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FEATURE

The 2019 Deloitte City Mobility Index

Gauging global readiness for the future of mobility

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What does smart urban mobility look like, city-by-city? How are global cities faring so far? Learn the steps that cities can take to realize the future of mobility in the coming decades.

Where should cities go tomorrow?

A smart city is a data-driven city, one in which municipal leaders and citizens have an increasingly sophisticated understanding of conditions in the areas they oversee and live in, including the urban transportation system. In the past, regulators used questionnaires and surveys to map user needs. Now, leaders can connect the dots about people, places, and products using a vast array of data from the Internet of Things, artificial intelligence, and other digital technologies. Using this information, they can gain a more accurate picture in a much shorter time frame at a lower cost to more proactively develop informed decisions.

Yet leaders need to gather the right data, ask the right questions, and focus on where cities should go *tomorrow* when designing and implementing a long-term vision for future mobility. In dozens of conversations with transportation leaders all over the world, we have seen how easy it is to ignore, misinterpret, or skew this data to fit a preexisting narrative.[1]

Transportation plays an essential enabling role in a city's sustained economic prosperity.[2] Our goal was to create a new and better way for city officials to gauge the health of their mobility network and their readiness to embrace the future. The result is the Deloitte City Mobility Index (DCMI), a collection of *conscious choices* based on what we think smart urban mobility should look like that is refreshed annually. The DCMI is an in-depth exploration into the rapid changes occurring in the way people and goods move about, with intermodal journeys, active transportation options (such as sidewalks and bicycle lanes), and public transit playing a prominent role. The DCMI takes a holistic view of the city's entire mobility landscape, and it is informed by our clear image of how the future of mobility could unfold in urban areas.

This overview explains how we constructed the DCMI and discusses some of the key findings. It accompanies in-depth city profiles and an interactive feature, which will be updated and expanded over time.

Measuring urban mobility performance

To assess the situation across the globe, we went beyond what transportation looks like today to explore what mobility *could be* in a truly smart, liveable, economically vibrant city. Three key themes emerged from this research:

1. **Performance and resilience.** Urban mobility should be efficient. It's a given that the trains should literally run on time. But cities that scored highest in this category also offer multiple, integrated modes of transportation, ensure the system is relatively safe, and maintain roads and other infrastructure to minimize congestion and travel times. As air quality is frequently linked to congestion levels, we measure that, too.
2. **Vision and leadership.** The second theme analyzes how deliberate and forward-thinking a city's leaders are regarding its mobility needs. Creating a high-performing, resilient, and inclusive mobility system does not happen by accident. Urban mobility requires innovation, investment, coordination among stakeholders, and direction. The choices made should also minimize negative environmental impacts.
3. **Service and inclusion.** Urban mobility should be accessible to all residents. Exemplary cities

in this category offer widespread public transit coverage, affordable options, and user-friendly ways to access a variety of transportation modes.

With these three themes as our lodestar, we dug into the component pieces of each. (See sidebar, "The Deloitte City Mobility Index methodology.") We also created a Future of Mobility Capability scale to assess how ready cities are to face the approaching changes.

What we learned: Select findings from The 2019 Deloitte City Mobility Index

"WHAT'S PAST IS PROLOGUE"[3]—BUT NOT DESTINY

Some of the cities we looked at are centuries old; they reflect countless choices made by political leaders, businesses, and residents over time. Naturally, those circumstances, both geographical and political, shape today's mobility landscape, and affected their rankings in our index. Cities in which decision-making authority rests with multiple actors, like New York City and Washington, DC, often struggle with articulating and acting upon a cohesive vision for the future.

That said, many of the cities we profiled have shown a remarkable ability to overcome their circumstances through new approaches. The mobility profile of Columbus, Ohio, for example, is typical of many mid-sized American cities: car-dominated, with limited public transit but also limited congestion due to its modest size. Faced with rapid growth and critical shortcomings, especially when it came to key health outcomes, city leaders crafted an ambitious strategy to remake Columbus's transportation system into a model for smart mobility.[4] Even weather need not be a hindrance. Walking and cycling are most prevalent in Paris, Berlin, and Amsterdam—all northern European cities. Helsinki is a top performer, too, where it frequently snows!

DON'T OVERLOOK THE BASICS

It is easy to become enamored with the array of emerging mobility technologies entering the market. Relatively new modes like bikesharing and electric scooters, along with new ways to understand and connect existing assets through sensors and analytics, offer tremendous promise for cities. But leaders should be careful not to blindly chase the latest high-tech wizardry at the expense of getting the fundamentals right.

Even as nearly every aspect of our lives becomes increasingly digital and mediated by electronic devices, mobility at its core remains grounded in the physical world. For transportation officials, that means there is no substitute for ensuring that physical infrastructure and assets *work*: that roads and bridges are maintained and safe, that buses and trains are clean and reliable, that traffic lights function. For many, this is challenge enough. Globally, needed spending on infrastructure is already failing to meet basic upkeep demands, and the cumulative shortfall in funding for road infrastructure could balloon to more than US$7.5 trillion by 2040, according to the G20-sponsored Global Investment Hub.[5]

Authorities also need to create an environment where rules are respected and enforced and where citizens feel safe. In Nairobi, pedestrians represent 65 percent of traffic fatalities.[6] In the United States, that number is just 16 percent.[7] Rail service in Johannesburg is frequently canceled due to theft of overhead electrical cables.[8] Developed countries are not immune. Rome, for example, has a well-developed transit network and is working to reduce vehicle emissions, yet its aging public buses caught fire as many as 20 times in 2017 alone.[9] No surprise, then, that more than one-third of the consumers Deloitte surveyed in Rome rated their public transit system "poor" or "very poor" on the question of safety.[10] Without safe transportation options and a level playing field for all users—whether private sector providers or end consumers—city leaders will likely struggle to meet the mobility needs of their constituents.

While these efforts may not be as glamorous as creating a new app for citizens or deploying smart traffic lights, they are the *sine qua non* of a well-functioning transportation system—and may not always require massive investment in new infrastructure (see sidebar, "Bus rapid transit"). Digital technologies can be important enablers, helping cities identify problem areas through crowdsourcing or better understand the strengths and weaknesses of their services through big data and analytics.

INTEGRATION IS KEY

Cities with high population densities such as London, Singapore, and Berlin scored highest on transportation performance. With more people funding systems that cover less ground, these cities get more bang for their bucks. Cities with large geographic areas, such as New York and Chicago, tend to do better within city limits but do not perform as well in their larger exo-urban areas.

One reason for this may be the lack of integration, coordination, and effective governance among transportation regulators and providers between the city and the suburbs, and between public and private bodies. The city itself usually has one transit authority, surrounding areas have their own, and the level of cooperation between the various entities can vary widely. In many cities, private operators appear to act in competition—rather than concert—with public ones. And it's not just integration across administrative or regulatory bodies; even within a single authority, simply having coordinated timetables where, for example, bus drop-offs at transport hubs are timed to align with train departures can mean less time spent waiting, and more convenience for riders overall. While this is improving in many of the cities surveyed, it still has a way to go.

Our findings suggest that having multiple regulatory providers inhibits a smoothly functioning and integrated transportation system, but inter-agency coordination can be successful. In Toronto, for example, the Toronto Transit Commission operates the subway network and buses within the city, while a multitude of smaller authorities (YRT/Viva, MiWay, and others) operate buses in the surrounding municipalities and the commuter rail network is operated by a provincial agency. The various municipal authorities operated independently—for years, passengers traveling between regions required multiple tickets and, apart from a few exceptions, travelers who crossed municipal boundaries had to pay two fares. However, since the creation of a regional transit authority, Metrolinx,

BUS RAPID TRANSIT

Pioneered and perfected in Brazil, Colombia, and Mexico, bus rapid transit (BRT) is a solution developed in emerging markets that can—and should—be exported to other cities around the world. As the name suggests, it is a bus-based transport system, but these are no regular city buses weaving in and out of traffic on busy city streets, making stops every few blocks. Using segregated bus-only lanes, often in the middle of the road, along dedicated corridors, requiring ticket purchase at the platform or station to speed up boarding, and giving priority to intersection crossings, BRT buses can move as many people as subway systems, with a much lower infrastructure load—and cost. In Bogota, the system can, at its peak, run over 2 million passengers per day on over 100 km of bus lanes.[11]

For cities that struggle with issues around infrastructure funding, planning, execution, or upkeep, a BRT system can be up and running in less time, with less cost, and less disruption to busy thoroughfares than building or expanding a traditional underground rail system. This can make it easier to deploy a BRT, and provides additional flexibility to change routes, allowing fast-growing cities to more easily service new neighborhoods and commuting corridors. As the City of Los Angeles' Seleta Reynolds observes, "It is not a mystery to us anymore how to do fast, cheap, high-quality, reliable, frequent transit service" using BRT. "But it's about convincing people to give up a lane of traffic for a bus."[12]

and the region's "Big Move" plan in 2009, integration has proceeded in stages. When completed, this multiyear endeavor will integrate fare payment across a single platform, allowing users to pay fares with a single card across the network.[13]

As cities grow and expand and housing costs rise, many young families have little choice but to move to the suburbs and commute into the city for work. Too often, it becomes clear that the only viable commuting option is driving; absent a single authority or close coordination among multiple authorities, public transportation can be too complex and time-consuming to utilize. But driving private cars adds to congestion, pollution, and parking challenges, not to mention the financial burden it places on individuals. In some cases, people find that the lower costs associated with a move outside of the city core are offset by car ownership costs or expensive travel passes. City governments would do well to work together with their surrounding regions to fix this issue, and to do so quickly.

There is also a direct tie between the presence of multiple regulatory authorities and service providers and having a lower ability or willingness to explore innovative solutions. In our index, the leading innovations include *smart parking and ticketing*, *integrated payments*, *intelligent transit systems*, and *electric vehicle infrastructure*. For any of these efforts to succeed, they often need to be offered across commuting corridors and interagency (regulatory body) coordination and cooperation are required. Data integration, governance, and security are also easier with more tightly-linked governing bodies.

It is now easier than ever, and ever more important, to integrate transport provision with some measure of public preference. Too often transport systems are planned, integrated, and managed from the perspective of the operator. Integration with the citizen is an afterthought. That approach is increasingly untenable as the increase in data has contributed to the rise of customer-focused, on-demand travel that has often competed with the public service. Cities will need to work hard to make the public system more convenient and user-friendly if they are to keep ridership up.

Finally, the data suggests that more than any other indicator, having low levels of integration is correlated with low readiness to face the future of mobility. Creating seamless urban transportation demands a unity of purpose and an ability to act in concert across different modes and jurisdictions (and international boundaries—see the sidebar, "Integrating across borders").

THE CHALLENGES OF PRIVATE CARS

Our vision for smart urban mobility emphasizes active transportation and public transit. This means any city that relies heavily on private cars—as many US cities do—will fare poorly on several metrics in the index. Many analyses, including ours, highlight the deleterious consequences caused by an over-reliance on private autos, which include congestion, pollution, and accidents.[14] If cities continue to grow—and the Organisation for Economic Co-operation and Development (OECD) predicts that 70 percent of the world's population will live in urban areas by 2050[15]—then public and private players need to find ways to move people and goods in ways that maximize use of space and minimize such social costs. As figure 2 indicates, more people can share the same street if they opt for shared or active modes of travel, rather than sit in single-occupancy personal cars.

As we have expanded the geographic coverage of the Deloitte City Mobility Index, the trade-offs associated with private cars have become more and more clear. Private cars can work well in some circumstances and are an important piece of the mobility landscape; in Columbus, for example, ample space and modest size mean road congestion is currently moderate. However, congestion seems increasingly ubiquitous globally, even as the root causes vary. Many of the North American cities we studied, such as Los Angeles, Atlanta, and Chicago, have "grown up" with the automobile, are geographically spread out, and have become dependent on private car use. Despite significant emphasis placed on road improvements and expansions, these cities have failed to keep pace with demand. Indeed, in a well-known paradox, more supply (roads) tends to beget more demand (traffic).[16] In contrast,

INTEGRATING ACROSS BORDERS

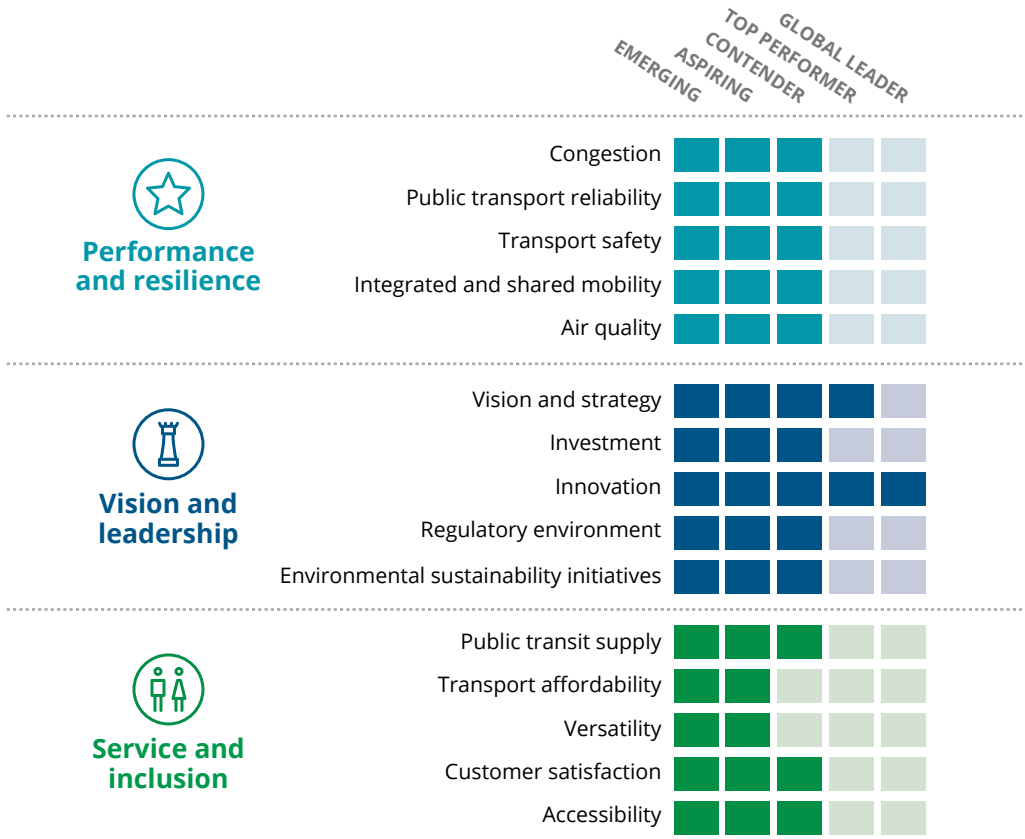
Integrating governing authorities across a city's effective transportation network is one of the most important success factors in our research—and one of the most difficult to achieve. Imagine, then, the complexities of enabling the frictionless movement of people and goods between two sovereign countries. That's the challenge being embraced by a pair of US cities and their Canadian counterpart. Michigan's Detroit and Ann Arbor and Ontario's Windsor have been working with the World Economic Forum to explore how the principles of a seamlessly integrated mobility system can be brought to life.[17]

The Detroit-Ann Arbor-Windsor region is a leader in automotive innovation, providing new mobility solutions and championing cross-border projects such as AV testing and the world's longest smart corridor. Pilots are underway, testing new forms of transit and novel partnerships with employers using e-scooters, on-demand microtransit to the suburbs, AV shuttles, and ridesharing.

Based on our analysis of the integrated region, to leverage these inherent strengths the region needs to address issues such as high private vehicle use. It would benefit from a more inclusive public transport network and increased collaboration between suburban and city authorities. A well-integrated transport network will further boost the region's economic revival.

FIGURE 1

Detroit–Ann Arbor–Windsor integrated mobility analysis



Source: Deloitte analysis.

FIGURE 2

Space needs when moving the same number of people by bus, bike, and car—each image represents the same number of people

Source: We Ride Australia.

many European cities predate the invention of the automobile and have streets poorly suited to accommodating heavy car use; absent wholesale reconstruction of often-historic urban centers, no amount of smart planning or technology is likely to relieve the challenges associated with cars in certain areas. And elsewhere, in India, Africa, and Latin America, congestion can often be traced to poor use of roads (including rampant illegal parking) and deficient supporting infrastructure (such as traffic signals and intersections). Given these disparate factors, how cities manage private cars as part of their overall transportation landscape is likely to continue to vary widely.

Still, cities that rely heavily on personal vehicles should explore ways to optimize their use. For example, by augmenting private ownership with carsharing and ridesharing, perhaps as part of an integrated multimodal solution, it may be possible to keep the cars-to-people ratio in check—or even reduce it. And cars are often the fall-back option when the first mile/last mile problem is unsolved. Our research suggests that if getting to public transportation is a problem, people will get in their cars … and won't get out until they reach their destination. Creating convenient and affordable solutions for the beginning and end of a journey—think bicycle-sharing, dynamic shuttles that adjust routes based on demand, and ride-hailing, ideally integrated via a full-fledged mobility-as-a-service offering—can help reduce reliance on personally owned vehicles.

CULTURE'S ROLE IN TRANSPORTATION

A city's mobility system will ultimately be shaped by its culture and "terroir" and have its own distinctive local flavor.

Geography plays a massive role in mobility, and this is something that leaders should consider when looking at other cities for inspiration. Spread-out cities tend not to rank highly for active transportation. This is no surprise; for most people, cycling across a large city is not a viable option. While it is relatively easy for cities like Amsterdam and Helsinki to do well in this regard, their recipes for success may be hard to replicate in a sprawling metropolis such as Los Angeles.

The role of culture is also much more important to the development of a transportation system than many would assume. Casual ridesharing is common in cities such as Washington, DC (where it is known as "slugging") and New York, but less so in other US cities. Similarly, Amsterdam is quite famous for its cycling culture, but this is not as common in other cities, even those with similar geographic and population profiles.

Then there is the issue of social attitudes toward public transportation, such as "bus stigma" and the cultural importance placed on owning a car. Cities can spend billions to upgrade their transportation systems, but if the public perceives taking a bus or train is a second-class option compared to driving, public transport passenger numbers will not increase—as was the case for Denver (not included in our survey).[18] Car ownership is deeply ingrained in the American psyche, is reinforced by decades of advertising by automakers,[19] and is an increasingly important status symbol in China.[20] Overcoming those cultural barriers could be particularly challenging for transportation planners. They should consider ways either to work with prevailing beliefs, or to find ways to shape them gently.[21]

Remaking your mobility landscape

Our research found that mobility plays a central role in a city's economic prosperity. This is why the rewards for getting it right are potentially great. Looking for out-of-the-box solutions to solve their problems, leading future of mobility cities demonstrate that finding money is rarely a long-term solution. Their success tends to stem from intelligent integration and innovation rather than sheer investment.

For cities that have scored relatively poorly across specific indicators, all is not lost. Given the speed of change and technological trends, any city has the opportunity to radically remake its mobility landscape over the next five to 10 years. Cities that rank poorly today could leapfrog to become leaders in the future of mobility by deploying advanced solutions that solve some of transportation's perennial problems.

Leaders need to identify what the "right" kind of spending is. In our experience, spending on integrating systems and introducing technological improvements typically produces better returns over time. While adding more service or building more roads can be helpful, developing better-integrated strategies with greater involvement from the private sector often yields better results. In these scenarios, the government often takes on different roles, such as enabling data sharing, monitoring cybersecurity, incentivizing private sector innovation and participation, and establishing the standards and rules by which mobility providers must abide.

DCMI METHODOLOGY

We chose more than 60 unique data parameters based on a review of existing literature, their correlations with economic growth, and our research team's analysis. Data was gathered from a variety of sources, including government statistical databases, third-party reports, private vendors, and nongovernmental organizations. We then brought in the qualitative judgments of a variety of experts both inside and outside Deloitte on urban mobility or particular cities.[22]

We assigned each metric a score between 1 and 5 based on the data parameters within it. Depending on the metric, score assignment involved converting a qualitative assessment into a number, indexing data to create a relative score, or both. We applied some data parameters and metrics to more than one theme.

To look specifically at a city's readiness for the future of mobility,[23] we focused more closely on the parameters that dealt with "smart" or "digital" elements of transportation. In particular, the DCMI looks at *integrated and shared mobility*, *vision and strategy*, *innovation*, *regulatory readiness for the future of mobility*, and *ease of use*. The metric scores were then averaged. "Five" indicates being closest to full future of mobility readiness. (Figure 3.)

The data was collected for the years 2016 and 2017 (or earlier where newer data did not exist). Unless specified otherwise, this information is no more than five years old. In some instances, trend data was collected, but predominately the data was cross-sectional for the latest year.

In all, we examined more than 50 cities. (Profiles of 18 cities were published in January 2018 and additional cities were added in the following months.) Cities were selected to achieve geographic distribution, a variety of sizes (population and area), and various levels of economic development.

Of course, any effort to create a composite measure such as this is a product of choices and assumptions made along the way. Ours were guided by a view of how seamless urban mobility that is faster, cheaper, safer, and cleaner than today could look, and the important contribution such a system can make to prosperity and productivity. Places that had multiple modes of easily accessible transportation; that had placed an emphasis on walking, biking, and public transit relative to personally owned automobiles; and that had taken steps toward digitally enabling their mobility network received high marks. Different choices and assumptions, guided by a different vision, would necessarily yield different results. In addition, the DCMI currently presents a snapshot, not a trajectory. It does not capture how cities have trended over time, nor can it evaluate how past investments have affected mobility. As we update the data every year, a more robust picture will emerge.

FIGURE 3

Deloitte City Mobility Index themes, metrics, and data sources

THEME	METRIC	EXAMPLE DATA	
Performance and resilience	**Congestion**	• Peak hours spent in congestion • Congestion level	• Driving time to city center (10 km drive from each cardinal direction, peak hours) • Dedicated bus lane in km
	Public transport reliability	• Percentage of metro/tram delays • Percentage of bus delays	• Average waiting time for public transportation (in minutes)
	Transit safety	• Road quality • Walkability score	• Number of traffic-related fatalities • Number of traffic-related serious injuries
	Integration and shared mobility	• Existence of open data or APIs for transport • Existence of integrated ticketing option across transport modes • Carsharing system in the city	• Bikesharing system in the city • Existence of MaaS-based application • Private car dependency
	Air quality	• Annual mean of PM2.5 concentration • Annual mean of PM10 concentration	• Carbon dioxide per capita emissions • Air quality index
Vision and leadership	**Vision and strategy**	• City innovation and Future of Mobility strategy	• Regulatory collaborations and joint initiatives with the private sector and academia
	Investment	• Transport budget as a percentage of the total local authority/city budget	• Investment levels in transport
	Innovation	• Electric vehicles (EVs) adoption • Existence of open data or APIs for transport • Smart transportation/FoM-focused accelerators/venture capitals/startups	• City rank in IESE Smart Cities index • City innovation and Future of Mobility strategy • Existence of MaaS-based application
	Regulatory environment	• Operation of ridesharing companies • Number of regulatory bodies • City innovation and Future of Mobility strategy	• Regulatory collaborations and joint initiatives with the private sector and academia • Autonomous vehicles (AVs)–city support
	Environmental sustainability initiatives	• Transport sustainability score • Sustainability plan score • Length of bicycle lanes (in km) • EV incentives	• Cars sold/registered in given year that are low carbon dioxide (BEV or PHEV) • Dedicated bus lane (in km) • "Environmentally friendly" modal share (includes public transport, walking, and cycling)
Service and inclusion	**Public transit supply**	• Rail system length (in km) • Number of light rail stops • Length of bicycle lanes (in km)	• Metro/subway average peak frequency (in minutes) • Dedicated bus lane (in km) • Average waiting time for public transportation (in minutes)
	Transport affordability	• Monthly public transport cost (in US$) • Fuel price per liter (in US$) • Average parking price (in US$) • Average cost of taxi (in US$)	• Minimum daily wage (in US$) • Modal share divided into percentage of trips by cars, public transport, cycling, walking, and other modes such as taxi, ferries, etc.
	Versatility	• Presence of tube or commuter rail system • Presence of tram system • Operation of ridesharing companies • Carsharing system in the city	• Presence of dedicated rapid bus transport • Presence of other modes of transport: rickshaw, taxis, ferries, etc. • Bikesharing system in the city • Private car dependency
	Customer satisfaction	• Customer satisfaction with public transport I • Customer satisfaction with public transport II • Road quality	• Congestion level • Average waiting time for public transportation (in minutes)
	Accessibility	• Transport accessibility score • Accessibility of bus fleet (in percentage)	• Accessibility of train or metro fleet (in percentage) • Walkability score

Source: Deloitte analysis.

Endnotes

1. City leaders are not alone in this. Corporate goal-setting is plagued by similar biases and challenges when it comes to assessing current performance and setting future goals. See Michael E. Raynor, Mumtaz Ahmed, Derek M. Pankratz, and Rob Del Vicario, "A theory of relativity: Setting priorities and goals for financial performance improvement," *Deloitte Review* 17, July 27, 2015.
2. Sir Rod Eddington, *The Eddington transport study: Transport's role in sustaining the UK's productivity and competitiveness*, HM Treasury, The Controller of Her Majesty's Stationery Office (HMSO), December 2006.
3. William Shakespeare, *The Tempest*, Act II, Scene 1.
4. The city of Columbus application, "Smart city: The city of Columbus," March 31, 2016.
5. Infrastructure Outlook, *Global infrastructure outlook,* accessed October 17, 2018.
6. Overseas Development Institute, "Road safety in Nairobi: At the crossroads," accessed October 17, 2018.
7. Richard Retting, *Pedestrian traffic fatalities by state: 2017 preliminary data*, Governors' Highway Safety Association, February 2018.
8. Thembelihle Mkhonza, "Cable theft, vandalism suspends Johannesburg train services," *Independent Online*, April 25, 2018.
9. Gaia Pianigiani, "Rome is burning (or at least its buses are)," *New York Times,* May 10, 2018.
10. Deloitte, *2018 global automotive consumer study: Exploring consumer trends on the future of automotive retail,* accessed December 11, 2018.
11. Wikipedia, "Bus rapid transit," accessed December 11, 2018.
12. Scott Corwin and Derek M. Pankratz, *To live and drive in LA*, Deloitte Insights, September 26, 2018.
13. Metrolinx, "The big move: Baseline monitoring report," September 2013.
14. See, for example, Graham Cookson and Bob Pishue, "INRIX global traffic scorecard," February 2017; Federico Karagulian et al., "Contributions to cities' ambient particulate matter (PM): A systematic review of local source contributions at global level," *Atmospheric Environment* 120 (2015): pp. 475–83; World Health Organization, "WHO global urban ambient air pollution database," 2016; OECD, *The Cost of Air Pollution: Health Impacts of Road Transport* (Paris: OECD Publishing, 2014); Jonathan I. Levy, Jonathan J. Buonocore, and Katherine von Stackelberg, "Evaluation of the public health impacts of traffic congestion: A health risk assessment," *Environmental Health* 9, no. 1 (2010): p. 65; and Erik Hansson et al., "Relationship between commuting and health outcomes in a cross-sectional population survey in southern Sweden," *BMC Public Health* 11, no. 1 (2011): p. 834.
15. Organisation for Economic Co-operation and Development and China Development Research Foundation, *Trends in urbanisation and urban policies in OECD countries: What lessons for China?*, August 27, 2010.
16. Gilles Duranton and Matthew A. Turner, "The fundamental law of road congestion: Evidence from US cities," *American Economic Review* 101, no. 6 (2011): pp. 2616–52.
17. Peter Vanham, "World Economic Forum teams up with cities in Michigan and Ontario for seamless integrated mobility," The World Economic Forum blog, June 28, 2018.
18. Andrew Small, "Denver radically expanded its transit. So why are more people driving cars?" Citilab, November 2, 2017.

19. Derek M. Pankratz, Sarah Kovac, Jordan Sanders, and Philipp Willigmann, "Framing the future of mobility," *Deloitte Review* 20, January 24, 2017.

20. Tania Branigan, "China and cars: A love story," *Guardian*, December 14, 2012.

21. Richard H. Thaler and Cass R. Sunstein, *Nudge* (London: Penguin Books, 2009). See also Deloitte Insights' collection on behavioral economics and management.

22. The sources of data included:
    - **2thinknow data**: Data sources purchased from 2thinknow, a research company based in Australia that focuses on analysis of cities. Data points include metro/subway average peak frequency, taxi rate per km, traffic-related injuries and casualties, and others (14 data points in total).
    - **Government statistical databases**: Including census reports, economic statistics, and geographical information.
    - **City and state/province websites**: Including US Department of Transportation, city transport authority websites.
    - **External reports and indexes**: Including Movmi Shared City Mobility Index, INRIX Global Traffic Scorecard, TomTom Traffic Index, Waze Driver Satisfaction Index, IESE Smart Cities Index, Arcadis Sustainability Index, Easy Park Smart Cities Index, Moovit average waiting time for public transportation survey.
    - **NGO reports**: These include the road quality rating provided by World Economic Forum, Particulate Matter (PM2.5 and PM10) reports by World Health Organization, European Alternative Fuels Observatory, OECD, CDP, and American Public Transportation Association.
    - **Qualitative analysis**: Done mostly by the Deloitte USI team. For example, evaluation of EV and AV regulation, operation of ridesharing companies.

23. See Scott Corwin, Joe Vitale, Eamonn Kelly, and Elizabeth Cathles, *The future of mobility: How transportation technology and social trends are creating a new business ecosystem*, Deloitte University Press, September 24, 2015; and Scott Corwin, Nick Jameson, Derek M. Pankratz, and Philipp Willigmann, *The future of mobility: What's next?,* Deloitte University Press, September 14, 2016.

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Deloitte's Smart City | Smart Nation practice strives to bring the full breadth and depth of the firm's capabilities to help cities tackle their toughest challenges. The SC|SN practice has developed a Smart City framework and solutions that help cities improve the quality of life for citizens and contribute to the sustainability of urban landscapes. The practice has delivered innovative strategies and solutions in cities across the globe, earning Deloitte recognition as a worldwide leader in Smart Cities strategy and execution.

About the Future of Mobility practice

The entire way we travel from point A to point B is changing. This transformation is creating a new ecosystem of personal mobility, with implications affecting more than just the automotive industry. Our Future of Mobility practice serves the entire ecosystem of companies working in and around mobility to actively shape its emergence. For the full interactive index, visit the Deloitte City Mobility Index at www.deloitte.com/insights/city-mobility-index. For Deloitte's insights on the Future of Mobility, visit www.deloitte.com/insights/future-of-mobility.

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