

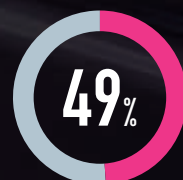
Some 49% of respondents think that changes in elected city officials often result in major changes to infrastructure policy. Fewer than one in three feels that those in power are making the right decisions about which projects to fund.

More than one-half of respondents (52%) believe that city officials take a short-term view of infrastructure planning, with 59% stating that large-scale transportation projects in the capital are usually delivered late.

London is not alone in thinking like this. It's a similar picture in Sydney, Los Angeles, New York, Toronto, Hong Kong and Chicago. And many Londoners (57%) agree that the private sector should be more involved in infrastructure development. The inference being that this could help to improve things.



Over half say that they haven't had the chance to feedback on transport services during the past year.



49 percent of respondents think that changes in elected city officials often result in major changes to infrastructure policy.

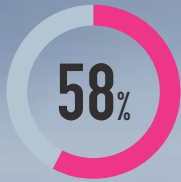
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**A PERCEIVED LACK OF ENGAGEMENT, ALONG WITH RECENT CONTROVERSIES SURROUNDING SOME PROPOSED PROJECTS SUCH AS THE GARDEN BRIDGE, COULD BE INFORMING LONDONERS' DISSATISFACTION WITH INFRASTRUCTURE MANAGEMENT AND DELIVERY.**





## INNOVATION



**58 percent** of Londoners now use mobile apps to keep up-to-date with public transport services.

**The good news is that Londoners' priorities for improvements broadly line up with Mayor Khan's agenda, emphasising greater connectivity and sustainability across the city.**

Upgrading public transportation features as one of citizens' top three priorities for improvements — ahead of upgrading utilities and just behind improving environmental sustainability. Londoners also identified fast rail connections to airports as one of the top three technologies that will have the biggest positive impact on their quality of life — underlining London's position as a global city.

In terms of innovation, London believes it has a head start. As London's Oyster card celebrates its 15th birthday, more Londoners (45%) agree that they have innovative payment options available to them for public transport than those who disagree (17%).<sup>9</sup> In addition, 58% of Londoners now use mobile apps to keep up-to-date with public transport services.

And, in a digitally driven future with London's infrastructure evolving to become smarter, the city's citizens recognise the importance of fast fibre-optic broadband for their quality of life.

Like other major cities, London faces a number of environmental challenges, including poor air quality and noise pollution, protecting its green spaces and the ever-growing impact of climate change.<sup>10 11 12 13</sup>

Reflecting this, citizens are focused on building a greener city. When asked, respondents identified improving environmental sustainability, upgrading water and power utilities and protecting against the impact of natural disasters to be among the most necessary improvements to infrastructure for their future.

Citizens also considered solar power and smart (digital) electricity meters in the home to be two of the top four technologies likely to have the biggest positive impact on their quality of life in the years ahead. Many Londoners also recognise the important role data will play in delivering smarter, better infrastructure to cities, and 47% say they are happy to share their personal data with relevant city agencies to help improve things.

“

**IN TERMS OF INNOVATION, LONDON IS PERCEIVED TO HAVE A HEAD START. IT IS ONE OF THE LEADING CITIES OFFERING CITIZENS INNOVATIVE WAYS TO PAY FOR THEIR TRANSPORT JOURNEYS WITHIN AND BEYOND THE CAPITAL.**

<sup>9</sup> <http://www.cityam.com/266991/oyster-card-hits-15-year-mark-five-things-you-didnt-know>

<sup>10</sup> <https://www.london.gov.uk/what-we-do/environment/pollution-and-air-quality/air-quality-statistics-and-research>

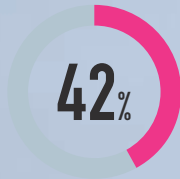
<sup>11</sup> [https://www.london.gov.uk/sites/default/files/mayors\\_noise\\_strategy.pdf](https://www.london.gov.uk/sites/default/files/mayors_noise_strategy.pdf)

<sup>12</sup> <https://www.london.gov.uk/what-we-do/environment/parks-green-spaces-and-biodiversity/green-infrastructure/natural-capital-account-london?source=vanityurl>

<sup>13</sup> [https://c40-production-images.s3.amazonaws.com/other\\_uploads/images/1789\\_Future\\_We\\_Don't\\_Want\\_Report\\_1.4\\_hi-res\\_120618.original.pdf](https://c40-production-images.s3.amazonaws.com/other_uploads/images/1789_Future_We_Don't_Want_Report_1.4_hi-res_120618.original.pdf)



## RESILIENCE



**42 percent** of London residents are not confident in their city's ability to protect them against such an event

**The challenges facing London are ever changing. In 2017 alone, there was a series of high-profile and deadly attacks. Throughout it all, Londoners have worked hard to keep the city going, but the challenges of keeping safe are ever present in their minds. Understanding the risks of being a global city, they want and need their city to be prepared.**

For them, the biggest threat to infrastructure now is cyberattacks. The threat you can't see, with 42% of London residents not confident in their city's ability to protect them against such an event — second only to Chicago in terms of their perception of this risk.

This reinforces what infrastructure professionals told us last year, when 70% of respondents in our 2018 *Future of Infrastructure* report felt that it is fairly likely or almost certain that hackers will disrupt the transportation network.

Higher than any other major city questioned, more than half (52%) of Londoners say that they have not been informed of drills or exercises to help prepare their city for emergency situations in the past two years. This lack of awareness could be feeding into citizens' perceptions about London's readiness to deal with such threats, 36% question the ability of London's infrastructure to withstand the impact of a terrorist attack, compared to 38% who think it can.

Another big concern is climate change. Some 40% of respondents believe their city government is falling behind other cities when it comes to sustainability. And over a third of citizens (37%) are not confident in the capital's ability to protect them against natural disasters, such as flooding — underscoring the priority respondents place on investing in infrastructure and technologies that mitigate these risks.

This is a common belief across the major cities surveyed, with many feeling like their governments were falling behind on sustainability.



# LDN

## LONDON AT A GLANCE

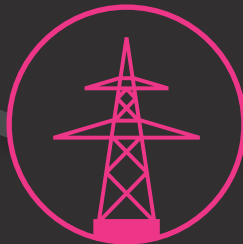
LONDONERS CARE ABOUT  
INFRASTRUCTURE



IMPROVING  
ENVIRONMENTAL  
SUSTAINABILITY



UPGRADING PUBLIC  
TRANSPORTATION



UPGRADING  
LONDON UTILITIES  
(WATER/ POWER)



**1,118**  
OF LONDON'S CITIZENS  
WERE SURVEYED  
AND SAID ...

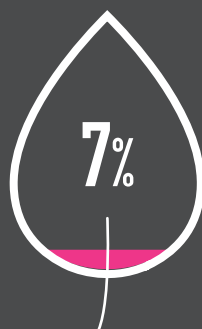
A GLOBAL LEADER,  
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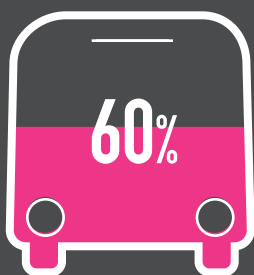




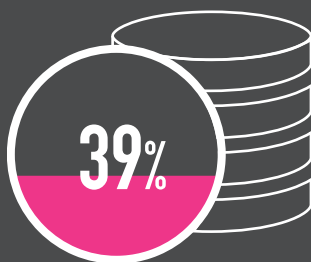
**40 percent** feel that their city government lags behind other cities in sustainability.



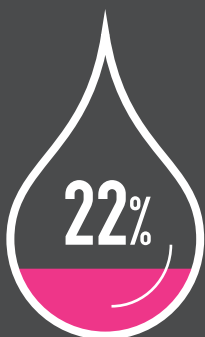
Only **7 percent** of respondents said they had had the opportunity to feedback on environmental sustainability in the past 12 months.



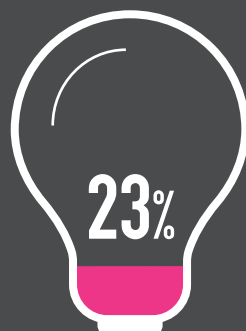
**60 percent** agree that using public transport in London is becoming more stressful.



**39 percent** of Londoners are willing to pay higher taxes to help fund infrastructure improvements.

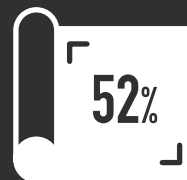


Fewer than a quarter of respondents feel that the service from their water (**22%**) and power (**23%**) providers has got better in the last year.



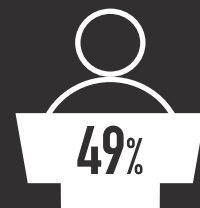
## LONDONERS WANT THEIR SAY

### LONDON'S DECISION MAKERS



**52 percent** believe city officials tend to take a short-term view of infrastructure planning.

**49 percent** think changes in elected officials often result in major changes to infrastructure policy.



**36 percent** of respondents say that city authorities are making it easier for them to engage through social media.

**57 percent** of respondents agree that the private sector should be more involved in the development of infrastructure.



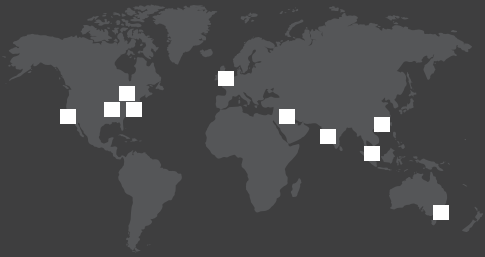
## TECHNOLOGY MATTERS

### LONDON'S VIEW ON WHAT TECHNOLOGIES WILL IMPROVE THEIR QUALITY OF LIFE

- #1** Fibre-optic broadband.
- #2** Solar power.
- #3** Fast rail connections to airports.

# GLOBAL FINDINGS

## IS ANYONE HAPPY WITH THEIR INFRASTRUCTURE?



**10,750** GLOBAL VOICES **ACROSS** **10** CITIES

INFRASTRUCTURE IS EVERYONE'S BUSINESS

Discover more at

[infrastructure.aecom.com](https://infrastructure.aecom.com)

### TOP 3 GLOBAL INFRASTRUCTURE PRIORITIES

When survey respondents were asked to choose between several possible initiatives — roads, rail and the environment are top improvement priorities for the future.

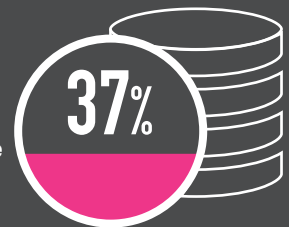
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## UPGRADING PUBLIC TRANSPORTATION



### RESIDENTS WANT TO PLAY THEIR PART

Some **37 percent** of residents are willing to pay higher taxes to fund infrastructure improvements in their cities.



**46 percent** are happy to share personal data with relevant city agencies to improve city infrastructure or infrastructure services.

### MORE KEY GLOBAL FINDINGS

## DEVELOPING RESILIENCE

**32 percent** have confidence in their city government's ability to protect infrastructure against cyberattacks.



**41 percent** have confidence in their city's ability to protect against natural disasters.

2/

## IMPROVING SUSTAINABILITY



### THE GRASS IS ALWAYS GREENER

45 percent say their city government lags behind those of other cities in implementing or encouraging environmentally sustainable practices.



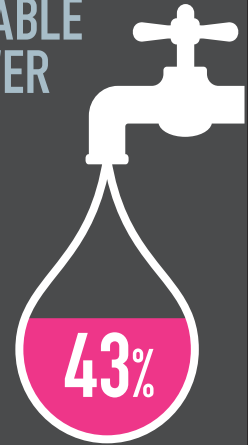
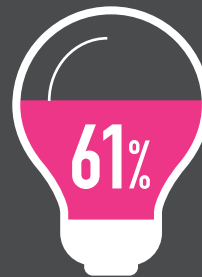
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## UPGRADING UTILITIES



### ACCESS TO RELIABLE WATER AND POWER

43 percent have experienced an interruption to their water supply in the past year.



61 percent have experienced one or more power outages in the past year.

## PEOPLE WANT THEIR SAY

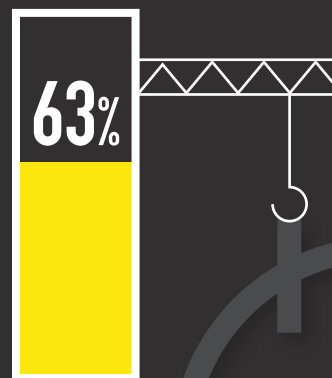
52 percent say requests for citizen feedback about infrastructure improvements or investments come too late in the planning stage to be meaningful.



55 percent say that they have not had an opportunity to provide feedback to a public transportation provider in the last year.

## PRIVATE SECTOR INVOLVEMENT

63 percent agree that the private sector should be more involved in infrastructure development.





# GLOBAL SNAPSHOT OF OVERALL INFRASTRUCTURE SATISFACTION

The Infrastructure Satisfaction Index draws on responses to selected questions from a global online survey of 10,750 people residing in 10 cities: Los Angeles, London, New York, Hong Kong, Riyadh, Sydney, Chicago, Mumbai, Singapore, and Toronto.



Scores for satisfaction, engagement, innovation, and resilience are based on a 1–10 scale. The Infrastructure Satisfaction Index results overall are shown below.



**10–7.6**

**Very satisfied**



**7.5–5.1**

**Moderately satisfied**



**5.0–2.6**

**Not very satisfied**



**2.5–1.0**

**Dissatisfied**

**LA**

**Los Angeles**

**4.01**

Investing in new infrastructure to build a safer, more sustainable, more livable city.

[aecom.com/la](https://aecom.com/la)

**NYC**

**New York**

**4.00**

An ever-evolving global hub, working to keep pace with growing demand.

[aecom.com/nyc](https://aecom.com/nyc)

**SYD**

**Sydney**

**3.94**

Big moves can help Sydney capitalize on its iconic status as a globally admired city.

[aecom.com/syd](https://aecom.com/syd)

**CHI**

**Chicago**

**3.93**

Resilience mixed with practicality sets this U.S. second city apart, making it an icon of community.

[aecom.com/chi](https://aecom.com/chi)

**TOR**

**Toronto**

**3.81**

Improving transit and reducing gridlock are Toronto's key priorities for the future.

[aecom.com/tor](https://aecom.com/tor)

## Executive Summary

# A TALE OF 10 CITIES

### Is anyone happy with their infrastructure?

It's a big question. And it's at the core of a survey conducted for this report with more than 10,000 people across 10 major global cities — Los Angeles, London, New York, Hong Kong, Riyadh, Sydney, Chicago, Mumbai, Singapore, and Toronto.

When a city's infrastructure works well, we tend to take it for granted. But when transportation and utility services fail to deliver, they have a negative impact on our quality of life, on business and on the wider economy.

We know infrastructure services are under strain to meet growing demand and that investment is lagging. With this in mind, it is perhaps no surprise that the residents of our 10 target cities tell us they are not entirely happy with their city government's management of local infrastructure and the services it delivers.

Based on our survey, results show an average infrastructure satisfaction score across the cities of 4.1 on a scale of 1–10.<sup>1</sup>

### The people's verdict: city governments must do better.

Informing this score, in large part, is residents' desire to have a greater say in the development of infrastructure in their cities. Across all of the locations, a perceived public engagement gap is undermining the best efforts of city authorities to upgrade local infrastructure and improve services. Residents want to be kept more informed about projects and contribute meaningfully to the debate around them.

Putting aside their concerns about engagement, citizens offer a more positive view of the quality and reliability of infrastructure overall. This support points to a measure of goodwill felt by citizens towards their cities' infrastructure on which city governments could build — strengthening users' sense of ownership of, and involvement in, future projects.

<sup>1</sup> The cities included in the study are Los Angeles, London, New York, Hong Kong, Riyadh, Sydney, Chicago, Mumbai, Singapore, and Toronto.





## WHEN A CITY'S INFRASTRUCTURE WORKS WELL WE TEND TO TAKE IT FOR GRANTED. BUT WHEN TRANSPORTATION AND UTILITY SERVICES FAIL TO DELIVER, THEY HAVE A NEGATIVE IMPACT ON OUR QUALITY OF LIFE, ON BUSINESS AND ON THE WIDER ECONOMY.

Here are the headline findings of our study, based on what more than 10,000 citizens told us about their use of infrastructure and ambitions for their cities.

**Infrastructure is everyone's business.** But many feel shut out of the conversation. Most of the 10 survey cities clearly underperform when it comes to engagement with citizens on infrastructure. Aggregate satisfaction is measured at a lowly 3.3 out of 10. It is highest in Mumbai and lowest in Sydney, Chicago and Hong Kong. And more-focused interaction with citizens could go a long way toward improving perceptions of city governments' performance on infrastructure and securing support for future projects.

**Residents want to play their part.** In several cities, residents show a willingness to pay higher taxes to fund infrastructure improvements. And almost one-half (46%) of respondents overall are happy to share personal data — the lifeblood of smart cities — with city agencies to help them improve infrastructure and services. Both commitments can be seen to underline citizens' desire to play their part in delivering better infrastructure.

**Wanted: more private-sector involvement.** A clear majority of city residents overall (63%) believe the private sector should be more involved in the development of city infrastructure. The hope being, potentially, that this could help to contribute to the financing, development, delivery and management of better infrastructure.

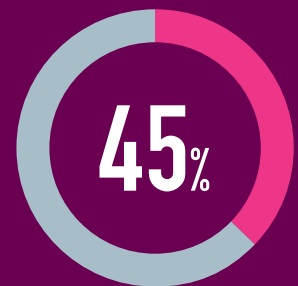
### **Roads, rail and the environment are top improvement priorities.**

Respondents were asked to choose between several possible initiatives, and upgrading public transportation — particularly roads and underground rail — is the top infrastructure priority. A close second priority is improving environmental sustainability, through solar power, recycling and wastewater re-use initiatives. Indeed, environmental sustainability is the main priority for five of our cities.

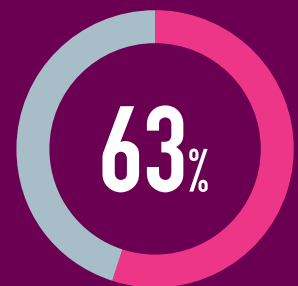
**Boosting resilience against cyberattacks is a pressing concern.** More respondents have confidence in their city's ability to protect infrastructure against natural disasters and terrorist attacks than those who do not. They are less confident, however, in their city's defenses against cyberattacks. And citizens need increased reassurance from city authorities about the capabilities of their infrastructure to withstand such events.

### **The grass is always greener.**

Almost half of respondents (45%) believe other city governments are doing a better job than their own in fostering environmentally sustainable practices. Solar power is viewed as extremely important to future quality of life, trailing only fiber-optic broadband. ➔



Almost half of respondents believe other city governments are doing a better job than their own in fostering environmentally sustainable practices.



A clear majority of city residents overall believe the private sector should be more involved in the development of city infrastructure.

# WHO IS HAPPY WITH THEIR INFRASTRUCTURE?

‘The Infrastructure Boom Cometh.’ That was a headline appearing in the Sydney Morning Herald in early 2018.<sup>2</sup>

The author pointed out the unprecedented investment in Australia in new transportation infrastructure in the face of rapid population growth and rising demand for services, and the fact that its largest state, New South Wales, of which Sydney is the capital, dominates this investment.

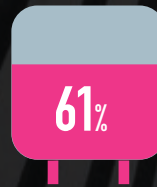
But for all of this, Sydney survey respondents seem to be displaying some impatience with the inevitable gaps between strongly increasing demand on transportation infrastructure and the ability to expand the necessary infrastructure quickly enough. This is a sentiment that is not out of line with other cities included in this report’s index. The 10,750 people surveyed for the study are generally ‘not very satisfied’ with their cities’ management of infrastructure and related services.

Despite tens of billions of dollars being poured into expanding capacity, Sydney has the third-lowest index score of the 10 cities, coming above only Chicago and Toronto.

In contrast, the highest score is found in Mumbai where, despite severe challenges, residents believe things are improving in various areas of infrastructure and service delivery.<sup>3</sup>

As the overall index scores by city show (see pages 14–15), it is not all bad news for city leaders. The main issue is not necessarily the quality of the infrastructure or services provided, but rather cities’ perceived lack of engagement and openness to keeping residents informed and involved in infrastructure improvement projects.

Overall, the survey respondents appear to be ‘moderately satisfied’ in all 10 cities with the reliability — and even affordability — of infrastructure and related services.



**61 percent** believe using public transportation in their city is becoming more stressful.

## Delivering daily life

When it comes to the services they use most often — electricity, water and public transportation — Hong Kong residents are the happiest of those in our sample. The vast majority in the territory deem their electricity supply, for example, to be reliable. Only 10 percent of respondents there have experienced a power outage more than once in the past year. Nearly two-thirds (63%) in Hong Kong say that the public transportation they use is ‘good’ or ‘excellent’ at getting them where they want to go. Fewer (35%) tell us the same about transport timeliness, but the vast majority (86%) state it is at least ‘acceptable.’ Riyadh residents are the least positive in the survey on infrastructure quality, although they can still be described as ‘moderately satisfied.’ ➡

<sup>2</sup> <https://www.abc.net.au/news/2018-01-11/sydney-rail-chaos-public-transport-nsw-subway-metro/9319908>

<sup>3</sup> See, for example, <https://www.bbc.co.uk/news/world-asia-india-44693602>; and <https://timesofindia.indiatimes.com/city/mumbai/city-to-face-power-cuts-for-a-week/articleshow/64421728.cms>



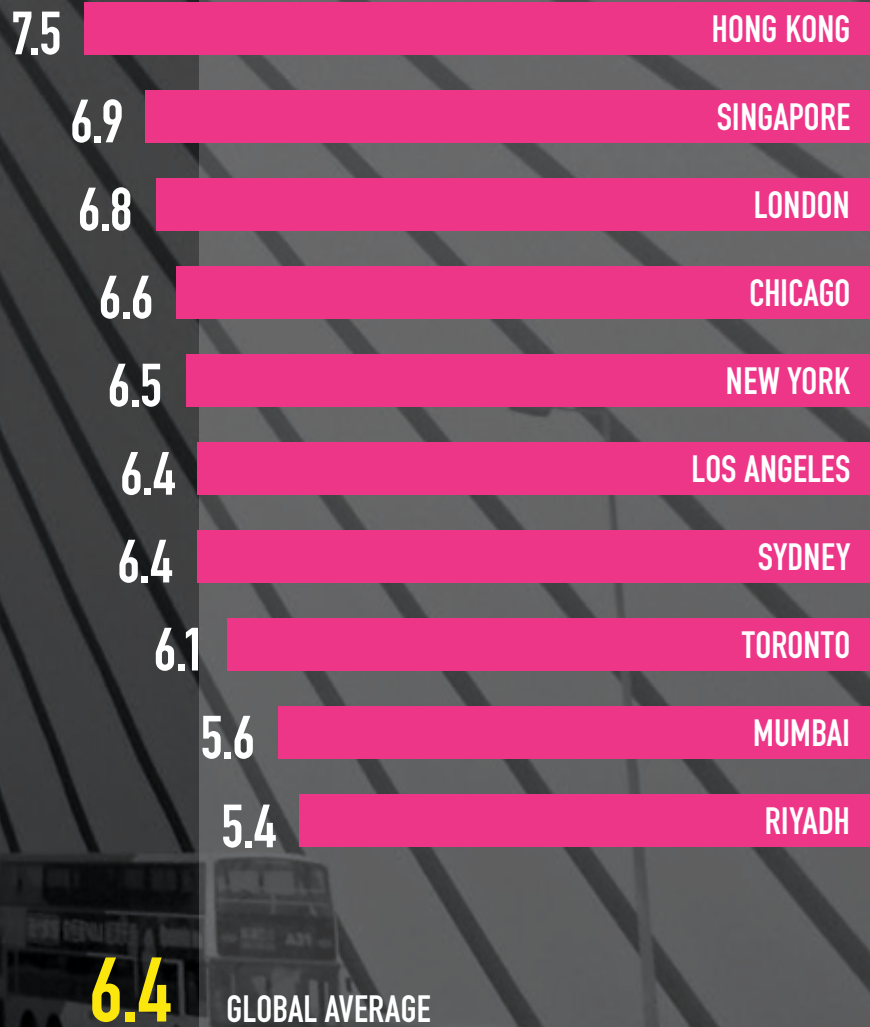
“

PUBLIC TRANSPORTATION IS VIEWED AS GENERALLY RELIABLE IN ALL 10 CITIES, BUT THAT DOES NOT MAKE USING IT ANY EASIER FOR COMMUTERS.



# SATISFACTION

What is the citizens' experience of core infrastructure — utilities (water and electric power) and transportation (rail, bus, roads, ports, etc.) in the city where they live?



**The Infrastructure Satisfaction Index** draws on responses to selected questions from a global online survey of 10,750 people residing in 10 cities: Los Angeles, London, New York, Hong Kong, Riyadh, Sydney, Chicago, Mumbai, Singapore, and Toronto. Scores for satisfaction, engagement, innovation, and resilience are based on a 1–10 scale, with four bands:



**10–7.6**  
Very satisfied



**7.5–5.1**  
Moderately satisfied



**5.0–2.6**  
Not very satisfied



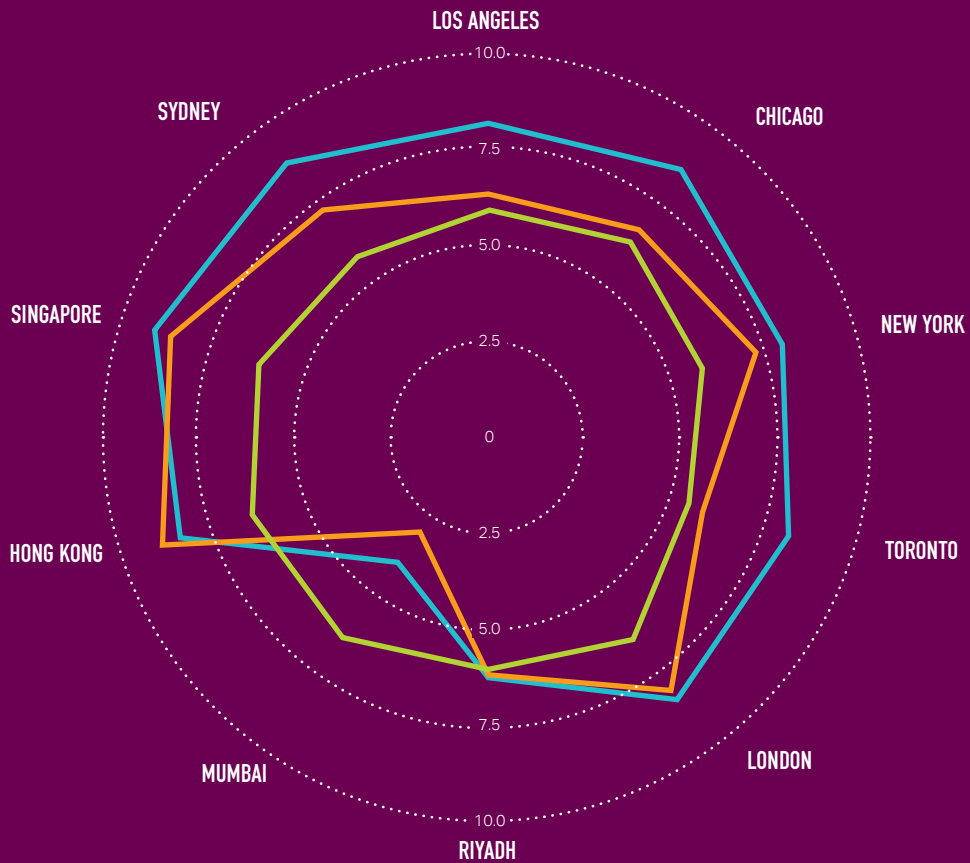
**2.5–1.0**  
Dissatisfied

### Reliability

Water, electricity and public transportation reliability index scores.

A higher score indicates more favorable responses in terms of fewer reported water and electricity outages, and transport performance and reliability.

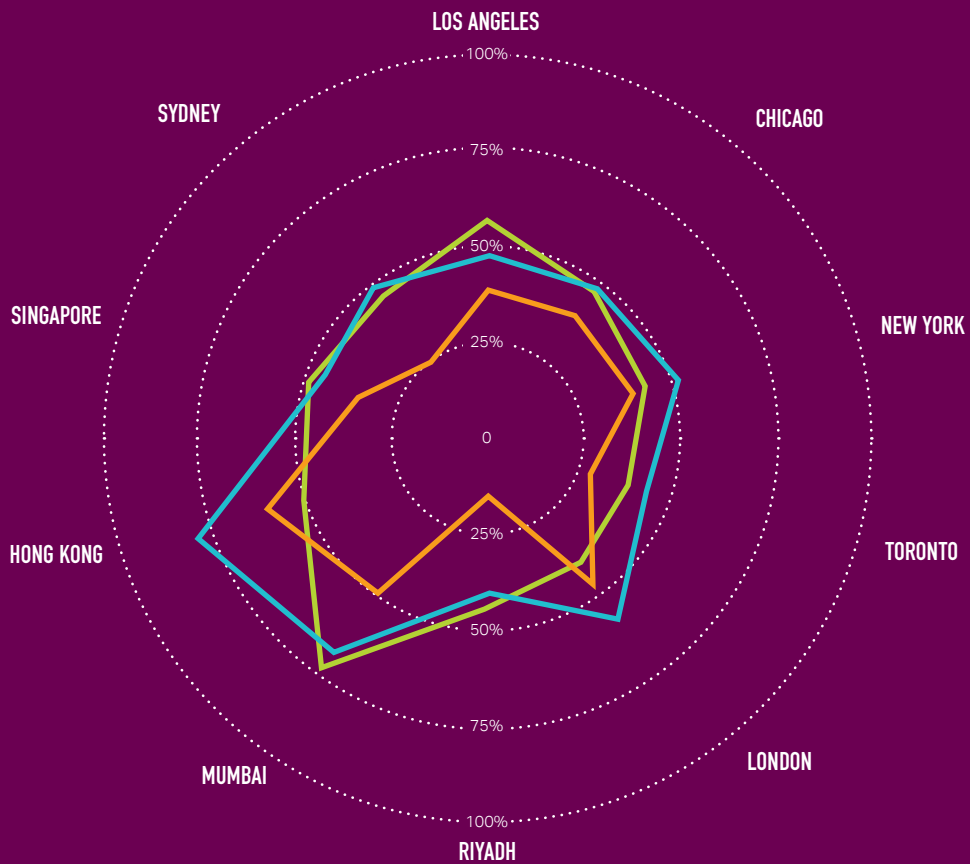
- Water
- Electricity
- Transport



### Affordability

Respondents were asked how they would describe the affordability of their water/electricity bills and public transportation fares in their cities. This figure shows the percentages for being 'overall affordable.'

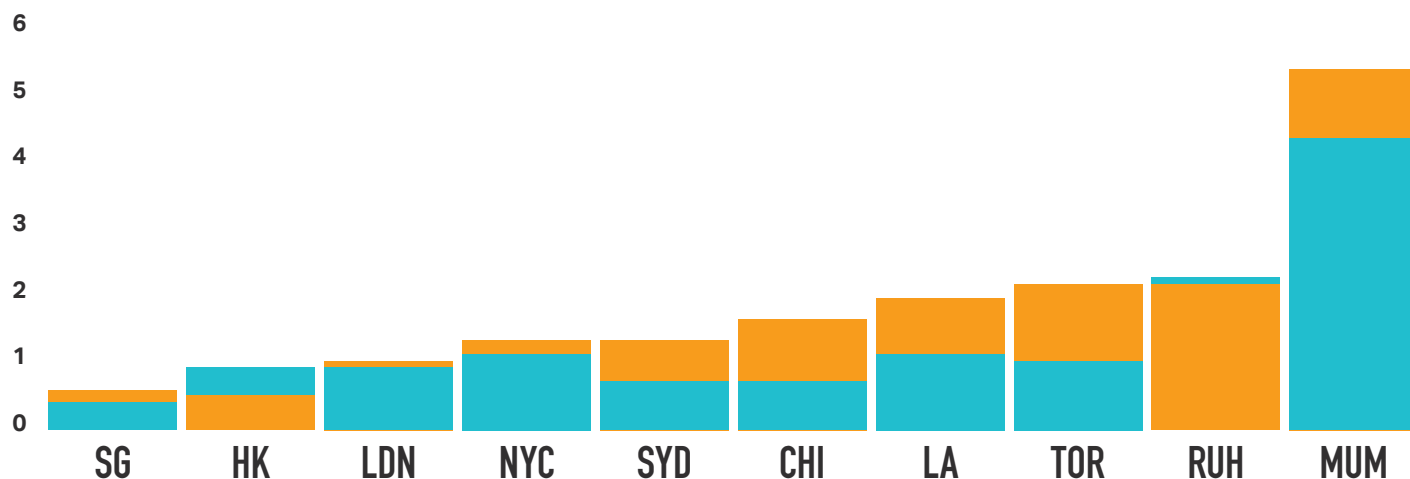
- Water
- Electricity
- Transport





The average frequency in the last 12 months, where respondents have experienced water outages or restricted supply, or loss of electric power to their own and neighbors' residences.

Electricity Water



Public transportation is viewed as generally reliable in all 10 cities, but that does not make using it any easier for commuters. Whichever form of transportation residents may select, most believe that the experience of traveling on public transportation is growing more, not less, stressful. Within the survey, complaints are loudest about delays. Nearly four in 10 New Yorkers, for example (38%), and three in 10 Torontonians (30%) rate public transportation in their cities as 'poor' on timeliness. However, vast majorities in both (86% and 80%, respectively) say the same means of transportation are 'acceptable' or better at getting them where they want to go. In the survey overall, half of respondents give a 'good' or 'excellent' grade to public transportation for getting them to their destinations, even if not always on time.

Relatively small numbers report a deterioration in the quality of transportation infrastructure during the past year. That figure is highest, though (28%), when it comes to roads

and bridges. Roughly one-third of residents in New York, Los Angeles, Toronto, London and Sydney say these infrastructure elements are getting worse, explaining why roads are viewed as the first or second priority for infrastructure improvements in all of these cities.

City residents are broadly satisfied with the reliability of their water supply, as they are with their electricity supply. There are, however, significant differences between cities. For example, water outages or restrictions are a rarity in Singapore, according to nine in 10 respondents there. They are more commonplace in Mumbai, where 67 percent of residents have experienced a restricted supply on three or more occasions in the past year. There are also stark differences in electricity supply. Whereas 91 percent of Singaporeans have experienced one or no outages in the past year, that figure is only 58 percent in Chicago, 52 percent in Los Angeles, 51 percent in Riyadh, 45 percent in Toronto, and 15 percent in Mumbai.



39%

39 percent have experienced no power outages in the past year.

### Squeezing household budgets

The cost of infrastructure and the public services it supports naturally has an impact on levels of public satisfaction. In all cities, more survey respondents find their public transportation fares to be affordable than unaffordable.

Hong Kong residents are the most likely in the survey to say their water and electricity bills are affordable. Citizens in Riyadh are least likely to say this, and as many as 75 percent of respondents there describe their regular electricity bills as unaffordable.

This disquiet with electricity tariffs extends more widely: 54 percent in Sydney and 42 percent in Toronto also say their monthly bills are unaffordable. When it comes to public transportation, the largest share of respondents (38%) saying that transport fares are unaffordable is found in London. [WL](#)



**WE'RE TRYING TO TAKE A BROADER VIEW AND SAY 'WE'RE PART OF MAKING A GOOD CITY' AND THAT'S NOT JUST ABOUT HOW WE MOVE PEOPLE FROM A TO B MORE EFFICIENTLY. IT'S ABOUT HOW THE TRANSPORT INFRASTRUCTURE INTERFACES WITH THE COMMUNITY, HOW LAND USE DECISIONS ARE MADE AROUND IT. IT'S ABOUT BEING MUCH MORE COGNIZANT OF THE BROADER IMPACT OF TRANSPORT, AND THE WAY WE THINK ABOUT IT IN TERMS OF CITIZENS, CUSTOMERS AND STAKEHOLDERS.**

KEN KANOFSKI, CHIEF EXECUTIVE, ROADS AND MARITIME SERVICES, NEW SOUTH WALES, AUSTRALIA

## Part One

# INFRASTRUCTURE IS EVERYONE'S BUSINESS: WE WANT MORE SAY

**W**ith quality of life and quality of infrastructure services being inextricably linked, respondents make it clear that they want to be part of the infrastructure debate. In several of our focus cities, more than half of the residents surveyed say they had no opportunity to comment on public transportation. Many want to have a say in how their infrastructure is planned, paid for, developed and operated. They want to follow the progress of major projects and get answers from city agencies to their questions about the work. Our research shows that large numbers of citizens are unimpressed with their authorities' efforts to engage with them.

A detailed look at the survey responses helps to explain the dissatisfaction. Only 38 percent of residents say that city planning authorities are making it easier for them to interact on infrastructure issues through mobile channels, and 39 percent say the same about interaction via social media. In the past 12 months, only one-third (33%) have viewed an infrastructure-related plan made available by city authorities.

Sydney stands out in its lack of engagement. Globally, over one-third (34%) of survey respondents —

and as many as 46 percent in Sydney — have had no interaction at all with public transport providers in the past year. The figures are almost as high in Chicago and Toronto. Residents of Mumbai and Riyadh, by contrast, have had considerably more interaction, particularly via mobile channels and social media.

“People can feel that they’re not being kept informed about progress with infrastructure or services in ways that are relevant to them,” says Peter Runcie, who is New Industries and Future Cities Leader with the Data61 unit of the Australian government scientific research body, the Commonwealth Scientific and Industrial Research Organization (CSIRO).

He observes that some of Sydney’s local area councils do a good job of interacting with residents on specific issues, such as road improvement, parking and development of local transportation strategies.

“Although uniformity is not desirable it can be difficult for these localized initiatives and best practices to be integrated at a city-wide level. People of course travel out of their local area so their perspectives — although not city wide — do include multiple localities that provide services to them as individuals.” ➡







## ENGAGEMENT

How much do citizens engage with city authorities and infrastructure providers?

“

ENGAGEMENT IS IMPROVING AT THE NEIGHBORHOOD LEVEL, BUT OVER TIME IN THIS COUNTRY [U.S.] WE HAVE CREATED A GAP IN INFORMATION ABOUT THE IMPACT OF INFRASTRUCTURE ON PEOPLE'S DAILY LIVES AND HOW IT'S PAID FOR. THERE'S A HUGE VOID BETWEEN REALITY AND WHAT THE PUBLIC KNOWS.

MICHAEL LEWIS, EXECUTIVE DIRECTOR,  
COLORADO DEPARTMENT OF TRANSPORTATION



3.3

GLOBAL AVERAGE

**The Infrastructure Satisfaction Index** draws on responses to selected questions from a global online survey of 10,750 people residing in 10 cities: Los Angeles, London, New York, Hong Kong, Riyadh, Sydney, Chicago, Mumbai, Singapore, and Toronto. Scores for satisfaction, engagement, innovation, and resilience are based on a 1–10 scale, with four bands:



**10–7.6**  
Very satisfied



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Moderately satisfied



**5.0–2.6**  
Not very satisfied



**2.5–1.0**  
Dissatisfied





## CITY STORY RUH

# KEEPING RIYADH RESIDENTS ENGAGED

**Construction work on the 112-mile (180-kilometer), 85-station Riyadh Metro, underway since 2014, has inevitably caused some disruption to daily life, acknowledges Saudi Minister of Transport Dr. Nabeel M. Al-Amudi, and therefore all stakeholders eagerly await its scheduled completion in 2021. In the meantime, he says, “We must keep citizens engaged and updated about how things are progressing. It shouldn’t be something that residents simply have to suffer through.”**

One initiative from the Arriyadh Development Authority (ADA) to keep residents interested was novel: in 2015, it held a competition to name the first of the enormous boring machines used to dig

the tunnels. Over 1,000 entries were submitted, and the winner was Dhafrah, which translates to English as ‘Victory.’<sup>4</sup>

Another initiative was to build an interactive visitor center showcasing the project. Opened in 2017, the exhibition enables visitors to experience the ticketing, payment and other technologies the metro lines will use when open. Visitors are able to walk through mock-ups of stations and trains, and to view screens to watch workers in action in different parts of the project.<sup>5</sup>

“Such initiatives have made it easier for people to make the project part of their daily lives,” says Dr. Al-Amudi. “The project becomes something that’s enjoyable, rather than onerous.”

<sup>4</sup> <https://www.strukton.com/news/2015/first-tunnel-boring-machine-starts-drilling-on-the-riyadh-metro-line/>

<sup>5</sup> <http://saudigazette.com.sa/article/524991/SAUDI-ARABIA/A-glimpse-inside-Riyadh-Metros-ride-to-the-future>



## Make it meaningful

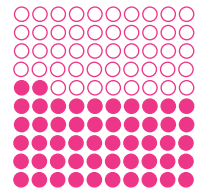
When people have opportunities to express their opinions, they also want to be confident that they will be heard.

In the 10 surveyed cities, the opportunities that do exist for better interaction are often wasted through a lack of attention to basic details. For example, no more than 36 percent of respondents feel that the authorities are clear when requesting citizen feedback about public transportation issues. Such clarity is particularly low, judging by the responses, in North American cities such as Chicago (27% in agreement) and Toronto (32%). And a majority (52%), believe that feedback requests come too late to be meaningful. Mumbai residents are most vocal on this count, with 70 percent agreeing with the complaint.

Transportation agencies and utility providers in many cities are getting better at interacting with the public on infrastructure issues, according to Lara Poloni, AECOM's Chief Executive Officer, Europe, Middle East and Africa (EMEA). "They certainly

understand that customer needs should be the top priority, in terms of planning, services and security," she says. Judging by the survey results, many cities are nevertheless finding it difficult to translate that understanding into effective engagement practices.

Public officials understand the need to engage more with the citizens on infrastructure projects agrees Sir John Armitt, Chair of the U.K.'s National Infrastructure Commission, but many are wary of the time it may add to the process. He terms them 'reluctant converts.' "They're worried about the time involved and the objections they're likely to encounter. However, by not consulting and making decisions in isolation, they're actually adding time to the process due to the resistance that follows." His recommendation is, "Get out and talk to people about the costs as well as the benefits. You might be surprised that the more you talk to them, the more they'll engage and warm to the ideas." ➔



# 52%

**52 percent** say agencies' requests for citizen feedback on infrastructure projects come too late in the planning stage to be meaningful.

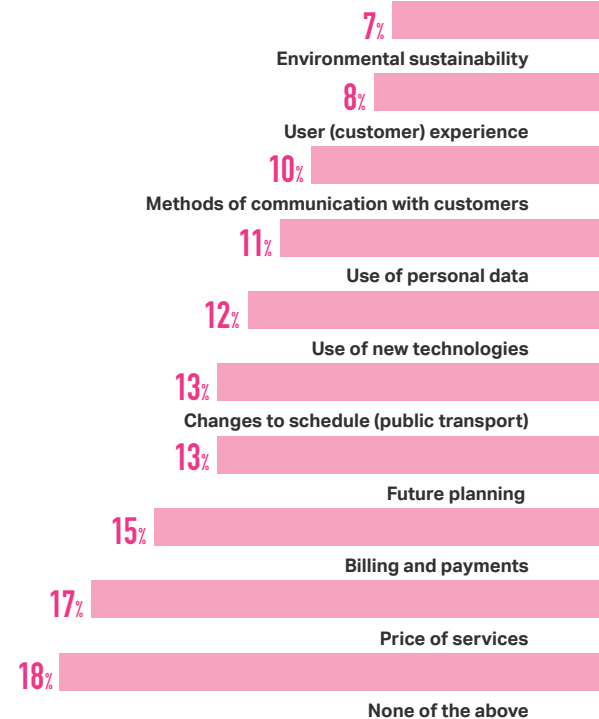
Types of public infrastructure issues where there have been an opportunity to provide feedback over the past 12 months.



**ONE OBSERVATION IS THAT CITY AUTHORITIES TEND TO ENGAGE THEIR CITIZENS ONLY ABOUT THE BENEFITS OF PROJECTS, WITHOUT TALKING ABOUT COSTS. THERE IS NOT ENOUGH EFFORT TO SENSITIZE CITIZENS TO THE COST OF THE PROJECT OR THE NEED FOR SOMEONE TO PAY. IT IS INDEED A DIFFICULT CONVERSATION, BUT GOVERNMENTS SHOULD ENGAGE THEIR CITIZENS ON BOTH THE BENEFITS AND COSTS OF PROJECTS AT THE SAME TIME.**

LAWRENCE WONG, MINISTER FOR NATIONAL DEVELOPMENT AND SECOND MINISTER FOR FINANCE, SINGAPORE

## Re-use/regeneration of infrastructure networks and services



45%



## ANGELENOS HAVE THEIR SAY ABOUT NEXT-GENERATION BUSES

**Los Angeles residents are helping to determine the city's new bus network plans. The NextGen Bus Study is gathering their input to help determine the new network's key objectives. A major spur to action is the 20 percent fall in bus use recorded since 2013.<sup>6</sup>**

As part of the study, an outreach initiative during 2018 sought residents' views on the plans. To collect this input, the Metropolitan Transportation Authority (known locally as Metro) developed an online engagement tool in which users entered details about their current travel practices and destinations, and answered questions about preferences for the network.<sup>7</sup> For example, they were asked to divide

a notional sum of money among different types of improvements, such as increasing geographic coverage and bus frequency at different times of day. The tool also asked residents to make a series of trade-offs, such as fewer stops on a line to enable faster trips versus more stops to shorten the walk to a stop.

Metro promises that residents' input will be reflected in new bus network plans that will be released in 2019 and implemented the following year. It should be clear by 2021 whether the overhaul will be enough to win back bus passengers on a large scale.

<sup>6</sup> <https://la.curbed.com/2017/8/29/16219230/transit-metro-ridership-down-why>

<sup>7</sup> <https://nextgen.metroquest.com/>



**AUTOMATION WILL INCREASE, AND MAKE IT EASIER TO BOOK SEAMLESS JOURNEYS, FROM CHOOSING THE FLIGHT TO CHECKING IN BAGGAGE. I SEE A TIME WHERE YOUR PHONE IS THE THING THAT HELPS YOU FIND THE WAY THROUGH AIRPORT BUILDINGS AND TRADITIONAL SIGNAGE BECOMES LESS PREVALENT.**

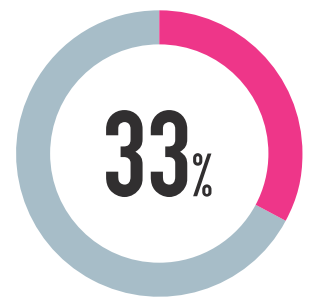
**PHIL WILBRAHAM, EXPANSION PROGRAMME DIRECTOR, HEATHROW AIRPORT, LONDON**

### Immersive experiences

A mastery of digital communication and visualization technologies would help city authorities boost their engagement success.

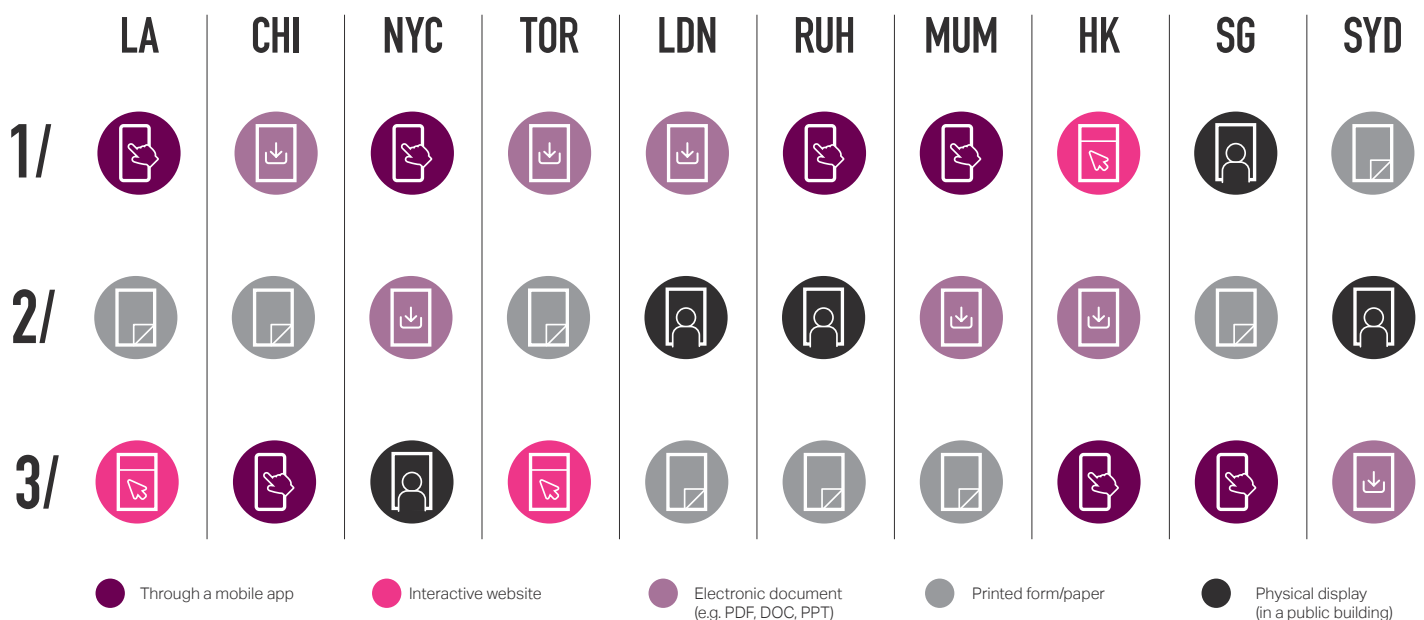
Citizens are increasingly technology savvy. A majority of survey respondents, for example, pay for their public services via internet banking and/or mobile apps. And when multiple channels of communication with city agencies are available, citizens appear to use them. Of the one-third

of respondents who have viewed an infrastructure-related plan in the past year, 33 percent used a mobile app to do so (including 36% in Singapore and Riyadh, and 52% in Mumbai), and 30 percent an interactive website (48% of Hong Kong residents have done this). One-fifth also viewed a plan in an interactive digital display, such as one that Riyadh authorities organized to showcase its metro rail project (see 'Keeping Riyadh Residents Engaged' on page 24). ➔



Of the one-third of respondents who have viewed an infrastructure-related plan in the past year, 33 percent used a mobile app to do so.

Top three ways in which infrastructure plans have been made available for view.



**Citizen-centric innovation**

Survey respondents' views about infrastructure quality suggest there is plenty of goodwill that cities can build on to increase overall satisfaction levels. Doing a better job of keeping residents informed and seeking their input about infrastructure projects can build on that goodwill. Doing this does not necessarily entail major financial investments, says Ronnie Hakim, Managing Director of New York's Metropolitan Transportation Authority. It does, however, require commitment of human resources, she says — finding good people to interact with the public effectively face-to-face and digitally.

Engagement should be treated as a core part of an infrastructure project and not an add-on, maintains Sir John Armitt. “There need to be clear targets and milestones [for consultation],” he says. “The targets may be daily, weekly, monthly or quarterly. When the targets are met and milestones reached everybody, including the wider public, needs to know. That’s how to maintain people’s interest over long drawn-out projects.” **WL**

**“**

**WE REGULARLY ENGAGE RESIDENTS IN THE VICINITY OF THE PROJECT WHO WOULD MOST LIKELY HAVE STRONG VIEWS OR ARE MORE DIRECTLY IMPACTED, AND OBTAIN THEIR FEEDBACK FACE-TO-FACE. WE ALSO OBTAIN FEEDBACK THROUGH ELECTRONIC PLATFORMS, WHICH HAS HELPED US TO GET A SENSE OF GROUND FEEDBACK AND RESPOND QUICKLY TO ISSUES.**

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**LAWRENCE WONG, MINISTER FOR NATIONAL DEVELOPMENT  
AND SECOND MINISTER FOR FINANCE, SINGAPORE**





## NEW YORK LETS CITIZENS DO THE BUDGETING

**Cycleways or sidewalks?  
Parks or libraries? An innovative  
program to invite local people  
to prioritize spending on their  
local infrastructure projects  
has been hailed as a success  
in New York City.**

Harvard University calls the Participatory Budgeting initiative 'the largest and fastest-growing' process of its kind in the United States and gave it an award for innovation in government.<sup>8</sup> Launched in 2011, the program involves inviting residents of individual districts to vote on how to allocate available funds on local infrastructure and other community projects. In one recent spending round, begun in August 2018, each of 31 districts had US\$1 million to allocate. Projects that have benefited from previous spending rounds have included schools and libraries; many

others involve parks, streets and sidewalks, bicycle lanes and other transit improvements.<sup>9</sup>

Each round begins with several hundred neighborhood meetings to brainstorm ideas for projects. Citizens are also invited to submit ideas via an online mapping site, where they can view proposed projects near them and in other districts.<sup>10</sup> Volunteers and officials of city agencies work to turn a select number of ideas into concrete proposals, which are then put to a vote by residents (five proposals in each district).

Critics say the funds available are limited and that new layers of city hall bureaucracy are blocking the scheme.<sup>11</sup> Its continued expansion in scope, however, suggests the program is having a positive impact as an exercise in civic engagement.

<sup>8</sup> [www.innovations.harvard.edu/participatory-budgeting-new-york-city](http://www.innovations.harvard.edu/participatory-budgeting-new-york-city)

<sup>9</sup> [www.govtech.com/dc/A-Look-at-New-York-Citys-Participatory-Budgeting-Map.html](http://www.govtech.com/dc/A-Look-at-New-York-Citys-Participatory-Budgeting-Map.html)

<sup>10</sup> <https://shareabouts-pbnyc-2018.herokuapp.com/place/new>

<sup>11</sup> See, for example, [www.nytimes.com/2018/11/04/opinion/editorials/nyc-ballot-proposals.html](http://www.nytimes.com/2018/11/04/opinion/editorials/nyc-ballot-proposals.html)



## Part Two

# SMART, CONVENIENT, DATA DRIVEN

**F**ive of our focus cities in this study — New York, London, Singapore, Toronto and Hong Kong — are among the world's 10 smartest cities, according to an authoritative annual ranking by Spain's IESE Business School.<sup>12</sup> These cities are using data and digital technology to improve residents' lives. Our survey respondents in these and the other cities believe there is considerable innovation around infrastructure and services. Overall, and in each city, citizens are 'moderately satisfied' on this count.

### Convenience on demand

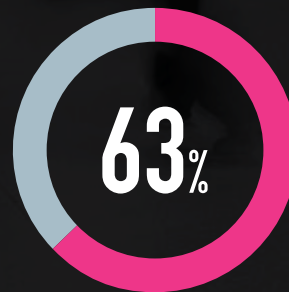
Several futuristic, eye-catching technologies will make their appearance in cities in the coming decade. Already a few can be seen in city pilots now, think autonomous buses and cars, pilotless drones for parcel delivery, airborne taxis, and augmented reality displays to help commuters navigate transport hubs. Corporate R&D units and technology start-ups are behind much of this innovation, but some public infrastructure agencies are cooperating with these and other entities to monitor progress and develop innovative applications of their own.

Such an initiative is the Colorado Department of Transportation's RoadX program, which, as the department's Executive Director, Michael Lewis, explains, provides seed funding to initiatives or ventures to develop connected vehicle infrastructure.<sup>13</sup> It is an example of what 63 percent of our surveyed citizens could have in mind in their belief that "the private sector should be more involved in infrastructure development."

5G mobile networks will be integral to enabling all such technologies to operate effectively in city environments, according to Derrick Pang, Chief Executive Officer of Allied Asia Infrastructure. Today's 4G networks will not be enough to support the data traffic the new technologies will generate and the applications they give rise to, he says. 5G services should be available in most of our study's focus cities by 2020.<sup>14</sup>

Other experts say that the most impactful infrastructure-related innovations in the coming years will be those that enhance personal convenience. According to Veronica Siranosian, Los Angeles-based Vice President of AECOM Ventures, the company's innovation team, these will be digital technologies that will "make people better aware of how they can access and use infrastructure and services." Lewis describes

these intuitive technologies, which enable people to select and pay for their journeys using a few simple steps, as 'citizen nirvana.' Mobility as a Service (MaaS) fits this description, says Gene Soo, Hong Kong General Manager of Citymapper, an award-winning transport app and service provider. A MaaS platform integrates different forms of transport, often provided by different public or private operators, into a single service that users can access and pay for on their mobile devices. European cities such as Helsinki and Stockholm are leading the way with MaaS; Soo expects pilots to be rolled out in the coming years in Singapore (see 'Integrated Mobility Continues its Expansion in Singapore' on page 33), Kaohsiung and other Asian cities.<sup>15</sup> ➡



**63 percent** believe the private sector should be more involved in infrastructure development.

<sup>12</sup> <https://media.iese.edu/research/pdfs/ST-0471-E.pdf>

<sup>13</sup> [www.bizjournals.com/denver/blog/earth\\_to\\_power/2015/10/colorado-unveils-20-million-transportation.html](http://www.bizjournals.com/denver/blog/earth_to_power/2015/10/colorado-unveils-20-million-transportation.html)

<sup>14</sup> [www.lifewire.com/5g-availability-world-4156244](http://www.lifewire.com/5g-availability-world-4156244)

<sup>15</sup> [www.juniperresearch.com/press/press-releases/mobility-as-a-service-to-replace-2-3-billion-priv](http://www.juniperresearch.com/press/press-releases/mobility-as-a-service-to-replace-2-3-billion-priv)





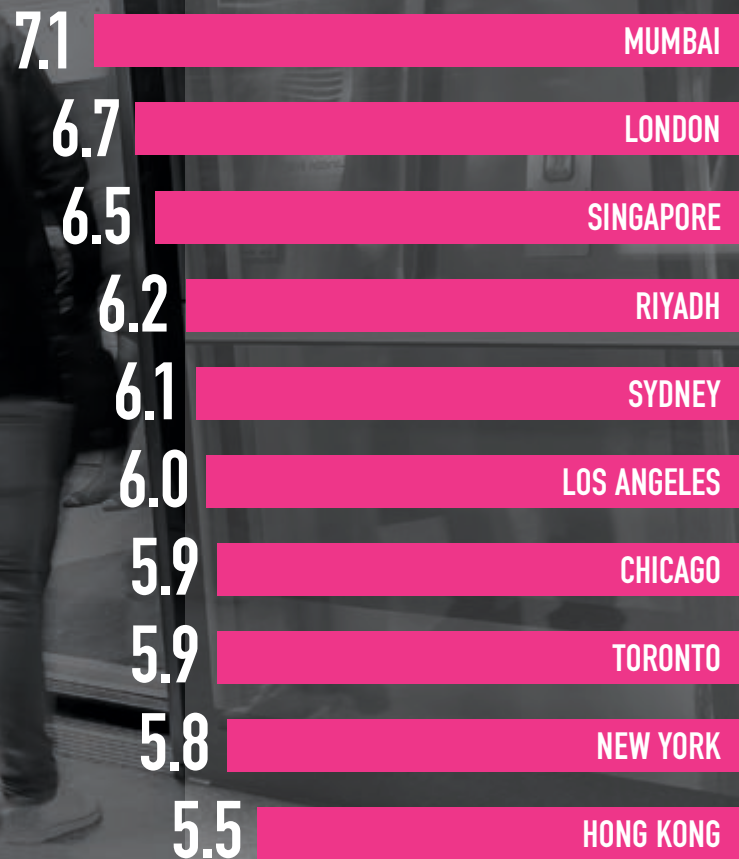
# INNOVATION

What is citizens' experience of innovative technologies in their city?

“

TECHNOLOGY IS NEEDED TO HELP ENHANCE EXISTING CAPACITY, CERTAINLY IN THE SHORT TERM, BECAUSE THERE'S A LIMIT TO THE FUNDING THAT'S AVAILABLE TO ADDRESS THE WISH LISTS OF MOST CITIES. WE NEED TO ASK HOW CAN TECHNOLOGY HELP US TO GET MORE OUT OF LESS?

LARA POLONI, CHIEF EXECUTIVE OFFICER, EMEA, AECOM



6.2

GLOBAL AVERAGE

The Infrastructure Satisfaction Index draws on responses to selected questions from a global online survey of 10,750 people residing in 10 cities: Los Angeles, London, New York, Hong Kong, Riyadh, Sydney, Chicago, Mumbai, Singapore, and Toronto. Scores for satisfaction, engagement, innovation, and resilience are based on a 1–10 scale, with four bands:



10–7.6  
Very satisfied



7.5–5.1  
Moderately satisfied

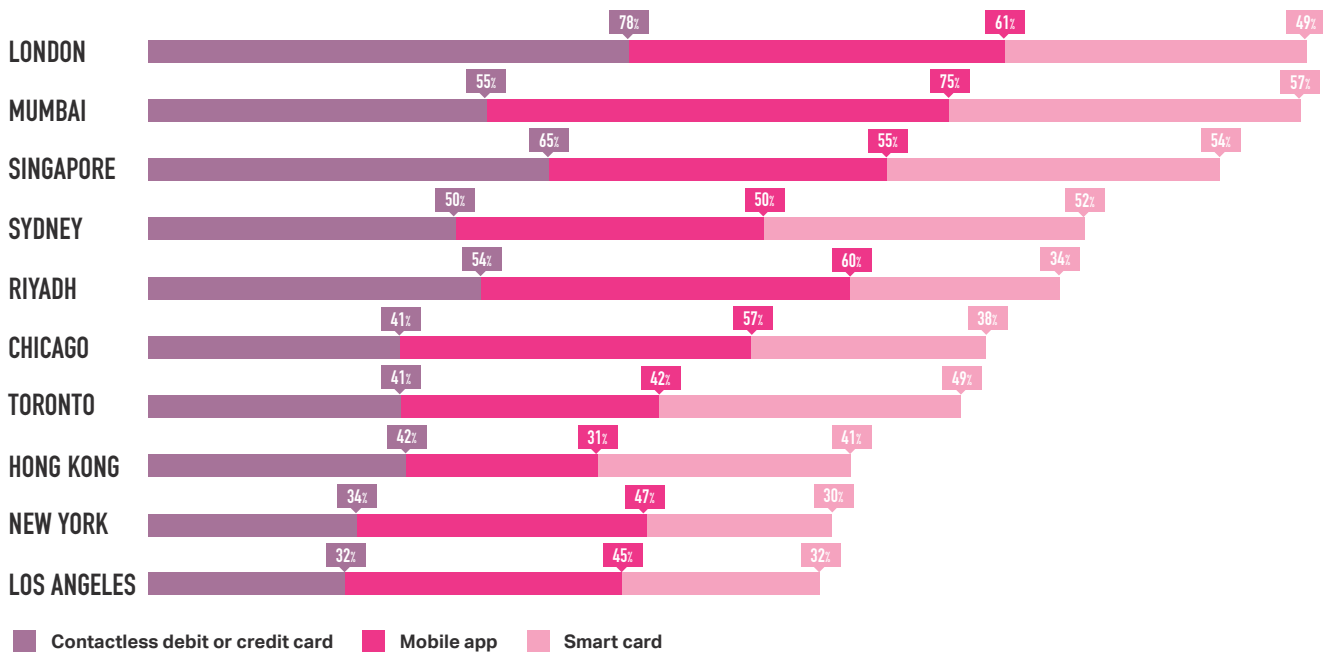


5.0–2.6  
Not very satisfied



2.5–1.0  
Dissatisfied

Share of citizens surveyed who are able to pay for public transportation or other utilities using mobile app, contactless debit or credit card, and smart card (for transport).



“

**CITIES MUST ALSO ENSURE EQUITY IN ACCESS TO DIGITAL AND OTHER INFRASTRUCTURE. NOT ALL CITIZENS WANT, OR ARE ABLE, TO ACCESS SERVICES VIA MOBILITY PLATFORMS, FOR EXAMPLE. ENSURING EVERYONE HAS SOME ACCESS TO FIBER OR WI-FI, FOR EXAMPLE, CAN ENHANCE EQUITY.**

VERONICA SIRANOSIAN, VICE PRESIDENT, AECOM VENTURES

## SMART TECHNOLOGY IN ACTION

When asked about the advanced technologies being deployed in cities today, nearly half (47%) of survey respondents say that charging stations for electric car batteries are available, while 49 percent can install digital electricity meters in their homes, and 40 percent have access to digital water meters. On all three of these measures, London's figures are highest. High-speed fiber-optic broadband — a fundamental element of modern digital infrastructure — is ubiquitous in Hong Kong and Singapore and widely available in London, although, according to respondents, it is less so in Sydney, New York and other focus cities.

New ways of paying for public services is a particularly active area of innovation.

More than four in 10 respondents overall (43%) say their main provider of public transportation makes available innovative payment options depending on time of day or usage. Over one-half (52%) pay for transport or other utilities using a mobile app. Nearly the same number (49% overall, and 78% in London) now use a contactless debit or credit card to pay fares.

It is a rich period of growth and diversification in new payment systems for public transport, says Peter Leung, General Manager of Operations Projects with Hong Kong's MTR (Mass Transit Railway) Corporation. Within a few years, though, he expects convergence around the few that are able to build a critical mass of users rapidly.







## INTEGRATED MOBILITY CONTINUES ITS EXPANSION IN SINGAPORE

**Singapore has long been a leader in developing and using public transportation. An impressive 84 percent of survey respondents use public transportation as their primary mode of travel, of which 55 percent take the subway.**

The Land Transport Authority (LTA) together with the Intelligent Transportation Society Singapore (ITSS), recently introduced a strategic plan called 'Smart Mobility 2030,' paving the way for a more connected transportation system through innovative and interactive smart mobility solutions.

Helping facilitate this is an existing open-source platform for real-time, transport-related datasets and APIs that help create personalized trips across multiple transportation modes.

Three key strategies and four focal areas have been identified to help Singapore realize its intelligent-transportation vision.

- / The first strategy involves implementing innovative and sustainable smart-mobility solutions for diverse travelers, and using intelligent data analytics to facilitate better travel planning and transport management.
- / The second strategy entails sharing accurate transport data, as well as the development and adoption of intelligent transportation system (ITS) standards to ensure overall system efficacy.
- / The third strategy seeks to establish partnerships and collaborations between public and private sectors, and heighten awareness of ITS in the industry and with the public.

Anchored on four key focal areas, namely informative, interactive, assistive and green mobility, the 'Smart Mobility 2030' initiative will leverage highly reliable data to provide more intelligent transport-related services and convenience, with advanced features to assist travelers with their daily commute. It will also help to streamline operational processes, and create a more sustainable environment.



**GOVERNMENT AND INDUSTRY NEED TO DO MUCH BETTER AT DETAILING HOW CITIZENS' DATA IS BEING USED TO DELIVER SPECIFIC IMPROVEMENTS. WHEN WE CAN DEMONSTRATE THAT, PEOPLE WILL BECOME MORE WILLING TO SHARE THEIR DATA.**

**ANDREW CARRUTHERS, END MARKET EXECUTIVE DIRECTOR —  
INFRASTRUCTURE AND ENVIRONMENT, ASIA PACIFIC, AECOM**

AECOM's innovation specialist Veronica Siranosian believes such platforms can be a useful engagement tool for cities. Los Angeles, for example, maintains an open-budgeting platform where people can see how the infrastructure budget is being spent and how projects are performing against key metrics.<sup>16</sup> "Just having that information enables people to evaluate, question, and participate in a more-informed way in government," she says. **WL**

#### Data in the driver's seat

Data collection and analysis lie at the heart of almost all forms of innovation in city infrastructure and services. Working with private- and public-sector partners, including private infrastructure owners and operators, city agencies are putting advanced technologies to work to improve their data capabilities. Internet-of-things (IoT) sensors in bridges, roads, traffic lights and railway infrastructure transmit ever-growing volumes of data about performance, erosion and possible maintenance needs. Advanced analytics, increasingly guided by artificial intelligence (AI), help agencies better understand user behavior in transportation and utility consumption.

Citizens understand the connection between data and good public services. Almost one-half

(46%) of survey respondents are happy to share their personal data with city agencies to help them improve city infrastructure or public services. That sentiment is strongest in Mumbai and Riyadh (68% and 56% of respondents, respectively), but is also strong in places such as London (47% agreement), which has several years of experience in using commuter data, including to deliver innovative transport services (see 'London is Open for Data' on page 35).

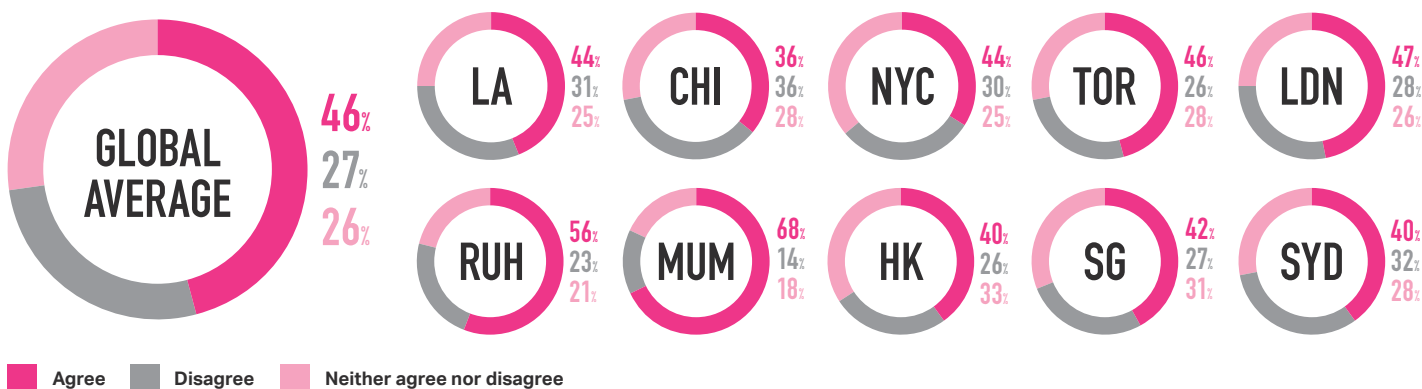
Government open-data platforms are part of the formula to develop better infrastructure and services. Most of the mobile apps and services discussed in this report could not exist without anonymized data being made available through such platforms. But they must be open to individuals as well as businesses.



**PEOPLE ARE LESS MATERIALISTIC. TIME IS THE ASSET THAT THEY REALLY VALUE. YOUNGER GENERATIONS ARE WILLING TO SHARE THEIR DATA IN RETURN FOR GETTING AROUND THE CITY QUICKER. SO, WE NEED TO GET TO A POINT WHERE PASSENGERS KNOW THE OPTIMUM TRAIN TO CATCH, IN TERMS OF COMFORT AND SPEED OF THEIR JOURNEY.**

**STUART HARVEY, MAJOR PROJECTS DIRECTOR,  
TRANSPORT FOR LONDON**

Proportions of citizens who are happy to share personal data with relevant city agencies.



<sup>16</sup> <http://openbudget.lacity.org/#/year/default>





## LONDON IS OPEN FOR DATA

**Transport for London (TfL), the local government body with overall responsibility for underground, bus and rail systems in the U.K. capital, is a serial innovator in public-service delivery. Its most renowned innovations are the Oyster payment card, introduced in 2003, and, later, the use of contactless credit and debit cards to pay for underground, bus and rail travel.<sup>17</sup>**

TfL's open-data initiative, started in 2009, is less celebrated than the Oyster card, but possibly just as impactful. According to accounting firm Deloitte, 42 percent of London commuters use one or more of

600 mobile apps that were built using TfL data. This data was made available to developers in application programming interfaces (APIs) and other types of data feeds. Some of the services originally built using TfL data have gone global, such as Citymapper. Deloitte estimates that TfL's open-data practices generate economic benefits of up to US\$166 million annually for itself, the city and travelers.<sup>18</sup> Among the ways the agency plans to keep that figure growing is to make its API platforms commercially available, and to make its data-sharing expertise available to other organizations in the same way that it has exported its contactless capabilities.<sup>19</sup>

<sup>17</sup> [www.zdnet.com/article/transport-for-londons-pioneering-contactless-and-mobile-device-payments-system-will-be-adopted-in/](http://www.zdnet.com/article/transport-for-londons-pioneering-contactless-and-mobile-device-payments-system-will-be-adopted-in/)

<sup>18</sup> <http://content.tfl.gov.uk/deloitte-report-tfl-open-data.pdf>

<sup>19</sup> [www.silicon.co.uk/projects/public-sector/tfl-licenses-contactless-ticketing-cubic-195028](http://www.silicon.co.uk/projects/public-sector/tfl-licenses-contactless-ticketing-cubic-195028)

## Part Three

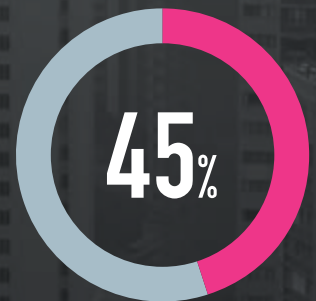
# FUTURE PRIORITIES: MAKE IT GREEN, EFFICIENT, FLEXIBLE AND SAFE

**T**wo priorities stand out for residents of our 10 cities when thinking about future infrastructure: upgrading public transportation and enhancing environmental sustainability. A cleaner environment is paramount in cities where air quality has been notoriously poor, such as Hong Kong, Mumbai and Los Angeles. Almost half of respondents (45% overall, and 64% in Hong Kong) believe other city governments are doing a better job than their own in fostering environmentally sustainable practices. The green improvements wanted by residents include more widespread and affordable use of solar power (and the use of feed-in tariffs), more green spaces, and more waste recycling and wastewater re-use.

When asked to name the technologies that will have a big impact on their future quality of life, survey respondents ranked solar power a close second behind high-speed fiber-optic broadband.

When it comes to transportation, residents of Chicago, Los Angeles and Sydney — where private cars are the main form of local transport — would channel future spending first and foremost toward improving the road network. By contrast, those in New York, Toronto and Hong Kong, where people are more reliant on mass transit, would prioritize spending on improving their underground metro systems.

However, new investment is not the only answer to road and transport network issues, says Andrew Carruthers, End Market Executive Director, Infrastructure and Environment, Asia Pacific, AECOM. He believes that Sydney's transport infrastructure needs a rethink. "We inherited [a transport infrastructure] that focuses on moving people from the outer suburbs into the CBD [central business district] and back. But people are becoming resistant to this, as their commute gets longer and more uncomfortable. We need to move away from this CBD-centric infrastructure toward one that connects several mini cities within the city." ➡



**45 percent** say their city government lags behind those of other cities in implementing or encouraging environmentally sustainable practices.





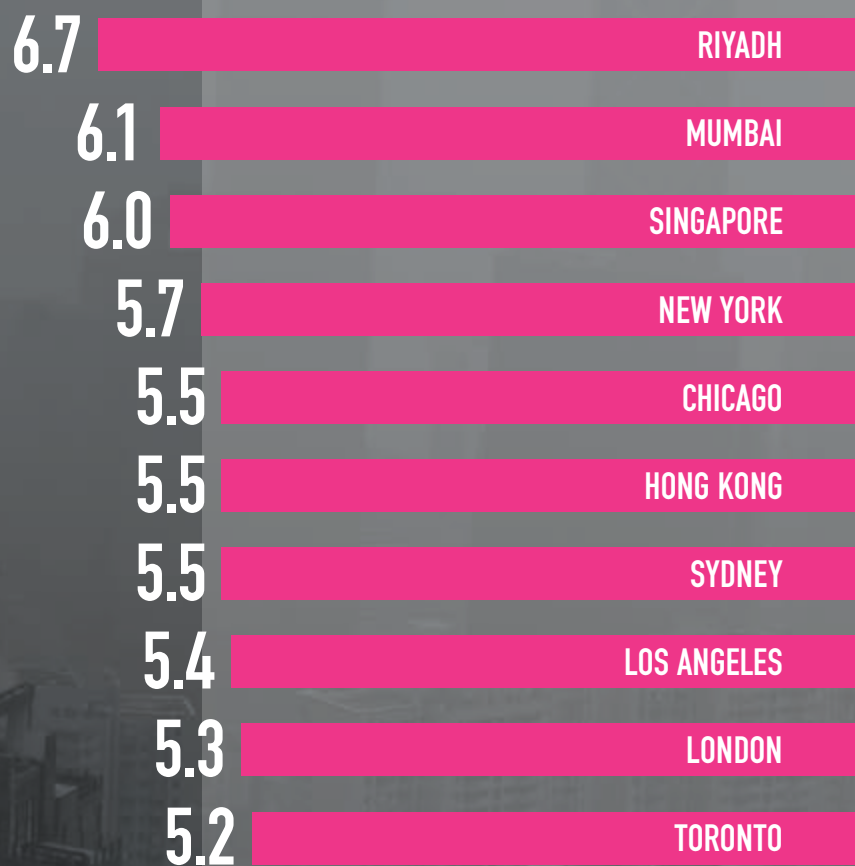
## RESILIENCE

How confident do citizens feel about their city's ability to protect infrastructure from natural disasters, cyberattacks, terrorism and other external hazards?

“

PEOPLE CAN SEE THE RESILIENCY WE'RE BUILDING INTO OUR PHYSICAL INFRASTRUCTURE, SUCH AS SECURITY GATES, FLOOD DOORS AND HEIGHTENED VENTILATION SHAFTS. THEY DON'T SEE THE MEASURES TAKEN TO SECURE OUR METROCARD OR E-ZPASS DATA OR OUR OWN EMAIL SYSTEMS. THAT DOESN'T MEAN THAT WE'RE NOT INVESTING IN IT.

—  
RONNIE HAKIM, MANAGING DIRECTOR,  
METROPOLITAN TRANSPORTATION AUTHORITY,  
NEW YORK CITY



5.7

GLOBAL AVERAGE

**The Infrastructure Satisfaction Index** draws on responses to selected questions from a global online survey of 10,750 people residing in 10 cities: Los Angeles, London, New York, Hong Kong, Riyadh, Sydney, Chicago, Mumbai, Singapore, and Toronto. Scores for satisfaction, engagement, innovation, and resilience are based on a 1–10 scale, with four bands:



**10–7.6**  
Very satisfied



**7.5–5.1**  
Moderately satisfied



**5.0–2.6**  
Not very satisfied



**2.5–1.0**  
Dissatisfied

We asked: in your city, which of these technologies will have the biggest impact on your quality of life, and which the smallest?

#### Fiber-optic broadband

#### Solar power

#### Fast rail connections to airport

#### Smart (digital) electricity meters installed in homes

#### Mobile payment channels

#### Wind power

#### Smart (digital) water meters installed in homes

#### Electric car infrastructure (e.g. battery charging stations)

#### Driverless vehicles

#### Social media payments channels

#### Virtual / augmented reality

Each value is an impact score out of 100, where for example a score of 20 is twice as important as 10.

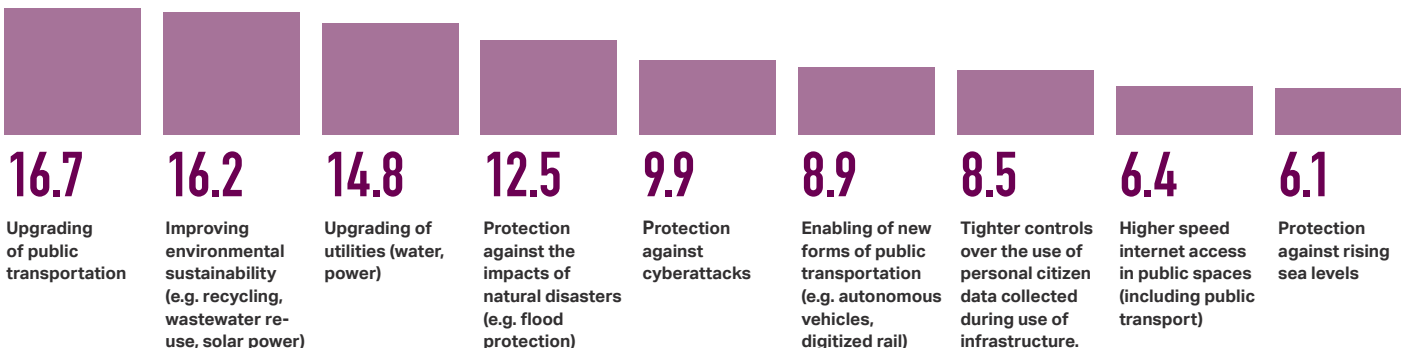
### Planning for the future

Infrastructure planning also needs to become more adaptable, says Carruthers. “Long-term planning was fine when rates of change were relatively slow, but change is much faster now. We must create the ability to build infrastructure for a shorter time horizon and factor adaptability into it.”

For Siranosian, adaptability could mean building multi-use infrastructure that uses data to respond to real-time needs. She cites the example of curbsides that are used for commercial vehicles during the day, but could become small parking spaces or even dining areas in the evening.

Infrastructure adaptability and responsiveness become possible when planners adopt agile practices (a methodology originally developed to guide software development), believes Rob Meikle, Chief Information Officer of the City of Toronto. “We’re using more-agile approaches in concept development and testing,” he explains. “As a result, we are able to get projects done faster in smaller pieces, which also allows us to validate the return on investment and benefits, and then scale accordingly afterwards.” ➔

We asked: in your city, which of the following improvements to infrastructure are the most important to you for the future, and which are the least important?



Each value is an importance score out of 100, where for example a score of 20 is twice as important as 10.



## LOS ANGELES METRO'S 'EXTRAORDINARY' APPROACH TO PLANNING

**Recognizing the limitations of long-term planning in an age of rapid technological change, Los Angeles Metro created an Office of Extraordinary Innovation (OEI). Set up in 2015, the OEI is more than a planning office; it acts as the transportation authority's in-house innovation agency, with a 10-person team whose remit is to incubate and implement innovative ideas for Metro.<sup>20</sup>**

The OEI invites proposals from the private sector to develop technology-based solutions to the city's transportation challenges. A current focus is on projects to develop shared mobility and mobility-on-demand services. It also takes on 'extraordinary'

projects, such as one to develop a gondola that would ferry 5,000 baseball fans an hour to and from Dodger Stadium.<sup>21</sup>

The OEI is among the first ventures of its kind to be set up within the transportation agency of a city in the United States. Larger agencies typically develop projects involving long-term capital investment in major infrastructure such as tunnels and bridges. Few are set up to solicit proposals and develop pilots for smaller projects with the private sector. The OEI could provide a model for other American cities, and beyond, looking to exploit fast-developing transportation technologies and services.

<sup>20</sup> <http://cao.lacity.org/debt/InvConf2016%5C12.pdf>

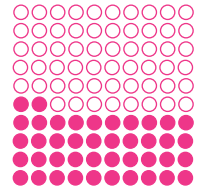
<sup>21</sup> [www.wired.com/story/dodger-gondola-bust-traffic/](http://www.wired.com/story/dodger-gondola-bust-traffic/)



### Resilient infrastructure

Resilience is another critical requirement in urban infrastructure. One facet of resilience is environmental sustainability, which is high on the list of citizens' infrastructure priorities. Better air quality and more green space contribute to perceptions of an improved quality of life, but sound environmental practices can also help cities deal with the damaging effects of climate change. Citizens also expect their city authorities to ensure the protection of infrastructure against more-immediate threats, such as natural disasters (e.g. earthquakes and flooding), terrorist attacks and cyberattacks.

While survey respondents express a moderate degree of satisfaction with the resilience of their city's infrastructure, there is some disquiet when it comes to cybersecurity. Just under one-third of respondents (32%) may have confidence in their city government's ability to protect infrastructure against cyberattacks, but more (36%) do not. [WU](#)



# 42%

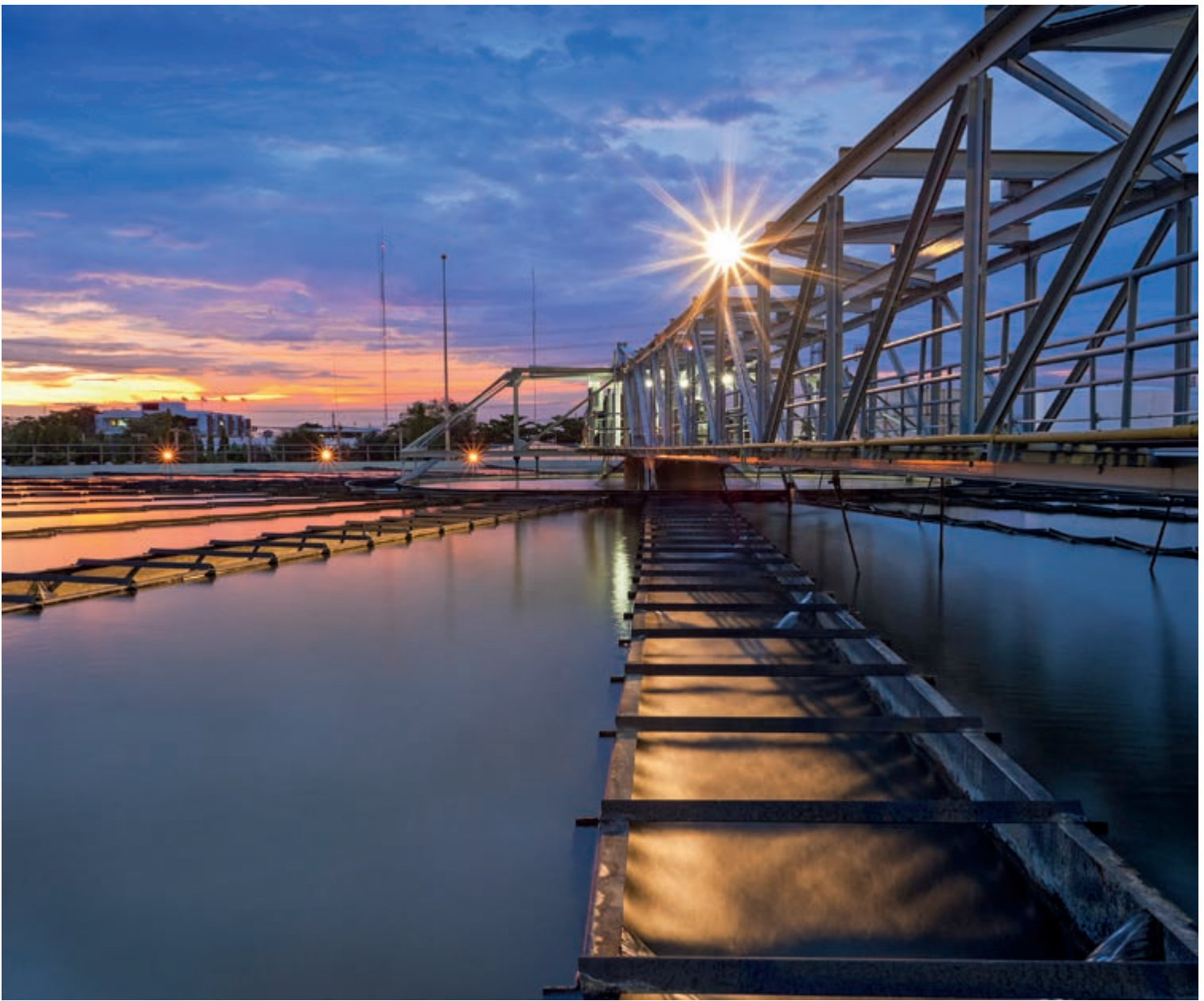
**42 percent** say the amount of open green space in their city has expanded in the past two years.

# “

**IN SINGAPORE, THEY'VE CREATED GREEN SPACES BETWEEN THE TRAFFIC AND PEDESTRIANS: FOUR OR FIVE-FOOT WIDE WITH TROPICAL PLANTS GROWING. IT JUST MAKES THE WHOLE PLACE FEEL THAT MUCH MORE LIVABLE AND COMFORTABLE.**

**SIR JOHN ARMITT, CHAIR OF THE U.K.'S NATIONAL INFRASTRUCTURE COMMISSION**





## HIGH-TECH LEAK PREVENTION IN TORONTO'S WATER SYSTEM

**Like most large cities with aging water infrastructure, Toronto faces challenges in maintaining the integrity of its mains, sewers and treatment plants. This is why Rob Meikle, Toronto's Chief Information Officer, has high hopes for a pilot that the city is conducting with the use of a 'smart ball' to inspect key components of its wastewater and water treatment facilities.**

The device contains sensors that can detect existing leaks and identify degraded sections of pipe that are likely to cause leaks. Rolling through the pipes, the ball collects data that is transmitted directly to surface stations or downloaded after the ball is recovered.

"This allows us to conduct preventive maintenance that will result in big savings of water," says Meikle. He adds that the data gathered is also helping the city to update its drawings of the central water plant. And by applying augmented-reality technology, he says, city water engineers can view realistic simulations of parts of the system to better understand their current state of repair and plan for future maintenance or upgrading. "We see enormous potential for this technology," confirms Meikle.



## Part Four

# CALLS TO ACTION: SIX LESSONS FOR MAJOR INFRASTRUCTURE PROJECTS

## 1/

### BUILD ON CITIZENS' GOODWILL

City authorities should not be surprised at the relatively positive attitudes that residents hold about the state of local infrastructure and services. But poor engagement can quickly change the mood. City officials, infrastructure agencies, utility providers and business stakeholders need to ensure greater strategic engagement to secure and maintain citizens' support during projects, and following completion.

## 2/

### BE PATIENT, CREATIVE AND OPEN

Gaining public acceptance of projects — and sustaining people's interest throughout implementation — involves time and money, but it will be well spent if objections are seen to be addressed. Creative use of digital, as well as traditional, channels of interaction must be the norm. Authorities must be up front with citizens about the costs and the benefits of projects.





# 3/

## BUILD CONFIDENCE THROUGH TRANSPARENCY

Citizens are willing to share their personal data to help bring about improvements in city infrastructure and public services. City agencies not only need to reassure citizens that their data is being handled with care, but they need to show them how their data is contributing to specific improvements. Citizens also need to know more about how their city infrastructure is being made resilient against various types of threats.

# 4/

## LEARN TO SHARE

Aspiring ‘smart’ cities benefit from exchanging data and ideas with companies, application developers and other innovators. City governments should ensure that their open-data platforms contain data of relevance and use that is kept up-to-date and user-friendly for individuals as well as private-sector and other organizations.

# 5/


## TAP INTO THE PUBLIC’S GREEN IMPULSES

Citizens make it clear that sustainability of their urban environment is very important to them. Prioritizing solar power and other green technologies is, of course, important. But individual residents and community groups can also be sources of useful ideas for improvements in areas such as air quality and green space. And with public interest high, creative interaction with residents on green initiatives can also boost engagement levels.

# 6/

## ADAPT TO THRIVE

Long-term planning is not going away, but rapid technology and demographic changes mean that opportunities for improving infrastructure can emerge at any time and be met at speed. Planners who adopt an agile approach can test, design and scale projects at pace — and engage more deeply with citizens. [WL](#)



# AN INFORMED, ENGAGED PUBLIC IS KEY TO MODERNIZING INFRASTRUCTURE

Most of us take for granted the infrastructure systems that make our modern lives possible. We've become accustomed to infrastructure occasionally falling short of what we need. It doesn't have to be like this. AECOM Chairman and CEO **Michael S. Burke** believes a knowledgeable and engaged public can be a key partner in delivering modern infrastructure.

*Specialist consultant Clive Lipshitz contributed to this article.*

**T**oo often, we only notice infrastructure when something goes wrong. Apart from being an inconvenience, congested roads, overcrowded rail services, power outages, flooding, and cyberattacks cost us billions of dollars every year.

There is an urgency in finding new, creative solutions to deliver modern infrastructure systems, but it can only happen with an engaged and supportive public.

A market-based approach to infrastructure investment presupposes an informed and active electorate. Working with the private sector and government, people must have access to data and tools to help them better understand how infrastructure 'works' and is financed. Our cities are too dependent on infrastructure





systems for those most affected by them to just accept things the way they are. This is especially true when service levels are subpar or when urbanization poses new stresses.

What's more, as our *Future of Infrastructure* report findings point out, the public is interested in being more fully engaged.

Providers can best address long-term infrastructure needs by better involving the public in three key ways: knowledge — providing greater transparency, primarily by making infrastructure data widely available; understanding — of infrastructure broadly and of how it is funded and financed, and engagement — encouraging the public to join the discussion through planning, advocacy and politics.

“

THERE IS AN URGENCY IN FINDING NEW, CREATIVE SOLUTIONS TO DELIVER MODERN INFRASTRUCTURE SYSTEMS, BUT IT CAN ONLY HAPPEN WITH AN ENGAGED AND SUPPORTIVE PUBLIC.

MICHAEL S. BURKE, CHAIRMAN AND CEO, AECOM

## PILLAR 1/ KNOWLEDGE: AWARENESS OF THE PROBLEM

As infrastructure data abounds, there is a need to leverage this rich material to improve our networks and systems, to inform public discussion about needs and procurement, and to improve government decision-making and accountability.

Infrastructure agencies should make as much data as possible publicly available so that constituencies including academia, think tanks, and the private sector can convert it into actionable information. Among the areas where access to wider data can make a positive difference:

- / **Quality of life.** Performance reports on critical infrastructure can provide public sector officials, planners, and the public with a reference point for measuring impact. For example, traffic data can be analyzed to quantify the true economic cost of road congestion, possibly supporting the case for investment in new transit or road infrastructure.
- / **Budget clarity.** Governments face growing obligations, such as debt service and pension funding. This means that less capital is available for infrastructure operations and maintenance, which leads to reduced service levels. An informed public needs to know this and understand available solutions.
- / **Project governance and accountability.** Too often, and for numerous reasons, major infrastructure projects come in late and over budget. With meaningful data from previous projects, accountability would be enhanced. Everyone involved in delivering new projects would be able to make realistic assumptions.
- / **Innovation.** Entrepreneurs have developed smart city technologies using data collected from critical infrastructure systems. More data leads to greater innovation. For example, flow rates through water utility mains have been used to develop leak-detection systems, while transmissions from internet-of-things sensors on LED street lights alert cities to outages.
- / **Private investment in public infrastructure.** Investors in large-scale, privately financed developments need sufficient data to calculate the risk and reward inherent in their projects. For example, inferences from interpretation of road and air traffic data encouraged private investors to develop new inter-urban and high-speed rail and Hyperloop systems. Similarly, historical traffic data is a prerequisite of private investment in toll road concessions. ➔



## PILLAR 2/ UNDERSTANDING: HOW INFRASTRUCTURE IS FUNDED AND FINANCED

At the heart of most conversations about infrastructure is a discussion on how best to pay for it.

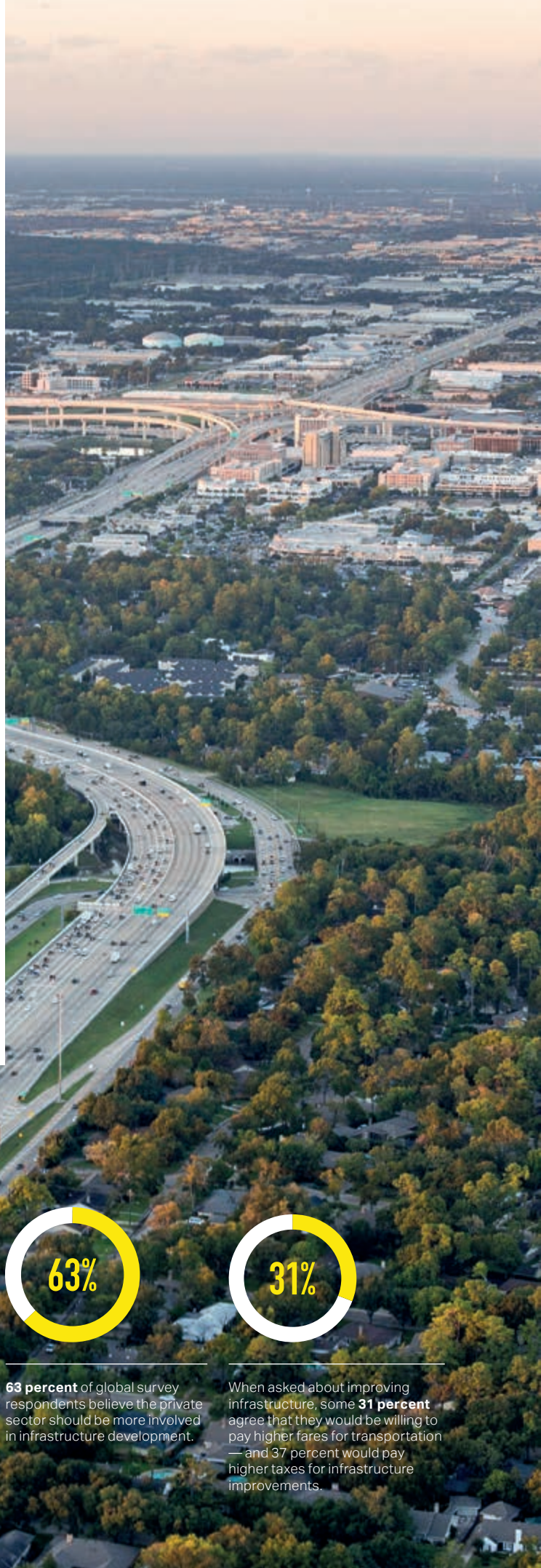
With price tags for major transportation, power, and wastewater projects running into billions of dollars, it is important to understand how infrastructure is funded and financed. Most citizens only confront these questions when they see their utility bills rise or are asked to approve infrastructure funding measures at the polls.

For governments, translating complex funding and financing models for the public can be daunting, but it is a critical step in boosting understanding as new models gain traction. Transparency, in particular, is an important concern. For example, any public-private partnership discussion must include the true implications for lifetime costs and risk-transfer characteristics. That's not an easy conversation.

It is difficult to introduce private financing to infrastructure that does not have a secure source of funding in the form of tolls, tariffs, or other user fees. Sometimes, such as in the case of a seawall, there is no obvious revenue source and innovative financing techniques need to be considered.

Greater understanding about financing options expand the toolbox of potential capital solutions, such as:

- / **Asset recycling**, which uses proceeds from the sale of existing assets to finance new development. This model is understood and implemented in Australia. It is not yet used in the U.S.
- / **Value capture** is another underappreciated and misunderstood financing technique: it leverages the value of property made viable by new infrastructure, such as a subway line extension, to finance that new infrastructure.
- / **Tax increment financing** earmarks incremental property tax revenues to service debt incurred to develop new transit infrastructure.
- / **Better asset management** Municipalities own substantial properties that are often underutilized. With more proactive asset management, cities could extract significant value that can be invested in infrastructure.
- / **The Canadian experience** There is much value in learning from Canada, which has established an infrastructure bank and pioneered direct investment in infrastructure, including greenfield projects, through public pension plans.



**63 percent** of global survey respondents believe the private sector should be more involved in infrastructure development.



When asked about improving infrastructure, some **31 percent** agree that they would be willing to pay higher fares for transportation — and 37 percent would pay higher taxes for infrastructure improvements.



## PILLAR 3/ ENGAGEMENT: POLITICS, PLANNING, AND PUBLIC ADVOCACY

While infrastructure delivery depends heavily on leadership from the public sector, there is an inherent conflict between the interests of those who control infrastructure assets (and public sector finances) and the interests of citizens whose lives are impacted by these assets.

In my view, a long-term perspective is essential in the case of capital-intensive monopolistic assets whose development is often irreversible (the physical location and layout of entire cities is effectively unchangeable once inter-urban and urban highways and local roads are developed).

One way to ease this conflict is through long-term planning by organizations independent of government that include representatives of major stakeholder groups. These municipal planning organizations can take an unbiased perspective, create long-term plans, and educate both the electorate and elected officials. New York's Regional Plan Association is a great example of an informed public advocating for change. A similar body could be established in other large metropolitan areas, and could share best practices, to everyone's benefit.

Another example of knowledge leading to change is in Los Angeles County, which, with more than 10 million people, is by far the most populous county in the U.S. In 2016, after a three-year effort that placed a premium on public education, voters overwhelmingly approved Measure M, a dedicated sales tax that provides up to US\$120 billion for future transit and road infrastructure needs.

An important consideration for long-term planners is the need to be realistic with the time horizon and the public's ability to project into the future. It is inadvisable to make plans based on population trends and — more controversially — environmental models that peer too far into the future. For example, projections of coastal cities being under water 100 years from now are less likely to lead



to action than are calls for coastal protection for the next 20 years.

Cities that meet the needs of their residents and listen to their voices are more likely to thrive than those that do not. This is as true with respect to infrastructure as it is with other urban systems such as public safety, healthcare and education. An informed population can take a long-term perspective, advocate for its infrastructure needs, and is more likely to be supportive of new development.

### And finally

It's time for a truly knowledge-based and interdisciplinary approach to infrastructure.

For too long, governments, financiers, engineers, and policy experts have operated in independent silos, and often without the benefit of an involved and educated public. Effective policy development and implementation requires breaking down these artificial boundaries and bringing everyone to the table to operate from a common base of knowledge, develop integrated plans, and ensure complete accountability. This way, we will make sure that the combination of infrastructure innovation and delivery that leads to positive benefits is everyone's business. **WL**

### About the authors

**Michael S. Burke**, Chairman and Chief Executive Officer of AECOM: Mr. Burke has guided the evolution of AECOM into the world's premier, integrated infrastructure firm. He is chair of U.S. Business Roundtable's Infrastructure Committee and co-chair of the Steering Committee, Infrastructure and Urban Development Industries, World Economic Forum.

**Clive Lipshitz**, Investment Strategist: Mr. Lipshitz has extensive experience within global asset management firms designing, developing, and marketing alternative investment products, particularly infrastructure and real estate strategies. With a strong interest in addressing challenges facing the largest institutional investors, Clive has undertaken and published solutions-oriented research into pension plans at Stanford University and New York University.

# HOW WELL DO YOU KNOW YOUR COMMUNITY?

People around the world say they feel excluded from discussions and decisions around their infrastructure services. They want more involvement in the whole process. According to stakeholder engagement champion **Kelli Bernard**, to shape future networks and systems, and ensure that major infrastructure projects get delivered on time and on budget, it is essential to work in partnership with your local community.



**W**hen it comes to discussions about infrastructure services, communities are feeling left out. According to the latest research in our *Future of Infrastructure* report, almost half the survey respondents of 10 major cities around the world said they had no opportunity to provide feedback to public transport providers on a whole range of issues from planning and pricing to schedules and sustainability. It is not surprising then, that people say that many infrastructure services fail to meet their needs and expectations.

The good news is that a growing proportion of those involved with the planning and provision of infrastructure assets and services want to better engage with their customers. And there are many new tools and forums for improved collaboration.

Genuine stakeholder engagement and management are arguably the most important ingredients for successful project delivery. Time and time again, the long-term success of a project has been positively influenced by a proactive and inclusive approach. And yet, stakeholder engagement has often been regarded as a ‘check-the-box’ activity, with little or no investment or attention paid to it. There have been instances where the community is classified as a risk, and negative attitudes have become a costly obstacle to project delivery. In addition, where the conversation has been handled badly, communities become unresponsive or adversarial due to their perception that project champions are not listening and that their feedback will not be considered.

Thankfully, much has been learned from past mistakes and we are seeing impressive examples of best practices all around the world. One of the keys to success is for infrastructure professionals, public and private, to get closer to their communities, to understand people’s concerns and aspirations, and to transform potential adversaries into advocates and ambassadors.

# 5

## STEPS TO WORKING CLOSER WITH COMMUNITIES

**Drawing on recent experience, here below are our suggestions for improved collaboration and project outcomes.**

### 1/

#### BE GENUINE

Build trust and stakeholder buy-in by seeking input on what can (or will) be considered by the project team. Only ask questions on topics where you want to hear opinions — people will stop engaging if they think you aren’t listening. And be aware that some communities may have bad experiences of engagement that have left them wary. So it’s important to do your community history homework. Every major infrastructure project has detractors, and they may not get the results they desire, but people appreciate truthfulness and will be more apt to consider the project team’s perspective if they have an opportunity to engage in meaningful dialogue. Regularly reporting back what you have heard and how this feedback is helping shape proposals will help keep people on board.

### 2/

#### BE TIMELY

Know your audience and plan carefully for when best to engage them; it may be earlier than you think and should ideally be before major decisions have been reached. It is not about informing the community, but rather consulting and involving them. Decision makers must allow space for stakeholder input to inform the program/development. Policy makers should engage stakeholders before all decisions have been made or plans finalized. Link engagement opportunities directly to project milestones so that input to goal setting, planning direction, technical and financial analysis and decision making is captured to keep the project moving forward. Be willing and prepared to follow up often. And remember that some stakeholders may need more time than others to engage, and will require additional opportunities to provide feedback.

### 3/

#### BE INCLUSIVE

While inclusivity is a requirement in most major infrastructure projects around the world, it’s always worth considering how to extend the possibilities. Go to where your stakeholders are, and speak their language. Engage broadly by providing many different ways to learn about or be involved in the project. Respect people’s time by offering quick and easy ways to participate online, as well as more involved, hands-on meetings. Help people understand the proposals and issues using plain language and engaging visuals.

### 4/

#### BE INNOVATIVE

Grab people’s attention. Share your project’s story in visually interesting ways, and make your collaborations engaging. Cycling and walking tours, pop-up consultations, online interactive surveys and maps, and virtual reality simulations and gaming experiences are great ways to gather insights. And getting the word out does not require the same old humdrum approach — educational and fun videos, infographics, inviting displays, eye-catching notices and original artwork go a long way to enticing a diverse audience to get and stay involved.

### 5/

#### BE COMMITTED

You’re in it for the long haul. Rarely during large infrastructure developments is the need for stakeholder consultation and involvement short lived. Ensure you have a flexible plan and the resources to stay with the project throughout. Regularly measuring the effectiveness of engagement will make it possible to fine-tune your approach and gain the support needed to progress your project. ➡

## CASE STUDIES

## MAKING CONNECTIONS

Helping to improve quality of life, the environment and community connectivity, the new rapid transit system for Waterloo Region in Ontario, Canada, has been an epic undertaking. Called ION, it involves 12 miles (19 kilometers) of track through two urban centers and required upgrading or relocating more than 35 miles (56km) of underground utilities (i.e. storm, sewer and water.) On opening this year (2019) the system will provide invaluable links between important landmarks including a university, hospital, two city halls, a central station and sporting hubs. It also helps provide a framework for new, compact urban development.

Work on this extensive and complex project inevitably had an impact on daily life and community support was crucial to facilitating local understanding of the process and benefits. Our community relations team, working for GrandLinq Contractors, was charged with leading communication, community engagement and issues management for the design and construction. Working alongside GrandLinq and the Region of Waterloo, this project has been incredibly varied, including developing a powerful brand and website to provide the community with updates. There has also been the



production of plenty of easy-to-follow communication materials including construction updates, social media posts and videos to help get the word out. In addition, big milestone moments were celebrated with the community and strong relationships were forged with local elected officials and the media.



**THE BENEFITS ARE TO REMOVE THE INTRUSION OF TRAFFIC AND HELP CONSERVE AND ENHANCE THE HISTORIC SITE WHILE ALSO PROVIDING A POSITIVE LEGACY FOR NEARBY COMMUNITIES.**

While there have been many challenges along the way, it's a mark of success that the local business improvement area (BIA) has praise for the stakeholder engagement approach, particularly in listening to the business community and the provision of timely and transparent information. "Although construction is never easy or without its toll, this team's presence helped our businesses feel heard, understood and engaged," said Patti Brooks, Executive Director (Past), UpTown Waterloo BIA.

## STRONGER TOGETHER

In an ongoing project on Australia's east coast, the New South Wales Environment Protection Authority has advised that the existing beach-face outfall and dunal exfiltration ponds at Merimbula Sewage Treatment Plant are not sustainable. The proposed solution is for a deep ocean outfall and upgrade of the treatment plant. The community has a strong objection to an ocean outfall and does not trust its local council's explanations of how and why an alternative is not possible.

Our engagement team is working with the local Bega Valley Shire Council to address this challenge. The community wants 100 percent irrigation reuse rather than disposing effluent into the environment. A key communication challenge is explaining how and why 100 percent irrigation reuse is not possible. Not only are there land and demand constraints that prevent expansion of reuse, disposal is always needed at any sewage treatment plant. Overcoming misinformation and communicating this complex topic to a large audience has required a comprehensive communication and engagement program. This program includes: in-depth briefing sessions with key stakeholders focusing on their specific concerns; information sessions for community members to have one-on-one conversations with the project team; and print and digital updates.





We also set up a community working group (CWG) of community members who reflect the demographic characteristics of the area. Through a process called ‘deliberative multi-criteria assessment’ — a decision-making process for CWGs to understand the problem, evaluate potential solutions and select a preferred option — the CWG will investigate, assess and analyze proposed options for the plant upgrade and ocean outfall. The CWG’s recommendation will be presented to the council for consideration and be made public — this means the wider community will know the group’s recommendation. This approach is designed to build greater trust and understanding between the council and the community.

Together with the community work, AECOM is developing a concept design and environmental assessment for a deep ocean outfall and upgrade of the sewage treatment plant. The successful delivery of this phase will help to fast track the delivery of the project.

**“**  
**COLLABORATIVE WORKING HAS BEEN FUNDAMENTAL TO THE IDENTIFICATION OF SEVERAL CRITICAL ENVIRONMENTAL SOLUTIONS, WHICH SIGNIFICANTLY REDUCE PROJECT RISK.**  
**”**

## A MONUMENTAL EFFORT

It is rare, indeed, to create new structures within a World Heritage Site (WHS). So, sensitive handling is required for the new twin-bored tunnel proposed past the WHS-listed Neolithic Stonehenge monument in the U.K. The two-mile (3.3-kilometer) underground tunnel is proposed to replace a busy highway that runs close by the monument. The benefits are to remove the intrusion of traffic and help conserve and enhance the historic site while also providing a positive legacy for nearby communities.

The project has a broad range of stakeholders with very different views on the proposed scheme. Our engagement work supported the design process by embracing the views of local landowners and residents, the local authority, statutory stakeholders, heritage and archaeological specialists, road users, and people involved in the local tourist industry. There were two key areas of activity; one involved substantial proactive engagement with directly affected landowners, statutory stakeholders, heritage and environmental interest groups and the local community to help inform ongoing design development.

The second was delivery of statutory consultation and subsequent supplementary consultation to seek formal feedback on proposals prior to their finalization and submission for development consent.

Methods of engagement included establishing a series of working groups to focus on key technical issues (e.g. a Heritage Monitoring Advisory Group was established to provide critical input around design and archaeological surveys and methodologies for the environment and heritage impact assessments). Along with this were weekly multidisciplinary workshops to encourage direct conversation between design engineers, environmental specialists and key stakeholders; creation of a local community forum to provide local residents with a direct link to the project team; one-to-one meetings with directly affected landowners; and officer and councillor briefing sessions. This collaborative working has been fundamental to the identification of several critical environmental solutions, which significantly reduce project risk.


In addition to stakeholder engagement services, AECOM (leading the AECOM Mace WSP Alliance) is providing engineering design, environmental services and procurement support. 

Image courtesy of Highways England



### About the author

**Kelli Bernard**, Executive Vice President, America Cities Program: A champion of high-quality stakeholder engagement, Kelli is responsible for creating strategies and solutions to address our cities’ most challenging problems by leveraging AECOM’s integrated delivery platform with innovative models across various market sectors. Kelli has extensive experience in economic development, land-use planning, housing, redevelopment and public affairs. She also has in-depth knowledge of public/private partnerships, public finance and infrastructure investment.

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# MAKING CITIES RESILIENT

## HOUSTON TAKES A CYBER STRESS TEST

For the first time in the U.S., a major city has undertaken a live twin-disaster-simulation exercise to help forge plans to strengthen the resilience of critical infrastructure. Highlights and learnings from the three-day simulation are recounted here by leading participants from the City of Houston — **Larry Satterwhite, George Buenik, Jack Hanagriff, Mel Bartis and Mike Bell.**





In the Gulf of Mexico, Hurricane Miguel is gathering strength. As it edges ever closer to the coast, this Category 4 storm is stacking up massive devastation for Houston. Predictions are for extensive flooding, tornadoes and storm surges that could reach up to 16 miles (26 kilometers) inland. As it makes landfall at Freeport, winds are recorded up to 155 miles (250km) per hour making emergency response impossible, and then reports come in of a potential cyberattack affecting important medical facilities, then Port Houston. Next come widespread power outages and communication errors for emergency services radio. The situation gains in intensity.

For everyone in Houston and beyond who remembers the terrifying impacts of Hurricane Harvey in 2017, this fictitious scenario of Hurricane Miguel is all too real. But this time, the scenario also includes the additional element of a coordinated cyberattack.

#### **The twin attack**

This fictitious disaster was created as the focus of a real-life exercise involving 135 participants from Houston's critical infrastructure sectors — transportation, energy, public utilities, telecommunications, education, emergency management, healthcare, and the military. Their task was to produce a united

response to the unfolding disaster by working together to find solutions.

Taking place over three days in the Houston Emergency Operations Center, the exercise simulated two simultaneous incidents — a natural disaster and a cyberattack. It examined the challenges those incidents placed on critical infrastructure including assessing response capability, agency collaboration, communications interoperability, and military integration.

Called Jack Voltaic 2.0 (JV2.0), this research project was led by the Army Cyber Institute at West Point in partnership with AECOM as the private-sector lead and the City of Houston. JV2.0 built on the inaugural JV1.0 exercise held in 2016 near New York City. The aim of JV2.0 was to improve preparation for and response to cyberattacks by building partnerships in an innovative, bottom-up approach to infrastructure resilience by enhancing Army research along with local readiness. Primarily, JV2.0 studied the interconnection of critical infrastructure, assessing gaps in cybersecurity capabilities and the impact of physical infrastructure degradation on an interconnected, networked environment (and vice versa). One of the core dilemmas and challenges faced by every community, business and city today is that with increasing network connectivity comes vulnerability. ➔

“

**THIS FICTITIOUS DISASTER WAS CREATED AS THE FOCUS OF A REAL-LIFE EXERCISE INVOLVING 135 PARTICIPANTS FROM HOUSTON'S CRITICAL INFRASTRUCTURE SECTORS — TRANSPORTATION, ENERGY, PUBLIC UTILITIES, TELECOMMUNICATIONS, EDUCATION, EMERGENCY MANAGEMENT, HEALTHCARE, AND THE MILITARY.**



Here, five key participants describe their experiences of how the Houston exercise unfolded, and their key takeaways ...



**LARRY SATTERWHITE**  
ASSISTANT CHIEF,  
HOUSTON POLICE DEPARTMENT



**GEORGE BUENIK**  
DIRECTOR OF PUBLIC SAFETY  
AND HOMELAND SECURITY,  
CITY OF HOUSTON



**JACK HANAGRIFF**  
LAW ENFORCEMENT LIAISON,  
CITY OF HOUSTON



**MEL BARTIS**  
DEPUTY EMERGENCY  
MANAGEMENT COORDINATOR,  
CITY OF HOUSTON



**MIKE BELL**  
CHIEF TECHNOLOGY OFFICER,  
HOUSTON POLICE DEPARTMENT



## EXERCISE ROLES AND OBJECTIVES

“

My daily role with Homeland Security means I am constantly dealing with threats both domestic and foreign where I have to look to the available resources, assess the issues, provide guidance and act. It was similar in this case for the hurricane component of the exercise because we have been through it before, most recently with Hurricane Harvey. However, this time we had the added complexity of the cyberattack. Immediately we were forced to think differently — how do we do this? How do we adjust?

**Larry Satterwhite**

“

I've been involved in major event planning now for 15 years, with everything from hurricanes to hosting the Super Bowl, and one of my objectives here was to understand more about cyber. We carry out a tabletop exercise for hurricane planning every year, but this combined physical and cyber event was something new.

**George Buenik**

“

My job in relation to the exercise was to make the event work; so the role was as coordinator of planning, preparation and execution. We know the city has expertise in handling physical disasters such as hurricanes, but we wanted to look for the gaps in our cyber protection.

**Jack Hanagriff**

“

I was part of the exercise planning team, and my job was to look at our strengths, and our areas for improvement, and to make recommendations. The most important objective for me was to get tangible knowledge to better inform our day-to-day operations.

**Mel Bartis**

“

From my point of view, this was a great opportunity, particularly in identifying any communications gaps. The event was realistic and enjoyable as we learned more through the exercise about the unfolding events and each other.

**Mike Bell**





# EXPECTATIONS AND ANTICIPATION

“

**WE KNOW THE CITY HAS EXPERTISE IN HANDLING PHYSICAL DISASTERS SUCH AS HURRICANES, BUT WE WANTED TO LOOK FOR THE GAPS IN OUR CYBER PROTECTION.**

**JACK HANAGRIFF, LAW ENFORCEMENT LIAISON, CITY OF HOUSTON**

“

We were all there to learn. So the expectation was to keep an open mind and pay attention. You do not want to miss anything, so you are constantly asking whether you know enough and how you can add value. We were amongst colleagues, so while confidence is a healthy thing, you also need to be open. No one can know everything so it is important to surround yourself with subject matter experts in relevant but diverse disciplines and solicit their input when time allows.

**Larry Satterwhite**

“

The exercise exceeded expectations in the way it was so realistic. The story started to unfold when we learned about the hurricane approaching. It was two days out and right away we were focused — we knew what we had to start doing.

**George Buenik**

“

Our city is good at handling the physical side of disasters, but cyber is a whole other issue. The expectation here was to build collaboration and involve all the city sectors from energy and water suppliers to emergency services and the military. In these types of major events, everyone shares the same pain points.

**Jack Hanagriff**

“

My expectations were that we would be able to bring together a large number of people from a wide range of sectors and address all of our objectives. Thankfully, we achieved exactly that. In addition, it was impressive to see how robust some sector cybersecurity planning is. People really are leaning forward and developing good strategies.

**Mel Bartis**

“

We have very good and longstanding relationships with many of the participants, but it was extremely helpful to build new contacts in areas such as the university and energy providers. In terms of anticipation there was certainly some adrenalin flowing. →

**Mike Bell**

“

**IMMEDIATELY WE WERE FORCED TO THINK DIFFERENTLY — HOW DO WE DO THIS?**

**LARRY SATTERWHITE, ASSISTANT CHIEF, HOUSTON POLICE DEPARTMENT**





# BREAKTHROUGH MOMENTS

“

Houston is an incredibly resilient city. We have been through many large-scale events so the big moment for me was when we realized a cyberattack had started in the middle of a natural disaster. We had a nefarious agent acting behind the scenes, the water supply was affected, it was creating fear in the public. That forced me to start rethinking. Preparations are never going to be exact, but we must use our imagination to anticipate future challenges then exercise in a manner to best prepare. While we will certainly face threats never accounted for, the act of planning and exercise enhances significantly our ability to successfully mitigate those threats and protect the public.

**Larry Satterwhite**

“

This exercise really opened my eyes. We are used to dealing with things like power outages during hurricanes, but now I know to think broader about the potential causes. In the future, we'll always question whether there is a cyber component in there.

**George Buenik**

“

In a military attack, the plan is to knock out communications, then the command center, followed by water and energy. With a cyberattack, those same things may happen, but cyber is silent and you don't see it happen. The breakthrough for me is that to beat this hidden enemy, all the agencies need to talk more and share knowledge.

**Jack Hanagriff**

“

Highpoints for me were to get exposure to the many different technologies and tools that people are using. I also learned a lot about military capabilities in relation to cyber. They were impressive.

**Mel Bartis**

“

There were several lightbulb moments for me. One in particular was when the university campus messaging system was compromised. That was the moment when the exercise switched into a public safety scenario. If you lose control of public messaging there is a significant escalation in the magnitude of your challenges. If you lose social media, that exacerbates all the problems.

**Mike Bell**

“

**IF YOU LOSE CONTROL OF PUBLIC MESSAGING THERE IS A SIGNIFICANT ESCALATION IN THE MAGNITUDE OF YOUR CHALLENGES.**

**MIKE BELL, CHIEF TECHNOLOGY OFFICER, HOUSTON POLICE DEPARTMENT**







“

IT'S GOOD TO SEE THAT BETTER RELATIONSHIPS ARE BEING DEVELOPED, BUT WE CAN ALL IMPROVE, PARTICULARLY WHEN IT COMES TO INCLUDING CYBER IN CONTINUITY PLANNING.

MEL BARTIS, DEPUTY EMERGENCY MANAGEMENT COORDINATOR, CITY OF HOUSTON

## POWERFUL OUTCOMES

“

We are always battling silos and trying to break down barriers to communication and process and planning. We still have a long way to go. We work hard and well with our regular stakeholders, and among the greatest outcomes of this exercise were the relationships we built that day in that room. We are always getting better at understanding each other and knowing how to work together. When we collaborate we can overcome a lot of hurdles.

**Larry Satterwhite**

“

We work well with our county, federal and state partners, but here we also opened up to thinking about who else we could collaborate with. In times of need you don't want to be starting with introductions, so it's all about building and maintaining relationships now.

**George Buenik**

“

It takes time to build confidence and trust, but at a time when we are all so reliant on our partners, we need to be talking more.

**Jack Hanagriff**

“

Very often, resilience plans are segmented within organizations and there is a disconnect between IT departments and the emergency managers. It's good to see that better relationships are being developed, but we can all improve, particularly when it comes to including cyber in continuity planning.

**Mel Bartis**

“

When it comes to success in resilience planning, it's all about collaboration and relationships.

**Mike Bell**

## SIX STEPS TOWARDS IMPROVING INFRASTRUCTURE RESILIENCE

While it's not possible to predict or avoid all hazards or threats, they can be managed. AECOM has developed a strong framework and approach to reduce the risk and impact of an event and speed the recovery, which dramatically reduces the cost in terms of physical, social and economic loss. National preparedness and infrastructure protection enable government at all levels, the private sector, and non-governmental organizations to work together to prepare for, prevent, respond to, recover from, and mitigate the effects of incidents regardless of cause, size, location, or complexity. In building a plan, we suggest six steps towards improving infrastructure resiliency:

1

**Act now**

Integrate security into design

2

**Think broad**

Plan for the physical and digital

3

**Team up**

Collaborate across the organization

4

**Prioritize**

Identify critical infrastructure assets

5

**Assess**

Adapt and be ready

6

**Take action**

Start now! **WL**

By **John Esquivel**, Director, National Preparedness & Infrastructure Protection, AECOM

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# OLMSTED DAM

## AND MAKING MODERN AMERICA

Aerial view of the works site: when initially assembled, the Olmsted Dam project's two-story 'super gantry' was the highest capacity gantry crane in the world.

Vital to the nation's economy for generations, the Ohio River has been the focus of epic feats of engineering and construction to ensure that this great waterway remains open for business. The latest upgrades have been delivered ahead of time and below budget by using innovative ways of working explain Lean specialist **Sue Ann Averitte**, productivity manager **Brad Bell** and project director **Kevin McLaughlin**.

**T**he village of Olmsted in southernmost Illinois is a modest kind of place. While it is home to only some 300 souls, it has secured a substantial entry in the history books.

Olmsted gives its name to the locks and dam which, thanks to a triumph of modern engineering and construction, have recently opened to replace the antiquated locks and dams 52 and 53 upstream of the project site. The necessity for this recent work was without question. The dilapidated old structures caused a significant bottleneck to the nation's shipping industry, resulting in countless hours of delays. About 6,500 vessels move 90 million tons (81.6 million metric tons) of cargo a year through this area, including vital supplies of limestone, coal, corn and soybeans for the domestic and export markets. The traffic makes this stretch of the lower Ohio River the busiest inland waterway in the United States.

The estimated US\$3 billion program cost is considered one of the nation's most expensive, making the project one of the largest civil works ever undertaken by the U.S. Army Corps of Engineers (USACE). However, thanks to an innovative project approach and an efficient funding stream, the project advanced four years ahead of what was initially expected to be a 2022 completion. It also came in US\$194 million under the 2012 cost estimate for the dam. The project is estimated to pay for itself within five years in terms of the economic benefits it delivers to the nation.

### The opening chapter

Olmsted first achieved renown almost a century ago, two months before the Wall Street Crash. It was Tuesday, August 27, 1929 when President Herbert Hoover joined an illustrious

## US\$640M

Olmsted will provide much-needed reliability and an average annual economic benefit of approximately US\$640 million per year.

party taking a cruise on the Ohio River. The occasion was to celebrate the opening of the Olmsted Dam and Lock 53, situated some 962 miles downstream from Pittsburgh. It marked the completion of the US\$125 million improvement and canalization of the entire river. The president's speech was prophetic, "While I am proud to be the president who witnesses the apparent completion of its improvement, I have the belief that some day new inventions and new pressures of population will require its further development."

Fast forward 89 years to 2018, and once again on a late-August day, a senior politician, this time Senate Majority Leader Mitch McConnell, took to the podium at the Olmsted locks and dam. "We're celebrating that now, as then, we are a great nation that can undertake great works and write new chapters of our history together. Once fully operational, Olmsted will provide much-needed reliability and an average annual economic benefit of approximately US\$640 million per year." And he underlined the project's importance, "It will be the lynchpin of our country's incredible inland waterways system."

This latest event marked the completion of the new Olmsted locks and dam. It was a long journey, some 30 years in the making and requiring more than 45 million labor hours. This chapter began when Ronald Reagan was president and Senator McConnell was serving his first term in Congress, when the Olmsted renewal scheme was first authorized with the passage of the Water Resources Development Act of 1988, which allocated US\$775 million for the project.

### Latest scope and innovative build

To help make the river fit for the 21st century, the latest project was to replace the deteriorating locks and dams 52 and 53 from 1929 with two much larger 1,200-foot locks (approximately 366 meters) and a 2,500-foot (762m) gated dam across the river. Without the upgrade, the USACE estimated the annual loss of trade to be at least US\$640 million.

The twin-lock chambers were completed using a traditional dry cofferdam approach, deploying a temporary wall to hold back the water. Following this, an AECOM-led joint venture constructed the dam for the USACE using an innovative 'in-the-wet' method to minimize impacts on the commercial towing industry and the environment.

This 'in-the-wet' approach involved creating massive precast concrete elements or shells — weighing up to 5,000 tons (4,500 tons metric) each, and measuring 100 feet wide by 100 feet long and 30 feet tall (approximately 30.5m by 30.5m, and 9.1m). The shells were transported on land to the river and placed on location using specialist equipment proposed by AECOM, including a Super Gantry Crane, a Hydraulic Skidway System, and a Catamaran Crane Barge. Once set on the prepared foundation in up to 40-feet deep (approximately 12.2m) moving river, tremie concrete was pumped into the annulus area under the precast shells to form a continuous bond between the pipe piles, rebar, and the surface shell.

The project encountered numerous challenges — from delays in receiving funding, rising material costs, changes to the design, and unpredictable river conditions. Work fell behind schedule and ran over the initial authorized cost of US\$775 million approved by Congress. ➡





**DURING THE PAST COUPLE OF DECADES, LEAN USE HAS BECOME MORE POPULAR IN THE CONSTRUCTION INDUSTRY. FIRMS ARE SEEING IMPROVEMENTS IN EFFICIENCY WHICH OFTEN RESULTS IN DELIVERING AHEAD OF SCHEDULE AND UNDER BUDGET.**

**SUE ANN AVERITTE, CORPORATE VICE PRESIDENT, GLOBAL QUALITY, AECOM**

It became clear midway through the project that action was required to bring the project back on track. USACE initiated preparation of a post-authorization change report (PACR) and AECOM proposed to implement a process improvement approach called Lean to execute the work.

### **Making Olmsted Dam a Lean project**

Adapted from the car manufacturing industry, the Lean approach is rooted in a team-culture designed to optimize efficiency and eliminate waste.

Using this process at Olmsted in conjunction with USACE's ability to provide an optimal funding stream resulted in achieving the dam's operational milestone in 2018, four years ahead of schedule and approximately US\$194 million under the 2012 PACR cost estimate for the dam. Illustrating the benefits of the Lean method, the average award fee score for the fee periods after Lean was deployed increased by 8 percent.<sup>1</sup>

During the past couple of decades, the use of the Lean method has become far more popular in the construction industry due to its advantages; firms adopting the Lean method are seeing improvements in efficiency, which often result in delivering ahead of schedule and under budget.

At Olmsted Dam, the Lean approach was rolled out after training in 2011. The key to Lean's success is in getting all team members involved with the project collaborating and contributing to planning and delivery, creating a roadmap to achieve the project's operational goals of productivity, safety and quality. It is a cultural shift. Essentially, the people who do the work help plan the work and are therefore more committed to delivery. Improved sequencing and the early identification and resolution of potential problems are just two of the significant benefits.

### **About the authors**

**Sue Ann Averitte**, Corporate Vice President, Global Quality: Sue Ann's focus is on further advancing AECOM's quality systems and the adoption of lean design and construction principles. Under her leadership, the firm is instilling a culture where employees strive for excellence and embrace continuous improvement. She is a Certified Six Sigma Master Black Belt and an ASQ Certified Manager of Quality / Organizational Excellence.

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**Brad Bell**, Senior Construction Engineer, AECOM: With his particular skill in improving productivity, Bradley has worked on a wide variety of construction projects as project engineer, lead scheduler, cost engineer, field engineer, office engineer, quality control inspector, and CAD operator. His firm fixed price or cost reimbursable projects have included hydroelectric power plants, light rail, roads and bridges, and locks and dams for various customers.

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**Kevin McLaughlin**, Executive Project Director, Vice President, AECOM: Kevin's work on major infrastructure construction projects includes dams, highways, and hydroelectric plants. His extensive experience in project execution includes project management, construction management, design oversight, constructability reviews, contracts management, construction engineering, construction, safety, quality, coordination with agencies and local jurisdictions. The projects he has worked on have been technically challenging and require significant coordination for successful execution.

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**5**  
**STEPS IN**  
**THE LEAN**  
**PROGRAM**

<sup>1</sup> Award fee score — this is a method of calculating contractor payment. An award fee contract provides an additional profit or fee amount that may be awarded, in whole or in part, based upon periodic evaluations of ongoing contractor performance — <https://corpslakes.erdc.dren.mil/employees/omcontracts/pdfs/section12.pdf>

1/

## PLANNING THE PLAN

This first step addresses long-lead items, looking at the scope to determine which teams will be involved. Major milestones are set, masterplanning takes place and the project's 'promises' are established.

2/

## ALIGNING THE WHOLE

At this stage, members of the team understand each other's scope and pacing, so that the project is as efficient as possible. Superintendents and engineers identify shared work areas and resources; hand-offs are planned; requirements are shared, so that all trades work in conditions suited to their tasks; and an overall phased schedule for the project is created.

3/

## PHASE PLANNING

This step starts with creating a plan that outlines each particular task in clear and simple detail on one page. Drafted collaboratively by project managers, lead members of the crew, engineers, and safety and quality inspectors, this document addresses each aspect of the project. These aspects include the human resources and materials requirements for its successful completion, which is summarized in a comprehensive, yet easy-to-digest, document available as a reference guide for foremen and crew alike.

4/

## KEEPING ON TRACK

A weekly meeting with supervisors and engineers is used to create a visual 3-4 week plan containing major activities and upcoming milestones, along with a highly detailed schedule for the next week's work. Importantly, the schedule for the coming week's work includes daily activities plus measurable goals, and is developed collaboratively by the tradespeople involved. Each day, team leaders, supervisors and superintendents take turns describing ongoing and upcoming work in their areas of operation during their regular meetings. They coordinate material and equipment and synchronize their work with the other trades scheduled for the same area immediately before and after their own teams.

5/

## PLAN-DO-CHECK-ACT

This final component is a cycle of actions and reactions that occurs once a plan, project or task is underway and continues until it is completed according to plan. The team plans what needs to be done next, completes that action, checks that everything is as it should be, and acts if something is not done as planned. The plan-do-check-act sequence helps the team to maintain quality control of the project and facilitates the streamlining of processes as the team incorporates lessons learned into revised plans during the 'act' phase. **WL**

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**THE KEY TO LEAN'S SUCCESS IS IN GETTING ALL TEAM MEMBERS INVOLVED WITH THE PROJECT COLLABORATING AND CONTRIBUTING TO PLANNING AND DELIVERY, CREATING A ROADMAP TO ACHIEVE THE PROJECT'S OPERATIONAL GOALS OF PRODUCTIVITY, SAFETY AND QUALITY.**





# RIGHT HERE, RIGHT NOW

## THE FUTURE IS MOBILITY AS A SERVICE

Less stressful, more reliable and accessible transportation to get us where we need to go? Affordable housing and greater economic and social inclusion across your city? Bigger, greener community spaces? What's not to like? Innovation specialist **Veronica Siranosian** and **Stephen Engblom**, global cities leader, discuss the potential for Mobility as a Service to transform urban spaces, improve citizens' lives and revolutionize the way cities are planned and run.

More recently, they've been joined by fleets of bikes and e-scooters too. This should be great news for travelers. But, as the U.S. 'scooter wars' of 2018 showed, our streets and sidewalks have become something of a battleground as everyone jostles for space.<sup>2,3</sup>

With their services launched in cities almost overnight, initial collaboration between TNCs, bike share, and e-scooter companies and city governments has been sparse to none. In response, city authorities have had to quickly develop policies and legislation to respond to and regulate these new transportation solutions and platforms. One issue is that these services can often add to cities' congestion, pollution and other transportation challenges.<sup>4 5 6</sup> According to a recent study, ride-hailing apps generated an additional 5.7 billion miles of driving, often without passengers, in the most populated cities — an overall increase of 160 percent.<sup>7</sup>

A potential answer to this and cities' other transportation challenges is shared Mobility as a Service (MaaS). This approach brings

Described as the ‘Spotify of transportation’, shared MaaS approaches — which are being pioneered in cities, states and countries across the world — create the potential for consumers to shift from an ownership and/or single provider model of transportation use to paying for travel as a service. If done well, shared MaaS can promote more sustainable decision making: enabling users to compare different transportation modes on costs, emissions and flexibility, and so on; and cities to incentivize, support and encourage travel behaviors that promote the long-term success of their citizens and city.<sup>8 9 10 11</sup>

95%

It has also long been argued that parking in cities is irrevocably linked to issues such as urban sprawl, constrained economic growth and environmental challenges.<sup>13</sup> Today, the average car spends around 95 percent of its time unused, with huge swathes of urban spaces from Beijing to Johannesburg dedicated to supporting these vehicles.<sup>14</sup> <sup>15</sup> Even during peak periods, only 10 percent of the U.S. vehicle fleet is in use.<sup>16</sup>

MaaS, when coupled with high-capacity, fixed-route, public transportation services, could give cities the catalyst they need to deliver substantive reform: increasing the utilization of existing vehicles via share schemes and other incentives, and providing a cost-effective and reliable alternative to car ownership and use. This could open up valuable real estate for redevelopment as mixed-use neighborhoods, which offer affordable housing, flexible workspaces, parks and other shared community spaces.

In addition, by increasing efficiency and optimizing how we use public roads, promoting transportation innovation and developing smart infrastructure, MaaS could help cities radically reduce their carbon footprint and make roads safer in the future.

Finally, for private operators, MaaS is a chance to secure an increased market share in a highly competitive industry, ensure the most efficient utilization of their resources, build improved community relations and benefit from a more collaborative relationship with city and transportation authorities. This includes establishing valuable data-sharing agreements between public and private transportation providers. ➡



<sup>16</sup> Fagnant, D., Kockelman, K. M. (2014). The Travel and Environmental Implications of Shared Autonomous Vehicles using Agent-Based Model Scenarios. Transportation Research Part C, Vol. 40 (2014), pp.1-13.



## How to map a MaaS blueprint

Money is tight and cities can no longer rely on building more roads to ease their transportation challenges. They need to improve the efficiency of their existing infrastructure and do things more innovatively and smarter. To make matters worse, cities are also reliant on transportation planning and modeling approaches, performance indicators and environmental measures that are fast becoming outdated, overtaken by new tech, real-time data and the rapidly changing transportation landscape. Given this uncertainty, it can be tempting for cities to double down on tried-and-tested approaches.

But change is both possible and increasingly necessary. Here, we set out the five key steps we believe that city authorities need to follow to create a MaaS blueprint.

# 1/

## THINK BIG AND PREPARE FOR THE FUTURE

Just like planning for other major public infrastructure projects, cities need to analyze and understand the mobility needs of individual communities. This includes identifying where and when people need to travel, the price they are able to pay, the scope of the city's current mobility approach to get them there, where gaps exist, and whether MaaS is a sustainable business model that could address the city's and citizens' needs.

This exercise will help inform a detailed mobility vision, including possible partners to enable delivery, and a phased plan to get there. As part of this, the city's focus must shift from prioritizing individual trouble spots for urgent funding and action, e.g. a busy junction or train route (spot fixing), to building a seamless, equitable and efficient transportation system that optimizes users' journeys and the city's use of resources as a whole (multi-modal network optimization).

Beyond funding, the biggest challenge is that city authorities will need to futureproof their plans and the policies, procurement guidelines and regulations that support them. Furthermore, consideration will be needed for the wider social, economic, environmental and public-health impacts of the proposed changes — big or small — on communities. For example, is the mobility package affordable and accessible to those who need it most?

To get the full picture, cities need to take a more holistic approach to mobility planning. This includes bringing together from the start not just the usual experts on infrastructure, transportation and planning, but also specialists in data science, cybersecurity, environment, public health and socio-economic issues, as well as the user community. This should help to: mitigate any risks from planned changes ahead of implementation; ensure you deliver a system that works for everyone; and produce shared measures and key performance indicators equipped to flex with the tech and assess whether the system is meeting your objectives and users' needs.

### Tackling the uncertainty

There is a great deal of uncertainty about how MaaS and other emerging technologies will continue to evolve over the coming decades, as well as the effects that customer acceptance, changing business models and shifting demographics and preferences could have. Building on our experience with technology development, travel-demand forecasting and long-range planning, AECOM has developed Mobilities™, a scenario-planning tool. It is designed to help agencies understand these uncertainties and the potential impact of new policies and technologies on the transportation system and other related concerns such as jobs, taxes, fees and vehicle ownership based on possible take up of new technologies.<sup>17</sup>

# “

THE BIGGEST CHALLENGE IS THAT CITY AUTHORITIES WILL NEED TO FUTUREPROOF THEIR PLANS AND POLICIES.

“IN THE YEARS AHEAD, THE  
FIXED PURPOSE OF MANY CITIES’  
SPACES WILL NEED TO BLUR.”

2/

## BE FLEXIBLE, OPEN AND COLLABORATIVE

Public transit should be the core component of every city’s MaaS package. But opening up the door for private companies to come in and bring innovative new ideas is also a crucial step.

Most mobility services are currently rolled out through individual apps and accounts, with Lyft, Uber and other TNCs only now beginning to integrate different modes across their own services. But we believe that cities could push for greater collaboration with private providers, including sharing data to create mutually beneficial partnerships and pilot programs, and leverage innovation and deeper insights into citizens’ mobility needs.

A number of city authorities, including Paris, London, Sydney, Seattle and Oslo, are already working to make their data more ‘interoperable and useable’ for third parties and transit users, by publishing open data sets online.<sup>18</sup>

Collaborations to facilitate MaaS will require cities and their partners to develop more flexible and integrated governance structures and partnership models, ranging from simple data-sharing agreements and common Application Program Interfaces (APIs) to connect disparate systems right up to integrated systems architecture. Cities will also need spaces for innovative ideas to be trialled.<sup>19</sup>

### Collaborate to innovate

Capri is a 19-partner consortium — led by AECOM and including other public, private and research organizations — collaborating to deliver a pilot scheme that could pave the way for the practical use of connected and autonomous vehicles (driverless shuttles) to move people around airports, hospitals, business parks, shopping centers and other contained environments. The team is combining expertise and using practical trials to write the blueprint for a viable autonomous MaaS.<sup>20</sup>

3/

## MAKE AND USE YOUR INFRASTRUCTURE SMARTER

Central to any MaaS framework is ensuring that your integrated transportation solutions will be able to connect and interact with the infrastructure that supports them. For example, fleets of shared electric vehicles require a reliable network of smart charging stations.<sup>21</sup>

Traditionally, cities have been designed and developed in a rigid way — a road is a road, a bus lane is a bus lane, and the sidewalk is the sidewalk. With shared, multi-modal spaces, such as New Road in Brighton, U.K. (where an over-congested road was redesigned to become a pedestrian-dominated space with vehicles), being rare, albeit transformative, examples.<sup>22</sup>

In the years ahead, the fixed purpose of many cities’ spaces will need to blur. In Chicago and San Francisco, for example, demand-responsive pricing for parking is securing valuable revenue for reinvestment in public transit and infrastructure.<sup>23</sup> In the future, ‘flex zones’ could take an even-more-innovative curbside management approach.<sup>24</sup> Instead of having fixed-parking zones or double yellow lines, cities’ curbsides could be designed, cleared and priced to accommodate multiple transportation modes and to optimize use throughout the day — for residents, deliveries, pickups and drop offs, or fleets of shared vehicles to rent. ➡

<sup>17</sup> <http://mobilities.aecom.com/>  
<sup>18</sup> <https://www.itf-oecd.org/sites/default/files/docs/shared-use-city-managing-curb.pdf>

<sup>19</sup> <https://www.webopedia.com/TERM/A/API.html>

<sup>20</sup> <https://caprimobility.com>

<sup>21</sup> <https://www.theguardian.com/business/2017/apr/20/uk-unprepared-for-surge-in-electric-car-use-thinktank-warns>

<sup>22</sup> <http://www.landezine.com/index.php/2011/04/new-road-by-landscape-projects-and-gehl-architects/>

<sup>23</sup> [https://www.aecom.com/without-limits/article/should-i-stay-or-should-i-go/#\\_ftn4](https://www.aecom.com/without-limits/article/should-i-stay-or-should-i-go/#_ftn4)

<sup>24</sup> [https://nacto.org/wp-content/uploads/2017/11/BAU\\_Mod1\\_raster-sm.pdf](https://nacto.org/wp-content/uploads/2017/11/BAU_Mod1_raster-sm.pdf) (p.54)





## 4/

## PROMOTE THE MOST SUSTAINABLE, EFFICIENT, AFFORDABLE AND ACCESSIBLE SOLUTIONS

The revenue sharing deals made with private transportation providers will help determine the pricing structure and payment systems of any city-led MaaS package, and must aim to create a win-win situation for the city, private service providers, and users.

If there is more than one agency collecting revenue, whether it is transit fares, congestion charges, curbside fees or tolls, they will want to allocate the revenue collected as soon as possible. Every organization involved in a MaaS scheme is going to be looking to minimize latency, and ensure they can secure the revenue they are owed quickly and efficiently.

The growing use of universal payment systems, such as Apple Pay, for transit in cities like Beijing, Chicago, Moscow, and London should make revenue sharing easier.<sup>25 26 27 28</sup> In an increasingly cashless society, the public is going to want more innovative payment options. At the same time, transportation organizations will need to ensure their services are still accessible to those without bank cards, smartphones or unlimited-data plans.

The pricing structure of your MaaS package should be designed in line with the city's policy priorities, whether it is to smooth out traffic/transit flow during peak periods, improve air quality and promote environment-friendly options, expand access, increase ridership or ensure solutions are affordable to all. There needs to be a clear incentive for people to change their behaviors to choose the option that is the 'smartest' for them and meet the city's objectives.

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**THERE NEEDS TO BE A CLEAR INCENTIVE FOR PEOPLE TO CHANGE THEIR BEHAVIORS TO CHOOSE THE OPTION THAT IS THE 'SMARTEST' FOR THEM AND MEET THE CITY'S OBJECTIVES.**

# 5/

## DATA IS KING, BUT PEOPLE MATTER MOST

No matter how impressive the technologies or transportation services might be, their acceptance will require a major shift in attitudes and behavior, built around public education, research and engagement.

It's already happening. Fewer young people are driving. By 2030, the stock of cars is set to fall by 29 percent in Europe and 22 percent in the U.S., while rising in China.<sup>29</sup> In addition, mobility services like ride, bike or scooter sharing are getting people used to the idea that you can consume trips and get to where you want to go in the way that you want, when you want. Artificial Intelligence can turbo charge these efforts, accelerating systems' optimization but also quickly enhancing the human experience.

But cultural shifts like this take time, and some will resist it. Car ownership remains a deeply embedded desire, and many still don't consider public transportation or shared mobility a viable option. The MaaS approach must be customer-friendly, intuitive to use and widely available — with a range of access points.


As part of this, it's important to make sure that private providers do not solely focus on the most profitable routes, but help the city provide equitable access to transportation solutions.<sup>30</sup> Technology solutions are an enabler to mobility, but they need to support a broad-based citywide mobility solution or MaaS framework to benefit all customers.

Finally, the system can also be fun to use. A huge part of the popularity of the Waze app is its gamification of GPS services.<sup>31</sup> Drivers earn points based on driving time and the help

they give other drivers. They can listen to Spotify — the music streaming service — as they drive, select different voices for directions and share their mood with others. A similar collective approach could incentivize users to switch to MaaS, offering them points or discounts to opt for more efficient, less busy or less intrusive routes, modes and travel times, as well as information on the impact of their choices on factors such as calories burnt, time/money spent or emissions generated, etc. In addition, users could access a website with real-time updates, customer reviews, FAQs and video content to help them use the system effectively.

### Realizing the vision

Transportation is shifting gear. MaaS gives cities — currently operating with limited budgets and resources — the opportunity to move more of their citizens to and from existing transportation systems more efficiently; provide point-to-point, multi-modal services accessible via a single system; and partner with private companies.

To make this a reality, cities need a clear, strategic vision, more flexible, sustainable and holistic approaches to urban planning, a focus on smart infrastructure and sustainable, efficient and affordable solutions, and greater collaboration and trust with private sector providers. Crucially, they need to show the public that MaaS can work for them, making their city a better place to live, work and visit. 

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BY 2030, THE STOCK OF CARS IS SET TO FALL BY 29 PERCENT IN EUROPE AND 22 PERCENT IN THE U.S., WHILE RISING IN CHINA.

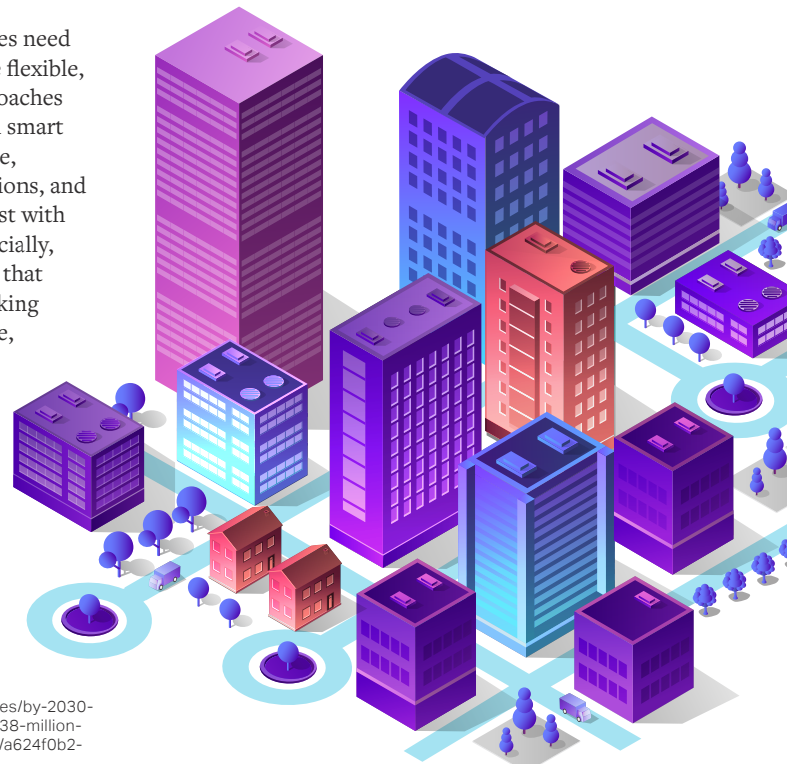
### About the authors

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<sup>25</sup> <https://appleinsider.com/articles/18/03/30/apple-pay-transit-card-integration-goes-live-in-beijing-and-shanghai>

<sup>26</sup> <https://www.transitchicago.com/popular-ventra-transit-app-now-accepts-apple-pay/>

<sup>27</sup> <https://www.mos.ru/en/news/item/32730073/>

<sup>28</sup> <https://tfl.gov.uk/fares/how-to-pay-and-where-to-buy-tickets-and-oyster/pay-as-you-go/contactless-and-mobile-pay-as-you-go>

<sup>29</sup> <https://press.pwc.com/News-releases/by-2030-the-transport-sector-will-require-138-million-fewer-cars-in-europe-and-the-us/s/a624f0b2-453d-45a0-9615-f4995aaaa6cb>

<sup>30</sup> <https://www.theatlantic.com/business/archive/2015/05/stranded-how-americas-failing-public-transportation-increases-inequality/393419/>

<sup>31</sup> <https://www.waze.com>



# ALL CHANGE?

## INFRASTRUCTURE'S NEXT-GENERATION WORKFORCE

How will infrastructure's workforce transform the industry and deliver the networks and services of the future? Human resources leader **Mary Finch** explores the potential for change and we hear from young professionals around the world about their hopes and aspirations for a growing focus on social purpose, flexibility, diversity and the use of emerging technologies as the norm.



**B**y 2025, Millennials — individuals born between 1980 and 1996 — will comprise three-quarters of the global workforce, while young professionals from Generation Z — those born from 1997 onwards — are just entering the workplace.<sup>1</sup> Identified as the 'great disruptors,' these first-generation digital natives have the drive to challenge traditional ways of working and build a better world.<sup>2 3 4</sup>

For these young people, change is more than a fact of life, it is an opportunity. Having grown up in a digitally enabled world, with industries transforming rapidly around them, the next-generation workforce admires those companies equipping themselves to compete in the Industry 4.0 era and looks to these organizations to help them succeed.<sup>5</sup>

<sup>1</sup> [www.ey.com/Publication/vwLUAssets/EY-global-generations-a-global-study-on-work-life-challenges-across-generations/\\$FILE/EY-global-generations-a-global-study-on-work-life-challenges-across-generations.pdf](http://www.ey.com/Publication/vwLUAssets/EY-global-generations-a-global-study-on-work-life-challenges-across-generations/$FILE/EY-global-generations-a-global-study-on-work-life-challenges-across-generations.pdf)

<sup>2</sup> [www.gallup.com/workplace/235814/trends-disrupt-workplace-forever.aspx](http://www.gallup.com/workplace/235814/trends-disrupt-workplace-forever.aspx)

<sup>3</sup> [hbr.org/2017/08/a-survey-of-19-countries-shows-how-generations-x-y-and-z-are-and-arent-different](http://hbr.org/2017/08/a-survey-of-19-countries-shows-how-generations-x-y-and-z-are-and-arent-different)

<sup>4</sup> <http://infrastructure.aecom.com/infrastructure-skills>

<sup>5</sup> [www2.deloitte.com/global/en/pages/about-deloitte/articles/millennialsurvey.html](http://www2.deloitte.com/global/en/pages/about-deloitte/articles/millennialsurvey.html)

<sup>6</sup> [fortune.com/2015/07/23/humans-are-underrated/](http://fortune.com/2015/07/23/humans-are-underrated/)

<sup>7</sup> [www2.deloitte.com/global/en/pages/about-deloitte/articles/millennialsurvey.html](http://www2.deloitte.com/global/en/pages/about-deloitte/articles/millennialsurvey.html)

<sup>8</sup> [www.catalyst.org/knowledge/revealing-real-millennials](http://www.catalyst.org/knowledge/revealing-real-millennials)



In turn, with technological innovation outpacing human development, organizations, including those in the infrastructure sector, must find new ways to assess the evolving set of competencies needed to thrive in the new workplace. This is not just about identifying someone's technical ability to do the job they have now well, but also their willingness to learn those skills required for the jobs of the future that do not yet exist.

In addition, the increasing automation of routine tasks does not necessarily mean fewer jobs. People will still matter, and the very human skills of critical analysis, strategic thinking, communication and empathy will become even more valuable as new and different kinds of problem-solving roles emerge.<sup>6</sup>

As an industry, we need to adapt to this digital mindshift and, for young professionals, valuing diversity is

an essential part of that. They see diversity as a core component for any forward-thinking organization, defining the concept more broadly to encompass: tolerance, inclusiveness and belonging; respect and acknowledgment of individuals; and different ideas and ways of thinking.<sup>7</sup>

Of course not everything in the years ahead will be different. For example, financial stability and a secure job will still matter. But, as members of the next-generation workforce become leaders, change is coming.<sup>8</sup>

To find out what the shifting landscape means for future infrastructure, we spoke to young professionals about why they chose to work in this field, their plans for the future and how they believe the sector needs to change to deliver faster, smarter and better. ➔



#### **LAN DUONG (LD)**

##### **ASSISTANT PROJECT MANAGER, ABU DHABI**

An ICE-qualified civil engineer, with over three years of experience in designing wet utility networks primarily for urban commercial developments in the U.A.E. and Saudi Arabia.



#### **CHANNING BICKFORD (CB)**

##### **TRANSPORTATION PLANNER, FLORIDA, U.S.**

Urban planner with a focus on environmental and transportation infrastructure, including bicycle/pedestrian planning and transit-oriented development, with a specific interest in Asia and emerging economies.



#### **AVNI JAIN (AJ)**

##### **CIVIL ENGINEER, SYDNEY, AUSTRALIA AND HONG KONG**

A pragmatic idealist, passionate about driving efficiencies in infrastructure development.



#### **ROY YAPP (RY)**

##### **ASSISTANT ENGINEER, TRANSPORTATION, BRISTOL, U.K.**

Transportation technician designing and modeling infrastructure projects for private, local and national government clients, and an 'Apprentice Ambassador' and Science, Technology, Engineering and Mathematics (STEM) advocate.



#### **POOJA MAHAJAN (PM)**

##### **CIVIL ENGINEER, LOS ANGELES, U.S.**

Water infrastructure engineer, specializing in design and modeling, with an interest also in strategic planning, data analytics and storytelling.



#### **JORDAN BUTLER (JB)**

##### **GRADUATE STRUCTURAL ENGINEER, PERTH, WESTERN AUSTRALIA**

The Engineers Australia 2018 Young Professional Engineer of the Year for Western Australia, invested in technical excellence and improving the built environment.



#### **CLARA KLEINE (CK)**

##### **JUNIOR PROJECT ENGINEER, ESSEN, GERMANY**

A georesources manager, who joined the infrastructure industry in 2017, working on environmental permitting and environmental services projects.



#### **ABHISHEK MALHOTRA (AM)**

##### **TECHNICAL DIRECTOR, DESIGN PLANNING AND ECONOMICS, GURUGRAM, INDIA**

Having 15 years of professional experience delivering infrastructure — including some mega-urban development projects — to provide better, safer and more liveable city environments.



## WHAT INSPIRED YOU TO WORK IN INFRASTRUCTURE?

**LD** I wanted to study a multidisciplinary subject and build a career with a strong sense of duty and purpose — infrastructure felt that way even when I was young. It captured my imagination as one of the hallmarks of an advanced civilization, like the Roman aqueducts (or Wakanda's vibranium trains).

**AM** Fascinated by machines since childhood, I got the opportunity to study architecture and specialized in urban planning. Multifaceted urban development programs are complex overlays of urban planning, urban design, sustainability, transportation and infrastructure, and inspired me to pursue this profession.

**PM** Infrastructure has a direct impact on economic growth and progress. Growing up in India, one particular aspect that caught my attention was the deficiency of water infrastructure in rural areas and how it impacted people's lives. Access to clean water is a basic human right and the infrastructure industry is instrumental in delivering clean water.

**JB** I wanted to: help create a world more valuable to humanity than the resources we use to build it; connect people; and improve the environment, so that people can achieve more than ever before.



## HOW HAS YOUR TRAINING EQUIPPED YOU TO WORK IN INFRASTRUCTURE?

**AJ** I majored in civil engineering (with a business minor) at the Hong Kong University of Science and Technology, with internships in infrastructure advisory and hydraulic design, and ended up in urban development after graduation.<sup>9,10</sup> Since then, I've been fortunate to be involved in design, contracts and tenders as well as supervised work onsite for a one-mile (1.5-kilometers) long elevated park. That's what I like about my work — it's so interdisciplinary. You can go anywhere.

**RY** I opted out of the more traditional route of going to university and decided to try the apprenticeship route. After securing a Level 3 BTEC diploma and EngTech accreditation, I'm studying for a BEng in Civil and Environmental Engineering.<sup>11</sup> On completion, I will be eligible to apply to become an Incorporated Engineer. I will have a degree, a recognized professional qualification and the bonus of seven years of experience.

**CK** I did a masters degree in GeoResearch Management. It combined environmental law with engineering and technical skills, such as ground and groundwater investigations. I write permit applications and provide environmental advice and support, managing communications between clients and authorities, so it was kind of perfect. I'm still learning a lot, but that is normal for a first job.

**AM** I am an architect and urban planner by training, and have strengthened my skill set on complicated urban development projects. Architectural training enables you to understand the scale of space around you and develop reasoning for any space based on its requirements. Urban planning focuses on the physical and social infrastructure components needed to help a city function for its citizens. To me, this combination of architecture and planning equips professionals to deliver for the present and prepare for the future.

## HOW WOULD YOU LIKE YOUR CAREER TO DEVELOP IN THE YEARS AHEAD?

**CB** Right now, I spend a lot of my time drafting reports, doing research, making maps and graphics, and giving presentations. Eventually, I would like to be a senior manager with more of an international focus. As part of a fellowship, I toured the Hong Kong-Zhuhai-Macau Bridge and I really want to be part of such exciting and complicated projects.

**AJ** I'm currently on secondment from Hong Kong, working on civil infrastructure projects in Sydney. I'm still learning the skills of the trade (I suppose you always are). But, down the line, I would like to lead large-scale, critical infrastructure projects. I would like to carve out my own career trajectory while having enough learning and development opportunities.

**JB** I want to develop to be the most proficient structural engineer I can be. I am open to wherever that takes me.

**CK** For me, the next step is to be a project manager, with more responsibility and input in the work I do. The more senior your role, the less directly involved you can be in projects. And, although progressing higher in a company is something I can imagine in the future, it's still early days.



**GROWING UP IN INDIA, ONE PARTICULAR ASPECT THAT CAUGHT MY ATTENTION WAS THE DEFICIENCY OF WATER INFRASTRUCTURE IN RURAL AREAS AND HOW IT IMPACTED PEOPLE'S LIVES.**

**POOJA MAHAJAN, CIVIL ENGINEER, LOS ANGELES, U.S.**

<sup>9</sup> [http://www.ce.ust.hk/programs/4yug\\_civil.html](http://www.ce.ust.hk/programs/4yug_civil.html)

<sup>10</sup> <https://www.ust.hk/>

<sup>11</sup> <https://www.engc.org.uk/professional-registration/the-professional-titles/engineering-technician/>



## WHAT ARE THE ISSUES THAT MATTER TO YOU WHEN YOU'RE CHOOSING A COMPANY TO WORK FOR?

**LD** I look at the organization's commitment to training and development. I am even willing to consider a lower salary if the training and development on offer is of a high enough standard. I also look for companies with a strong identity, clear goals and plans for growth that their people understand and can realize.

**RY** Do they offer you the freedom to use your creativity and innovation? Do they give you room to grow, a place where you can actually excel? Do you share the same culture, vision and values as they do? Is it a company where managers are mentors, with a focus on work-life balance? It is about making a difference.

**PM** As a young engineer, I want to work in a company that offers diverse experience and opportunities beyond my job description/responsibilities, such as working with a different business group, leading employee engagement activities or volunteering to create social impact. A focus on driving innovation also matters, because innovation stimulates creativity and boosts productivity.

**JB** What matters most is pride in my work and the projects I do. It is important to me not just to take work for the sake of income, but to do excellent work that will reflect the very best of what we can deliver. ➔



## HOW DO YOU THINK THE INDUSTRY WILL EVOLVE IN THE COMING FIVE, THEN 10 YEARS?

**AJ** Recently, I asked a senior professional what had changed over their career and they said, “In a nutshell, not much.” For them, our industry’s evolution has been very slow. But, in the future, infrastructure will need a different DNA — to support electric and autonomous vehicles, prefabricated houses, etc. And it makes sense for everyone in the industry to upskill themselves digitally. Secondly, we will probably continue to see consolidation and integration across the industry and value chain.



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**IN THE FUTURE, INFRASTRUCTURE WILL NEED A DIFFERENT DNA — TO SUPPORT ELECTRIC AND AUTONOMOUS VEHICLES, PREFABRICATED HOUSES, ETC.**

**AVNI JAIN, CIVIL ENGINEER,  
SYDNEY, AUSTRALIA**

**CB** It’s totally dependent on young professionals like us. Early adopters will thrive and be leaders. How we build, maintain, use, interact with and pay for infrastructure will be different. Our solutions will incorporate more technology and computer-based modeling. Construction will be safer, faster and use more-durable materials. A lot of maintenance and inspection will be digitized, and more infrastructure will be funded privately or through public-private partnerships.

**LD** The industry will undergo major digitization. Millennials and Generation Z are tech savvy and we readily jump on digital trends — we expect our organizations to do the same. As our generation advances to positions of responsibility in the industry, we will push for our workflows to embrace the latest technologies.

**AM** I see the industry growing at an exponential rate. India is set to have 69 cities with populations of over one million citizens by 2025. The government is building new infrastructure and modernizing existing infrastructure to meet the demands of this new India. Aiming for 7–8 percent growth, its immediate focus is transportation (i.e. new airports, upgraded ports, high-speed rail, etc.), alongside a commitment to build 100 smart cities.

## WHAT ARE THE BIG CHANGES THAT YOU WOULD LIKE TO SEE HAPPEN IN THE INDUSTRY?

**RY** The infrastructure sector is being increasingly challenged to improve its environmental footprint. The mentality of dismantling, excavating and disposing of materials needlessly has to change. We need to design for the project’s whole life cycle. I would also like to see a greater respect for engineers. The term engineer gets thrown around effortlessly. But, I think that being an engineer should be as prestigious a profession as being a doctor, lawyer and accountant.

**PM** I hope to see: a focus on leadership development and mentorship for young engineers; having an impact-driven, multi-disciplinary approach toward projects; and increased collaboration with effective communication to build dynamic teams that work seamlessly on projects.

**CK** I would like to see more green energy and clean industry, and that includes reducing the amount of paper involved in environmental permit applications! It’s one of the big questions of our time. I would also like the infrastructure industry to bring countries closer together. On a daily basis, we are working with people from other countries. We are global right now. We depend on each other. But I feel like people are afraid, and do not feel part of this. I hope people get to see more of the connections between us and lose their fear.

**CB** I would like there to be more diversity in the industry. By leaving some people out of the conversation, we are missing other perspectives and innovative ideas. An organization that attracts a diversity of voices will be stronger in the future. I would also like to see the industry be more proactive with new technologies. Too often, tech companies drive change and other industries react and incorporate. Instead of modifying roadways to accommodate driverless technology, how can we design both systems to interact in a mutually beneficial way, enhancing safety, comfort and environmental protection?

### About the author

**Mary Finch**, Executive Vice President and Chief Human Resources Officer: Aligned to her strengths and experience in driving business transformation, Finch’s focus is establishing a culture aligned to AECOM’s strategy of creating the world’s first fully integrated infrastructure company. Through partnership with the executive leadership team, Finch established a renewed set of core values, leadership behaviors and attributes to inform and direct the company’s ways of working and an overall talent strategy.

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# THE VIEW FROM THE PROFESSIONS

**ALESHA PRINTZ**  
FIEAUST ENGEEXEC CPENG NER

**GENERAL MANAGER,  
VICTORIA DIVISION,  
ENGINEERS AUSTRALIA <sup>12</sup>**

The younger generation are tech savvy, adaptable, creative and have grown up in a faster paced, digitally connected world. They won't be limited by the practices of the past, but will complement the knowledge held by the older generation and exemplify the value of diversity.

Young professionals' career paths will be fast paced and exciting, but different. They will be more mobile. The corporate ladder will look more like a jungle gym with sideways, and dare I say backwards, moves to progress upward. Young professionals will need to take greater ownership of their own professional and career development. But the breadth of their experience will be huge and enable them to quickly advance their careers.

As an industry, we need to market ourselves to better engage the best and brightest students. We need to sell the positive impact a career in infrastructure can have on people's lives and communities. We also need to promote engineering and STEM professions as a great career choice for girls. And we need to work harder to retain women in the profession. Finally, we need to raise the status and profile of engineers, ensuring more parents and teachers encourage kids to consider engineering.

**JESSE GORMLEY**  
P.E., ENV SP

**CHAIR OF THE COMMITTEE ON  
YOUNGER MEMBERS, AMERICAN  
SOCIETY OF CIVIL ENGINEERS <sup>13</sup>**

Many of today's young professionals grew up with the internet as practically another parent — able to access any information, to learn anything, at the push a button. Pair this with the workforce becoming increasingly social and you can see how approaches like integrated project delivery stand to hugely impact infrastructure in a good way.

Alongside this, on average, the next generation has greater concern regarding sustainability, resiliency, diversity, and social/cultural equity than previous generations. Project-delivery mechanisms, construction techniques, materials, material sourcing, and many other aspects of the infrastructure industry will all see holistic shifts, moving emphasis away from cost as the bottom line.

They are also being driven to greater specialization, while simultaneously being asked to understand the dynamics of the larger infrastructure system. Those able to collaborate well across disciplines will be more likely to succeed.

In response, the infrastructure industry needs to embrace change, including quicker implementation of emerging technologies, as well as allowing more-flexible schedules and locations. By enabling young professionals to integrate work into their life better, organizations will yield a more dedicated and ultimately more innovative workforce. Programming, too, needs to become a key piece of our (and most fields') curriculum.

**STEVE FEELEY**

**DIRECTOR OF MEMBERSHIP  
RECRUITMENT, INSTITUTION  
OF CIVIL ENGINEERS**

As highly creative, inquisitive, scientific problem solvers driven by a desire to make a difference, young infrastructure professionals today have much in common with previous generations. The significant difference is the skills they will need to thrive in the Fourth Industrial Revolution.

Educated and raised in an era of huge technological change, these young professionals see smart technology and internet connectivity as part of the fabric of daily life and expect these tools to be readily available to use in all aspects of their role. The information they need to help them do their jobs is also only a click away. This gives rise to a different set of challenges, requiring knowledge, judgment, curation, interpretation and assimilation to process effectively.

In addition, the ever-increasing multi-disciplinary nature of infrastructure delivery, combined with digital, means that infrastructure teams will become more diverse, making collaboration, communication, team-working and leadership even more critical.

We're already seeing a new generation of engineers keen to bring their technological understanding into traditional engineering disciplines where, perhaps, it is not yet the norm — with apprentice and graduate digital champions sharing innovation and digital best practice. This generation will be at the forefront in delivering the smart infrastructure revolution that is happening now. **WL**

<sup>12</sup> [www.engineersaustralia.org.au/About-Us/Divisions/Victoria#VictoriaStaff](http://www.engineersaustralia.org.au/About-Us/Divisions/Victoria#VictoriaStaff)

<sup>13</sup> [www.asce.org](http://www.asce.org)



## ABOUT THE RESEARCH

The analysis in this report draws on the results of a global online survey of 10,750 people residing in 10 cities: Los Angeles (1,121 respondents), London (1,118), New York (1,128), Hong Kong (1,031), Riyadh (980), Sydney (1,096), Chicago (1,014), Mumbai (1,088), Singapore (1,109), and Toronto (1,065). Respondents were not compensated for their participation and AECOM was not identified as the research sponsor.

The survey was conducted in September and October 2018 on behalf of AECOM by Longitude, a Financial Times company.

Quotas were set to ensure an even split of male and female respondents in each city. In the global sample, 48 percent of respondents were between the ages of 18 and 34, 42 percent between 35 and 64, and the remaining balance were 65 or older.

The Infrastructure Satisfaction Index draws on responses to selected questions from the survey. Scores for each of the four pillars, which are satisfaction, engagement, innovation and resilience, and the Index overall are on a 1–10 scale, with four bands: 1.0–2.5 — ‘dissatisfied’; 2.6–5.0 — ‘not very satisfied’; 5.1–7.5 — ‘moderately satisfied’; and 7.6–10 — ‘very satisfied.’

This report was produced by AECOM's Strategic Marketing Team.

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### Disclaimer

AECOM would like to thank all clients, partners and project teams for their help in producing this publication. Every effort has been made to ensure accuracy, give credits and trace copyright holders where appropriate. If any have been inadvertently overlooked, the necessary arrangements will be made at the first opportunity to amend the publication.

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### Articles:

#### **Making cities resilient: Houston takes a cyber stress test**

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#### **How well do you know your community?**

With thanks to AECOM's global stakeholder engagement team and, for the case studies, Tom Parrish, Ian Newiss, Avril Fiskien, and Sonia Doohan.

#### **Right here, right now: the future is Mobility as a Service**

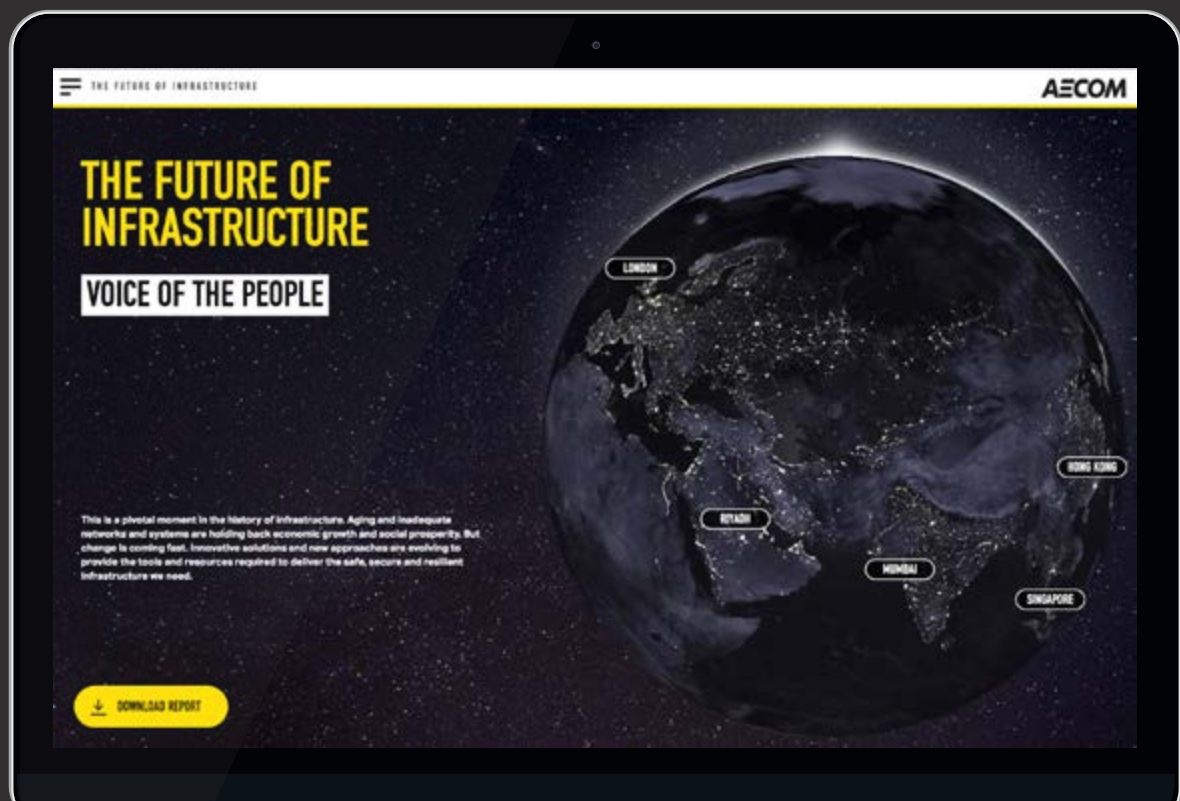
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# THE FUTURE OF INFRASTRUCTURE

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