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#InfraTech is here

#InfraTech

Foreword

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There has never been a more exciting — and more terrifying — time to be working in the infrastructure sector. Indeed, if your heart does not race at the very thought of the technological disruption we now face, it may be time to retire. It's certainly time to change your perspective.

Never before has technology offered so much opportunity for the sector. New innovations are creating massive opportunities and new efficiencies, both in the development and the operation of assets. Citizens are interacting with their infrastructure in new and amazing ways, driving an immense wave of engagement and utilization. New models are rapidly emerging and, as they do, are creating new opportunities to change the way we pay for and optimize our existing assets. Don't even get us started about the mind-boggling new technologies that are being invented and commercialized in unexpected places around the world.

However, there is also great uncertainty. Expectations are rapidly changing and nobody knows what services and assets users will truly want in the future. The new models that are emerging could easily undercut and disrupt our tried-and-true approaches to delivery, driving up the risk of asset obsolescence and wasted investment. In many cases, developing markets are now overtaking the markets once considered 'mature' and, in doing so, are changing the global status quo. Uncertainty and disruption are rife.

The problem is that as a sector, we have not been terribly good at keeping pace with technological change. We build assets with the expectation that they will last decades. We regulate them on the same basis. We work with fixed technology sets and base our assumptions on historical precedent. We deal in bricks and mortar, not data and disruption. We eschew the unknown in favor of proven approaches.

No more. We need to change our perspectives and our approach quickly if we hope to continue to deliver on the needs of our citizens. We need to start to assess, adapt and embrace the opportunities and risks that technology brings. We need to be the catalysts of change rather than the purveyors of tradition.

#InfraTech has arrived and we're tackling some of the big questions now facing governments, infrastructure owners, investors, developers and operators as we move into this era of unprecedented change and uncertainty. We have also focused on bringing together a wide range of views in hopes of inspiring you, our readers, to think differently about ways we embrace technological change and the ways we deliver on our objectives.

On behalf of KPMG's global network of infrastructure professionals, we would like to thank all those leaders and visionaries who contributed to this vitally important issue. We hope that this magazine excites and inspires you. Moreover, we hope it catalyzes new ways of thinking and a new sense of urgency amongst infrastructure participants.

To explore any of the themes identified in this publication — or to discuss your own unique infrastructure challenges — we encourage you to contact your local KPMG member firm or any of the authors who contributed to this magazine. ■

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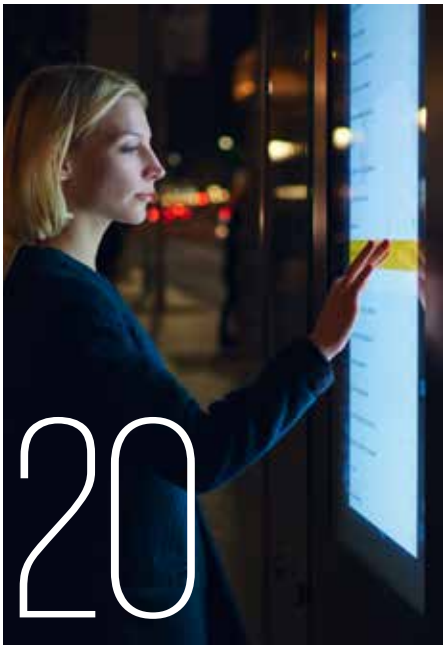
#InfraTech is here



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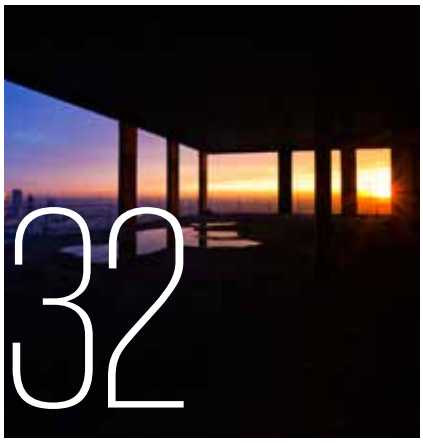
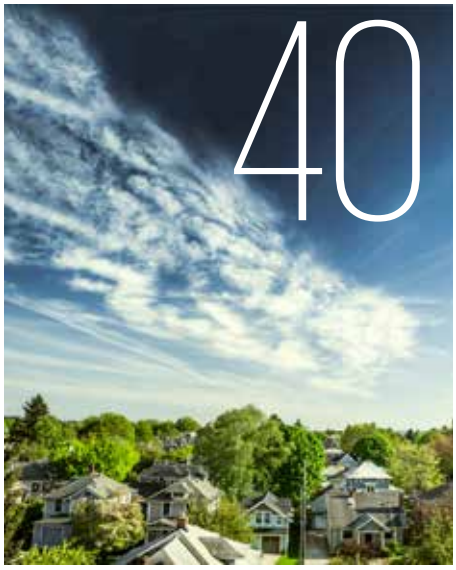




Other news

Getting the most from technology

Valuable technologies are emerging at an amazing rate. We should be making better use of them.

New technology is everywhere. It is in the hands of consumers and in the labs of massive corporations. It is in the air and under the ground. It is not a single idea or innovation but, rather, a universal theme that impacts everyone, everywhere.

As this publication illustrates clearly, technology can mean very different things to different people. For some, it elicits images of futuristic moonshots — entirely new modes of transportation, and disruptive business models — that often feel more like science fiction than achievable realities. For others, technology is all about the here and now — real and tangible innovations that, in unexpected ways, change the way we view the world around us.

While it is certainly tempting to focus on the big disruptive ideas, we believe that significant value could be achieved by thinking more practically about the smaller ones that could be applied today to create real and sustainable value for people around the world.

How, for example, could we be leveraging the internet and artificial intelligence (AI) to improve the way we deliver quality education to students around the world? Could we be using solar-powered drones to bring water to remote villages in Africa and Asia? Could we be using mobility data to improve the way we plan and develop new transit assets?

We believe that we can. Yet, in many cases, we seem to be stuck in our old ways of thinking and old models of delivery. In part, this is because of the economic models we have created to support and sustain our current infrastructure. Investors, be they public or private, expect a certain rate of return from the assets they have already developed.

However, it is also due to a failure of imagination and innovation. Why else would we continue to develop infrastructure that assumes the technology set will remain static for the next 50 years when we already know that it won't?

We also believe firmly that decision-makers need to start putting much more focus on seeking ways to use existing technologies to solve current challenges. Rather than focusing on the 'next big thing', we should be spending more time expanding our use of what exists today. We should be finding ways to improve efficiency, expand access and remove waste. We should be using the technological advances we have already made to prepare for the future rather than trying to anticipate what technology will bring us tomorrow.

That is not to say that decision-makers should be ignoring the fundamental changes now underway. Quite the opposite; they should be learning from what has already happened over the past decade to build more flexibility and adaptability into their current plans and models.

However, we should also not be staring up into the sky waiting for the next big disruptor. We should be doing more with the technology we already have. ■

“We believe firmly that decision-makers need to start putting much more focus on seeking ways to use existing technologies to solve current challenges.”

Is technology bridging or widening the gap?

> “There is a good chance that technology will actually increase the gap between the rich and the poor, remove jobs and create disparity between nations and sow social discontent.”

If we're not careful, technology could expand the gap between the rich and the poor.

It's easy to paint a rosy picture of the future. As robotics and AI start to take on manual, repetitive and mundane tasks, people will be free to enjoy more leisure time without sacrificing productivity or quality of life. Smarter cities will lead to happier, healthier and safer populations. Automated and electric vehicles will eliminate congestion and pollution. Access to better information will remove cultural divides and create more cohesive societies.

However, there is an equally good chance that technology will actually increase the gap between the rich and the poor, remove jobs and create disparity between nations and more congestion in our networks. Indeed, left unchecked, this is the more likely scenario.

Yes, the automation of labor could conceivably allow every human being to work fewer hours and enjoy more leisure time. However, that assumes that the impacts of automation are evenly distributed and the benefits of automation are shared equally among all stakeholders. The more likely outcome is that laborers will be made redundant while knowledge workers continue to toil at their desks; shareholders will profit while workers lose out.

Automated cars could certainly reduce congestion, but only if automation leads to a reduction in the number of cars on the roads, and the number of vehicle miles traveled, not just the effort of driving. Smarter cities, if placed in the hands of authoritarian governments, could lead to less personal security and privacy, not more. And we are already seeing how increased access to information can build walls between groups rather than remove them.

In much the same way, the adoption and availability of technology could also increase the gap between the developing world and mature markets. However, it could also allow developing markets to leap ahead of the mature markets.

Consider, for example, the rapid adoption of solar generation in Africa, Asia and Latin America versus that in Europe and North America. Or the fact that the vast majority of smart cities are being built in the developing world while cities in the mature markets struggle to smarten up. Lacking legacy infrastructure and onerous or mis-focused regulation , developing markets could reap significant dividends from the advance of technology.

Unfortunately, there are no easy answers. There are no institutions dedicated to ensuring that the benefits of technology are shared equally. In fact, as governments and private companies vie for every competitive advantage and technological edge, the potential for the gap to widen is only growing.

We believe that governments at all levels must start to grapple with the question of equality now. When investing in new technologies, decision-makers will need to consider not only whether their investments make financial and operational sense, but also whether they make sense socially. Governments will need to return to their roots of securing the greatest benefits for the greatest numbers of people and to the modes of the less fortunate.

The alternative is that we allow technology to advance unchecked. And, in doing so, sow the seeds of our own discontent. ■

Managing the risks of distributed models

When all else fails, who will be left holding the bag?

Technological disruption is enabling markets to become more distributed and fragmented which, in turn, has given consumers more choice and, in time, will bring more dynamic pricing. But what happens if (or when) those distributed models fail? Who will be the provider of last resort?

In some sectors, the result may be fairly benign. If the Airbnb system goes down, for example, millions of travelers may be impacted, but there is little chance that lives will be lost or that property will be destroyed. However, in other scenarios, the impact could be much more dire.

As the risks rise, what role should government play in ensuring that basic services are maintained and secure? And at what price?

The reality is that regardless of how the services are provided, governments have an obligation to ensure their citizens have access to basic services. Private sector providers can be encouraged to augment government services and this can certainly lead to better pricing and improved services. However, government still needs to ensure that the services remain available, even if the private markets fail. It cannot escape that imperative.

Consider, for example, national energy markets. Over the past few years, we have seen a significant shift toward renewable energy generation (wind and solar power in particular) and, as the technologies mature, prices have fallen; in some cases lower than that of coal or nuclear. However, that does not mean that we can stop building or maintaining these larger and more stable forms of power generation, even if the cost for the base load/residual supply seems uneconomic.

A similar scenario could be painted for national healthcare systems. All signs suggest that technology could soon start to play a significant role in the provision of elder and social care. But what happens if a failure or a cyber-attack renders those systems inoperable. Should the government maintain a base load/residual supply capability that could immediately step in? Is that a reasonable expectation?

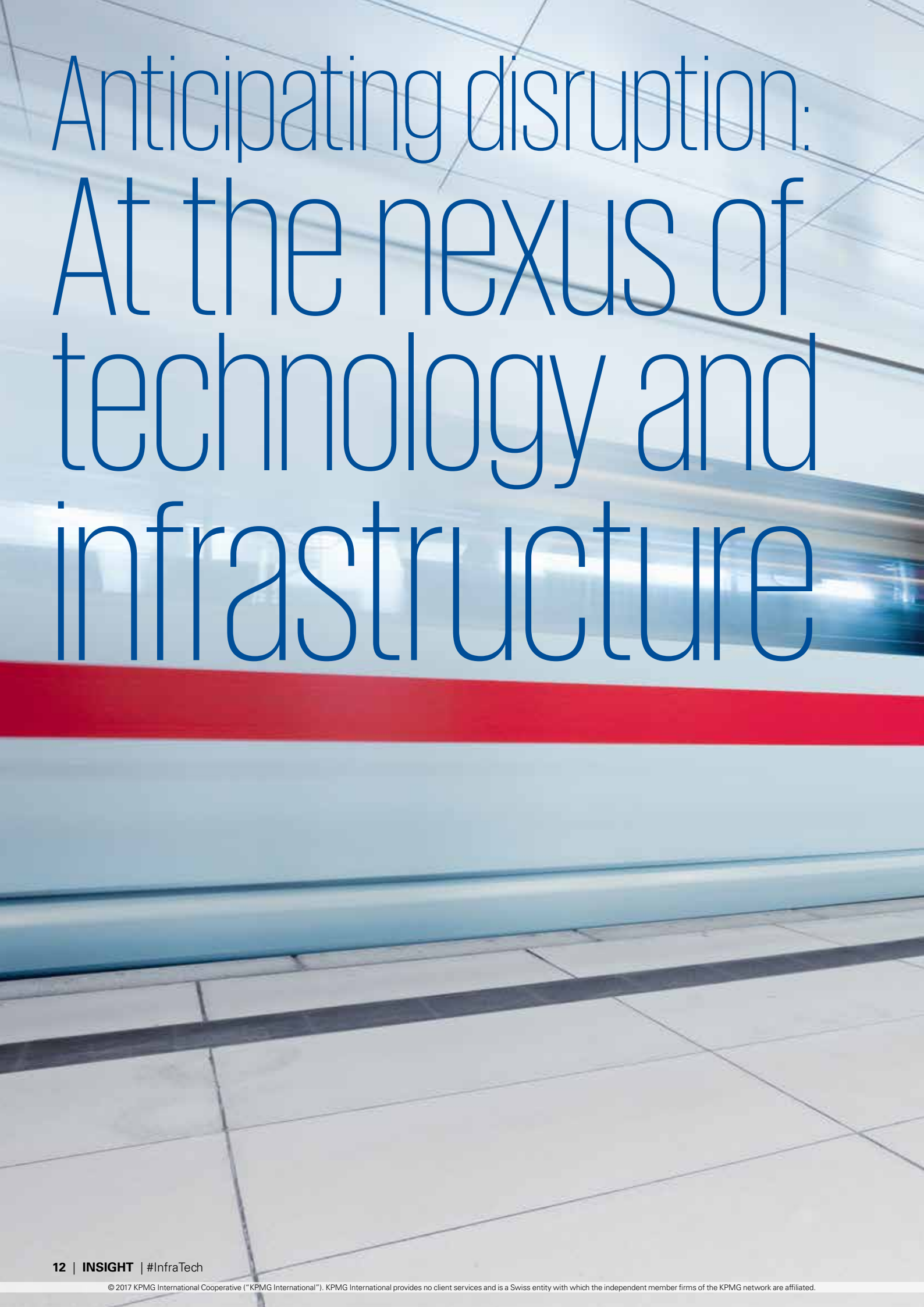
Ultimately, it comes down to who the provider of last resort is. And, if it is the government (which it invariable is), should they be taking that risk?

In this context, we suspect governments will need to continue to invest into large, potentially uneconomic assets, such as nuclear power plants and hospital systems, until viable and secure alternatives can be developed.

The bottom line is that, for the time being at least, the advance of technology and the development of distributed models will not necessarily mean that government can absolve itself of responsibility or investment. When all else fails, they will be the ones left holding the bag. ■

> “Government still needs to ensure that services remain available, even if the private markets fail.”

Anticipating disruption: At the nexus of technology and infrastructure



Dr. Rick Geddes
Professor, Department of Policy Analysis and Management at Cornell University

Darran Anderson
Director of Strategy and Innovation at the Texas Department of Transportation

Shashi Verma
Chief Technology Officer at Transport for London

Jim Hall
Director of the Environmental Change Institute at Oxford University

The pace of technological change is increasing. However, not all infrastructure sectors are being disrupted in the same way. And that is creating significant uncertainty for owners, operators and investors.

*So, to help separate hype from reality, we sat down with leading infrastructure experts — **Dr. Jim Hall**, Director of the Environmental Change Institute at Oxford University; **Dr. Rick Geddes**, Professor, Department of Policy Analysis and Management at Cornell University; **Darran Anderson**, Director of Strategy and Innovation at the Texas Department of Transportation; and **Shashi Verma**, Chief Technology Officer at Transport for London — to find out how they think technology will influence the world of infrastructure. You may be surprised at where they are placing their bets.*

ED: In which infrastructure sectors do you expect to see the greatest technological disruption?

Jim Hall(JH): I would argue that the most remarkable changes over the past few years have been in the energy sector. We're already seeing price structures in renewables — offshore wind and solar in particular — become price-competitive with fossil fuels and that represents a massive change in technology and economics. And, obviously, transport is on the cusp of significant disruption with the introduction of electric vehicles and driverless cars. But I also think that changes on the demand side are potentially disruptive, again most notably in energy and transport. The introduction of 5G telecoms services has been slower than anticipated, largely because demand simply isn't there yet.

Rick Geddes(RG): Clearly, there is lots of innovation happening in the transportation sector. All of the big automakers are engaged in intense competition to develop and deliver greater levels of autonomy and safety in their vehicles. And there are lots of new technologies being tested and developed — such as vehicle-to-vehicle (V2V) communication and vehicle — infrastructure integration — that could accentuate the impact of these innovations. But technological disruption doesn't always require big system change. There's also a lot of innovation happening at the material level — new concretes and road surfaces, new bridge technologies, new coatings for water and sewage pipes, for example — that are also having a significant impact on the way we plan and deliver infrastructure.

Darran Anderson(DA): I think Rick is absolutely right. Technology can change the way people think about living and working; it can influence the way people interact on a daily basis. Transportation is definitely in an era of potentially revolutionary change in our future mobility options. But I also look at it as a 'system of systems', where we can use transportation technology as one part to help improve the quality of life for our citizens, such as greater access for those with disabilities, or significant accident reductions. Right now, I'm focused on the technologies that form the backbone of all this — WiFi, 5G, DSRC, Internet of Things and analytics systems, for example, and their security and privacy needs.

Shashi Verma(SV): I would agree. And I would add that, more often than not, it's the more mundane technological advances that have the greatest influence. Consider, for example, how the introduction of pneumatically controlled doors changed the efficiency of trains. Rather than needing eight employees to operate a six-car train, you suddenly needed just two — a driver and a guard. Modern computer-controlled signaling has allowed us to put many more trains through a tunnel than ever before. And the introduction of smart ticketing technologies, such as the Oyster Card in London, has not only had a huge influence on revenue, it's also taken steps out of the customer journey which, in turn, increases our capacity.

Ed: How can infrastructure and government leaders prepare for disruption?

DA: We need to recognize that we aren't going to compete with industry in developing these technologies. What we can do, however, is prepare to enable it. So, one of our larger focus areas is around improving the way we share and use data. We need to think about how we can improve our data sets, reinforce security and drive increased integration to support not only the cars themselves, but also the auto manufacturers, traffic management systems and fleet operators, for example.

RG: I would extend that idea out to the existing hard infrastructure, too. It might be little things, like repainting the lines on the road so that autonomous cars can read them, filling in potholes and making sure that road signs are large and clear. At the same time, government will need to take the lead in the regulatory side of all of this. The big question is how you strike that balance between promoting innovation on one hand and ensuring public safety and trust on the other.

JH: I think a lot of the decisions will come down to what government wants to achieve. If the local drivers are around air quality, then you're probably going to see more rapid change in the electric vehicle and clean energy markets. If the main drivers are around affordability, you'll probably see more focus on encouraging technologies that reduce the cost of service delivery and lead to greater overall affordability. The first step, therefore, is to understand the drivers at play in your market.

SV: I would argue that we need to separate hype from reality. There's lots of talk about revolutionary technology but some will take much longer to materialize … if they ever do. Certainly, there's lots of work and investment going into entirely new modes that, like Hyperloop, will require a very big mental leap forward to achieve.

Autonomous cars, on the other hand, follow some very well-understood fundamental principles that basically adapt our existing infrastructure to make the new technology feasible.

Ed: Will technology allow less developed nations to 'leap frog' the centuries of investments made in the mature markets?

DA: I believe we are already seeing that happen. In the developed markets, we're often limited by what we can do with our existing infrastructure and we are confined by our traditional view of how infrastructure operates. And that may be hampering the speed at which we create and adopt new technologies and solutions. I think many developing markets also enjoy a much more streamlined delivery process, where clear government directives can help remove roadblocks and drive adoption, versus the mature markets where you often need to navigate many levels of government to reach a viable delivery solution.

RG: I would agree with Darran. I suspect that, in a number of key areas, the mature markets will start to fall behind the developing world. In part, it comes down to the challenges Darran noted: getting different levels of government to work together around a common solution. At the same time, some of these markets may also enjoy significant advantages over places like the US. If you're building a hyperloop, for example, you'll probably want long, straight shots across level terrain. And you will want lots of sunshine to power the solar cells. You're more likely to find that in the Middle East than you are in the US North East.

SV: I have no doubt that new cities can overcome some of the big concerns that may be slowing technology adoption in the more mature cities. But I also worry that the model of development that is being followed in many of the 'new cities' largely ignores the lessons that were learned in the mature markets. At the end of the day, it's not the new technology that drives markets, but rather the economic viability of that technology. It's one thing to talk about implementing new technologies at scale, but making the economics of that activity work is another thing altogether.

JH: When you balance the potential for economic growth against the lack of required infrastructure, it seems clear that the developing markets offer the greatest opportunity for disruption and technological advancement. But, at the same time, new technologies often bring with them new interdependencies, new regulations and new markets, which creates a massive governance challenge. The big question is whether these markets can overcome those challenges to reap the rewards of the new technologies that are available to them.

Ed: If you had 100,000 bitcoins to invest into one technology today, where would you put your digital money?

RG: That's a tough one. If you are looking for low-risk returns, you may want to steer away from those technologies that have already become ultra-competitive. It's difficult to know which company will win in the end. So, my bet would probably be on things that help enable that future; developments in concrete, sensors and asphalt, for example. It may not be the headline grabbing stuff, but it's all absolutely central to enabling whatever technologies may win out in the future.

JH: If I look at the technologies that are attracting the most finance at Oxford these days, I'd probably put my bitcoins into machine learning and 3D printing. But the under-recognized outsider that I'd love to see receiving more attention is the trend toward a circular economy, which is creating some fantastically innovative approaches to what would otherwise be rather staid areas like waste, sewage and water.

SV: If I had to bet on a single technology area, it would probably be driverless cars. But I also think there's a lot of hype in the market and that delivering on the promise of full automation may be more difficult than anyone is letting on. If I could put the 100,000 bitcoins towards something socially productive, however, I'd probably want to invest it into ideas that encourage and support driverless cars, technologies that help manage congestion and models that re-envision the current economics of transportation.

DA: Like Rick and Jim, my focus would be on the technologies that underpin some of the big trends we are talking about. And, from my perspective, the biggest requirement for future technology adoption is going to be trust, which, in turn, will require much better approaches to cyber security and the protection of data. So, if I'm playing with house money, I'd probably put my investment into novel solutions like quantum computing or blockchain that may enable trust and deliver greater confidence to users. I might also think demand for battery solutions will continue to grow for mobility and utility systems, as more countries seek less oil dependency and greener options. ■

The triumph of consumer choice

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Technology has put the consumer in the driver's seat. And that is having a massive influence on the way we use, plan and invest in infrastructure. Are you ready to respond to shifting consumer demand?

> If we ignore the data and signals consumers are sharing, we run the risk of investing into the wrong assets at the wrong time.

The impact of technology on consumers is undeniable. New devices, new interfaces, new relationships and new data are all giving consumers unprecedented control over their decision-making.

Consider, for example, how way-finding apps (such as the popular Waze app) are allowing drivers to identify, and possibly avoid, traffic and congestion. Or how smart home systems are enabling consumers to take greater control over their utility usage. Or how ride sharing programs are changing the way people own vehicles and pay for mobility.

Interestingly, this is not a triumph of technology. Rather, it is a triumph of consumer choice and information. Waze doesn't remove traffic; it allows consumers to make smarter decisions based on available information. Ride sharing doesn't eliminate the need for vehicles, but it does allow consumers to select from a far wider range of mobility options. The point is that the consumer, not the technology, is making the decisions.

The power shifts

In the past, it was the infrastructure leaders and owners who were in the driver's seat. They were the ones who decided what options would be available to consumers. They selected how much capacity would be developed. They worked with regulators to select fixed prices that, in many ways, influenced the way consumers used available infrastructure.

Today, however, many of these decisions have been passed to the consumer. Time-of-day and surge pricing, for example, allows consumers to decide when they will use services and at what price. Mobility options allow them to select from a wide range of both public and private transport modes. New 'as-a-service' models are allowing consumers to choose whether they want to be owners of assets or merely passive users.

A new paradigm emerges

A triumph for consumers, indeed. However, it is also a massive challenge for planners and investors. On the one hand, greater consumer choice is leading to shifting expectations and demand. Peak traffic hours are starting to change, as consumers adapt their patterns to avoid congestion and make better use of their time. This is freeing up capacity at peak hours. However, it is also changing what 'peak hours' actually means.

Many of the more disruptive consumer technologies are designed to do just that: utilize spare capacity. Uber makes use of spare vehicle capacity; Airbnb leverages living space capacity; Waze connects users to spare road capacity. At the outset, this will allow many infrastructure owners to delay new capacity decisions. However, as trends evolve and adoption increases, the trend will eventually lead to entirely new capacity requirements.

These consumer trends are leading to two fundamental changes in the way we plan and pay for our infrastructure. On one hand, new technologies are disrupting the traditional 'fixed' technology set. Consider, for example, how the introduction of autonomous cars will change the way we build and plan roads (one could imagine that lanes might be narrower, traffic management systems would be less obvious and signage would be simplified).

> Infrastructure owners will need to start behaving much more like tech CEOs.

At the same time, the way consumers use and pay for infrastructure will become much more modular. In some cases, consumers will want to pay only for their actual usage and value. In other instances, users may be just as happy paying for basic access to service through flat fees and tax levies. However, in each case, the way consumers expect to pay for services will have a massive impact on the way governments and owners plan to fund those assets. In this type of market environment, the role and compensation of the residual/reserve supplier becomes increasingly important.

The data to decide

While technology may be creating some challenges for planners and owners, it is also helping create solutions. Indeed, given the amount of data and information now being generated by users, assets and organizations, infrastructure planners should now have unprecedented insight into demand … assuming they can handle all the data and translate it into usable insights. Interestingly, this proved a significant challenge in our recent *Cities Benchmarking Study*.

In part, this insight will be achieved by improving and simplifying the user interfaces in a way that improves the feedback loop and generates rich insights. However, it will also require owners to partner with new solution providers and technology companies to ensure they are seeing all the relevant data. Consider, for example, how investments into roads might be improved by visualizing actual user data from way-finding apps.

The problem, however, is that humans can be unpredictable. Even with all of the data available, one can never know for certain what consumers will actually want in the future. Nor can one know what technologies might be available to deliver on those demands. In this environment, owners must be able to apply judgment to data and experience to insights.

Making the right choices

Ultimately, the trend toward technology-enabled consumer choice is creating a new reality for owners and planners. And it is forcing them to take dramatically different approaches to the way they develop, operate and pay for their assets.

For one, as we suggested in our *2016 Emerging trends in infrastructure*, owners will need to start behaving much more like tech CEOs than ever before. The reality is that our assets are becoming much more dynamic and this, in turn, requires infrastructure decision-makers and leaders to understand both the tactical requirements and the strategic imperatives of shifting consumer choice. It is no longer the case of 'if you build it, they will come', but rather 'if they see value, they will come'. And this will require a ceaseless focus on the customer.

Owners will also need to recognize that the old technology set may no longer be fit for purpose. And that will require them to build a new level of intellectual flexibility into their planning and investment. Data will certainly help make these decisions easier, but owners and planners will still need to make some pretty big bets for the future, particularly in areas where they are obligated to ensure a reserve level of peak capacity (such as power, water, roads and transit).

If we can get this right, the future will be both bright and highly responsive to consumer needs. However, if we make too many assumptions, or if we ignore the data and signals consumers are sharing, we run the risk of investing into the wrong assets at the wrong time. And that is a risk nobody is willing to face, particularly in this era of consumer choice. ■

How is data changing the way we plan infrastructure investment?

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In the past, infrastructure development was largely a 'bricks and mortar' proposition. However, over the past decade, the availability of data and the digitization of services has changed the way people use and view infrastructure. Indeed, in many sectors, the availability of good data is just as important to building a new asset as the availability of resources.

In the health sector, for example, new models of care are forcing decision-makers to rethink the assets they develop. "In the nineteenth and twentieth centuries, healthcare was defined by the availability of hospitals and primary health clinics," notes Mark Britnell, Chairman of KPMG's Global Healthcare practice. "As we move into the twenty-first century, hard infrastructure is starting to give way to softer infrastructure needs such as health information systems, artificial intelligence and — increasingly — robotics."

Rather than travelling long distances to visit a primary care physician, for example, some communities in rural Australia are piloting holographic consultations, in which a doctor can be summoned — live and in real time — into the home of a patient. In Japan and Singapore, robotic care providers are being used to supplement elderly care both at home and in care facilities. "New technologies are changing the model of care that has existed for decades," adds Mr. Britnell.

Similar disruption is taking place in the transportation sector. In the past, consumer choice was fairly binary: in a large number of countries you could either take a car or you could take public transit. Today, the combination of real-time traffic information, routing information and sophisticated apps is allowing travelers to choose from multiple routes using multiple different modes of transport. All of this is altering the way infrastructure is planned and developed.

As Andreas 'Zac' Zachariah, CEO and Founder of TravelAI suggests, this shift is forcing transportation authorities to rethink the way they plan and develop new infrastructure. "Planners often know where someone starts their journey and where they end, but they don't know very much about the route they took or the modes of transport they used to get there," he notes. "But for the citizen, it's all about the route — that's what dictates the cost, the speed and the comfort of their journey."

As a result, the way infrastructure owners and authorities think about investment is changing. "There's an increasing desire to use technology and data to improve the understanding of what's happening in the network and in the system. Unlocking value and spawning new services is something disruptors like Lyft, Uber, Gett and Chariot for example are particularly adept at," adds Mr. Zachariah.

The availability of data is also changing the way planners think about individual assets. "Customer data is helping owners understand how customers use their assets, where people are dwelling longer, where they are getting congested, how they are moving around the asset," notes Ben Foulser, Associate Director in the Infrastructure Advisory practice at KPMG in the UK. "And that is allowing planners to design major assets like railway stations and airports to be more efficient and more convenient for passengers."

> "Planners often know where someone starts their journey and where they end, but they don't know very much about the route they took or the modes of transport they used to get there," he notes. "But for the citizen, it's all about the route — that's what dictates the cost, the speed and the comfort of their journey."

This, in turn, is forcing infrastructure owners and planners to rethink the way they collect and use data. "Infrastructure decision-makers are recognizing that the data and processes they used in the past are no longer fit-for-purpose," adds Mr. Zachariah. "They are thinking about how their existing data can be complemented by new technologies and new data to improve their understanding of use and demand."

In the past, the richness of the available data was often a challenge. Mr. Zachariah's company — TravelAI — was created to support decision-makers as they evolve their approach to , bringing mode and geography agnostic digitization tools to the transportation sector. Their first app was developed to help authorities understand cyclist travel patterns.

"There's almost no data about how pedestrians and cyclists actually travel through the urban and rural environment," he says. "We wanted to understand not only their routes, but also how they then interact with other forms of transportation. Do they cycle to a train station and then, on the other side, walk to their office? We wanted to understand the real narrative of how people travelled around a city and, in doing so, help authorities better plan their investments into cycle paths, transit and roadways."

As a result, new dynamics and new choices are emerging for infrastructure planners. "Once you have the right data to fully understand how people are travelling and what they are looking for, you can start to make important decisions about how you manage the overall network," added Mr. Foulser.

While consumer preference and demand are important factors in the decision-making process, the challenge for many infrastructure authorities is to balance what the customer data is telling them against data and trends within the wider policy environment. "Transport authorities have a number of objectives they are trying to achieve — air quality, reduced congestion, affordability, public health and economic stimulus," adds Mr. Foulser. "You can't just start cutting out busses because people are taking more Ubers. It's a much more complex decision-making process."

As Mr. Britnell points out, the availability of improved data and the adoption of new forms of service delivery will not remove the need for hard infrastructure assets. "You'll always need hospitals and clinics. There is only so much care that can be provided in someone's home. So the hard infrastructure will always need to be built," he argues. "But we also need to use the data at our disposal to understand how those assets will evolve in the future."

"As infrastructure authorities start to adjust the system to respond to new trends and technologies, they will need to take a much more dynamic approach to the way they collect, analyze and understand data," says Mr. Zachariah. "Going forward, the key to infrastructure planning and decision-making will be in the data."

Ultimately, the key to building robust, resilient and valuable new infrastructure assets will be in the quality of the data available to the decision-makers, whether they be policy makers, developers, investors and customers. ■

Millennial perspectives on the future of infrastructure

Infrastructure has traditionally had a monopoly on shaping the future. Its high capital costs, technical complexity and centralized models required tight regulation, economic support and mass political appeal to succeed. Any attempt at an alternative vision, such as hydrogen-powered homes and cars, was unadvisable if not unattainable. Once a technology was entrenched in our infrastructure, it became economically and politically difficult to replace it.

Previous generations, particularly the baby boomers, developed and built infrastructure by investing in a future they were confidently certain of. They strengthened that foundation and passed it on to younger generations, complete with the public debt model and flawed discounted cash flow method they had conveniently used to pay for it:

— *Boomer: "You're welcome."*

— *Millennial: "Hold my avocado and kale smoothie. I'm about to launch an unregulated, data-driven nursing home with robot caretakers…"*

We are now more than 20 years into an information and telecommunications revolution that is shaping and defining a new era in human history. Just as the Boomers adapted and prospered from the Post-World War II economic surge, Millennials are positioned to be equally influential as the pace of technological change accelerates, threatening obsolescence and disrupting traditional infrastructure business models.

***John Kjorstad**, a pre-Millennial, post-Boomer Associate Director in KPMG's Global Infrastructure business interviews a panel of five young professionals from different corners of the world about the impact of technology on infrastructure: What does it mean for them professionally and, more importantly, how it will shape their lives and affect them personally?*

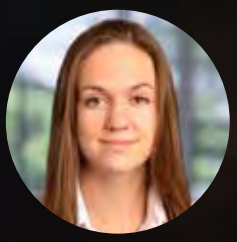
The "Millennials"

Alan Mak
KPMG Canada

Alan Mak is a manager in KPMG's Global Infrastructure practice based in Toronto, helping clients evaluate the long-term sustainability of their tangible assets, understand the requirements of data and analytics for decision-making and integrate disruptive technologies to understand and improve their processes.

Yesenia Arteta
KPMG Colombia

Yesenia is a senior consultant in Colombia's infrastructure projects practice, helping clients reach sustainable solutions for projects in the country.

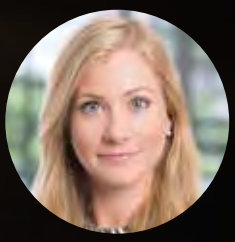


Ashleigh Mateer
KPMG in the UK

Ashleigh is an assistant manager and Chartered Accountant in KPMG's Transport Advisory practice in the United Kingdom, supporting primarily rail and public sector transport clients with a particular focus on rail franchise bidding.

Morten Reimer
KPMG Denmark

Morten Reimer is a Senior Manager in KPMG's Infrastructure Advisory practice and leads transport in Denmark. Morten is helping transport operators develop and execute on digital transformation strategies.



Lauren Kerr
KPMG Japan

Lauren Kerr is a Senior Manager specializing in infrastructure and cross border M&A transactions. Originally from KPMG in Ireland's Dublin office, she is currently based in Tokyo, Japan.

How will societies take advantage of technology advancements in the future?

Ashleigh Mateer on 'smarter transport'
Technology is going to make life lot easier. In London, we have a lot of issues with transport capacity. The London Underground, for example, is not pleasant at peak times. New services like Crossrail are coming soon, but they are expensive and take considerable time to develop. Technology might allow us to manage movement smarter — allowing people to work from home and make remote working more commonplace. That could smooth out some of the peak capacity demand and help operators manage the whole system more efficiently.

Technology will also have the potential to free up capacity on the roads by making logistics, ordering and supply operate more efficiently. In addition, 3D printing might change how and where companies manufacture products, shortening the distance between production and consumption. There is also last-mile logistics, in which companies like Uber can activate people driving near a house or a supply centre to pick up a delivery of goods and take it somewhere near their intended destination. That's particularly prevalent in Asia, where there are more experimental things going on.

Yesenia Arteta on 'cleaner transport'
Colombia is different than other countries when it comes to public transportation. We are really into Bus Rapid Transit (BRT) systems! Bogotá has one of the biggest — if not the biggest — BRT systems in the world. What's changing is that we are trying to move toward cleaner sources of energy. We are going from diesel-powered to maybe electric, hybrid, other types of energy that do not cause as much pollution.

We are also evaluating a metro light rail system in Bogotá because the city has a lot of people and the BRT system is not quite enough. We are trying to come up with ideas to see if we can increase the availability of transportation modes to service all of the people.

Morten Reimer on 'digitalization'
Infrastructure organizations are becoming much more data-driven. They are seeking reliable information to support better decision-making. There is great potential for further digitalisation in cities, with machine learning, forecasting tools and predictive analytics being used to solve urgent challenges and drive better use of existing infrastructure.

In Denmark, we are helping organizations to be much more data-driven and, thereby, being able to apply machine learning to predict traffic situations. We see a critical need for combining different data sets to be more proactive and predictive about causation. For example, by combining traffic and weather forecast data and linking it to big events, we will have a more reliable picture of reciprocal consequences going forward and that "picture" is important to establish in the urban areas.

Alan Mak on 'drones'
Drones will play an important role in our future. I usually put them into three buckets: long-distance transportation for rural areas, fragmented transportation for the urban environment and augmented data collection. Augmented data collection would include things like site surveys, 3D model capture, thermal imaging and collecting pollution or temperature data. Currently though, it is the first two that generally get the most attention when, for example, companies like Google are heavily invested in these systems.

The hard part is using drones within cities, both in terms of the regulatory environment and technology capabilities. Can a drone be made to not collide with a skyscraper? If a drone hits the wall of a skyscraper that's 50 floors up and suddenly falls down and hits someone, that would be a huge safety issue. If a drone fails over a farm field, there is much lower risk. People within the industry and government need to validate what are the risks associated with drone technologies and balance that with the benefits to be achieved.

Lauren Kerr on 'different ways of working'
From an Irish perspective, there is a mass movement of young people to Dublin, so working remotely and leveraging technology to make your working life and your personal life easier is quite common. It's also probably linked to the fact that Ireland's transport infrastructure isn't currently as strong as it could be, so commuting can be more difficult/time consuming.

Japan, by contrast, is heavily developed with very good transport infrastructure. Yet, working remotely and leveraging technology isn't as common. Certain companies have initiatives to encourage different ways of working but there's also a strong cultural perception that you need to be seen at work. So, technology-enabled remote working hasn't really fully delivered what it could here.

Millennial poll: "Do you own a car? If not, would you want to?"

"My personal view is, if you live in a city, you probably don't need a vehicle. When I moved to Toronto, I sold my car within 2 months because I only used it about three times. If you do need a vehicle, there are car sharing services like car2go. People in cities want that kind of flexibility in their transportation systems." — Alan Mak

If we move to autonomous vehicles and you're able to join a car club — pay a subscription — and some days you want a convertible and others you want a family wagon, would that appeal to you?

Alan Mak
That leap in technology is already there. Right? We already have car clubs and car shares in Toronto, which use phones to find a nearby car. Maybe the next leap will be to offer autonomous vehicles for rent.

Morten Reimer
That will appeal to me. But I will also want to have my own car. I don't want to let that freedom go. But actually, when I'm traveling a lot around in urban areas, I use multiple types of vehicles. I use trains, bicycles, buses, and all of the different transportation modes available. So I'm actually not using my leased car that much.

I think the whole autonomous driving concept is really interesting. There are some philosophical issues that need to be solved. Not that it scares me, but I think it's something we'll have to deal with in the near future.

Lauren Kerr
I think that car clubs are already quite popular in Japan, especially in the bigger cities and surrounding areas. The ongoing maintenance costs of having a car (tax, insurance and parking) can be quite prohibitive if you live in the centre of Tokyo, considering how seldom you may actually drive, so having the flexibility to just pay a low monthly charge and have access to a car whenever you need it can be a convenient way to avoid excessive fees, etc. It can also be really handy for trips outside of the city if, say, you want to go hiking and you need a car to get there or back. Outside the centre and in more rural areas, transport options can be limited. For example, there may only be a bus and it may only depart once every 1 to 2 hours. Using technology to get around this just makes so much sense.

Millennial poll: "Do you own a home? If not, would you want to?"

What impact can technology have on healthcare infrastructure?

Ashleigh Mateer on 'data awareness'
People being armed with more information about their health are going to live healthier lifestyles and be more productive. Having wearables, like Fitbits and smart phone apps, creates a new level of awareness that comes with the idea of having things that tell you your heart rate and your calories during the day.

The danger is self-diagnosis causing people to seek out more healthcare than they actually need. But perhaps this, too, can become more formalized through technology and bring some of the cost out of health organizations from the bottom so that more money can be spent on a more detailed and complicated technology to do it more effectively with some of the more serious health issues.

Morten Reimer on 'machine learning'
I see a huge potential for machine learning and IT solutions to get healthcare more digitalized in general. Machine learning will help to deliver a better diagnosis of what is wrong with you. For example, I know that IBM Watson has been tested to deliver more accurate oncology diagnoses.

Yesenia Arteta on 'virtual healthcare'
Medical histories are mostly handed by paper in Bogotá. Hospitals are trying to move these records toward tablet computers, having everything online or in a cloud, to provide easier access whenever, for whatever information is required. But the journey toward a technology-friendly environment is not easy.

I think there is great potential in Colombia for virtual healthcare. We have the difficulty of mobility, both moving through congested cities and accessing some more remote parts of the country. Given that most people in Colombia own a cell phone — probably a smart phone — it's interesting to imagine that we are not far from extending low-cost basic healthcare through technology and providing virtual access to people that otherwise would have a hard time going to the doctor.

How is technology impacting energy infrastructure?

Lauren Kerr on 'Japan's energy future'
There is a big push now toward renewables in Japan — quite a significant push. Japan has lagged a bit behind in terms of renewables generally, so that is something that has been gaining more attention, in particular since the 2011 Great Japan Eastern Earthquake and subsequent shutdown of the nuclear power reactors. Wind energy is becoming increasingly popular here, though the main focus to-date has been solar PV (photovoltaic) because the FITs (feed-in-tariffs) are quite high. From next year, Japan will start a reverse FIT auction where the FIT starts at the cap price and reduces rather than ever going back up as high as it used to be. The increase in renewables has sparked related conversations that focus on decentralized energy and how that impacts on the grid in terms of intermittency of supply, battery storage and smart grids etc.

Alan Mak on 'microgrids and distributed generation'
The main concern with distributed generation in Canada is the regulatory portion and cost function. For example, if I generate a kilowatt of energy here, what price do I get when I sell it? Do I sell it at the distributor price or can I sell it at the generator price? If you sell at the generator price, then it's not economically viable yet. But if you sell at the distributor rate (what I pay when I use energy at home), then it becomes much more economically viable for generation that is used locally. The argument against this is "the system is a system" — you can't use 1 percent of the system and not think about the other 99 percent. Each has a valid point and I'm not sure where it's going to go. If you want to encourage people to have segregated energy sources, it's likely going to be the distributor price. I think the government is pushing it more that way." ■

Millennial poll: "What is society's greatest challenge for the future?"

Encouraging autonomy

Kirk Steudle
Director of the Michigan Department of Transportation

Peter Kestner
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New technologies are creating massive opportunities for consumers, governments and infrastructure owners. However, they are also creating risks and new challenges. As the shift toward autonomous vehicles demonstrates, the successful adoption of new technologies will require significant cooperation and action.

There are few technologies as emblematic of the transformative change undergoing infrastructure as the automobile. For the past 100 years, cars have defined the way we plan and build our cities. And now, as the auto industry moves toward electrification and automation, cars are once again disrupting the status quo.

Anticipating autonomy

Depending on who you ask, most pundits think that fully autonomous vehicles will be 'on the road' within the next decade. The automotive sector is certainly pulling out all the stops to make autonomous cars a reality. So, too, are big name startups and tech companies, such as Tesla, Google and Uber.

Countries vary greatly in their readiness for autonomous vehicles. The US states of Michigan and Florida already allow autonomous vehicles to operate on their streets. And in Europe, the UK, France, Belgium, Germany, Spain and the Netherlands have allowed driverless cars to be tested in real-life situations.

The benefits of autonomous vehicles are fairly clear. "For us, it's really about making our roads safer. Last year, there were more than 1,000 fatalities on Michigan roadways due to traffic crashes," notes Kirk Steudle, the Director of the Michigan Department of Transportation. "Current estimates suggest that autonomous vehicles could reduce that number by 80 percent. That's 800 lives that could have been saved in our state last year alone."

Setting the stage for adoption

While the technology behind vehicle autonomy is moving ahead at breakneck speed, it may be some time before our infrastructure is ready for the massive changes that vehicle autonomy will bring. Getting regulators and consumers ready for the change may take even longer.

According to Mr. Steudle, the autonomous vehicle industry will still need to overcome some pretty big challenges before driverless cars become commonplace. "It's going to take some time before automotive companies are comfortable enough with their systems to assume the liability for what their vehicles do on the roadway," he notes from his office in Detroit.

Many of the autonomous technologies now in development will require authorities to improve their infrastructure. Road lines will need to be repainted and widened. Road surfaces will need to be improved. Traffic signaling will need to be updated. Road signs will need digitization. "These are things public road agencies should be considering as they make their current investments," suggests Mr. Steudle.

Understanding the risks

Yet, as the technology evolves, things may become more complicated. To enable 'platooning' (where autonomous cars move together in a convoy) and reduce crashes, new vehicle-to-vehicle and vehicle-to-infrastructure communications protocols will need to be developed and tested.

According to Peter Kestner, a partner in KPMG's Cyber Security practice based in Germany, this could take some time. "The industry is now starting to think about how the technologies will work together. What protocols will be required? What bandwidth will be used? How large should the radius be? These are all questions that will need to be answered," he notes.

More challenging, perhaps, will be developing the 'ethical code' by which driverless cars will operate. "If an accident is inevitable, should the car be able to choose who to hit? Will it be able to decide between

the family of five or the single driver in the pickup truck? These are moral and ethical decisions that will need to be built into the algorithms, but I don't think anyone has a clear view of the right answer at the moment," he adds.

Regulating public safety

One of the biggest concerns for regulators, automakers and drivers will be around cyber security. Indeed, as cars become increasingly connected to each other and integrated into the surrounding infrastructure, the risk of a malicious cyber hack will increase. The military, in particular, is concerned that cars could be hijacked by terrorists to cause significant damage.

"Right now, everyone is racing to develop the enabling technology that will allow vehicles to move autonomously but, unfortunately, security is often an afterthought," says Mr. Kestner. "The reality is that security needs to be embedded right from the beginning of the design process. One major attack on the system could put adoption back by a decade."

While much of the responsibly for security will fall on the automakers and their suppliers, both Mr. Steudle and Mr. Kestner believe that government has a significant role to play in encouraging security and standards.

"In the US, the National Highway Traffic Safety Administration has a long history of regulating automobile safety standards and, in my opinion, that's where the regulatory authority needs to stay," notes Mr. Steudle. "There isn't a state employee anywhere in the country that fully understands what is happening inside the vehicle."

Mr. Kestner suggests that while car manufacturers will need to review their products and suppliers' products to ensure they meet a minimum security requirement, regulators will also need to play a role in defining security protocols. "When it comes to the movement of people, regulators will need to play a role in setting that base security requirement," he notes. "But they need to start moving now. They can't sit back and wait for problems to happen before they act."

Finding common ground

Both Mr. Steudle and Mr. Kestner agree that the best way to encourage adoption and remove risks is for automakers, technology companies, governments and regulators to work together on a common solution.

"I think we all recognize that the shift to autonomous vehicles will require everyone to work together to bring this forward in a safe and effective manner," suggests Mr. Steudle. "The issues are too big and too complicated to leave to just one party or company."

Mr. Kestner agrees. "There is so much we can learn from each other and from other industries," he adds. "The most important thing anyone can do is encourage collaboration — on security, on standards and on technologies. If we keep working in silos and in competition, I worry that we're going to be in real trouble down the road." ■

The city of the future

Peter Auhl
Head of IT for the City of Adelaide

Seok Tae Kim
Chief Marketing Officer at Gale International Korea

Stephen Beatty
Americas and India Head of KPMG's Global Infrastructure practice
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As technology evolves and cities become 'smarter', government decision-makers are looking for new ideas and leading practices to help them encourage innovation while simultaneously managing risks.

*To learn more about the city of the future, we asked city leaders — **Peter Auhl**, Head of IT for the City of Adelaide; **Seok Tae Kim**, Chief Marketing Officer at Gale International Korea; and **Stephen Beatty**, KPMG's Head of Infrastructure Americas and India — to share their insights and expectations.*

What will distinguish the city of the future from today's cities?

Peter Auhl (PA): I would argue that the city of the future will be overwhelmingly focused on delivering customer outcomes. In Adelaide, our focus is very much on adding value to our customer interactions and giving our customers a choice. We think that the best thing government can do is to get out of the way so that citizens can make their own informed decisions. So our approach has been to curate our services and information in a way that allows customers to interact with city services and infrastructure in the way they choose.

Seok Tae Kim (STK): We have a similar opinion. When developing our smart city in Songdo, we believe that it's the people that live within the city that make it 'smart', not the technology. The focus must be on helping citizens participate as partners with the city, sharing their ideas, data and feedback so that we can improve convenience and choice. In Songdo, we are striving for three key characteristics: the use of technology to improve citizen convenience, the right facilities and infrastructure to improve quality of life, and increased sustainability. I believe that the city of the future will represent a combination of those three characteristics.

Stephen Beatty (SB): Absolutely right. And I would argue that the most successful cities in the future will be those that are able to find innovative ways to minimize the man-made and institutional friction between people, systems and infrastructure. As cities evolve, I expect to see government's focus on helping citizens become much better-informed decision-makers. And that should lead to much greater alignment between the 'micro' decisions that people make on a day-to-day basis and the 'macro' decisions that we make as city leaders.

What impact will this shift have on urban society?

SB: I believe that we will start to see cities evolve into nodes of social good. Rather than travelling distances to access social services like healthcare and senior services, I suspect we will see a shift toward more small-scale systems housed within complex nodes of development. Today, we're very focused on creating very simple development environments but, as we densify existing land uses, we're going to see much more complex and much more responsive social environments.

PA: One of the perverse impacts of technology is that it has actually pushed people away from each other. Social media has been the driving force behind this change. I think that in the future, technology will instead start to bring communities closer together. In the future, I hope that we are going to see technology start to encourage people to interact more within their communities. I believe that as people get more information about what's happening in their communities, we'll see the current scenario flip itself to once again reinforce our social interactions rather than separate less meaningful interactions.

STK: Right. And this comes back to people being at the heart of the smart city. I believe that technology will enable city leaders to focus on the well-being of their citizens, allowing them to provide a better experience through improved access to culture, education, the arts and other facilities that ultimately improve the quality of life for those living in the city.

What can governments do to encourage the transition towards the city of the future?

PA: There's a lot about the future that we don't know. But what we do know is that connectivity is going to play a very important role. So we've been focused on creating a new type of infrastructure that we refer to as "10 Gigabit Adelaide", basically creating a private network across the entire city that allows businesses to connect with businesses across the city and then connect the entire city directly to cloud infrastructure via interconnection (non-internet dedicated cloud connections). This will allow businesses to improve connectivity and to scale their services quickly, reliably and securely and connect their businesses to the world economy. The 10 Gigabit Adelaide network will also provide base infrastructure to enable a number of smart city projects.

STK: Infrastructure is certainly important. But so, too, is enabling regulation. When we started to develop Songdo, we worked closely with the government to create regulation that actually encourages development in key areas, such as healthcare, social services and education. Now, we have the honor of hosting five universities and a number of international health centers, which serve as a great incubator for innovation and creativity in our city. The government has also provided significant financial support by, for example, investing more than US$1 billion into developing the right environment to support international campuses.

SB: I would agree with both Peter and Seok Tae — the city of the future needs better connectivity and it needs supportive regulation to become reality. I think governments also need to start thinking about how they program and deliver their services in a much more integrated way. They need to start thinking about how their services interact with each other, how they can become more agile and responsive to the changing needs of the population and how they are going to use their capabilities and assets to respond to the social needs of their future citizens.

What role will data play in the city of the future?

STK: Data will be very important. In Songdo, we are partnering with local service providers, government organization and multinational technology companies to maximize our use of data. But, at the same time, we are also starting to collect much more data than ever before. For example, as part of our city management and security

system, we have added hundreds of modern surveillance cameras that collect data and help us improve our decision-making for traffic management, security and public safety. And that is helping us create an even smarter and more responsive city.

PA: Data has been a key focus for us in Adelaide. We recognize that data is central to not only government decision-making, but also business and personal decision-making. So we've created a very comprehensive open data tool kit that allows businesses and government decision-makers to visualize a wide range of key information though a single pane of glass. And that is helping government and businesses to make better decisions about their investments.

SB: One of the reasons I'm so optimistic about the city of the future is that I believe that cities are starting to gain access to and curate increasing amounts of data that will eventually allow them to do more and better things in a more efficient and effective manner. I see data as the first step on the journey towards creating the city of the future, not only as a way to deliver services, but also as a way to compare their effectiveness against other cities and, by doing so, identify ways to improve service delivery and customer experiences.

What are some of the risks that worry you when you think about the city of the future?

STK: Every country is witnessing a rise in cyber terrorism and cyber attack. And, as our infrastructure and data become more integrated and start to flow through operations centers, I worry about the disruption that might occur if there is a data breach or interruption of services due to hacking. So we are working hard to ensure that our technologies are continuously updated and to maintain and enhance the security of our data. But there is no perfect solution to these challenges.

PA: I would agree with Seok Tae. Any time you connect things together, you increase your risk of having those things compromised. One of the benefits of our 10 Gigabit Adelaide concept is that we are building security into the design of our city as a core element rather than retrofitting security on top of something that is already insecure (the Internet). We also think a lot about asset obsolescence which means we really have to keep focused on two horizons: what we are doing today and what we need to be doing tomorrow.

SB: I'm not sure it's a risk, per se, but I do think that we're going to need to come to terms with the fact that we are going to see a general decline in personal privacy. And that means that we are going to start to see much more electronic surveillance and a much greater focus on security. The unfortunate reality is that the world is not going to get any safer over the coming years. If anything, the risk of people acting out and harming others will increase rather than decrease and that will require citizens, businesses and governments to think very differently about security and privacy.

What advice would you offer city leaders as we move toward the city of the future?

PA: My advice is simple: focus on the customers. Governments have an ability to encourage massive changes that can have a very positive — or negative — impact on millions of people. The only way you are going to get it right is if you start focusing on customer outcomes and thinking about how governments serve our people and communities.

SB: I absolutely agree. And I think that city leaders have a great opportunity to study the experiences of other cities that are going through the same journey and find ways to share best practices, ideas and innovations. In part, that means better benchmarking and more rigorous measurement of efficiency and effectiveness. But it also means more dialogue, more collaboration and more cooperation between cities.

STK: Right. But I would also add that cities need to adapt their approach to the needs and characteristics of their region, culture and population. You can benchmark and compare yourself against other cities but, at the end of the day, you really need to serve your local population and that means understanding the particular characteristics of the city and population you intend to serve. ■

“Data is the first step on the journey toward creating the city of the future, not only as a way to deliver services, but also as a way to compare effectiveness against other cities and identify ways to improve service delivery and customer experiences.”

Energy2Go: The future of energy?

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Nobody knows what the city of the future will look like. What we do know, however, is that the way we generate, source and use energy will be significantly different.

In many cities, energy usage patterns are already changing. Smart meters and time-of-day billing has encouraged consumers to rethink their energy consumption. Falling prices for home solar kits and battery storage are enabling some to move 'off the grid' and others to sell energy back into the grid. And now, the shift to electric vehicles is disrupting energy consumption patterns once again.

At the same time, the move toward deregulation of energy markets is rapidly changing the supply side of the equation. In many markets around the world, energy deregulation has introduced competition and enabled a host of new players — increasingly from outside the sector — to tighten competition. Gas firms sell electricity and vice versa. Foreign companies are breaking into new countries. And organizations such as supermarkets and banks are extending their brands into energy. Switching suppliers has never been easier.

"The introduction of third-party access to the market means that consumers can essentially buy electricity from whatever retailer they want," notes Miroslaw Sołtysiak, PGE Polska Grupa Energetyczna Operations Department Director, Poland's largest power producing company. "The big question now is whether large businesses will start to demand single contracts that span all of their locations and assets. If you operate 100 stores across Europe, why wouldn't you want a single contract and a single bill for all of your energy use?"

In the city of the future, shifting consumer energy usage patterns may make things even more complex. Rather than paying one bill for home energy consumption, one for work consumption and another to fuel up their electric vehicle, consumers will likely want to combine all of these sources into one contract. It's a concept that we're calling Energy2Go.

"It's less about getting a deal on electricity prices and more about getting better information about energy usage," notes Mr. Sołtysiak. "Energy efficiency is a high priority for consumers and businesses alike and, in the future, I believe that the information customers receive will be just as important as the actual energy."

The fact that the energy is physically provided by a number of different grids would be invisible to the user in the same way that their mobile networks can vary according to location. And smart grids would link users to the most cost-effective source of energy, which will come from an increasing range of sources.

Europe is already putting in place a framework for cross-border billing of energy bills. And a number of countries have signed up to the initiative, including Belgium, Denmark, Germany, the Netherlands, Norway and Poland. Similar programs are emerging in other parts of the world.

"I suspect that the technology is already in place to revolutionize the settlement system," adds Mr. Sołtysiak. "We would still need to work out how the infrastructure provider would be remunerated and we would need to create a much more dynamic approach to the way contracts are assigned and meters are used, but once that happens, I think we'll see a massive change in the way energy markets are managed."

To avoid being relegated to commodity players, the main energy firms will need to consider how to give both personal and business customers the flexibility they're looking for when buying energy. And there is a further implication for capital expenditure: If they no longer hold the customer billing relationship, it becomes harder for grid operators to plan future demand and invest appropriately in energy generation assets.

While energy use patterns in the city of the future are still unclear, the Energy2Go concept could create yet another unwanted pressure for energy providers. Or it could be viewed positively as a chance to rethink the business model and own the new breed of empowered customer.

Regulating innovation

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> In an environment in which technology lifecycles can run full circle two to three times in a single year, the ability traditional regulatory models to respond to actual technological change is still limited.

In today's environment, the innovation lifecycle is counted in months — sometimes even days. Yet, when it comes to infrastructure assets, lifecycles often stretch for decades.

The problem is that traditional infrastructure focused on capital expenditure is very expensive and, in many cases, susceptible to market failures. And that means that governments and infrastructure authorities often need to provide strong regulatory oversight to ensure that what customers demand is developed and maintained.

Governments, therefore, have two basic choices. They can build and operate the infrastructure themselves. Or, as has more often been the case in recent years, they can create regimes either through private public partnerships (PPPs) or regulated private companies and concessions to engage private organizations to fund and operate the infrastructure on their behalf.

Yet, as the pace of innovation picks up, many governments and regulatory authorities are starting to wonder how they might rationalize the need to embed and drive value from new innovation against the equally strong need to provide investors and operators with long-term security and confidence.

The challenge with long term

In a fully competitive market, this isn't much of a problem. The price and the service level is set by the most competitive provider which, invariably, is the one that uses the most up-to-date technology and processes. Better technology usually means that customers benefit from better service, better solutions and better prices.

However, due to the nature of most infrastructure assets (where the vast majority of the costs are locked up in large upfront capital expenditures) infrastructure tends to be based on fixed contracts, concessions or licenses that do not always offer enough flexibility for continuous improvement, innovation or technological disruption.

Consider, for example, the optimal PPP structure for a reservoir or a nuclear power station. In order to incentivize private investment and finance, governments often need to provide very long-term contracts that provide a high level of visibility in terms of revenue and pricing. And that means that the price that 'customers' pay is generally also fixed over a longer term. Any benefits of innovation that may be achieved through the life of the contract, therefore, tend to flow back to the investor, not the customer.

Accounting for innovation

In the regulated utility sector there has always been room for innovation and improvement. And, as a result, regulated utilities generally follow somewhat more dynamic models that do allow for the benefits of innovation to be recognized and captured by customers.

Generally speaking, most regulated utility contracts (those with large, up-front capital expenditures, in particular) tend to follow what is called a financial capital maintenance model, in which the investor is expected to recover all of their invested capital over a set time period. Period reviews can create incentives and shorter term goals but to a limited extent.

In contrast, under the operational capital maintenance models, new technologies can be reflected in prices to customers, but this creates risks which are often unacceptable to investors in infrastructure. This allows contracts to be 'reopen' to adjust for expected and reasonable improvements and innovations. Calculations are made to assess at what cost a new entrant into the market would be able to provide the same service, and the contract is then adjusted to reflect this new reality.

Even then, the pace of change significantly lags that of modern innovation cycles. Most operational capital maintenance model reopeners are set anywhere from 1 year to 8 years. In an environment in which technology lifecycles can run full circle two to three times in a single year, the ability of traditional regulatory models to respond to actual technological change is still limited.

New ideas needed

While the operational capital maintenance model provides some leeway for new innovation, it is a rather crude model for capturing the potential innovation within other, non-utility, infrastructure sectors. The pace of the reopeners is one challenge. However, it also offers little comfort for those assets that require large up-front capital costs.

One potential takeaway is that governments and those developing PPP contracts may want to start thinking about how they can include these types of reopeners, at a more frequent pace, into longer-term contracts but within limits to ensure a degree of price and revenue visibility that private investors need, but this is likely to require more active economic regulation.

Another is that infrastructure procurement authorities should start thinking in terms of systems rather than individual assets. One of the reasons that utilities are able to live with reopeners is that as part of a larger system or network, there is significantly more room to apply new innovations. If you simply focus on one single asset, the scope for change is limited. If, however, you are looking to drive improvements across an entire system, the potential to leverage new technologies increases (without putting an undue burden on a single asset or investor).

Finding new models will require significant debate, innovation and partnership between all parties, particularly policy makers, regulatory authorities and private investors. And it will require renewed focus on what is best for the consumer.

We look forward to the debate. It won't be easy. But it will be incredibly valuable — for governments, infrastructure authorities, private investors and, above all, consumers. ■

> Policy makers and regulatory authorities should start thinking in terms of infrastructure systems rather than individual assets.

Disruption is coming: Think outside the box

The top three big ideas that might change our world

While it's easy to get caught up in the hype of new technologies and blinded by big ideas, there are a number of new concepts that, while not yet fully 'ready for prime time', do point toward the potential for massive and fundamental disruption in the infrastructure sector. And, therefore, they are worth watching. Here are the top three concepts that I'm personally following:

Machine learning

Machine learning essentially allows computers to learn by themselves and, by doing so, enables massive amounts of data to be analyzed to uncover new insights. Machine learning is already being used in the medical field to sort through DNA and find new disease markers. It could also be used to analyze passenger data and uncover new efficiencies in metro systems, for example, or to discover new compounds to improve the strength and durability of building materials. When computers are let loose to learn on their own, how will we make sure they are learning the right things and acting ethically?

Mobility as a service

Uber and Lyft are already demonstrating that there is a growing market for urban mobility solutions. However, once vehicles become fully automated, many expect the urban mobility market to really take off as people seek to get more value from their vehicle investments and ride-share programs start to invest into fleets of self-driving cars. This, in turn, should help reduce congestion on city streets and radically alter demand for urban parking lots. Will new ride-share and urban mobility services require regulation? Will they cannibalize current mass transit solutions? And who will ensure the safety of passengers, pedestrians and other road users?

Data and analytics (D&A)

D&A is already having a massive impact on the way infrastructure is designed, built and operated. Owners are using D&A to understand the optimal design and placement of new assets; construction companies are using D&A to reduce costs and improve safety; operators are leveraging D&A to monitor performance and extend lifespans. The more sophisticated analytics techniques are even being used to predict future outcomes and impacts. The challenge isn't getting the insights from the data but rather acting on those insights in a way that improves the way infrastructure is delivered. Are infrastructure developers, owners and operators ready for data-driven predictive decision-making?

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It's been 10 years since Apple launched the first iPhone. It's been 8 years since the UK government started talking about High Speed 2 (HS2) and Hinkley Point C. Since then, Apple has launched 11 new models of the iPhone and construction on HS2 and Hinkley Point C has barely started.

This is not to disparage the efforts of the UK government; nuclear power plants and high-speed rail systems take decades to fully develop. However, it does clearly demonstrate that the pace of technological change far outstrips the pace of infrastructure development.

The implications for infrastructure planners and developers are massive. Indeed, the vast majority of assets that are currently under development around the world are based on the expectation that they will serve their purpose for decades to come. However, will they still be needed in the next 10 to 20 years? Or will technological change have made them obsolete?

The reality is that, across almost every infrastructure sector, disruption is inevitable. Plummeting costs for wind and solar generation is already disrupting the energy sector. The introduction of telehealth and remote monitoring is shaking up the health sector. The development of automated vehicles will soon change the way we build roads, parking lots and even residential neighborhoods. The question is not whether or not disruption will occur but rather how fast and how dramatic the change will be.

So why do we continue to develop infrastructure to meet the needs of today without planning for the possibility of tomorrow? Why do we simply assume that the current technology set will remain static? If we know beyond a shadow of a doubt that disruption is coming, why do we insist on sticking our heads into the sand and pretending that it isn't coming?

It's easy to simply say that the future is unpredictable; that we do not know what tomorrow's consumers will need and want; or that we can't prepare for what we don't yet know. But uncertainty is not an excuse.

I believe that we can start developing infrastructure that will meet the needs of future generations. We just need to be willing to build more flexibility into our assumptions and our plans. We need to stop planning on the basis of a single future scenario and start looking at multiple planning scenarios. And then we need to test our business plans against them until we find the solution that will deliver the best result against the greatest number of likely scenarios.

In some cases, that will likely mean choosing the option that, in our current reality, may seem somewhat suboptimal but offers the greatest flexibility and opportunity in the future. It will likely mean investing slightly more today in order to maintain the value of our investments tomorrow. And it may mean taking some bets and possibly making some mistakes. But preparing for the future is possible.

When building a new transport corridor, for example, we should be thinking about what may replace present day technology in the future and how our plans can be adapted to accommodate a range of potential new technologies. This future feasibility may cost more up front but will save millions.

For instance, when designing and developing new high-speed train lines, we should also be thinking about how we would use the same land and space to also accommodate a Hyperloop line or maybe a drone corridor. When developing a new hospital or community center, we should be thinking about how we could repurpose that asset into an elderly care facility or school. When building cycle paths, we should be considering what other modes of transport might also use that space and plan accordingly.

The bottom line is that technological change is coming and it's coming faster than we think. We need to put more time into thinking about the possibilities and the opportunities. We need to be more flexible and we need to think about all of the potential future scenarios. And, in some cases, we need to invest more today in order to make the right choices for tomorrow.

We can no longer ignore the coming disruption. It's time to think outside the box. ■

A smart catalyst to development

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Urbanization can bring significant benefits to a country's economy, development and citizens. However, it can also lead to significant inequality. India's Smart Cities Mission aims to leverage technology in order to improve access to services, create new opportunities and enhance the quality of life for India's growing urban population.

Like most developing markets, India is enjoying a period of rapid urbanization. In fact, India's urban population has grown by more than 1 percent per year over the past decade, making it one of the fastest-growing urban populations in the world.

However, while urbanization has delivered some clear benefits to India's economy, it has also created significant challenges for the population. "Poverty, unemployment, environmental degradation and poor health facilities are becoming the signature feature of Indian cities," notes Vivek Aggarwal, Secretary to the Chief Minister of Madhya Pradesh and Commissioner of Urban Development. "There are growing concerns that India's cities will be known for overcrowding and underachievement rather than global centers of growth and opportunity."

India's Smart Cities Mission, announced by Prime Minister Modi in 2015, hopes to change that trajectory. Backed by a budget of more than US$15 billion, the vision is to create 100 new smart cities and to rejuvenate 500 existing cities across the country. In part, the mission aims to catalyze continued economic growth within the cities. But the government also hopes that the initiative will improve the lives of India's growing urban population.

"India's Smart Cities Mission is crucial to fostering spaces that are safe and creative for the young, old and differently-abled inhabitants of India's urban areas," notes Mr. Aggarwal. "By using the latest technologies, we hope to create jobs, provide energy efficient housing, high frequency mass transportation, 24/7 water and power supply and seamless internet connectivity so that millions of Indians can live, work and play with maximum productivity and a minimum impact on the environment."

Data-driven development

In early 2016, the Ministry of Urban Development announced the '20 Lighthouse Cities' that would lead India's Smart Cities initiative. Of the 20, three were proposed by the Madhya Pradesh State Government: Jabalpur, Indore and Bhopal.

> The city command and control center will eventually act as the backbone of the city and will provide a decision support system that integrates all of the civic services into a single display.

"In Madhya Pradesh, we have adopted a 'responsible development' approach that focuses on responding to the future needs of our citizens," adds Mr. Aggarwal. "The goal is to anticipate the future needs of citizens rather than simply responding to today's design trends. We want to build cities that will be seen as a model for inclusive cities and will represent workplaces of the future."

To achieve this, the state has put significant focus on improving the collection, management and analysis of data. "Citizens create massive amounts of data through their activities and interactions and this data can be harnessed to show what people actually do, rather than what they say they do," says Mr. Aggarwal. "Harnessing analytics to make sense of the patterns in the data allows us to understand the 'science of cities' in a way that was not possible before."

Measurement has been key to the state's success to date. Many cities are now starting to measure key services and inventory resources with the intention of creating low-waste, low-carbon strategies that allow cities to track key aspects, such as resource depletion and greenhouse gas emissions. With this data, the cities hope to eventually improve the way they manage their financial and natural resources.

Building the right environment

One of the keys to Madhya Pradesh's success to date has been the state's focus on creating the right underlying infrastructure to support the development of smarter cities. For example, the state has developed a cloud-based data center in Bhopal that will serve all of the smart cities across the State. This will allow the cities to standardize around specific software platforms and visualize their performance through dashboards and data analytics tools.

"The city Command and Control Center will eventually act as the backbone of the city and will provide a decision support system that integrates all of the civic services into a single display," adds Mr. Aggarwal. "This will allow cities to not only optimize costs and reduce complexity, it will also create opportunities for local and international systems integrators to provide best-fit solutions that suit our cities' needs."

The state is leveraging their investment to drive ICT infrastructure into the vast majority of existing cities across Madhya Pradesh. And this is enabling significant benefits for cities and citizens. "A strong urban ICT backbone will allow us to convert streetlights to LED, equip public schools with smart labs, modernize city health infrastructure and improve the ease of doing business in the state with faster clearance processes and improved access to city services," adds Mr. Aggarwal.

Jumping out ahead

While financial aid for the Lighthouse Cities will only become available in the 2017-2022 planning cycle, the Government of Madhya Pradesh has already started to make significant progress towards their goals.

The Common Command Control and Communications Center has already been established to serve the seven planned smart cities within the state. At the same time, many of the state's urban local bodies (ULBs) are well on their way to digitizing their own disparate payment mechanisms into a single integrated system, which has greatly improved revenues, the quality of services and convenience for citizens.

To improve local innovation and create indigenous solutions to India's city challenges, the state is also creating city labs that will act as technology incubation and proof of concept centers. "The idea is to create an urban marketplace for new technologies that will not only meet the Government of India's vision but will also help us define the quality and standards that we will expect across the state," adds Mr. Aggarwal.

Creating local solutions

Madhya Pradesh's experience to-date suggests that localization is key to sustainable smart city development. "You can't just take a model from overseas and implement it locally, as every city has its own ethos, culture, psychology, system and style," he notes. "We need to carefully study and consider internationally available models but, more importantly, we then need to amend and adapt these ideas to suit our own local conditions."

Ultimately, the needs of local citizens must be the driving force behind any new developments. "City infrastructure is there to serve the citizens of the city and that means focusing on improving the quality of life," he adds. "We want our children to grow up in cities they can experience, walk in and work in. And that, in turn, will enable us to foster a more sustainable, healthy and dynamic society in our urban centers." ■

Reaching new heights in India's airports sector

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India's airports are nearing capacity. Can technology help keep the country's air passengers moving?

India's air industry is booming. Passenger traffic is up — way up — and the country's 22 operating commercial airlines are adding new routes and new aircraft at an amazing rate. In fact, based on its current trajectory, most observers expect the country to become the world's third-largest aviation market by 2020.

In some cities, the growth in air traffic has been astounding. In Bangalore, passenger air traffic has grown by almost 25 percent in each of the last 2 years. As Mr. Hari Marar, President and Executive Director at Bangalore International Airport Ltd notes, the tremendous growth in air traffic reflects both growing optimism in India's economy and the changing nature of India's economy.

"Particularly in Bangalore, our economy is fueled by the services sector, which is people-intensive and requires a lot of travel. At the same time, almost half of the workers in Bangalore's services sector come from outside of the city, so there is a lot of demand for air travel, not only for work, but also to see family and for leisure," he notes.

Breaking the choke hold

However, India continues to struggle with significant capacity challenges. By some accounts, just 75 of India's airports are fully

> New technologies will allow us to improve our overall sustainability by helping us track and reduce our use of resources.

operational. And in the largest urban areas, airports are bursting at the seams. Indeed, up until 2008, Bangalore was served by a single-runway airport with capacity for just 3.6 million passengers per year.

Bangalore's new airport, *Kempegowda International Airport*, opened in 2008. It now handles more than 22 million passengers per year, with plans to expand capacity to 50 million passengers by 2021. In part, the additional capacity will be achieved through the development of new assets. A second runway is nearing completion and a second terminal is now being constructed.

Yet, as Mr. Marar notes, new facilities will only be part of the solution. "In the past, expanding capacity meant pouring more concrete. But, today, we are focused on finding ways to better utilize our existing capacity. Our belief is that, going forward, India's main challenge will be to build smaller and smaller airports that can handle larger and larger volume of passengers."

The technology to soar

Technology will be key to achieving those goals. "The game changer will be technology," asserts Mr. Marar. "In today's airports, passengers spend an inordinate amount of time in queues waiting to be processed. But if we apply better technology, we can start to process passengers as they walk through the airport, and that would allow us to utilize our existing capacity much more effectively."

Mr. Marar also expects technology to help improve operational efficiency by improving coordination between the various entities at the airport. "By creating a seamless exchange of information between all parties, we can deliver better customer experiences, achieve better operational efficiencies and improve key metrics, such as on-time performance and baggage handling."

Technology will also allow the airport to better serve customers and improve the overall customer experience. Mr. Marar notes that, in part, this will be achieved by improving passenger access to airport information which will enhance transparency and overall satisfaction. However, it will also allow the airport to better understand its customers and to create experiences that are better tailored to specific customer needs.

Mr. Marar expects technology to help deliver on a range of other key objectives as well. "New technologies will allow us to improve our overall sustainability by helping us track and reduce our use of resources," he says. "It will also allow us to improve employee engagement and satisfaction which, in turn, influences operational efficiency and customer satisfaction."

Creating the right environment

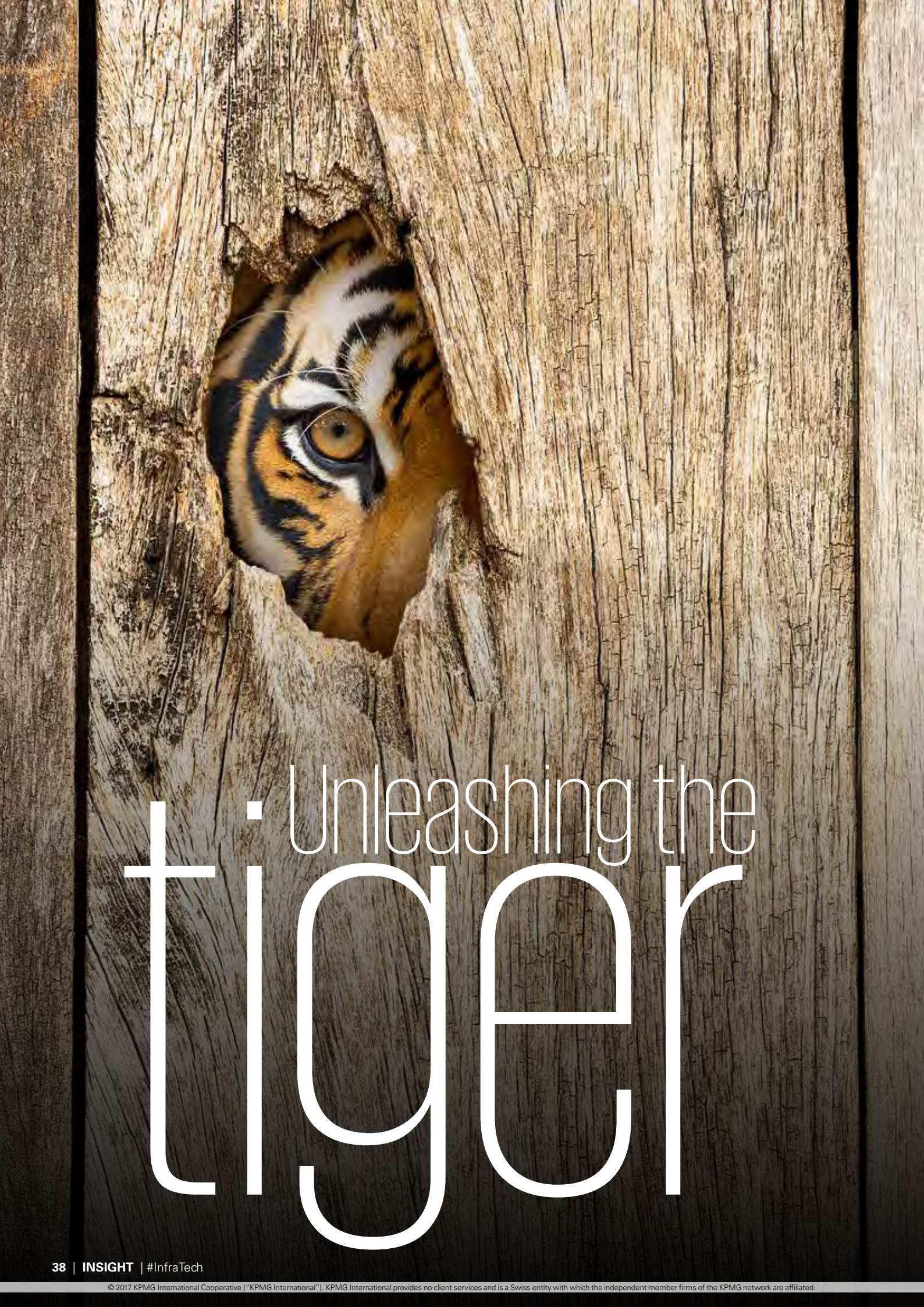
While Mr. Marar has high expectations for technology, he also recognizes that technology is only part of the solution. Other structural and market reforms will also be needed if India is to meet the massive growth in demand for air travel.

"From a structural capacity perspective, I worry that our airports will get choked in the big metro cities within the next decade and we'll need new urban centers and airports in these new urban centers to take on that load," he notes. "The airlines, too, will need to rethink their business model to move towards a far more distributed system than they have in the past."

At a national level, Mr. Marar suggests better integration between various modes of transport will be critical to delivering a better transportation solution to India's citizens. "For travelers, the problem is how to get from point A to point B as quickly, safely and conveniently as possible. The problem is that, in India, we look at the various modes of transport in silos. We need to improve the integration between aviation, rail, road and shipping to deliver the transportation solutions that customer actually want."

Looking ahead, Mr. Marar is hugely optimistic about India's air and transport industry. "Every market has risks but, in our case, I believe these risks are very manageable. Our regulatory regime has matured significantly over the past few years and investors are now almost guaranteed a healthy rate of return," he argues. "At the same time, our government has proven itself to be extremely proactive and reform-oriented, which enables growth and encourages risk-taking."

All signs suggest that India's air travel market will continue to grow and prosper. "It's a very exciting market right now and there are massive opportunities for foreign investors, developers and technology companies," he suggests. "India's airports sector is a great place to invest for the long term." ■



Unleashing the tiger

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It has been just 3 years since Prime Minister Modi's announced the Make in India campaign and Foreign Direct Investment (FDI) has jumped by almost 70 percent. At the city, state and national level, India's governments are pulling out all the stops to encourage investment.

When Prime Minister Modi came to power in 2014, India's rapid economic growth seemed on fragile footing. The global recession had reduced foreign investment into the BRIC countries and there were growing concerns that India's booming economy may sputter as investors shifted to safe-haven markets.

At the time, the *Make in India* campaign looked ambitious. More than just another advertising campaign, Modi's government aimed to institute significant regulatory reform in a massive effort to reduce red tape and attract new foreign investors into key industry segments including railways, defense, insurance and medical devices.

As Mr. Deepak Bagla, Managing Director and CEO of Invest India, boasts, "India has been successful in transforming the notorious red tape into a red carpet. More than 1,200 obsolete laws have been repealed. And a Business Reform Action Plan has been rolled out in an effort to enhance the ease of doing business and to help annually rank states since 2015."

Removing the thorn of regulation

At the same time, Invest India was set up as the first point of reference for potential investors. "India has a multi-tiered federal structure of governance, which adds a certain degree of complexity in starting and running a business," says Mr. Bagla. "Invest India provides sector and state-specific inputs, as well as 'hand-holding' support to investors through the entire investment cycle. We are the first point of reference for potential investors."

To simplify the investment process, the government has also launched a single window government-to-business portal known as eBiz. The portal provides online access to core services needed to obtain the necessary clearances, licenses and complete mandatory tax registrations, as well as composite application forms for around 20 central services and several state government services.

Many state governments have also instituted single window clearance mechanisms. The Government of Andhra Pradesh, for example, has created a single window process for more than 55 different approval requirements, with a goal of delivering clearances within 21 days of application.

"Twenty-one days is the outer limit," says Solomon Arokiaraj, Secretary of Industries and Commerce for the State of Andhra Pradesh. "There are 10 clearances that can be delivered 'on the spot'. And there is another class of services which get cleared within 7 days. In the past, it took between 60 and 90 days to get these clearances. Today, around 80 percent of them are cleared within 7 days, and close to 98 percent within 21 days."

Paving the road to investment

While reform has been a key tenant of Prime Minister Modi's ambitious plan, the central and state governments are also keenly focused on providing the right infrastructure to support India's industrialization goals.

"India is creating world-class infrastructure in roads, railways, air and shipping sectors," notes Mr. Bagla. Some schemes, such as the Delhi-Mumbai Industrial Corridor are focused on improving national infrastructure and improving industrial connectivity across the country. "But we also need to create and augment dedicated export infrastructure to sustain and accelerate this growth," he adds.

In Andhra Pradesh, these initiatives and investments are helping drive further investment at the state level. "We see the industrial corridor development approach as the key to attracting new investment," explains Mr. Arokiaraj. "On top of the funding provided by the Asian Development Bank, the state government is also chipping in another US$215 million to improve infrastructure, create logistics parks and enhance water and power supply."

Over the next few years, Andhra Pradesh plans to develop eight new ports and six new airports to improve connectivity and encourage export growth. The state will also develop seven new industrial 'nodes' along the planned Industrial Corridors, as well as a number of sectoral 'zones' focused on 10 priority sectors (such as automotive, aerospace and defense, electronics and textiles).

The tiger roars

By all accounts, these government initiatives are paying off. In Andhra Pradesh, for example, the state has attracted new investments from a number of major auto parts suppliers and at least two major automotive OEMs, Isuzu and Kia Motors. "Kia Motors and their subsidiaries are investing almost US$2 billion into our state to set up an ultra-mega integrated automobile project," boasts Mr. Arokiaraj. "It's one of the largest foreign direct investments India has seen over the past few years."

The state has also gained significant accolades for its efforts to improve the investment climate. It was named 'State of the Year' by CNBC; it was ranked first in India for Ease of Doing Business; and it was recognized as the top destination for private foreign investment in 2016. "Foreign investment is flowing into the State," Mr. Arokiaraj adds.

India's central government is also receiving very positive feedback and increased investment from its initiatives. "Our strategic partnership model for the defense sector is encouraging collaboration between Indian firms and foreign OEMs, creating an estimated US$335 billion in potential defense projects," notes Mr. Bagla. "The phased manufacturing program (PMP) is estimated to increase mobile manufacturing in India to 500 million units by 2019, of which 120 million phones are likely to be exported."

Of course, the most important proof is in the national numbers. According to a recent press release by the Ministry of Commerce and Industry, FDI inflows jump to US$60 billion in 2016–17 from US$36 billion in 2013–14. Over the past 3 years, the country's manufacturing sector enjoyed growth of 14 percent over the previous 30 months.

As the *Make in India* campaign notes, "Today, India's credibility is stronger than ever. There is visible momentum, energy and optimism. *Make in India* is opening investment doors. The world's largest democracy is well on its way to becoming the world's most powerful economy." ■

A better place to live: Housing as an infrastructure sector

Kathleen Llewellyn-Thomas
General Manager of Community Services with the City of Vancouver

Anne Kerr
Global Head — Cities at Mott MacDonald

Leslie Gash
Vice President of Development at Waterfront Toronto

Where people live and work has a massive impact on the way we plan and develop infrastructure. And, today, there are a growing number of cities that view housing as a key part of the infrastructure mix. Yet, as the need for housing evolves and demand for services changes, many city and government leaders are wondering whether their housing strategies are fit for purpose.

To learn more about how housing strategies are changing — and influencing civic infrastructure — we sat down with three housing leaders: ***Anne Kerr****, Global Head — Cities at Mott MacDonald;* ***Kathleen Llewellyn-Thomas****, General Manager of Community Services with the City of Vancouver; and* ***Leslie Gash****, Vice President of Development at Waterfront Toronto.*

Ed: Why is housing moving up the government and social agenda?

Kathleen Llewellyn-Thomas (KLT): I think many governments and leaders recognize that the housing market does not always meet the needs of the local population, particularly in terms of household size and affordability. We know we can't stop urbanization, so the big question is how we can accommodate more people affordably in a constrained area. At the same time, governments are looking at demographic shifts and trying to assess what the housing needs will be in the future.

Anne Kerr (AK): I absolutely agree. Availability and affordability are real challenges around the world and particularly relevant in parts of Asia and the Far East. Migration into cities is happening at an alarming rate, putting huge pressure on the housing and affordable housing markets. Up until today, the response has often been to encourage people out of cities and into more distant communities, where housing may be more available and reasonably priced. But the problem is that people then lose community connections and can be disconnected from their work and the city community.

Leslie Gash (LG): Right. And I think that has led governments and city leaders to take a more holistic view of housing that incorporates factors such as transportation, social cohesion, sustainability and economic development. In many cases, governments are looking to improve the availability of family housing in the center, not only to help people live closer to their work and reduce travel times, but also to increase densities in those areas where good infrastructure already exists, thereby helping the city function more smoothly and efficiently.

Ed: How is this impacting the way housing is planned?

AK: Governments and planners recognize that they need a much more dynamic mix of development in their cities. And that means thinking about more than just affordability. So now, they are building their strategic plans to reflect a range of other considerations, such as the availably of employment and transport. There's a growing recognition that land, transport and residential strategies need to be fully integrated with changing employment opportunities for housing to really contribute to the vibrancy of a city.

LG: One of the big challenges is how to deal with some of the legacy issues. Past housing strategies actually created a lot of isolation. In many cases, it created a separation between low-income neighborhoods and more affluent neighborhoods: streets that don't connect to the rest of the city; lighting and security issues; communities that were 100 percent rent-geared-to-income housing. The big question is how you move from that toward more mixed communities and dynamic developments.

KLT: I absolutely agree. And I think that is leading cities to think more about the types of housing and the types of services they need to provide, either in the community or perhaps in the same building, to create inclusive and well-run communities, where people feel connected and supported. And that may not mean replacing all the housing stock, but rather, thinking about how you preserve the community aspects while expanding the model and increasing the density of the area to build social resilience into the community.

Ed: How are cities encouraging the development of better housing stock?

LG: Land value capture strategies are supporting the development of new and revitalized housing stock in Toronto. As we redevelop our older housing estates, we are entering into public private partnerships where the land value is used to support and rebuild the communities. The idea is that by selling or leasing that land for condominium development, we are also improving the availability of new private rental stock and encouraging developers to include a mix of low-income and affordable housing.

AK: Hong Kong has taken a similar approach, with a key role being played by the development of the mass transit railway (MTR) lines. Simplistically put, land values appreciate around the new stations to create attractive development opportunities that include commercial space and residential space, which incorporate below-ground and above-station development. And that is encouraging a much more integrated community with transit, commercial opportunities and housing all in the same location. The model has proven to be a big success and is now being used in cities around the world.

KLT: We're also using policy tools in Vancouver to encourage a better mix of housing stock development. We have an inclusionary housing policy that asks developers in certain zones to allocate 25 percent of their stock to affordable or low-income housing. We also have expectations for how much of the development is built to meet family requirements, versus building massive towers filled with one-bedroom and bachelor apartments.

Ed: How are technology and demographic trends influencing the housing strategy?

AK: Technology has been a huge help to developers and planners. At the highest level, we're using new technologies, data and analytics to help cities and governments conduct really good, appropriate and logical collective planning at a much faster rate than ever before. At the asset level, you're seeing massive innovation in the way houses are designed and built, with the inclusion of 3D printing and other advanced techniques. With new materials being developed and used to make the houses we build much more efficient and resilient.

KLT: I think we're also going to see new pressures and considerations arise as a result of the circular or shared economy. It hasn't changed the way we think about supply yet, but it is starting to influence the way people think about housing and affordability. We don't want to get in the way of homeowners and renters finding supplemental income that could mean the difference between paying their rent or not paying rent. So, we're also thinking about how we bring about shared-economy regulation to bring those types of transactions into the regular economy.

LG: Taking that idea slightly further, we're starting to talk about some of the other impacts of the shared economy. We've started to see people — non-family members — enter into shared ownership agreements for houses. And we're seeing many people, millennials in particular, delay housing purchases until later in their lives. And both of those trends are impacting housing availability. It won't be enough to reduce demand for new and affordable housing, but it may influence the way we build and develop homes in the future.

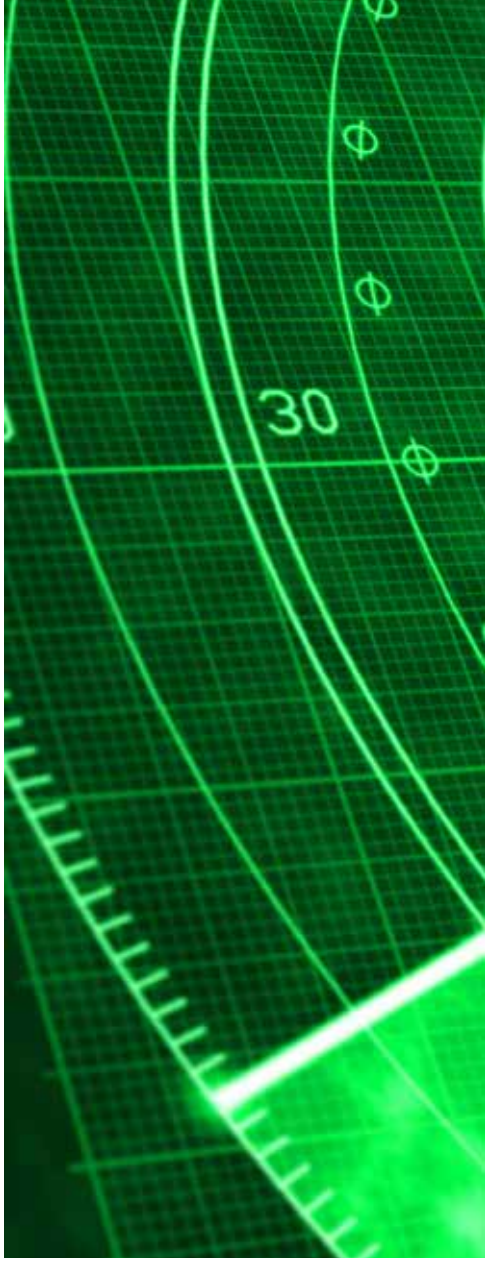
Ed: What role does civic infrastructure play in delivering on the housing strategy?

KLT: Civic infrastructure plays a massive role in helping create the communities we want to see. One of the key goals is to increase densification as a way to make better use of the existing infrastructure — water pipes, sewage, transit systems, fire and police services and garbage collection, for example. I think it also means a change in the way we plan and develop those assets. We need to think about the housing, employment and mobility connections. Investing in affordable housing on transit is important and just as important is planning for living wage jobs on transit lines too.

LG: Densification around existing infrastructure is central to improving the value and reach of those assets. But it is also key to enhancing the resilience of a community and housing development, both from a social and a physical perspective. Around the world, we are seeing the importance of building resilient communities and cities, not just to protect against climate risks, but also sociopolitical ones. And that requires strong and resilient civic infrastructure.

AK: I actually think we are going to start to see much stronger links between housing and infrastructure. I've spent a lot of time talking to city and government leaders about how they can design assets to take on a 'second life' after they have outlived their initial purpose. We're already seeing this happen after major sporting events. For the London Olympics, some assets were built in a way that allowed them to be dismantled and converted into new uses once the games were over. And I think we need more of this kind of thinking in our everyday infrastructure decisions. ■

Navigating infrastructure planning and investment



The G20's Global Infrastructure Hub has created a number of online tools to support better planning and investment in infrastructure. ***John Kjorstad****, an associate director with KPMG's Global Infrastructure team, explores how governments and investors should use these tools to make better decisions.*

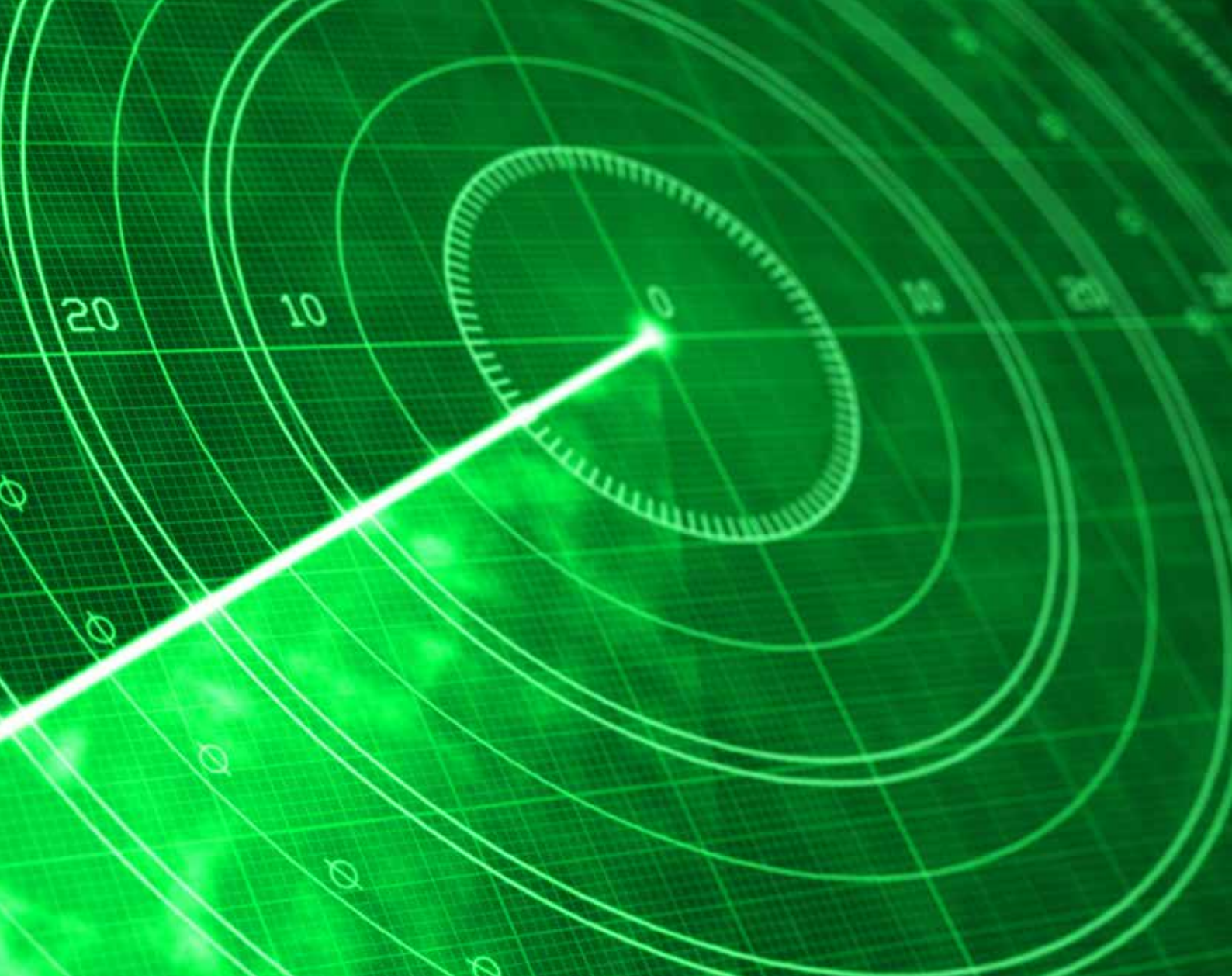
Sailing on open seas without navigation is, at best, aimless and at worst, reckless. The tools of navigation that maritime professionals have used throughout history have changed dramatically. Yet, the core tenets of understanding position, direction and destination have not.

Effective infrastructure planning requires a similar compass. While not inherently bad, developing and operating infrastructure in silos is imperfect and leaves society exposed to projects promoted through self-interest (be it individual, departmental, political or financial). The lack of influential governance and holistic planning equates to drifting without navigation for executive leadership in the public sector.

If a city, region or country's strategy is not clear, or the paths to achieve it are uncharted, then public servants risk investing billions in infrastructure without fully achieving the benefits citizens expect. This leads to inflated budgets, 'white elephants' (infrastructure that is expensive to maintain and difficult to justify even after completed) or worse yet, abandoned unfinished projects that tarnish a country's reputation. Public leaders love to cut ribbons, but no one wants to leave behind a decaying monument to poor leadership and reckless public spending.

It doesn't have to be this way. There are relevant examples of countries of different population sizes all over the world developing holistic, cross-sector strategies that improve internal policy frameworks and enhance delivery capabilities beyond disruptive political cycles. There are organizations, such as the OECD and the World Economic Forum, that are collecting data, measuring efficiency and promoting international best practices. The challenge, until recently, was knowing where to look for relevant benchmarks, recognizing performance beyond a single data point and understanding the nuances of the varied sources that exist.

Launched by the G20, the Australia-based Global Infrastructure Hub (GIHub) is mandated to grow the global pipeline of quality, bankable infrastructure projects and navigate governments and investors. By facilitating knowledge



> Foreigners coming to Slovakia compare what they can see here with what they have seen in other countries. Benchmarking can help us with setting the right direction for future infrastructure development.

sharing, highlighting reform opportunities and connecting the public and private sectors, GIHub aims to increase the flow and quality of opportunities for private and public infrastructure investments. InfraCompass (http://infracompass.gihub.org) is one of GIHub's insightful navigation tools, helping governments and investors better understand their position, direction and destination when planning infrastructure investment.

The experience can be enlightening as well as informative. Last summer, I used the InfraCompass in a presentation to the office of the Deputy Prime Minister's Office for Investments and Informatization of the Slovak Republic. While they were already well aware of their infrastructure challenges, the GIHub's findings provided a constructive framework for a deeper discussion around indicators where the country scored well and others that might require some attention. It also allowed us to compare Slovakia to its peers and reflect on why different countries are apart in specific areas.

"Being an EU member state and enjoying the benefits of the single market mean every day benchmarking, whether we like it or not. Inevitably, our citizens compare our infrastructure with that of Austria, Germany, France or with our regional peers, the Czech Republic, Hungary and Poland," said Peter Pellegrini, Deputy Prime Minister of the Slovak Republic for Investments and Informatization. "This works the other way around as well. Foreigners coming to Slovakia compare what they can see here with what they have seen in other countries. Benchmarking can help us with setting the right direction for future infrastructure development."

"Another aspect of benchmarking is linked to private investment in infrastructure. Slovakia is the member of the Eurozone. Fiscal discipline in the euro area imposes certain limits on budgetary spending. It is in our interest to make the projects attractive to private investors. In addition, the private sector is a driving force of innovation, efficiency, effectiveness and transparency."

Q&A

Peter Pellegrini
Deputy Prime Minister of the Slovak Republic for Investments and Informatization

Q: Why does Slovakia want to invest in infrastructure?

When Slovakia joined the European Union in 2004, a huge imbalance existed with respect to the level of development and quality of infrastructure between the so-called new member states and the EU15. Slovakia and its peers from Central and Eastern Europe started benefiting from massive transfers from the European Structural Funds and the Cohesion fund. The funds were primarily directed to infrastructure projects, mainly related to transport and municipal environmental infrastructure. In addition, they supported activities in the area of research, education and human resources. Despite some progress in a number of the above-mentioned areas, key infrastructure has remained incomplete and requires further investment. Indeed, infrastructure still calls for special attention.

Q: What are the greatest infrastructure challenges Slovakia faces in terms of what is measured by the GIHub's InfraCompass (governance, regulation, permitting, planning, procurement and delivery)?

Clearly, our greatest challenge is to address the absence of long-term planning. We need to define clear priorities in infrastructure development which would become immune to electoral cycles. Infrastructure is, by definition, a long-term asset. In addition, the preparatory phase of complex infrastructure projects takes on average 8 years — well beyond the standard 4 year political cycle. There is another consideration linked to the long-term nature of infrastructure projects — its potential attractiveness for private capital. Private investors prefer governments with predictable intentions not subject to frequent revisions or changes. Coherence in the decision making is key.

Q: How would you like to reform or improve Slovakia's existing policies?

Our new approach includes the introduction of the strategic planning function at the central government level. My office (the Office of the Deputy Prime Minister for Investments and Informatization) was established in June 2016 and has been mandated to prepare a first National Infrastructure Plan (NIP) — a document similar to those of the United Kingdom, Australia or other advanced countries. We understand the NIP as an integral part of the strategic planning framework by which the governments, present and future ones alike, will support the long-term priorities of Slovakia´s national development. The NIP will identify the key investment priorities and the projects for Slovakia up to 2030 in the area of economic and social infrastructure. Right at the beginning, we realized that setting the priorities is enormously difficult, given the existing conflict between the country´s huge needs and the limited availability of public funds. In order to prioritize between different needs, we have started a visionary exercise to imagine the country in which we all would like to live in 2030. The vision will embrace all three dimensions of sustainable development in line with the UN Agenda 2030 and serve as a guide for respective line ministries to align their own priorities with those identified in the vision and to propose projects and programs by which they intend to deliver them.

Other elements of the strategic planning framework include two key documents — I should rather say 'methodologies' — both approved by the Government. The first is a handbook for public servants on how to write a good public strategy and the other prescribes the principles and rules governing preparation of the cost-benefit-analyses of individual projects. The next step — and I must say that it is very challenging — is to introduce a whole-of-government approach and remove existing silos across the government. We won't face this challenge alone, as the OECD will come to help us.

Funding not financing, governance not project preparation

There are two great myths in global infrastructure development. The first is that there is a shortage of capital available to address the needs and gaps identified to support economic growth and the United Nation's Sustainable Development Goals. While the needs and gaps are certainly real, as outlined by another GIHub initiative, the Global Infrastructure Outlook forecasting tool (https://outlook.gihub.org/), the bigger problem is knowing how projects will ultimately be paid for. This is funding, not financing — and a well governed society has to prioritize spending and know its limits.

The second great myth relates to project preparation. It is often suggested, particularly by those who say the problem is funding, not financing, that there are not enough bankable, well-prepared projects to invest in. Yet, there has never been more international support earmarked for project preparation than there is now. Tools such as the Sustainable Infrastructure Foundation's (https://public.sif-source.org/) and hundreds, if not thousands, of willing development-minded global experts, have enormous reach and resources supporting project preparation wherever the lack of capacity and expertise within governments presents itself as a prickly issue.

In reality, international investors are primarily concerned about capital preservation and a long-term return on investment. The apprehension they may feel venturing beyond traditionally vanilla and privately financed infrastructure markets is driven primarily by long-term confidence in a country's governance. This includes the rule of law that enforces contracts, insolvency recovery and, critically, assurance that society will pay for the projects that governments fund for the duration agreed.

Confidence is measured independently by credit ratings and is far more important in the eyes of investors than ticking boxes to establish an individual project's readiness. That is not to say that financing and project preparation are not important. It's to say that this industry spends too much time talking about these two issues, whereas if proper funding and long-term governance are in place, financing and project preparation will take care of themselves.

Q&A

Otacílio Magalhães
Business Solutions Director
at Banco do Brasil S.A.

Q: Why does Banco do Brasil support Brazilian infrastructure investment?

"Brazil needs more services, especially in energy and transportation, to manage the country's growth potential. By 2025, Brazil's agribusiness exports will grow 40 percent as production increases by more than 65 million tons. Transport is linked strongly to agribusiness production so Brazil will need to improve its roads, railroads and ports to meet this expected demand while reducing the time and cost of delivering products to market.

Q: What are the greatest infrastructure challenges governments face in terms of what is measured by the GIHub's InfraCompass (governance, regulation, permitting, planning, procurement and delivery)?

Investors are looking for mature regulatory environments, attractive interest rates and positive returns. Brazil is getting some attention right now because of the government's recent law concerning the PPI (Investment Partnerships Program). The law established a private investment partnership program that will generate revenues and boost the country's infrastructure investment.

Rule of law is also important to investors and equally strong in Brazil. For example, there aren't cases of the government breaking contracts with the private sector. By tracking and comparing these issues across countries, I think the InfraCompass will help investors make decisions about which markets they are going to invest in.

One point which I would like more information on is regarding discount rates. It would be helpful to see what valuations and discount rates other countries are using to finance infrastructure projects. Perhaps, the InfraCompass could be used to capture this as an improvement in the future.

Q: How would you like see Brazil's existing infrastructure policies reformed or improved?

Brazil has a good track record of private investment in power generation and transmission lines. Transportation is growing and on a good path. What is necessary is more investment in water and sewage and waste treatment. However, these sectors are not concentrated in the federal government and each municipality has the authority to promote its own PPPs. This can be a challenge for investors. It would be better if we could make the regulation stronger and more centralized like in other countries.

The most relevant point is that Brazil has growing demand. There are more passengers in airports, 30 million people don't have access to treated water, 50 percent of wastewater is not collected and only half of what is collected is treated. Agribusiness is exploring new harvest frontiers in the north and center west of Brazil and there is a lot of work to do to make the infrastructure in those regions more efficient.

Q&A

Andrew Greenup
Deputy Head of Global Listed Infrastructure Securities at Colonial First State Global Asset Management

Q: Why does Colonial First State Global Asset Management invest in listed-infrastructure?

We invest in global listed-infrastructure as we believe it provides attractive risk-adjusted returns from inflation protected income and modest capital growth. By investing in a globally-diversified, liquid portfolio of listed-infrastructure companies with high barriers to entry, strong pricing power, structural growth and predictable free cash flow, we aim to protect and grow our clients' wealth. As the 'baby boomer' generation retire, we believe the need for lower-volatility, income-producing assets like listed-infrastructure will increase over time.

Q: What are the greatest infrastructure challenges governments face in terms of what is measured by the GIHub's InfraCompass (governance, regulation, permitting, planning, procurement and delivery)?

In our view, the greatest challenge governments face is the 'planning and selection' of infrastructure. Too often, objective cost benefit analysis of the planning and selection process is overridden by political objects to the detriment of society as a whole. This politicization of infrastructure projects leads not only to sub-optimal resource allocation outcomes, but creates uncertainly as governments change with 2-to-5 year electoral cycles versus investors in infrastructure assets with 30-to-60 year life cycles.

Q: How would you like governments to reform or improve existing policies?

No matter where we invest in the world, we seek open, transparent regulation of infrastructure assets which provides a degree of certainty. We look for fair outcomes for all stakeholders: governments, customers, employees and shareholders. Fair outcomes in a transparent regulatory regime provide investors with the confidence to invest in an infrastructure asset. When the rules of the game are changed (i.e. new taxes, aggressive changes in the regulatory regime or different interpretation of concession contracts) to materially favor one set of stakeholders at the expense of others, this reduces confidence in the system. For investors, unexpected material changes can cause capital to flee and demand a higher rate-of-return for future investments to the detriment of all stakeholders.

Measuring progress, acting on insight

Countries seeking to chart a way forward for economic and social development might have a destination in mind, but do their governments truly understand where they are relative to where they want to be?

Policy makers, particularly those in dedicated infrastructure units or finance departments, have been encouraged to use the InfraCompass to identify where improvements and reforms are needed. InfraCompass transparently combines multiple independent and publically-available data sets in one convenient measure. Governments can dissect a country's performance in six key areas: governance, regulation, permitting, planning, procurement and delivery.

Each area can be drilled deeper for greater insight, so if a country is noted for having below average governance, the compass user might find that indicators on rule of law, control of corruption and lack of an infrastructure agency are three reasons why. Similarly, they might find that infrastructure quality and the lack of project finance activity has lowered a country's delivery capabilities.

In total, 49 countries are profiled and benchmarked against developed or emerging country averages through the InfraCompass platform's interactive visualisation of data. In addition, countries can be compared to up to six other countries as the GIHub tool helps people understand each country's market and points directly to where improvement is needed in relation to global best practices.

Emerging economies are catching up with developed countries in terms of the quality of their infrastructure. The list of top improvers over the past decade is dominated by emerging countries. Central to this strong performance is that many of these countries have seen rapid policy development, including better governance (through lowering corruption levels and enhancing the rule of law), improved regulatory quality and simplifying permit procedures and land administration.

Across economies, there are few stronger drivers of investment than the rule of law. Upstream enabling environment reforms are key to unlocking quality infrastructure in over 20 of the countries analyzed.

Who else should use the InfraCompass?

The compass is not only for governments. Bilateral and multilateral development banks, aid organizations, export trade and investment promotion agencies, private consultants, international investors, EPC contractors and suppliers — essentially anyone with a vested interest in global infrastructure development — will find it helpful.

Advisors can use it to support clients with strategic planning and technical assistance in both the public and private sector. This includes helping individual governments identify their infrastructure policy priorities or advising international investors on the markets that are best aligned to serve their preferred investment criteria. Investors and contractors can also use the compass as an additional triangulation point and validation source in their investment due diligence process.

Promotion agencies might use the InfraCompass to underline areas where their market performs well (or is improving) to attract more inwards investment. Export trade banks and international aid organizations might use it to see where their support will have the greatest impact for development and their domestic infrastructure businesses. ■

Q&A

Dr. Thia Jang Ping
Senior Economist at the Asian Infrastructure Investment Bank (AIIB)

Q: Why does the AIIB support infrastructure development?
AIIB sees infrastructure as critical to development. Economic development will require continuous investment in infrastructure. Integration between countries will require connectivity infrastructure. Even social development will require infrastructure. For example, when governments build homes, schools and hospitals, these need to be powered by electricity and connected by transportation. In short, infrastructure is a core and irreducible part of development. There is also a recognition that there has been an underinvestment in infrastructure, and the AIIB is thus set up as a bank that focuses on this area of needs.

Q: What are the greatest infrastructure challenges governments face in terms of what is measured by the GIHub's InfraCompass (governance, regulation, permitting, planning, procurement and delivery)?
The various aspects measured by GIHub are all very relevant. Broadly speaking, risk reduction (and also reducing the perception of risks) is the biggest challenge. In some countries, the key risks come from macroeconomic conditions, such as currency risks, interest rate spreads etc. (the policy aspect, as mentioned in GIHub's InfraCompass). In other countries, risks are higher at the implementation phases (delivery). The specific challenges will be different from country-to-country, but the overall objective of reducing risk to infrastructure remains key.

Q: What should governments do to improve their infrastructure policies?
The most important aspect is perhaps to ensure sound finance and economics. There should be an appropriate tariff and cost recovery model for the investment. This injects robustness in project selection and prioritization and also ensures fiscal sustainability. Where there is a need for public sector support due to positive externalities, there should be clarity in terms of cost and benefits. A sound and realistic appraisal of economics and finance will allow risks to be properly distributed amongst different parties and reduces the likelihood of ex-post uncertainty to project viability. Consistent policies to structure infrastructure investment based on sound finance and economics can go a long way to reducing investment risks.

Q&A

Laurence Carter
Senior Director for Public Private Partnerships at the World Bank Group

Q: Why do the IFC and World Bank Group support infrastructure development?
If you buy into the notion that there is a link between infrastructure and access to services to economic growth, then you understand why infrastructure is so important to our organization. The point, really, is about getting people better access to better public services — and it absolutely has to be sustainable. Multilateral development banks are working more closely than ever to increase development impact by mobilizing and operationalizing the G20's Hamburg Principles and Ambitions to crowd-in private finance.

Q: What are the greatest infrastructure challenges governments face in terms of what is measured by the GIHub's InfraCompass (governance, regulation, permitting, planning, procurement and delivery)?
A major challenge for many governments is capacity, especially in highly-specialized areas like infrastructure. This manifests itself in governance. It is increasingly important to have institutions that function well with decent project preparation, but those skills are hard for governments to develop and retain. Without strong governance, we see leadership undertaking procurement in non-competitive ways, state-owned enterprises combining regulation and execution, and sometimes regulation being ignored all together.

Q: What should governments do to improve their infrastructure governance?
They should, together with their development partners, invest more in the upstream part of the sector. There is too much focus on finance and not enough on governance and planning. This includes preparing programs through centralized infrastructure units aligned with fiscal support and clear authorization reflecting executive power that is sector neutral. When governments do this, we see a response. For example, preparing a pipeline of investable projects attracts more interest from investors. Once that infrastructure unit is place, and the coordination problems get taken care, there should be immediate improvements in development, delivery and operations.

Around the world in infrastructure

The Americas

US

Unblocking the water pipe

California's massive WaterFix Project took a solid step toward become a reality when the California Department of Water approved a resolution to issue US$8.8 billion worth of revenue bonds to support the planning and preconstruction phase of the project. The plan envisions the development of two four-story tall tunnels that will carry fresh water from the Sacramento River into the state's existing water projects. Once completed, the project is expected to serve fresh water to more than 25 million people and multiple commercial projects. A number of county water agencies have since agreed to buy into the bond offering.

Preparing for the future

The Pennsylvania Turnpike Commission is currently evaluating Statements of Qualifications from six consortiums interested in bidding for the Commission's Broadband Public-Private-Partnership project. The project is being developed as a design, build, finance, operate and maintain contract for a fiber optic network housed within the turnpike right of way. While the project is currently aimed at improving connectivity to the turnpike's cashless tolling system, administrative buildings and transport systems, it is also expected to play a significant role in delivering and managing future applications for connected and automated vehicles.

Canada

New transit for the capital

The City of Ottawa's Light Rail Transit 'Stage 2' project received a US$1 billion boost this summer from Canada's federal government. The project will add 35 kilometers of new rapid transit and 19 stations to the existing LRT system, bringing an estimated 70 percent of the city's population within 5 minutes of rail services. Stage 1, known as the Confederation Line, is already nearing completion and is expected to open in 2018. This next phase, with a total estimated price tag of US$3 billion, will begin construction in 2018 and is expected to be completed by 2023.

Improving connectivity in Toronto

A proposal to develop a new transit hub at Toronto's Pearson International Airport seems to be moving ahead. In August, the Greater Toronto Airport Authority issued an RFP for initial design consulting services for the proposed US$9 billion project and recent reports suggest the initiative is receiving positive support from the three levels of government involved.[1] Using existing airport land, the project will serve as an important connection point between multiple transit systems, including the regional GO Transit system, the TTC subway and LRT lines, the UP Airport Express and the Mississauga BRT, to improve connectivity and transit in the region.

GOing places

In a further boost for Ontario's transit systems, Canada's federal government announced a US$1.5 billion investment into Southern Ontario's regional GO Transit system as part of a project to improve regional express rail in the province. The investment is expected to help the GO Transit system to electrify existing trains, improve service frequency along the system's busiest routes and build more than 40 kilometers of new tracks. The investment is part of the federal government's Public Transit Infrastructure Fund which, according to government sources, has already seen funding flow to more than 300 transit projects in the province.

Jamaica

Bid process takes off

Jamaica's Norman Manley International Airport authority hosted a bidder's conference in September to promote the development of the new proposed airport. Structured as a private-public-partnership, the Request for Qualification process, which closed in May 2017, attracted nine potential bidders who are seeking to participate in the development and maintenance of the island's second-largest airport. An earlier round of applications conducted in 2015 failed to materialize and the government has since adjusted the terms of the agreement to better suit the international consortia involved.

Europe

The Netherlands

Relieving congestion on Rotterdam's roads

Preparatory work has begun on the new A16 Rotterdam bypass and three consortia have been shortlisted to bid for the contract. Financed in part by the European Investment Bank, the new motorway will connect the existing A13 to the A20 motorways, allowing traffic to bypass the north-east border of Rotterdam. With a total estimated cost of EUR1 billion, the project includes 11 kilometers of new roadway including a cut and cover land tunnel. The project, which is being procured as a design-build-finance-maintain PPP, will begin full construction in 2019 and the new roadway should open in 2024.

Spain

An extraordinary effort

The Government of Spain has announced a massive highway renewal program that aims to develop more than 2,000 kilometers of new roads over the next three years. The 'Extraordinary Road Investment Plan' will see franchisees assume the maintenance of the roadways for up to 30 years. Announcing a preliminary budget of around EUR5 billion, the government hopes to modernize the country's roadways and complete a number of projects that were put on hold as a result of the country's recent austerity program. In the coming months, the government also plans to

Source:
[1] https://www.thestar.com/news/canada/2017/10/12/momentum-builds-for-new-pearson-airport-transit-hub.html

launch similar large-scale programs in the high-speed rail and water sectors.

Norway

Go through it

The Norwegian Coastal Administration has received the green light to start planning the world's first ocean shipping tunnel. The 1.7-kilometer passage will cut directly through the Norwegian Stad mountain, requiring the removal of more than 3 million cubic meters of rock. Once completed in early 2023, the 37-meter-high, 26.5-meter-wide tunnel will be able to accommodate ships weighing up to 16,000 tons (large enough to support Norway's massive cruise ships and oil tankers). The project, which was included in Norway's most recent transportation plan, is estimated to cost more than US$330 million.

Asia

Asia Pacific

Focus on emerging cities

The Asian Development Bank's Future Cities Program seems to be continuing to generate positive results for the six cities now involved in the Technical Assistance scheme which aims to support integrated planning activities that address unique urban challenges. A recent report by the OpenGov.com website[2] suggests that the program has succeeded in attracting more than US$10 million worth of additional technical assistance programs and more than US$30 million in grants intended to bring some US$1 billion worth of projects through the pipeline.

Singapore

Improving waste management

Singapore's National Environmental Agency (NEA) is moving ahead with the development of an Integrated Waste Management Facility capable of handling several different waste streams to help improve the nation's waste management and recycling efforts. The facility, the first of its kind to be developed globally, will include a 5,800 ton-per-day waste to energy plant alongside facilities to manage to manage almost 1,500 tons-per-day of household recyclables, food waste and dewatered sludge. The project, which will be constructed in phases, will see the first treatment facilities come online in 2022.

Expanding the airport

Land preparation and construction efforts are underway at Singapore's Changi Airport to develop a third runway, a new 10 million square foot terminal and associated Automated People Mover and Baggage Handling systems. Changi Airport Group is currently looking for a Master Architect and Master Civil Consultant for the project. Costs are currently projected to run into the tens of billions of dollars with the first phase of the project slated to open in late 2020. Once completed, the new terminal and associated buildings will help increase the airport's capacity to more than 135 million passengers per year.

Vietnam

Firing up the PPP environment

Construction on Vietnam's Nghi Son 2 thermal power plant is expected to begin by the end of this year following government approvals in June of this year. The US$2 billion plant, made up of two 600 Megawatt facilities, will be structured as a build-operate-transfer project with a 25-year concession. The project is being financed by a consortium that includes Japan's Marubeni Corporation, the Korea Electric Power Corporation (KEPCO) and Japanese and Korean development banks. It is the first international tender project for a large-scale coal-fired power plant in Vietnam's history.

The Middle East

Kuwait

Achieving a vision

The Sheikh Jaber Al-Ahmad Al-Sabah Causeway Project is more than 80 percent complete and seems on schedule to open by the end of 2018.[3] The cable-stayed bridge, connecting Al-Sabiya City to Madinat Al-Hareer (also known as Silk City), is one of the longest cross-sea bridges in the world and will eventually cut travel times between the two cities by 75 percent. At a cost of approximately US$2.6 billion, the project should help reduce traffic congestion in the surrounding areas and help integrate the northern regions of the country with the densely populated central and southern region.

Africa

Djibouti

A new port for East Africa

Africa's most advanced port, the Doraleh Multipurpose Port, is now fully operational after 2 years of construction. The 690-hectare facility currently contains four separate terminals and six berths, with plans to expand to 15 berths during the second phase of construction. The port, which cost almost US$600 million and was jointly financed by the Djibouti Ports and Free Zones Authority and China Merchant Holdings, represents a major boost to regional trade.

Kenya

Biggest single investment since independence

The first section of the much-vaunted East African Railway Master Plan opened this year with Kenya's new railway from Nairobi to Mombasa. The US$13.8 billion project, which was mostly financed by the Export-Import Bank of China, will see trains travel at 120 kilometers per hour between the capital and Kenya's largest port, thereby reducing travel times from 12 hours to just 4. The East Africa Community anticipates that the railway will eventually be extended to Uganda, Rwanda, South Sudan and Ethiopia, further strengthening ties between the East African neighbors.

Egypt

Basking in the glow

Egypt's ambitious plan to develop the world's largest solar park moved closer to reality when the International Finance Corporation (a member of the World Bank Group) committed US$660 million toward developing 500 Megawatts worth of projects. This comes on the heels of similar US$500 million investment from the European Bank for Reconstruction and Development (EBRD) last June. Once completed, the project is expected to generate 2 gigawatts of energy, allowing Egypt to meet its goal of sourcing 20 percent of its power from renewable resources by 2020. ■

Source:

[2] http://www.opengovasia.com/articles/7644-exclusive---adbs-future-cities-program-building-the-jigsaw-one-piece-at-a-time

[3] http://www.kuna.net.kw/ArticleDetails.aspx?id=2625766&language=en

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Insight — The global infrastructure magazine

Insight is a semi-annual magazine that provides a broad scope of local, regional and global perspectives on many of the key issues facing today's infrastructure industry.

Issue No. 9 — Globalization

This edition offers our perspective on the impact of globalization on the infrastructure sector.

Issue No. 8 — Infrastructure Morality

This edition focuses on hard issues such as migration, corruption, social equality and affordability — and asks the difficult questions of infrastructure leaders at the forefront of the morality debate. It also includes a special report on asset delivery.

Issue No. 7 — Who controls our infrastructure?

This edition explores some of the big challenges and trends influencing the debate around infrastructure control. It also includes a special report on rail, a sector often at the epicenter of the debate around control.

Issue No. 6 — Population

This edition takes a closer look at the link between unprecedented population changes and demographic shifts underway and the infrastructure needed to meet these challenges. It also includes a special report on Asia Pacific's infrastructure market.

Foresight: A global infrastructure perspective

Foresight is a series of articles that feature our take on the most recent topics, trends and issues facing our firms' clients.

Brazil's latest privatization drive should prove attractive to investors

Brazil's government has announced a sweeping privatization drive that potential investors will no doubt be turning their attention to.

Energy2Go: The new battleground for energy customers

A combination of deregulation and technology is breaking down borders and could soon enable consumers to buy energy from a single provider, anywhere in the world.

Smart devices, smarter airports

Mobile technologies are creating valuable opportunities for the airport sector. But it will take more than slick new apps and devices to unlock the benefits of new technology.

Not all equity is the same: When contractors become equity investors

As public-private partnerships get larger and capital costs continue to rise, new equity investors and equity structures are starting to play a larger role in infrastructure delivery.

SPECIAL EDITION: Emerging trends in 2017

In the fifth edition of this special report, three KPMG's Global Infrastructure leaders share their views on new trends that will influence the world of infrastructure in 2017 and beyond.

India strengthens its commitment to infrastructure investment in 2017 budget

By pledging one of the highest ever levels of annual infrastructure spend, the Indian government has signaled its firm commitment to this vital sector.

Global Construction Survey

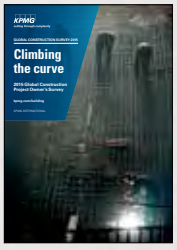
The Global Construction Survey monitors engineering and construction issues to provide timely insights that help clients make informed decisions.

Make it, or break it

The 2017 Global Construction Survey focuses on reimagining governance, people and technology.

Building a technology advantage

The 2016 Global Construction Survey reviews how the industry can harness the potential of technology to improve the performance of major projects.



Climbing the curve

The 2015 Global Construction Survey focuses on the challenges facing owners as they seek to climb the maturity curve.

KPMG's Global Infrastructure practice

Integrated services | **Impartial advice** | **Industry experience**

We believe that nobody knows infrastructure like KPMG. And nobody understands the local implications of globalization like KPMG professionals. Every day, our network of more than 2,500 highly-experienced people work shoulder-to-shoulder with infrastructure leaders across more than 150 countries to share industry best practices and develop effective local strategies.

Clients see a difference. They recognize that member firms tackle their unique challenges with a global mindset and local practicality. We challenge infrastructure to be better, integrating innovative approaches and deep expertise to help clients succeed transparently, sustainably, ethically and commercially. In today's rapidly-evolving global landscape, clients know KPMG professionals seek to offer trusted insight, actionable advice and market-leading services across advisory, tax, audit, accounting and regulatory compliance.

In times of disruption, we aim to inspire confidence and empower positive change in government organizations, infrastructure contractors, operators and investors. Member firms help clients ask the right questions that reflect the challenges they are facing at every stage in the lifecycle of infrastructure assets and programs. From planning, strategy, finance and construction through to operations, divestment and decommissioning, our Global Infrastructure professionals apply passion and purpose to help clients solve some of the most significant challenges of the twenty-first century.

By combining valuable global insight with hands-on local experience, we understand the unique challenges facing different clients in their individual markets and in the rapidly-evolving global marketplace. By bringing together valuable interrelated disciplines, including economics, engineering, project finance, project management, strategic consulting, tax and accounting, KPMG's Global Infrastructure professionals provide integrated advice that achieve effective results and help clients succeed.

For further information, please visit us online at **kpmg.com/infrastructure** or contact:

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Take the wheel, or don't

Are city streets ready for the autonomous vehicle?

Many governments are stepping up to help introduce autonomous vehicles onto our roadways and it's a matter of time before they become the preferred consumer choice. Working together, KPMG practitioners can help prepare cities for this shift in a safe and effective way. Because #InfraTech is here and we need to be ready for it.

Anticipate tomorrow. Deliver today.

KPMG