



2019 Autonomous Vehicles Readiness Index

**Assessing countries' preparedness
for autonomous vehicles**



KPMG International

kpmg.com/avri

Quick reader guide

The Autonomous Vehicles Readiness Index (AVRI) is a tool to help measure 25 countries' level of preparedness for autonomous vehicles. It is a composite index that combines 25 individual measures from a range of sources into a single score. More information on the results, methodology and sources used is in the [Appendix](#).

The intended core audience for the AVRI is public sector organizations with responsibility for transport and infrastructure. It should also be of interest to other public and private sector organizations that are involved with, or make use of, road transport.

This report uses the term 'autonomous vehicles', abbreviated to AVs, to refer to the technology used both within vehicles and externally, such as digital networks and road infrastructure. It also uses AVs to refer to vehicles that can do everything a traditional vehicle does without human intervention, sometimes described as 'level 5 automation', where vehicles are fully self-driving and the human driver becomes a passenger. The terms AV and driverless car are used interchangeably, although this report also covers autonomous buses and trucks.



Index results

Rank		Country	2019 score
2019	2018		
1	1	The Netherlands	25.05
2	2	Singapore	24.32
3	n/a	Norway	23.75
4	3	United States	22.58
5	4	Sweden	22.48
6	n/a	Finland	22.28
7	5	United Kingdom	21.58
8	6	Germany	21.15
9	8	United Arab Emirates	20.69
10	11	Japan	20.53
11	9	New Zealand	19.87
12	7	Canada	19.80
13	10	South Korea	19.79
14	n/a	Israel	19.60
15	14	Australia	19.01
16	12	Austria	18.85
17	13	France	18.46
18	15	Spain	15.50
19	n/a	Czech Republic	14.46
20	16	China	14.41
21	n/a	Hungary	11.99
22	18	Russia	8.55
23	19	Mexico	7.73
24	20	India	6.87
25	17	Brazil	6.41



Contents

05

Foreword

Richard Threlfall on how the AVRI has evolved and what AV adoption will mean for society.

06

Introduction

How governments can harness AVs' ability to increase road safety, improve public transport and freight, and even reshape cities.

08

2018 milestones

Last year's key events in the development of AVs.

10

Executive summary

Overview of the top 5 countries, methodology updates and key actions countries can take.

12

National profiles

Policies, events and companies in each of the 25 countries with commentary from KPMG's national AV experts.

40

The road ahead

What governments can do next, and how KPMG's member firms can help.

42

Appendix: Results and methodology

Detail on the data and methodology used to build the AVRI.

Foreword

A year ago, our first *Autonomous Vehicles Readiness Index* sought to raise awareness of the transformational social and economic benefits that autonomous vehicle (AV) technology could offer society.

It felt like a conversation in its infancy. Since then, through 2018, we have seen a huge acceleration in investment in AV technology, in policy adoption by governments to encourage AVs, and in media coverage of the topic.¹ Countries and states including the Netherlands, the United Kingdom, Australia, France and California have passed or are passing legislation opening AVs' access to public roads. Trials are underway from Singapore to Madrid to Gothenburg.

To help maintain the momentum, we published this second edition of the index. It adds five new countries (Czech Republic, Finland, Hungary, Israel, Norway); new measures including consumer opinion on AVs; and provides greater insights into individual countries, drawing on the expertise of colleagues in KPMG's national firms.

The Netherlands and Singapore again claim first and second place, respectively; the former benefiting from its European leadership in transport public policy, the latter from its brilliance in attracting investment from global technology leaders.

But many of the overall scores are very close and there are numerous opportunities, identified in this report, for countries to make significant progress. Those that did would rise quickly in the rankings. The most successful countries have a policy framework that enables innovation, a strong track record in technology, high-quality road and digital infrastructure, and populations that are eager to adopt new technologies.

I continue to believe that the social benefits of AV adoption will be enormous in reducing road deaths, improving accessibility for the young, old, disabled and those in remote communities, and driving economic growth. By sharing the best national achievements, I hope the AVRI will continue to accelerate the pace of this revolution.



Richard Threlfall
Global Head of Infrastructure
KPMG International
 @RThrelfall_KPMG



Introduction

Governments around the world are working on how they can deliver AVs' anticipated societal benefits. These include the prospect of much-improved road safety, more efficient public transport and freight services, and cleaner cities with more room for people and green spaces. There are also potential challenges to mitigate, including big changes to labor markets and industries including motor insurance, privacy and cybersecurity risks, and greater suburban sprawl.

Safety

1.35 million people were killed on the world's roads in 2016, up from 1.25 million in 2013, according to the World Health Organization,² with studies suggesting that human error causes at least nine in 10 accidents.³ Removing human error risk by moving to AVs should therefore deliver an enormous reduction in vehicle-related deaths — something that is important to remember, in light of the first death caused by the testing of AVs, as well as one from the use of a partially autonomous car, in 2018.⁴

Vehicle makers looking to reassure the public about AVs could follow the aviation industry, where aircraft makers have embedded safety in their processes. Airlines share information and learn from accidents on a no-blame basis. Modern passenger aircraft are regularly flown by autopilot software, albeit with the supervision of human pilots — and in 2017, there were no fatalities at all in commercial passenger jets.⁵

Public transport and freight

Despite the focus on when driverless cars will be available, autonomous minibuses are already providing passenger services in countries including Norway, Sweden and France, and AVs are likely to be as important in transforming public transport as they will be for private cars. They will allow public transport providers to move from fixed-route, fixed-timetable bus services to on-demand autonomous alternatives, which would efficiently and effectively take people from door to door.

Freight is set to be another early adopter of AVs. The Netherlands, for example, is working with Germany and Belgium on establishing 'truck platooning' — where one human-driven vehicle leads a convoy of autonomous ones — on major roads. In the US, it is predicted that soaring increases in delivery vehicle miles traveled (VMT) could reach 78 billion VMT per year by 2040, to meet the consumer demand for same-day or same-hour delivery.⁶ There is also strong potential for AVs in closed environments such as ports. Such use will help combat the increasing scarcity and cost of drivers in some countries, with the median salary for an American driver on a national, irregular route having risen 15 percent since 2013.⁷

As a possible result, some fear a rapid disappearance of driving jobs, which are a major source of employment with 4.8 million people in the 28 European Union (EU) countries alone.⁸ However, there are reasons to expect that the replacement of professional drivers with technology will be gradual, with software initially taking over some elements of driving but with people still required for the likes of close maneuvering.

The future of cities

AVs should lead to much cleaner and efficient use of roads, as well as making them safer. Much of this will result from the shift from fossil fuels to electric vehicles (EVs), with most AVs expected to run on electricity. In September 2018, the United Kingdom joined Canada, China, Finland, France, India, Japan, Mexico, the Netherlands, Norway and Sweden in pledging that at least 30 percent of new vehicles sold will be EVs by 2030.⁹ Norway has already exceeded this target, and enters the AVRI this year in third place, partly as a result of its advanced adoption of EVs.

One of the greatest benefits in efficient road use will come from public authorities being able to track and optimize the flow of vehicles. This will require standardized protocols to allow data to travel to and from vehicles. To comply with privacy laws such as the EU's General Data Protection Regulation, which



came into force in May 2018, personal data will need to be separated from that needed to guide vehicles. The data-sharing environment is also important as it enables greater collaboration between government and private industry on AV development, so this year's AVRI adds a new measure assessing this.

As well as making more efficient use of roads, AVs are likely to change city landscapes — although this might take different directions depending on how usage develops. If AVs lead to less car ownership, less urban space will be needed for roads, parking and garaging, potentially allowing higher population densities and more green space. If people prefer to own AVs then they may choose to live further from work, leading to more low-density suburbs, more road traffic and a need for daytime parking for their AVs, although this could be on the edge of cities rather than next to offices.¹⁰

Insurance and other industries

AVs will have effects far beyond the road transport sector, not least because almost every organization makes use of

transport to deliver its goods and move its staff or clients. There are likely to be some surprising industry-specific impacts (see box).

Insurance may see particularly big changes. A 2014 actuarial analysis by KPMG in the US suggested that the personal automotive insurance sector could shrink by 40 percent within 25 years, with the number of accidents per vehicle dropping by 80 percent.¹¹ In 2017, the Bank of England predicted a fall in motor insurance premiums of 21–41 percent by 2040.¹²

There are many uncertainties over the effects of AVs, both in time-scale, degree and direction. What does seem certain is that a wide range of organizations, both government and private-sector, will be profoundly changed by their adoption. For the countries that can manage these changes, AVs offer benefits on safety, efficient road-use, better public and freight transport, and the chance to reshape cities around humans rather than vehicles. As the results of the second edition of the AVRI show, some countries are already well on their way.

Examples of how AVs may affect specific industries

- **Policing:** fewer resources may be needed to police roads with AVs programmed to obey traffic laws.
- **Healthcare:** fewer traffic accidents may mean less demand for emergency surgery and fewer organ donors. AVs may make it easier for older and infirm people to travel to appointments, allowing greater centralization of services.
- **Air and rail:** fewer passengers on some routes if AVs allow users to relax or sleep their way to long-distance destinations.
- **Media and advertising:** AV users freed from driving could turn their attention from audio to video, written word and social media; advertising could be targeted by location, potentially subsidizing the cost of travel.
- **Power generation:** EVs including AVs, will increase demand, but ability to choose when to charge at home could boost variable-output renewable power.
- **Power grids:** home charging will require strengthened local grids, but smart control of when to charge as well as use of plugged-in vehicles as batteries could smooth demand.

2018 milestones

January:

Norway legalizes testing of AVs on public roads, with driverless minibus services starting in several locations later in the year.¹³

February:

Chinese government allows first official tests of AVs on public roads.¹⁴
German coalition government agreement includes plans to legislate for AVs by 2021.

March:

Dutch infrastructure minister announces legal framework for AVs, including equivalent of driving license for self-driving vehicles and work on truck platooning.¹⁵
Death of pedestrian in Arizona in the United States (US) during an AV trial.¹⁶

April:

California Department of Motor Vehicles lifts requirement that AVs must have a human driver to take over in emergencies.¹⁷

May:

European Commission transport commissioner announces plans for European rules governing AVs and investment in road and telecoms networks.¹⁸

June:

Japanese government plans to start tests of AVs on public roads with goal of offering self-driving car service for 2020 Tokyo Olympics.¹⁹

July:

Ford creates new AV division with plan to invest US\$4 billion by 2023.²⁰
Uber ends development of self-driving trucks to focus on cars.²¹

October:

Waymo starts charging passengers in Phoenix, Arizona, for rides in its AVs.²⁴
Australian government establishes an Office of Future Transport Technologies to prepare for AVs.²⁵

December:

A Swedish start-up and German logistics company announce they expect regulatory approval shortly to run driverless trucks on public roads.²⁷

August:

UK Parliament passes legislation meaning insurers will be liable for damage caused by AVs when in self-driving mode.²²
Russian company Yandex launches what it claims is the first autonomous ride-hailing service in Europe, in Innopolis, and later in Skolkovo.²³

November:

Ford, Walmart and delivery start-up Postmates announce US trial using AVs to deliver groceries.²⁶



Executive summary

Methodology

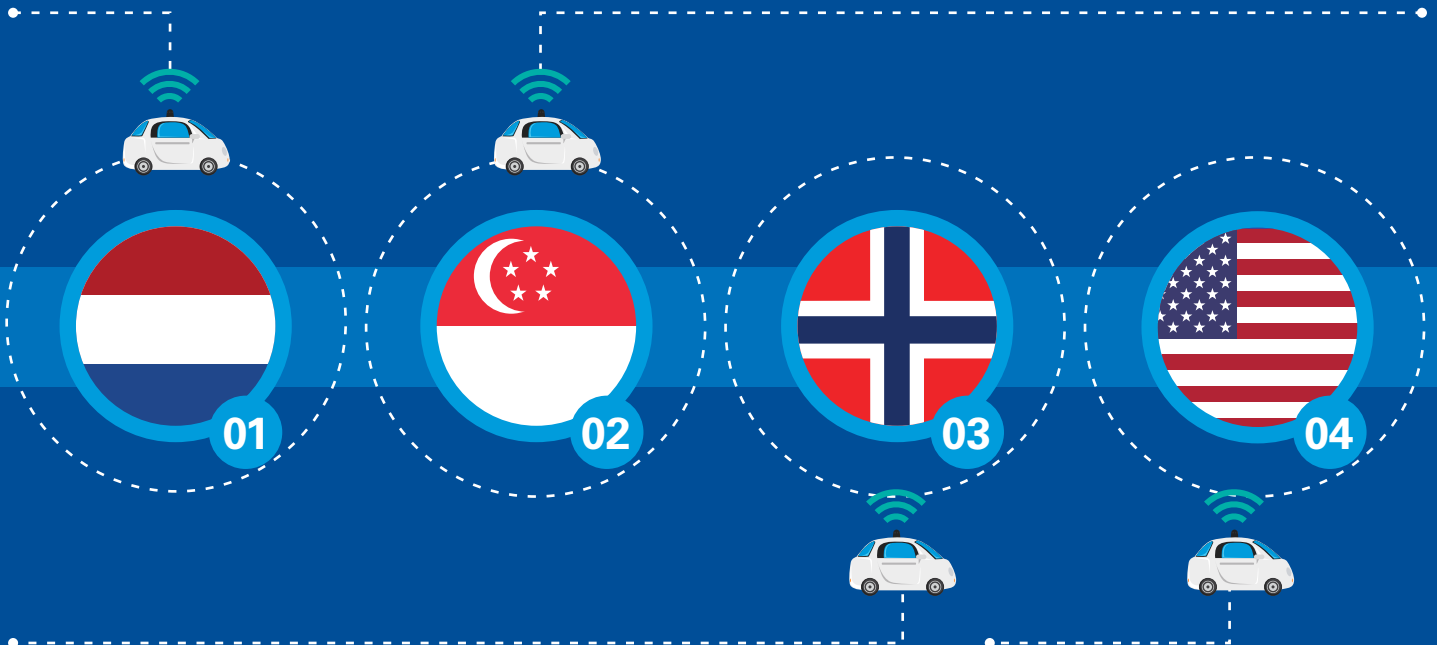
This edition of the AVRI assesses 25 countries on 25 different variables, organized into four pillars. Four of the variables are scored for this index by KPMG International and ESI ThoughtLab; one uses a consumer survey conducted for this report; and the rest use existing research by KPMG and other organizations. Full details are in the [Appendix](#).

The Netherlands Page 14

- The AVRI's leading country is working with neighbors to adopt AV technology for freight, with a plan to launch platoons of more than 100 driverless trucks on major routes from Amsterdam to Antwerp and Rotterdam to the Ruhr valley.
- It is introducing new laws that will encourage AVs, something also pursued by the UK, Australia and France among others.
- The Dutch government is taking an active role in AV safety and legal issues, with the infrastructure minister announcing a 'driving license' for self-driving cars in a March speech.

Singapore Page 15

- With a leading university, Singapore has created a test town for driverless vehicles complete with traffic lights, bus stops, skyscrapers and a rain machine to recreate its extremely wet tropical weather.
- Next year, it will introduce self-driving minibuses in several areas, including a university campus — an approach already taken in Norway and France.
- Singapore, along with Hungary, leads a specific measure on having a single government organization that deals with AVs, which improves AV coordination and reduces confusion around who does what.



Norway Page 16

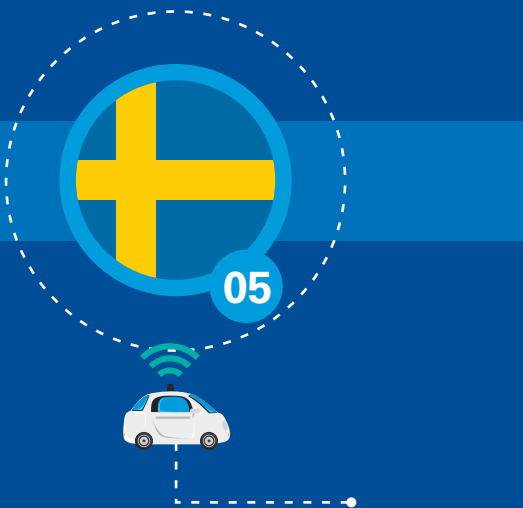
- The country legalized AV testing on public roads in January 2018, giving clarity for providers and leading to trial bus services in several locations.
- As a result of significant tax breaks, 40 percent of new cars sold in Norway are electric, many having some autonomous functionality.

United States Page 17

- Individual states including Ohio, Michigan and Massachusetts are working to encourage AV development and adoption by opening access to roads and setting up a single coordinating organization.

Also noted

- A new measure on government data sharing, reflecting the importance of this in the development of AVs, is led by the UK (7th overall).
- Several countries enjoy a dynamic business ecosystem with a focus on AVs, but Israel (14th overall) gains top scores in the AVRI's technology and innovation pillar through the outstanding performance of its sector.
- The AVRI's newly introduced consumer survey measuring enthusiasm for AVs is led by India (24th overall) and Mexico (23rd overall), suggesting that countries currently lacking good road transport may be particularly keen to adopt AVs.



Sweden Page 18

- The country's cutting-edge work on freight includes a road that charges electric trucks as they drive over it and pilot use of an AV truck to link two logistics centers.

Key insights for governments



Advanced AV markets could invest more in technology and innovation:

Top ranked countries could far outpace others if they focused on Pillar 2 (technology and innovation); in particular, investing in AV-related firms and R&D, industry partnerships, and an innovation-friendly business environment.



Countries leading in technology and innovation could work on achieving greater policy and institutional clarity:

Countries that lead in technology and innovation tend to have mid-level scores in their AV regulatory environment and institutions. Adapting and revisiting regulations and establishing an AV-focused institution could take these countries to the top of the rankings.



Most countries that do well on infrastructure readiness could reform their policy and legislative environment:

Six of the 10 countries that lead the world on infrastructure readiness — Australia, Austria, Japan, South Korea, Sweden, and the UAE — do not feature in the top 10 for the policy/legislative environment. To improve their overall ranking they could work on establishing new AV regulations and institutions.



Less-developed AV markets could take advantage of higher consumer interest in AVs if other areas, including policy and technology, are addressed:

In general countries with the lowest overall scores have the highest scores for positive consumer sentiment about AVs. These countries would rise quickly in the rankings if governments actively developed other pillars.



National profiles



Policy and legislation



Technology and innovation



Infrastructure



Consumer acceptance

1 | The Netherlands



The Netherlands retains its lead by doing many things consistently well, including investigating AVs' use in freight and logistics and passing new legislation.

The Netherlands, which again leads the AVRI, is an example of how to ready a country for AVs by performing strongly in many areas. It leads the index's infrastructure pillar, is ranked second on consumer acceptance and is fifth on policy and legislation. The country also scores highly on many individual measures, including supportive regulations, road infrastructure quality, exposure to AV testing and market share of EVs.

This balanced approach is shown in the way the Dutch government is considering the potential to use AVs in freight, while working to improve safety and enhancing the legal framework.

On freight, it plans to have dozens of driverless delivery trucks operating closely together on international highways. In a March 2018 speech, Dutch infrastructure minister Cora van Nieuwenhuizen said the country will work with Germany and Belgium to introduce 'truck platooning' along the 'Tulip corridors' from Amsterdam to Antwerp and Rotterdam to the Ruhr valley, with the aim of enabling convoys of at least 100 trucks and eventually self-driving vehicles at night.²⁸ She also said that she would work to connect vehicles using 5G technology and install 1,200 smart traffic lights. This would build on the Netherlands' existing leading status on availability of EV charging stations, something also recognized in this index.

The ministry also announced a legal framework for autonomous driving. The Experimenteerwet zelfrijdende auto (law governing the experimental use

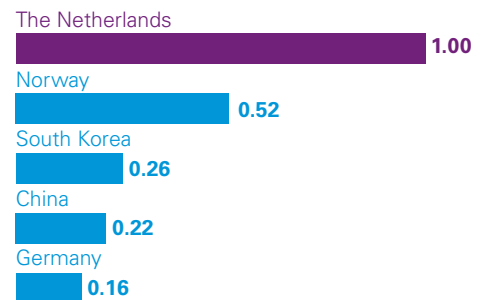
of self-driving vehicles) was approved by the House of Representatives in April 2018 and the Dutch Senate in September 2018. It allows experiments with AVs on public roads without drivers in vehicles, although they must be monitored remotely.²⁹

The Netherlands are also preparing a Driving License for a Vehicle. This is being developed in cooperation between the Dutch Vehicle Authority (RDW), the main road authority (Rijkswaterstaat) and the central office for driving exams (CBR). The approach focuses on the extent to which a vehicle can produce safe and predictable automated driving behavior that aligns as closely as possible to human performance in an open traffic system. Finally, the Netherlands are working on a "Vehicle Safety & Security Framework (VSSF)" to be able to assess the robustness of in-vehicle software.

As well as freight and private cars, Dutch companies are working on the potential for AVs in private industrial environments with foreign manufacturing and logistics firms.³⁰ Such uses may precede AVs on urban Dutch roads, which are much busier than in the US and other countries: "We have a lot of bicycles," points out Stijn de Groen, Manager Digital Advisory, Executive for Automotive, KPMG in the Netherlands. "In urban, crowded areas it will be very difficult to start autonomous driving." As a result, it may make more sense to keep transport modes separate rather than integrating AVs to work there.

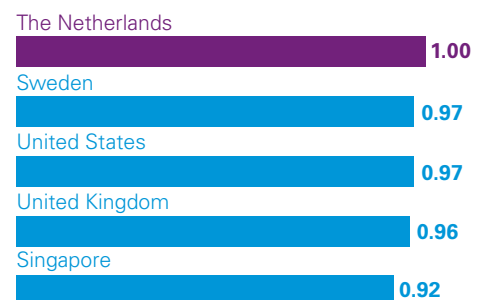
"The Netherlands is spreading its AV bets across projects including truck platooning pilots, public transport in airports and transporting containers in harbors," adds Loek Kramer, Sector Lead for Automotive, KPMG in the Netherlands, summing up the Dutch approach of looking for opportunities to use AVs across road transport, rather than just for cars.

Electric vehicle charging stations — score by country (top 5)



Source: International Energy Agency, 2017

Consumer adoption of latest technology — score by country (top 5)



Source: World Economic Forum, Global Competitive Index 2018

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— **Loek Kramer**
Sector Lead for Automotive,
KPMG in the Netherlands

2 | Singapore



The government is positioning the city-state as a center for AV development with the deployment of a simulated urban test-bed and plans for driverless buses.

Singapore leads the policy and legislation and consumer acceptance pillars, and is second only to the Netherlands on infrastructure. Its government is working hard to consolidate the city-state's position as a center for AVs. It opened the Centre of Excellence for Testing and Research of Autonomous Vehicles at Nanyang Technological University (Cetran) in November 2017,³¹ which includes bus stops, traffic lights, skyscrapers, hills and a rain-making machine to allow realistic testing. The government is drawing on this facility in setting new road traffic rules, which are due to be published by early 2019.

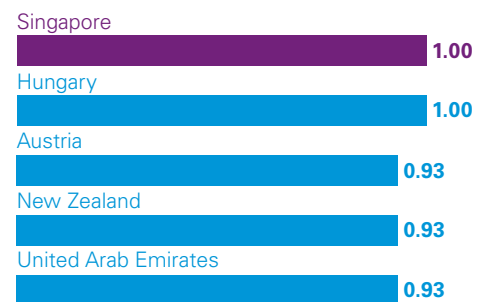
Singapore has also announced that three areas, Punggol, Tengah and the Jurong Innovation District, will use driverless buses and shuttles for off-peak and on-demand commuting from 2022, and it is working with the Netherlands on an international standard for AVs. In November 2018, a bus operator announced a year-long trial of a self-driving shuttle service at the National University of Singapore's Kent Ridge campus, starting in March 2019 and operating on actual roads, although it will only carry passengers after initial tests are complete.³²

"The government is very proactive in thinking about the future of mobility. It is seriously investigating the possibilities as well as preparing for a regulatory environment that will facilitate a future that is autonomous," says Satya Ramamurthy, Partner, Head of Infrastructure, Government and Healthcare, KPMG in Singapore.

Singapore ranks relatively low on technology and innovation, at 15th of 25. UK-founded home appliances manufacturer Dyson recently announced it would open a new factory in Singapore to build electric cars in 2021, as well as moving its corporate office to the city-state, although much research and development work will stay in Britain.³³ Ramamurthy says Singapore's lack of conventional automotive manufacturing may prove to be a strength in developing EVs and AVs, as they use a substantially different set of components. He adds that the relatively low number of electric charging points is presently a weakness, but that electricity providers and others are planning to install more of these.

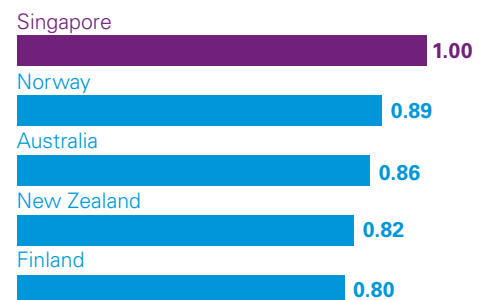
Singapore taxes private cars heavily, which provides a way to promote AVs — at a cost. "Effectively the pricing is done to discourage people from driving," says Ramamurthy. "That brings with it a whole set of opportunities." At present, around two-thirds of the price of a car is tax. "There is a lot of policy room for the government to do things to promote adoption, should it wish," he says.

AV department within government — score by country (top 5)



Source: KPMG International, 2019

Availability of high-performance mobile internet — score by country (top 5)



Source: GSMA Global Connectivity Index, 2017

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3 | Norway



Following the legalization of AV testing in January, several cities now have driverless minibus services and Norway is also working on truck platooning.

On 1 January 2018, Norway legalized AV testing on public roads,³⁴ and operators have started small-scale autonomous bus services as a result. In May, a Stavanger transport provider gained the right to run driverless minibuses, and from June to December 2018 it ran a free service in Forus.³⁵ However, initial regulations meant there was always an employee on-board who could apply a brake, only six passengers were allowed and the maximum speed was 7.5mph (12kph).³⁶

Ruter, the mass transit provider for Oslo, announced in October 2018 it is starting similar tests with a Danish company, with the aim of having 50 such minibuses in use by 2021.³⁷ Elsewhere, the national road administration has been testing automated truck platooning in the north of Norway, and pilots of autonomous taxis are set to start in

2019. Norway has a specialist supplier in this area, Applied Autonomy.³⁸ Such work is reflected in Norway's strong performances in both the technology and innovation pillar, where it is second, and consumer acceptance, where it is third.

Ståle Hagen, Director, Head of Transport and Mobility, KPMG in Norway, says the bus tests involve a variety of environments, including business parks, urban streets and even a service from a shopping center to a beach.³⁹ "The feedback on AV technology has been quite positive. Passengers are not afraid of using this kind of transport," he says. Familiarity is developing for another reason: "Fifty percent of all the cars sold in the Oslo region are now electric and these cars are prepared for autonomous driving."

Norway has by far the highest market penetration of EVs in the index, contributing to its second place in the technology and innovation pillar. Ketil Marcussen, Partner, Infrastructure Sector, KPMG Norway, says this is due to generous tax breaks, exemptions from road tolls and parking charges, access to bus lanes, free charging stations and the country's cheap home electricity.

Availability of the latest technologies — score by country (top 5)



Source: World Economic Forum Networked Readiness Index, 2018

Market share of electric cars — score by country (top 5)



Source: International Energy Agency, *Global EV outlook 2018*.

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Director,
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KPMG in Norway

4 | United States



The US is home to the world's leading AV companies and a lot of testing work, but the lack of a strong national approach means individual states have to work hard to attract AV businesses.

The United States (US) is home to companies that lead the world in AV development, while the country's mainstream vehicle makers are working hard to establish AV fleet and ride-hailing services. This contributes to strong US performance in the technology and innovation pillar, where it is third. It moves from third to fourth overall as a result of Norway joining the AVRI, and scores less well on infrastructure, where it is eighth, and policy and legislation, where it is ninth.

The US Department of Transportation published *Automated vehicles 3.0* detailing its approach to AVs in October 2018.⁴⁰ The report's principles include prioritizing safety; remaining technology neutral; preparing for automation through guidance and pilot programs; and protecting and enhancing freedoms enjoyed by Americans — such as driving their own vehicles, emphasizing that AVs will operate alongside human-driven motorized vehicles and other road users.

The document also says the department "will encourage a consistent regulatory and operational environment" across the US. However, states and cities have significant control of transport work, and differences in approach can be an

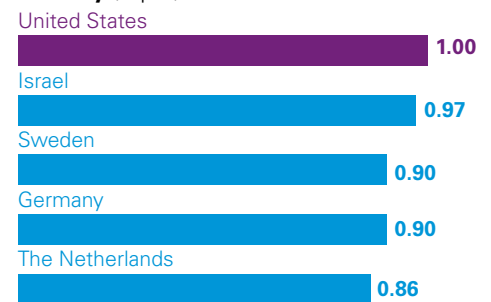
advantage for suppliers according to Ted Hamer, Managing Director and Head of Mobility, KPMG in the US. "If one state is really tight in its restrictions and another isn't, you have the ability to adapt and to move around," he says, whether for testing, manufacturing or deployment. Arizona had broader rules on AVs, leading to it being used for several pilot projects, although it has tightened these since the Uber accident in May.

Hamer adds that some states do an excellent job of supporting AV development in a joined-up fashion, in the way some countries do at national level. In May 2018, Ohio's outgoing governor John Kasich signed an executive order opening AV testing on the state's roads, one of a number of projects coordinated by DriveOhio, a one-stop shop launched in March.⁴¹ The Michigan Economic Development Corporation has taken advantage of the state being home to the biggest vehicle manufacturers,⁴² while Massachusetts has successfully encouraged adoption of EVs through a 2017 law.⁴³

The Virginia Department of Transportation's (VDOT) also launched program to help guide the department in the deployment of AV related technologies and initiatives.⁴⁴

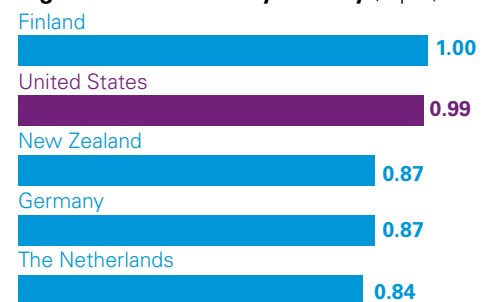
He adds that a year ago, many states were focused on attracting AV testing work, but this has developed: "There is recognition that states have to start laying the groundwork for connected vehicles and the infrastructure that underlies them, and understand where AVs are going to be deployed, whether it's urban environments or more in freight and logistics."

Capacity for innovation — score by country (top 5)



Source: World Economic Forum Networked Readiness Index, 2018

Efficiency of legal system in challenging regulations — score by country (top 5)



Source: World Economic Forum Networked Readiness Index, 2018

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Head of Mobility,
KPMG in the US

5 | Sweden



Sweden trials electric-charging roads, AV trucks and driverless buses, while working on revamped legislation for 2019.

In April 2018, Sweden opened what is believed to be the world’s first electric-charging road, a 2km stretch near Arlanda airport. An electric truck belonging to PostNord, the Swedish-Danish postal company, uses it to recharge automatically while moving between the airport and a logistics center 12km away. The road joins another recharging pilot, which uses overhead cables on a motorway near Gävle, both supported by the Swedish Transport Agency.⁴⁵

Sweden is second only to Norway in adopting EVs, which means developing infrastructure that will be used by AVs. But its government is also undertaking direct measures, with legislative changes likely in July 2019 that will allow AVs on public roads and tests without human drivers.

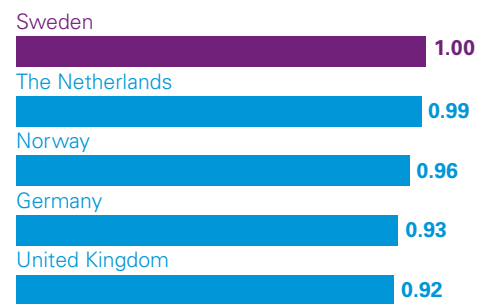
The transport agency has already permitted small-scale AV pilots. These include a driverless bus service that started running on 1.5km section of public road in northern Stockholm in

January 2018, which is free to use and has an emergency human driver.⁴⁶ In September 2018, the agency gave Swedish vehicle maker Volvo permission to begin real-world tests of its self-driving cars in the Gothenburg area.⁴⁷ AV truck maker Einride and German logistics group DB Schenker have been piloting use of a 7.5 tonne electric AV truck between two logistics centers since November 2018, and hope to gain regulatory approval for its use on public roads in January.⁴⁸

“There is a very good attitude from lawmakers and policy-makers in Sweden,” says Christoffer Sellberg, Head of Automotive, KPMG in Sweden. “They believe that AVs will improve traffic safety, contribute to the efficiency of the transportation system and be a part of Sweden’s sustainable agenda.”

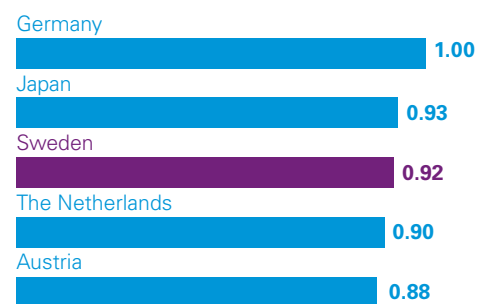
He adds that Sweden’s reputation for innovative technology is a major strength, as well as having excellent road and mobile network infrastructure. These factors are recognized in the AVRI, with the country among the highest-rated for government readiness for change, AV company headquarters, capacity for innovation, road infrastructure for logistics, civil society technology use and consumer adoption of technology.

People and civil society adoption of new technologies — score by country (top 5)



Source: KPMG International, 2019

Infrastructure quality for logistics and trucking — score by country (top 5)



Source: World Bank Logistics Performance Index, 2018

“There is a very good attitude from lawmakers and policy-makers in Sweden. They believe that AVs will improve traffic safety, contribute to the efficiency of the transportation system and be a part of Sweden’s sustainable agenda.”

— **Christoffer Sellberg**
Head of Automotive,
KPMG in Sweden

6 | Finland



Finland is focusing on getting AVs to work in winter conditions and automated bus services — and is repainting the yellow lines on its roads to an AV-friendly white.

Finland is exploiting its cold climate through research on how AVs can handle icy roads and tracks. In December 2017, government research organization VTT showed its robot car Martti driving autonomously on a snow-covered road, and the project team has since added 5G technology to the vehicle.⁴⁹ Future work will include off-road driving on tracks and at night. Other research includes Swedish truck maker Scania trialing truck platooning in icy conditions, and a 5G network established in the northern town of Oulo that allows organizations including VTT to test applications such as AVs.⁵⁰

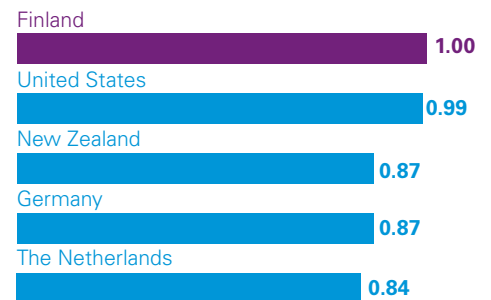
Driverless minibuses are a priority in Finland, with Helsinki’s transport authority having run trials since 2015, when it introduced a free, temporary service from a train station.⁵¹ In May 2018, the city introduced a regular ‘Robobus’ service running on public roads on a trial basis, with a non-driving human operator. It plans to introduce commercially viable

driverless bus services in 2021.⁵² Meanwhile, local AV company Sensible 4 is developing automated minibuses that work in harsh Finnish winters. It recently partnered with Japanese designer Muji to develop Gacha, an all-weather AV bus that also aims to look elegant.⁵³

Finland, a new entrant to the AVRI, scores well on having supportive regulations, its judicial system, the number of AV companies and the availability of the latest technologies, although it is among the lowest for investments. “Finland has a positive legal and regulatory environment. The traffic safety authority is quite permissive, granting permits for trials to anyone who is interested in experimenting with AVs,” says Henry Beniard, Global Strategy Group, KPMG in Finland. “The entire road network is available for experimentation.”

He adds that the government has recently passed two new laws that enable AVs. The Transport Service Law opens taxis to competition, allowing ride-hailing services to gain access from 2020, and permits someone to control a vehicle remotely.⁵⁴ The Road Traffic Act will integrate detailed location data on roads, signs, traffic lights and other control mechanisms for AV operators to use, and is set to repaint the continuous yellow lines on Finnish roads in white, partly as these are easier for machines to detect.⁵⁵

Efficiency of legal system in challenging regulations — score by country (top 5)



Source: World Economic Forum Networked Readiness Index, 2018

Availability of the latest technologies — score by country (top 5)



Source: World Economic Forum Networked Readiness Index, 2018

“Finland has a positive legal and regulatory environment. The traffic safety authority is quite permissive, granting permits for trials to anyone who is interested in experimenting with AVs. The entire road network is available for experimentation.”

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Global Strategy Group,
KPMG in Finland

7 | United Kingdom



Supportive legislation and an increasingly coordinated national strategy address key barriers. Public trials are ramping up. Infrastructure presents an opportunity for improvement.

The United Kingdom (UK) continues to be a leader on policy and legislation and performs well across a number of sub-pillars. However, it needs to continue proactive efforts to address the critical factors of infrastructure and consumer acceptance. The UK has moved down two places in 2019, but only due to high-performers Norway and Finland joining the index.

The UK government's forward-thinking approach to deploying AVs places it second on the policy and legislation pillar, and first on the new data-sharing sub-pillar. In August 2018, the UK Parliament passed the Automated and Electric Vehicles Act, which adapts the existing motor insurance framework by extending compulsory insurance to AVs as well as the driver.⁵⁶ In November, the government announced support for three public trials in 2021, including AV buses across the Forth Bridge in Scotland and self-driving taxis in London.⁵⁷ Additionally, in December 2018, the UK Parliament published an extensive report outlining their proactive approach to pursuing the benefits of MaaS.⁵⁸

Cross-government collaboration has also been effective. For instance, the Law Commissions of England and Wales and Scotland are currently reviewing the UK's legal framework for AVs, due to be completed in March 2021.⁵⁹ Across the UK, there has been a concerted effort to develop CAV strategies, business plans and road maps, with recent initiatives spanning Scotland, the West Midlands and the UK's federal Department for Transport (DfT).

"The UK has made a lot of inroads, with big investments, a committed government

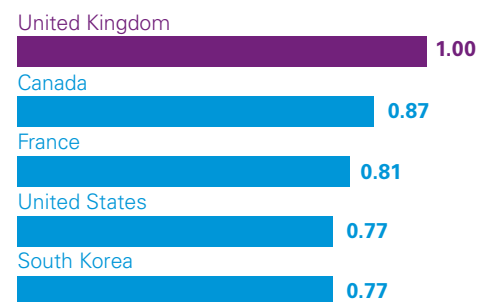
and world-leading policy; it has seen many positive announcements regarding both private sector initiatives and local and central government strategies," says Sarah Owen-Vandersluis, Partner, Head of Public Mobility Strategy, KPMG in the UK. "In both the public and private sectors, the pace and scale of activity is rapidly increasing. New initiatives and collaborations are beginning to identify benefits like improved accessibility, productivity, safety and economic growth, and prove the commerciality of new business models."

The UK faces challenges concerning digital and physical infrastructure, especially since investments in this sector take time to bear fruit. It lags behind other countries in 4G coverage, global connectivity, quality of roads (especially smaller roads) and logistics infrastructure. Promisingly, extensive investments are being made in 5G to connect 5G test beds and test tracks.

Regarding physical infrastructure, the UK's island geography — and therefore short freight journey distances, a larger number of bends on motorways and frequent junction points — may inhibit the development of truck platooning, which is an early opportunity for AV technology. However, physical infrastructure will improve as the UK government delivers increased investment across the road network and key infrastructure operators collaborate with central government and industry to support the deployment of AVs.

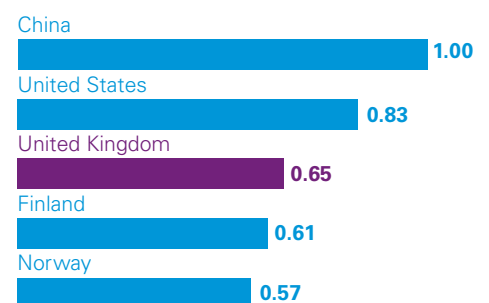
Improving consumer acceptance will be critical for the deployment of AVs. To achieve this, government and industry have a role to play in communicating the benefits of AVs and the efforts being taken to ensure their safety. In part, this can be achieved through rigorous testing and the publication of safety standards — such as the new cyber security standard for AVs, published in December 2018.⁶⁰

Data sharing and open data environment — score by country (top 5)



Source: Open Data Barometer, 2018

Consumer adoption of online ride-hailing apps — score by country (top 5)



Source: Statista, 2018

“The UK continues to make strong progress towards AV adoption, as a center of innovation and testing, which is supported by world class policy and legislation.”

— **Sarah Owen-Vandersluis**
Partner,
Head of Public Mobility Strategy,
KPMG in the UK

8 | Germany



Germany has a national strategy for AVs and plans for using them ethically but its federated structure, which can spur innovation in regions, may threaten consistency at the country level.

Since 2015, the German government has followed a national AV strategy and has recently started working to ensure that AVs are used ethically, including protecting people rather than property or animals.⁶¹ “Last year, the Federal Government passed an action plan on the report by an Ethics Commission on Automated and Connected Driving,” says Moritz Püstow, Partner, KPMG Law in Germany. “The government has developed measures to implement these ethical rules. It is unique worldwide.”

More generally, based on the coalition agreement for Germany’s new federal government from February 2018, a legal framework is being developed to allow autonomous driving in specific settings.⁶²

The coalition agreement also led to the government agreeing to establish a National Platform Future of Mobility task force,⁶³ which will consider digitalization among other topics.

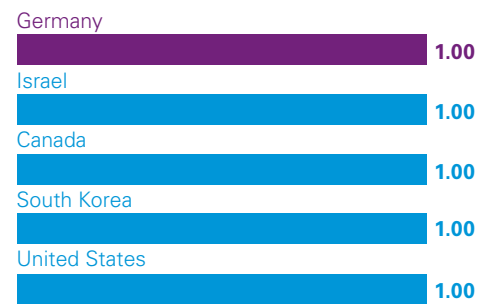
“The German federal government is systematically implementing its strategy for automated and connected driving,” says Christine Greulich, Division Head, Automated Driving and Intelligent Transport Systems at the German Federal Ministry of

Transport and Digital Infrastructure. “This includes working closely with automotive and IT sectors as well as universities and research institutions. The legal requirements for the use of the first highly automated and fully automated driving functions for regular operation in road transport have been in place since 2017. Germany is thus a global pioneer.”

Several of Germany’s powerful states are also working on AVs. North Rhine-Westphalia, which includes Cologne and Düsseldorf, has established a Zukunftsnetz Mobilität (future of mobility) network to support municipalities,⁶⁴ with the promotion of AVs among its tasks. Berlin and Brandenburg (the state surrounding the capital) are both analyzing the market for research and development work on AVs. Public transport providers in Berlin, Hamburg and Frankfurt, as well as the national railway company Deutsche Bahn, are testing autonomous buses in a range of settings, and there are more than 20 AV test sites nationwide.

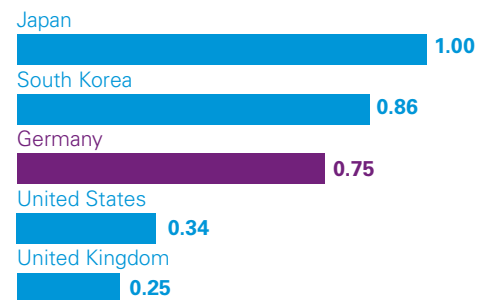
As with the UK, Germany moves down two places as a result of new entrants in the index. It records the best score for road logistics infrastructure, as well as strong results on industry partnerships and AV-related patents. While Germany’s powerful automotive industry gives the country a strong base, with Bosch particularly active in filing patents on AV technology, Püstow says the highly devolved nature of government — with more than 11,000 municipalities — makes it difficult to set national standards and strategy.

AV-related industry partnerships — score by country (top 5)



Source: KPMG International, 2019

AV-related patents (per capita) — score by country (top 5)



Source: PatSeer, 2018

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9 | United Arab Emirates



The UAE is boosted by good road quality and high consumer opinion of AVs, but does less well on data-sharing, AV businesses and patents.

The United Arab Emirates (UAE) moves up one place relative to the other countries in the AVRI because it has outpaced other countries in the consumer acceptance pillar, with the third most-positive consumer opinions of AVs. It leads the measures on road quality and the change readiness of its technology infrastructure, and also scores highly for its government's overall change readiness. It scores less well on data-sharing, AV company headquarters and AV-related patents.

Dubai, the UAE's largest city, aims to make 25 percent of all transportation autonomous by 2030, based on a strategy launched in 2016 that focuses on environmental and efficiency improvements and is expected to generate AED22 billion (\$US6 billion) annually.⁶⁵ In September 2016, Dubai's Road and Transport Authority trialed an AV shuttle on a 700m route, offering free rides to commuters.⁶⁶

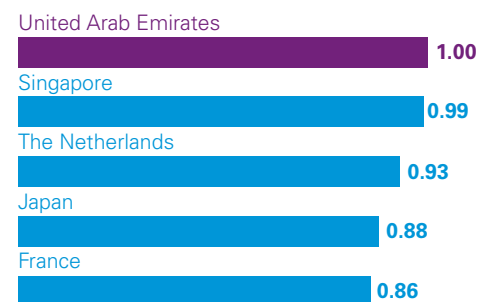
Other technology initiatives by Dubai may contribute to these ambitions. In October 2018, it announced the launch of a government-endorsed blockchain platform, using technology from IBM, as part of a move towards

making its government paperless by 2021.⁶⁷ Dubai aims to run "all applicable government transactions" through blockchain, a decentralized system that uses encryption to make data entered permanent and unalterable, which can be used for 'smart contracts' that automate transactions between multiple parties. Such contracts could be used by AV operators to handle payments for charging or selling data generated by vehicles.

"With Dubai's enthusiasm for technological innovations, in particular its forays into artificial intelligence and blockchain, the UAE is well-positioned to do even better in the future," says Ravi Suri, Partner, Global Head of Infrastructure Finance, KPMG in the Lower Gulf. "These are technologies that should enable the introduction of AVs."

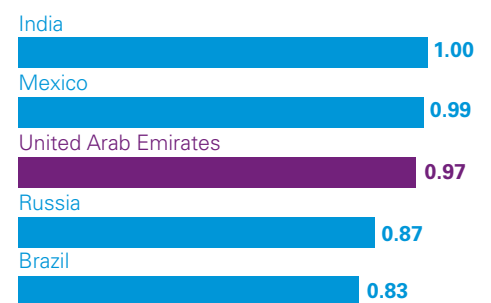
Newly built Masdar City, in Abu Dhabi in the UAE, has transported more than two million people on its Personal Rapid Transit driverless pods since 2010, running on special guideways. In October 2018, the city launched a regular AV minibus service, with plans to launch seven more in 2019.⁶⁸

Road infrastructure quality — score by country (top 5)



Source: World Economic Forum, Global Competitive Index 2018

Consumer opinion about AVs — score by country (top 5)



Source: KPMG International, 2019

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10 | Japan



Japan performs well on innovation and infrastructure and sees a specific need for AVs for its aging population, but needs more deregulation and promotion.

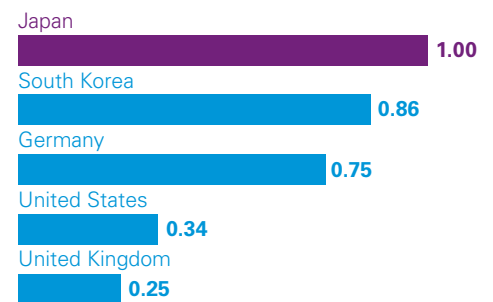
Japan performs strongly on technology and innovation, where it is fifth overall and has the most AV-related patents. It also does well on infrastructure, where it is third overall and has the second-highest scores for both 4G coverage and road logistics infrastructure. These help improve its ranking, despite the entry of new countries above it. It is mid-table on policy and legislation and consumer acceptance, and currently has one of the lowest uses of online ride-hailing.

The use of AVs in Japan will be influenced by its status as a rapidly aging society, where a quarter of the population is older than 65, according to Koichi Iguchi, Partner, Head of Global Strategy Group, KPMG in Japan. This means a focus on reducing accidents and congestion, improving efficiency and — in particular — providing mobility for older people, particularly in rural areas. Hundreds of towns and villages have no doctors, millions of older people have difficulty shopping and there has been a sharp increase in those who have had to return their driving license over the last decade.

2018 saw AV proofs of concept by public and private-sector organizations focused on taxis and buses within defined areas, including airports. Iguchi says that the development of AVs in Japan means dealing with strong regulations, pressure groups and technical problems caused by snowfall and earthquakes. “The problems of aging public infrastructure, in roads, tunnels and bridges, and their maintenance costs are also serious,” he adds.

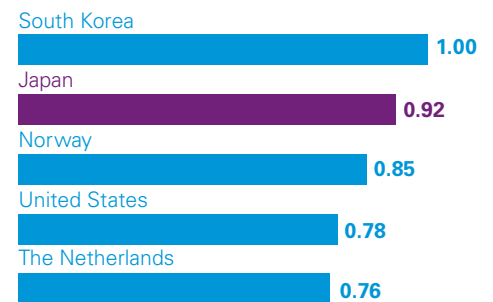
He believes that deregulation and a campaign to promote AVs led by leading companies would be of benefit. “There are great opportunities surrounding the 2020 Olympic Games in Tokyo. This means there is a possibility that the practical application of automatic driving will be accelerated in the next couple of years,” he says. There is already political will behind this: in June, an economic review by the government included plans to start testing AVs on public roads, followed by a public service for the 2020 Games, then a commercial offering by 2022.⁶⁹

AV-related patents (per capita) — score by country (top 5)



Source: PatSeer, 2018

Extent of 4G coverage — score by country (top 5)



Source: Open Signal, 2018

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— Koichi Iguchi

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11 | New Zealand



New Zealand's strong government performance partly counteracts lack of scale and domestic manufacturing, and the country has opportunities in software and agriculture.

New Zealand has a strong reputation as a place to develop new technologies, although further development often takes place elsewhere. Ohmio, a company that staged trials of its driverless minibuses at Christchurch airport, announced in June 2018 a new joint venture with the city of Heshan in China, which would see manufacturing and much research move to that city.⁷⁰

The government is working to encourage early-stage work. The New Zealand Transport Agency has identified an area of Christchurch that was 'red-zoned' (categorized for redevelopment after damage in the city's 2011 earthquake) as a location for the Christchurch Mobility Lab, a trial area for AVs.⁷¹

The country is already used by companies testing the Cora, an autonomous flying taxi.⁷²

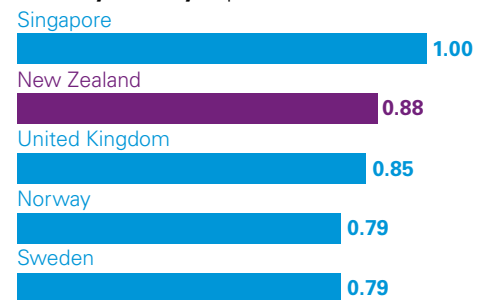
New Zealand does not manufacture vehicles or carry out mainstream research and development, its domestic market is small and many technology companies are foreign-owned. In the index, New Zealand scores low on the number of AV companies and industry investments, despite both being calculated per capita. The country's low population density and location provide particular challenges for AV adoption: there is little current justification for management infrastructure on

mainly quiet roads, mobile networks are patchy and current vehicles are a mixture of new cars from Europe and second-hand imports from Asia. Istvan Csorogi, Director, Advisory, KPMG in New Zealand, says this will make it harder to introduce infrastructure for AVs.

However, it does have excellent governance, recognized by its third place on policy and legislation and high scores for AV-focused agencies, effectiveness of legislative process and quality of judicial system. "New Zealand is well-placed in its readiness for AVs due to our robust regulatory and business environment," says Richard Cross, Manager, Strategic Policy and Innovation, Ministry of Transport. "Our legislative process and relatively small size compared to many other countries means that we can be agile. New Zealand regulators have a can-do attitude and a focus on finding solutions and removing barriers." The government has defined a specific testing framework for AVs.⁷³

Csorogi says there is potential for the country to specialize: "In New Zealand, it's about developing the intelligence within these vehicles. I don't think we'll ever produce mainstream AVs, but there is an opportunity to develop artificial intelligence and AV controls here." This could focus on specific areas including agriculture, drones and controlled environments such as campuses and airports. He adds that autonomy should have particular benefits for New Zealanders, where the lack of central barriers makes lane correction an important safety measure, something which may take advantage of work the country is undertaking with Australia to augment the accuracy of GPS satellite technology.

Effectiveness of the legislative process — score by country (top 5)



Source: World Economic Forum Networked Readiness Index, 2018

Industry investment and partnerships in AV-related firms (per capita) — score by country (bottom 5)



Source: CrunchBase, 2018

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12 | Canada



Canada has a good quality workforce and strong government leadership, with Ontario allowing tests of fully driverless vehicles, but the country's large size and remote locations may stretch AV infrastructure.

Canada's main strengths on AVs are the high quality of its existing workforce, its status as an attractive and open destination for skilled immigrants and strong leadership from different levels of government that see the potential benefits, according to Colin Earp, National Transport Lead, KPMG in Canada.

"There's this real feeling that transport drives not just economic productivity, it drives social equity and commercial activity. In that respect, you're seeing civic, provincial and national leaders really begin to create an inclusive and collaborative culture to drive better transportation in the future, including AVs," he says.

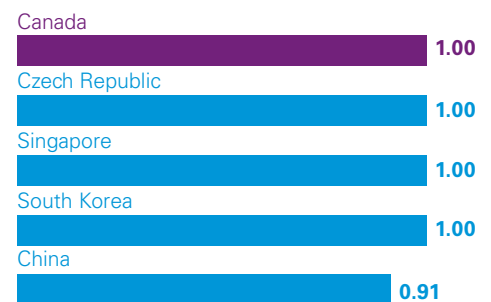
An example is Ontario, which is home to more than a third of the population and many vehicle and technology companies. The province has lifted some regulations on AVs, meaning that from January 2019 completely driverless vehicles can be tested on its roads. The changes are a development of Ontario's 10-year Automated Vehicle

Pilot Program, started in 2016 and involving Uber — which is testing self-driving vehicles in Toronto — Canadian technology company BlackBerry and the University of Waterloo.⁷⁴ The province has established an Autonomous Vehicle Innovation Network and an Automotive Supplier Competitiveness Improvement Program, the latter providing matched funding for innovation by smaller suppliers.⁷⁵

Earp says that specific challenges for AVs in Canada include designing systems that work in remote areas and urban environments, and work needed on exporting and international partnerships. However, he adds that there are likely to be opportunities from the Investing in Canada Plan, through which the federal government is spending more than 180 billion Canadian dollars (US\$137 billion) over 12 years on a range of infrastructure. The plan covers transport in two of its five main areas, and in 2018, ran a specific Smart Cities Challenge competition for localities. The federal government has also supported research into how AVs will change Canada's economy and job market.⁷⁶

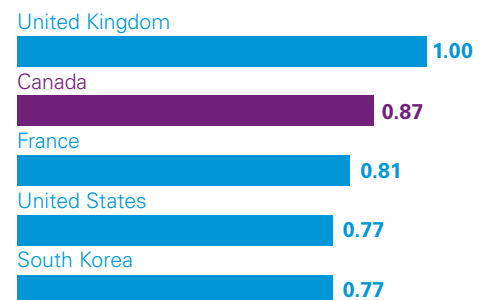
While Canada does relatively well on government and industry involvement, it ranks low on 4G coverage, the two infrastructure scores and EV charging stations, and drops five places in the overall index, partly due to two new entrants higher in the index.

Government-funded AV pilots — score by country (top 5)



Source: KPMG International, 2019

Data sharing and open data environment — score by country (top 5)



Source: Open Data Barometer, 2018

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13 | South Korea



South Korea opens the K-City test facility, pilots driverless buses and works on detailed mapping for AVs.

On 10 December 2018, South Korea opened K-City, an experimental city environment equipped with 5G technology that will be used to test AVs. K-City, built in Hwaseong by national telecoms provider KT and the Korea Transportation Safety Authority, will focus on testing and commercializing Level 3 AVs, which include sophisticated autonomous features but that still require a human driver to take over when required.⁷⁷ In November, KT tested an autonomous bus at the country's Incheon airport, including changing lanes and stopping at traffic lights.⁷⁸

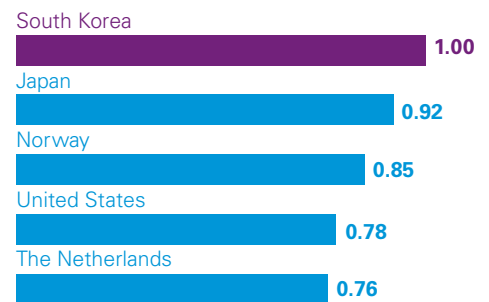
In March, the South Korean Ministry of Land, Infrastructure and Transport announced that it planned to create detailed maps for AVs as part of Cooperative Intelligence Transport Systems (C-ITS), a project designed to enhance the safety of AVs.⁷⁹

Meanwhile, in January, South Korean technology group Samsung released a hardware and software platform for AVs, following its US\$8 billion purchase in 2017 of a US-connected car company and its establishment of a US\$300 million automotive innovation fund.⁸⁰

South Korea scores highly on several AVRI measures, including government-funded AV pilots, industry partnerships, availability of EV charging stations and 4G coverage, which it leads with 96 percent population coverage. However, it is poorly rated on the effectiveness of its legislative processes.

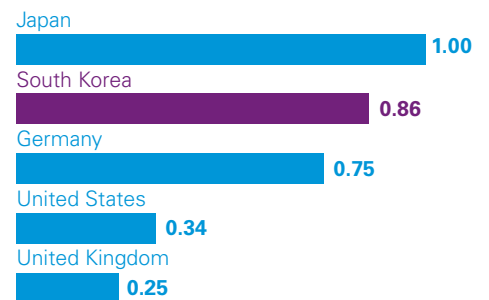
Unlike countries on the forefront of AV legislation, South Korea is limited by rules that only allow pilot driving of level 3 AVs, showing a slower legislation process compared to those at the top of this index.⁸¹ Overall, the country moved down from 10th to 13th, as Norway and Finland climbed up the rank and as Japan outpaced South Korea on the technology and innovation pillar.

Extent of 4G coverage — score by country (top 5)



Source: Open Signal, 2018

Number of AV-related patent applications (per capita) — score by country (top 5)



Source: PatSeer, 2018

“Reforming regulation, securing relevant technology will be pivotal for South Korea in reducing the gap between its AV industry and that of other leading countries. Based on the government’s newly established R&D Foundation and K-City initiatives, we expect to see positive outcomes in the near future.”

— Hyo-Jin Kim

Partner, Head of Infrastructure, KPMG in Korea

14 | Israel



A powerful technology start-up sector makes Israel a leader in AV innovation, but lack of domestic manufacturing may push back local deployment.

Israel's strength in AVs lies in its export-focused technology sector, which helps the country top the index's technology and innovation pillar as well as specific measures of industry partnerships, investment and headquarters.

Following Intel's 2017 acquisition of local AV specialist Mobileye for US\$15.3 billion,⁸² 2018 has seen more international interest in Israeli automotive technology companies. Vehicle manufacturer Daimler invested in smartphone data analytics company Anagog, energy giant BP bought into fast EV charger StoreDot and Japanese conglomerate Mitsubishi has put money into SoftWheel, which is focused on wheel innovation.⁸³ Meanwhile, other major vehicle manufacturers have announced they will locate research and development work in Israel.

"Perhaps the most interesting thing about AVs in Israel are the investments being made to create them," says Hillel Schuster, Principal, Head of Management Consulting, KPMG in Israel. The country has 500–600 automotive start-ups, with around a fifth focused on AVs. Many benefit from technologies originally developed for Israel's military, in areas including logistics, mapping, lidar (light detection and ranging technology) and night-vision.

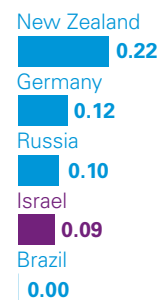
It may take a while for Israelis to get access to AVs, however, with the country ranked in the bottom-half of the index on both policy and legislation and infrastructure. "Most of Israel's businesses are oriented towards creating solutions for international companies," says Schuster. Furthermore, as a country with short journey distances and no domestic vehicle manufacturing, it may be a hard place to introduce AVs — something that may be exacerbated by the fact that autonomous and human-driven vehicles will have to work hard to co-exist on the country's crowded urban roads.

Industry investment and partnerships in AV-related firms (per capita) — score by country (top 5)



Source: CrunchBase, 2018

Extent of 4G coverage — score by country (bottom 5)



Source: Open Signal, 2018

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— **Hillel Schuster**

Principal,
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KPMG in Israel

15 | Australia



Australia’s performance could be boosted by the recent establishment of a federal body for transport technologies, as well as efforts by states.

Australia gains the top score on regulations supportive of AVs and there have been broader signs of change on policy and legislation. It also saw significant improvement on its infrastructure score. Overall, Australia dropped only one spot in the overall 2019 rankings, despite the five new countries added and two of those (Norway and Finland) landing in the top six.

In 2016, Australian transport ministers agreed to a phased reform of current driving laws to enable use of full AVs from 2020.⁸⁴ In October 2018, the federal government established the Office for Future Transport Technologies, a 9.7 million Australian dollars (A\$) (US\$7.1 million) initiative to unify the states’ and territories’ governments and agencies in delivering future transport technologies in a safe and responsible manner.⁸⁵ New South Wales, Queensland, South Australia and Victoria have also made significant investments.⁸⁶

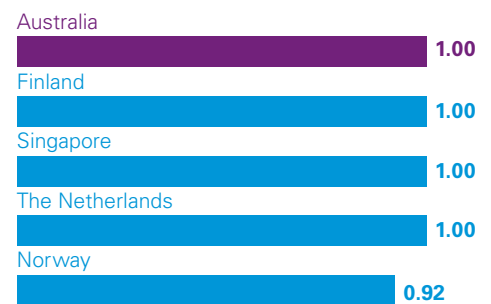
In a country as large and diverse as Australia, with a multi-tiered system of government, collaboration is critical. Dr Geoff Allan, Acting Chief Executive Officer of Australia’s National Transport Commission, says that “all levels of government are working closely with industry to support automated vehicle deployment. Federal, state and territory governments are collaborating to develop the regulatory framework, expand trials and research infrastructure requirements.”

Road operator association Austroads has undertaken work focusing on supporting vehicles’ operations through machine-readable signage and road marking, open-data in the context of road-operator data, and the opportunities for automated heavy vehicles in remote and regional areas.⁸⁷ Outside government, toll road operator Transurban has conducted trials of connected and autonomous vehicles in partnership with six vehicle manufacturers.⁸⁸ It is now possible to circumnavigate Australia in an EV, following significant new installations of charging infrastructure.⁸⁹

In October 2018, Infrastructure Victoria, an advisor to that state’s government, published a detailed investigation on the implication of AVs and their infrastructure requirements.⁹⁰ It said that by 2046, AVs would reduce annual greenhouse gas emissions by 27 million tonnes, allow a 91 percent increase in Victoria’s road network efficiency and boost economic growth by A\$15 billion US\$10.8 million annually.

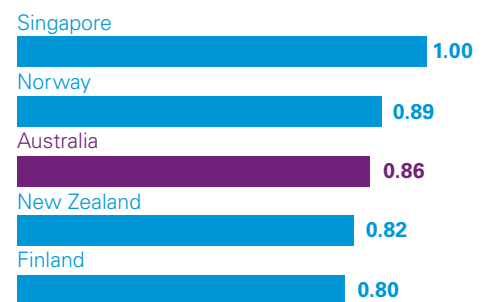
“While Australia is making progress, there are a number of opportunities for the effective integration of AVs,” says Praveen Thakur, Partner, Transport and Infrastructure, KPMG in Australia. “These include implementing recommendations for infrastructure and addressing consumer sentiment and concerns. More generally, as EVs and AVs become more ubiquitous, greater focus is needed on energy policy and road pricing as governments seek to deal with new energy demand patterns and replace revenues as traditional fuel consumption is reduced.”

Regulations supportive of AV use – score by country (top 5)



Source: KPMG International, 2019

Availability of high-performance mobile internet – score by country (top 5)



Source: GSMA Global Connectivity Index, 2017

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Partner,
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KPMG in Australia

16 | Austria



Austria joins with Hungary and Slovenia to create a 'driverless region' as its AV companies develop international links.

In March 2018, Austria joined with Hungary and Slovenia in agreeing to establish cross-border development and testing of new vehicle technologies including AVs, through a new Austrian-Hungarian-Slovenian driverless region.⁹¹ Austria receives one of the highest scores for its AV-focused agency, the Austrian Ministry for Transport, Innovation and Technology (BMVIT — Bundesministerium für Verkehr, Innovation und Technologie).

Within the scope of the first Automated-Connected-Mobile Action Plan (2016–2018), Austria has established a legal framework, and test environments and a variety of research projects have been started. BMVIT invested around 25 million euros in this period to support the development of automated driving in Austria. Over 300 AV professionals are working there on three aspects of AV readiness: ensuring transparent information, safe testing and standard operation, and logging lessons learned. In total, 34 specific measures are planned for the next few years.⁹²

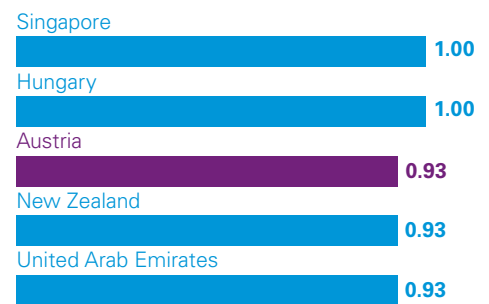
Whereas the achievable potentials as well as building (inter)national networks of Austrian supplier firms and research institutions were important then, a sensible use in terms of traffic has priority for the new Automated Mobility Action Package (2019–2022). Test reports and experience from current tests and

projects illustrate that the technological development will not be completed tomorrow and a good roll-out can only be made possible with formative framework conditions by the public sector. With the new action package, the BMVIT mainly seeks to ensure a sensible and efficient use of automated mobility in terms of traffic as well as to strengthen Austria's competitive position on the international stage. First and foremost, the Ministry is focused on creating liveable public spaces and ensuring a sustainable, climate-friendly mobility system.

The country's willingness to work internationally was demonstrated in June 2018, when companies from the Austrian Light Vehicle Proving Region for Automated Driving (ALP.Lab) visited Slovenia to meet a government minister and discuss cooperation.⁹³ Meanwhile, 2018 saw Austrian-based transport technology group TTTech, whose investors include Samsung, sign AV agreements with German vehicle-maker BMW and China's SAIC.⁹⁴

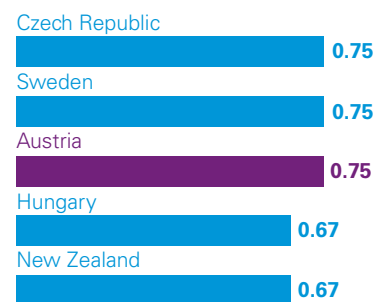
Austria falls four places in the overall AVRI ranking, due to the addition of Norway, Finland and Israel and Australia's faster growth in the infrastructure pillar.

AV department within government — score by country (top 5)



Source: KPMG International, 2019

Industry partnerships — score by country (countries #15–20)



Source: KPMG International, 2019

“ In fields of software development and artificial intelligence, we have an ongoing race between traditional manufacturers and new actors. But autonomous driving is not only about technology — it also requires an effective regulatory framework to ensure safety and sustainability. ”

— **Werner Girth**
Partner Advisory,
KPMG in Austria

17 | France



French legal changes in 2019 hope to add to driverless bus services already running, while the Paris Motor Show highlights links with Israeli technology companies.

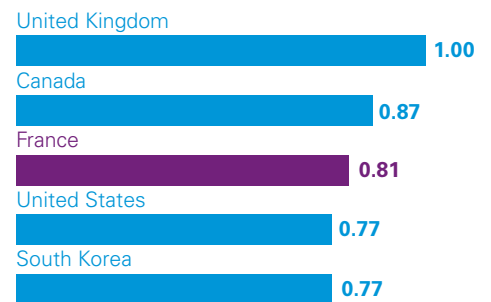
Driverless minibuses already move passengers around otherwise pedestrianized areas of La Défense, an office complex in the west of Paris.⁹⁵ Through legal changes expected to come into force in early 2019, the French government hopes to see more services of this kind. The changes will allow drivers of AVs to be outside vehicles and will release them from responsibility for accidents that take place when the software is activated.

“We expect that these legal changes will facilitate new experimentation,” says Laurent des Places, Partner, Head of Automotive, KPMG in France. There are already more than 50 AV pilots taking place across France, with many around Paris and others in cities including Rouen and Lyon, the latter claiming the world’s first autonomous public transport service from September 2016.⁹⁶ The changes are part of a national strategy for AVs published in May 2018, which also considers safety, public support, the development of digital infrastructure, how data is exchanged and the overall transport ecosystem.⁹⁷

France is mid-table on all four pillars of the AVRI and fell four places due to Norway, Finland and Israel joining the index and Australia’s progress on infrastructure, but its vehicle manufacturers as well as government are working to do more. In March, vehicle maker Renault showed a concept car designed to work as an electric robot taxi, the EZ-GO, at the Geneva Motor Show.⁹⁸ French vehicle part makers are also involved in development in the area⁹⁹ and October 2018’s Paris Motor Show highlighted links with Israeli automotive technology companies.

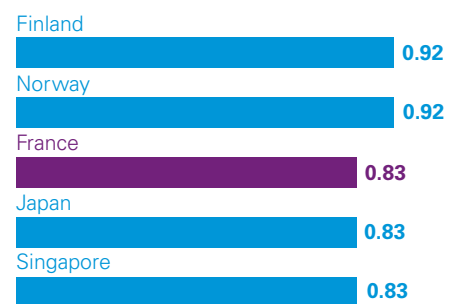
“The French tech ecosystem is very well-connected to other places in the world where things are happening, whether Silicon Valley or Israel,” says des Places. He adds that this makes sense given the relatively small size of its market and companies: “How relationships develop with the key digital players is still a question.” He adds that a national strength is the French government’s provision of significant tax credits for research and development work.

Data sharing and open data environment — score by country (top 5)



Source: Open Data Barometer, 2018

AV-related industry partnerships — score by country (6th–10th)



Source: KPMG International, 2019

“The French tech ecosystem is very well-connected to other places in the world where things are happening, whether Silicon Valley or Israel. How relationships develop with the key digital players is still a question.”

— **Laurent des Places**
Partner, Head of Automotive,
KPMG in France

18 | Spain



The Spanish government and cities are working with companies on real-time information systems and collision avoidance technology.

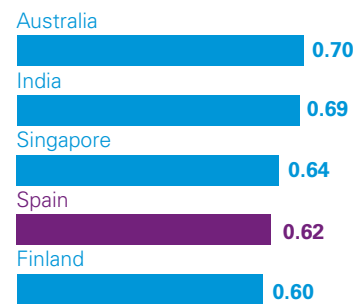
In October 2018, the Spanish Directorate General of Traffic (DGT) awarded a 3.4 million euros (US\$3.9 million) smart mobility contract to a consortium 50 percent owned by KPMG in Spain. The 4-year Plataforma de Vehículo Conectado 3.0 (Connected Vehicle Platform 3.0) aims to establish a real-time system through which vehicles can connect and exchange traffic information. It aims to address the directorate’s “visión zero” objective of zero fatalities, harm, congestion and emissions.¹⁰⁰

Spanish cities are undertaking their own projects. From September 2017, Transports Metropolitans de Barcelona has been piloting Mobileye’s Shield+ collision avoidance system, which is designed to improve urban road safety. The city initially tested the system in buses, street-cleaning and waste

management vehicles and police vehicles, and plans to extend it to all municipal vehicles.¹⁰¹ Madrid, along with Lisbon in Portugal and Paris in France, is one of three pilot cities in Auto C-its, an EU-funded study on regulating AVs.¹⁰² The Universitat Politècnica de València is involved in another European project — as the field test site for 5G technology run by the UK’s University of Lancaster.¹⁰³

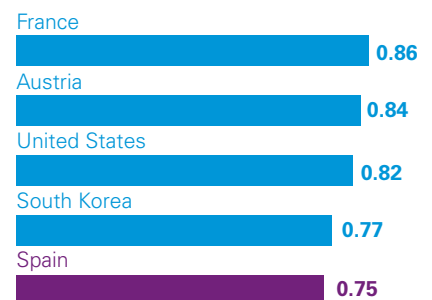
Spain is in the bottom-half of the table for all four pillars, but there is potential to change this. “There is clear commitment from the Directorate General of Traffic to boost AVs. The development of a digital platform to connect vehicles and infrastructure in real-time will strengthen our existing high-quality interurban transport network. Moreover, in the last few months, we are seeing our big cities implement new transportation modes very quickly, a clear signal of improvement in terms of consumer acceptance,” says Ovidio Turrado, Head of Infrastructure at KPMG in Spain.

Extent of 4G coverage — score by country (11th–15th)



Source: Open Signal, 2018

Road infrastructure quality — score by country (6th–10th)



Source: World Economic Forum, Global Competitive Index 2018

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— **Ovidio Turrado**
Head of Infrastructure,
KPMG in Spain

19 | Czech Republic

Policy and legislation

17

Technology and innovation

18

Infrastructure

19

Consumer acceptance

20

New AV test sites, supporting the country's top rating for AV pilots, should build on the Czech Republic's reputation of local vehicle manufacturing.

The next few years will see new AV testing grounds built in the Czech Republic, including one being constructed by German vehicle maker BMW at a 1,200 acre site in Sokolov near the German border. It will spend more than 100 million euros (US\$113 million) on the site, which is due to start work early next decade. BMW chose the test site, its first in eastern Europe and in a country where it does not currently manufacture, from 82 potential locations, with lower costs as a factor.¹⁰⁴

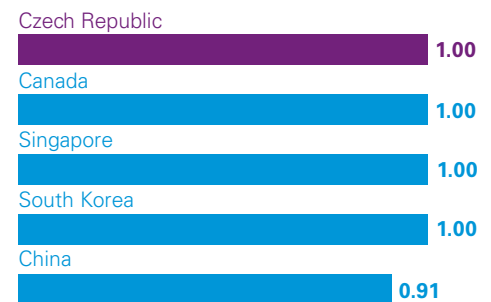
The country's economy relies on vehicle manufacturing, including by Volkswagen and Hyundai, and the new test facilities should help maintain this work for the AV era, according to Pavel Kliment, Partner focusing on infrastructure, KPMG in the Czech Republic. "The government feels this is an important step to position the country for the future.

The manufacturers are already here, they know the environment and have significant investments, so it's natural to continue with that. The country has a skilled workforce, including in research and development."

These projects help the Czech Republic, a new addition to the AVRI, gain the highest possible score for government-funded AV pilots. The government has published a strategic plan for AVs that, as well as, supporting testing, discusses a legal framework and support for international standardization. In June 2018, it announced draft legal amendments to facilitate AVs, similar to changes made by Germany in 2017.¹⁰⁵

However, the country receives lower scores in other measures, including the quality of its judicial system, locally headquartered AV companies, AV-related patents and industry investments. Kliment says that the strategic plan and the establishment of the two test sites provide grounds for optimism, but adds that local deployment of AVs is unlikely over the next few years.

Government-funded AV pilots — score by country (top 5)



Source: KPMG International, 2019

AV technology firm headquarters (per capita) — score by country (bottom 5)



Source: Vision System Intelligence, Comet Labs and CrunchBase Pro, 2018

“The manufacturers are already here, they know the environment and have significant investments, so it's natural to continue with that. The country has a skilled workforce, including in research and development.”

— Pavel Kliment

Partner focusing on infrastructure, KPMG in the Czech Republic

20 | China



The Chinese government allows first approved AV tests in 2018, with large number of local companies working to compete globally.

2018 saw the start of government-approved tests of AVs on public roads, with tests held by Chinese start-ups Jingchi and Pony.ai in the southern city of Guangzhou in February.¹⁰⁶ Although companies including Baidu, which runs China’s main search engine, had run such tests as early as 2015,¹⁰⁷ the move represents a regularization of the process.

“The environment in China for testing new innovation is much easier than in most other markets in the world,” says Huu-Hoi Tran, Partner, Automotive Sector, KPMG in China, adding that regulators prefer to allow companies to try innovations before intervening.

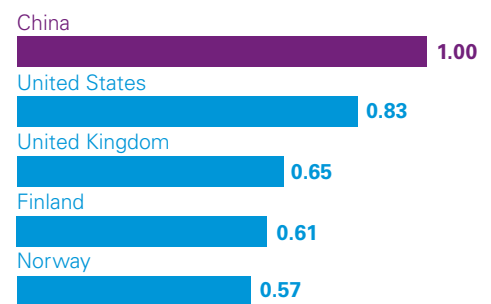
China shows relative improvement in the technology and innovation and infrastructure pillars, and gains the highest score on a new measure focused on online ride-hailing, with 21 percent of people having used such a system. However, it scores lower on measures including the availability of latest technologies and consumer adoption of technology. On

some measures, including numbers of headquarters and patents — on which it is third numerically to Japan and the US — its score is reduced when these are calculated per capita. China also ranks last on a new measure assessing the data-sharing environment.

Tran says that the government sector can enable AV adoption through more spending on communications infrastructure. “Autonomous driving will come gradually, on certain routes, streets and highways. That gives more confidence for developers to develop autonomous driving functions gradually, from easier routes to more complex situations, including AVs co-existing on streets with normal cars.”

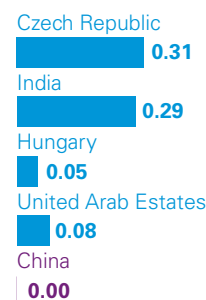
China is also likely to benefit from a large number of companies focused on vehicle technology, including start-ups aiming to compete globally. In March 2018, KPMG in China published a list of 50 leaders in this sector, based on research covering more than 4,000 companies.¹⁰⁸ Philip Ng, Partner, Technology Sector, KPMG in China says that companies of particular interest include RoboSense and SureStar, both of which focus on lidar, and Horizon Robotics, which focuses on artificial intelligence microchips.¹⁰⁹

Consumer adoption of online ride-hailing apps — score by country (top 5)



Source: Statista, 2018

Data sharing and open data environment — score by country (bottom 5)



Source: Open Data Barometer, 2018

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— **Huu-Hoi Tran**
Partner, Automotive Sector,
KPMG in China

21 | Hungary



Hungary focuses on testing and manufacturing with Zala Zone test center and investment by BMW, but domestic use of AVs looks set to trail other countries.

Hungary is seeking to position itself as a research and development (R&D) AV center, most significantly through the development of Zala Zone, an all-purpose proving ground set up at Zalaegerszeg in the west of the country. The facility, ordered by the government in 2016 to test hybrids, EVs and AVs, includes stretches of country road, highway and an urban environment.¹¹⁰ It is already partially open with one German carmaker having booked use early in 2019, and it is scheduled to be fully functional in 2020.

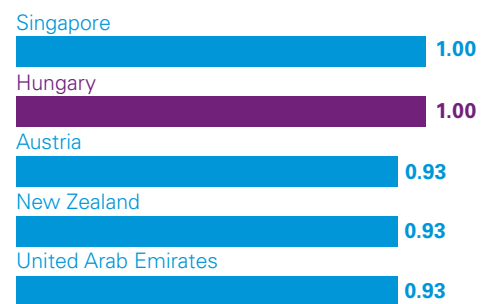
Márton Zsótér, Manager of Infrastructure, Transportation and Energy Advisory, KPMG in Hungary, says that this is part of a trend for increased R&D work, involving suppliers, universities and technology companies. This includes a Budapest-based AV start-up, Almotive, which has partnerships with companies including PSA Groupe, Samsung and Volvo and carries out its R&D work in Hungary.¹¹¹

Hungary is also attracting increasing levels of manufacturing. In July 2018, BMW announced it will spend 1 billion euros on a new plant in Debrecen in eastern Hungary, which will include capabilities for automation.¹¹² The country has also signed an agreement with Austria and Slovenia to develop cross-border cooperation on developing and testing AVs.¹¹³

Hungary is one of the countries given the highest score for having an AV-focused agency, although it has weaker scores on the quality of its judicial system and on several measures of innovation. Zsótér says that while Hungary is helping to develop AI technologies, Hungarians are unlikely to be among the first to use them, due to a small domestic market and a focus on exporting, and despite enthusiasm to develop R&D, the Hungarian government has not passed any legislation concerning local use of AVs.

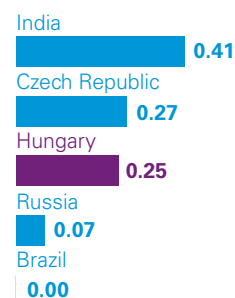
He adds that AVs represent a significant opportunity for many Hungarian companies: “Logistics companies, public transportation and similar industries are all facing labor shortages. AVs could be a solution for them to overcome this issue.”

AV department within government — score by country (top 5)



Source: KPMG International, 2019

Road infrastructure quality — score by country (bottom 5)



Source: World Economic Forum, Global Competitive Index 2018

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22 | Russia

Policy and legislation	22	Technology and innovation	24	Infrastructure	24	Consumer acceptance	24
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Russian company carries out test in snow and claims first European AV ride-hailing service, with new government resolution allowing tests on public roads.

2018 has seen increasing Russian interest in AVs, with February seeing AV car testing on the streets of Moscow, with snow and in below-freezing temperatures.¹¹⁴ In August, the company launched what it claims is the first autonomous ride-hailing service in Europe, in the university town of Innopolis.¹¹⁵ The summer also saw Moscow’s government agree to develop autonomous transport at the State Research Center of the Russian Federation (known as Nami). In September, the government indicated that planned changes to the international Vienna Convention on road usage would trigger changes to Russian law.

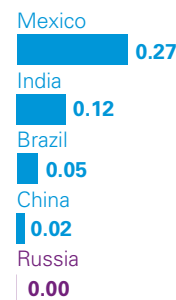
Vadim Toporov, Associate Director, Advisory, KPMG in Russia, has seen rising interest in AVs among a number of firms, with the focus shifting from theoretical questions to practical ones. “In Russia, Yandex is the industry leader. It has started driverless ‘Robotaxi’ service in two Russian cities and received permission to test on public roads in Russia, Israel and United States, showing its global ambition. There are also other companies with working prototypes, including

Kamaz and Volgabus and AI software developers, like Cognitive Technology,” he says. “There are also good transport information services, in particular Moscow’s traffic control system, which monitors buses, taxis and car-sharing.” Another strength, according to the GSM Association, is that more than 80 percent of Russians will have access to 5G networks by 2025.¹¹⁶

In November, the Russian government issued a resolution allowing testing of AVs on public roads in Moscow and Tatarstan from December 2018 to March 2022, with the aims of confirming they can operate on roads and developing technical requirements.

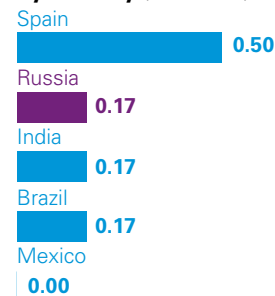
Dmitry Lobanov, a member of AutoNet, a government working group that aims to improve legislation and remove regulatory barriers, says that Russia approved measures in March 2018 to allow AVs on public roads and is now improving this access. This builds on a more general resolution passed in 2016 that aims to cut barriers to technology innovation. “Several major organizations — including Yandex and Kamaz — are engaged in the development of highly automated and fully automated vehicles,” he says. “This interaction between the state and competent commercial organizations creates a friendly environment for the introduction of AVs.”

Availability of the latest technologies — score by country (bottom 5)



Source: World Economic Forum Networked Readiness Index, 2018

Industry partnerships (vehicle makers and AV technology suppliers) — score by country (bottom 5)



Source: KPMG International, 2019

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— Vadim Toporov
Associate Director, Advisory,
KPMG in Russia

23 | Mexico

Policy and legislation	24	Technology and innovation	23	Infrastructure	22	Consumer acceptance	21
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Mexico’s new trade agreement with the US and Canada may involve transfer of AV technology, although there is room for improvement in infrastructure.

Mexico’s consumers are second only to India’s in enthusiasm for AVs, and there are other reasons to be optimistic, according to Ignacio Garcia de Presno, Head of Infrastructure, KPMG in Mexico. These include the new US-Mexico-Canada (USMCA) trade agreement, announced in October 2018. “We’re getting more integrated with the US and Canada,” he says, and as those two countries’ manufacturers invest in AVs, Mexico is likely to be involved.

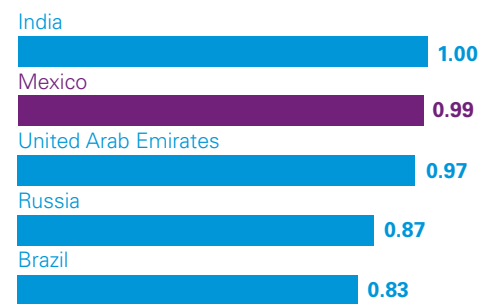
The USMCA agreement requires that 75 percent of locally used vehicle parts are made within the three countries by 2023, up from 62.5 percent under the North American Free Trade Agreement that USMCA will replace. While the agreement requires a proportion of vehicle content to be built by workers earning US\$16 an hour, more than most Mexican workers, industry association INA believes part output will rise by about 10 percent over the

next 3 years to around US\$100 billion, creating 80,000 new jobs, as a result of the deal.¹¹⁷

Recent changes in the Mexican Federal Government have slowed down progress nationally in terms of electric and autonomous vehicles, and road infrastructure is generally weak. According to de Presno, local administrations are more likely to do preparation work, like in the case of Mexico City, which is pledging better and cleaner transport.

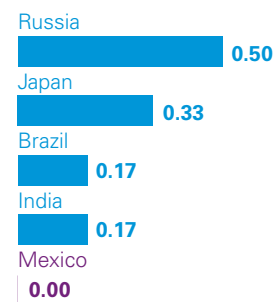
Industry is likely to play a part too, with Tesla extending its network of charging points in the country. Liberalization of Mexico’s electricity market, opening it to private investment by the end of 2018,¹¹⁸ should boost this process. “There’s a huge opportunity to improve our electricity network and to increase the number of participants in the sector. I’m optimistic that the private sector will work with local government to start improving,” de Presno says.

Consumer opinion about AVs — score by country (top 5)



Source: KPMG International, 2019

Regulations supportive of AV use — score by country (bottom 5)



Source: KPMG International, 2019

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24 | India



Indians lead poll on enthusiasm for AVs, while its companies develop technology and partnerships.

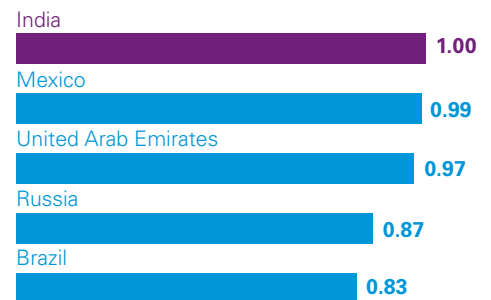
India leads the AVRI's new consumer opinion measure, according to a KPMG survey that asked participants about their general opinion of AVs. Indians also gave the most positive reactions to other questions in that survey, including the likelihood to use an AV and willingness to buy or lease one. In a similar study, close to 50 percent of Indians surveyed said they wanted driverless cars, perhaps given roads in the country experience heavy congestion.¹¹⁹

India is introducing driverless trains on a new underground line in Mumbai¹²⁰ (although similar trains have been used in other countries for some years). This could pave the way for AVs to be deployed in public transport, freight and logistics, but India is still at an early stage. Sameer Bhatnagar, Partner, KPMG in India, says that "building an AV ecosystem in India would require a massive investment in new and dedicated physical infrastructure given the geographical expanse, density and population of the country."

However, several Indian start-ups are working on developing AV products for trucks, minibuses and cars, in some cases with a focus on exporting to other countries.¹²¹ In November 2017, car-sharing aggregator Revv partnered with Intel subsidiary Mobileye to install the latter's systems with the aim of reducing accidents.¹²² India is also working to adopt EVs to tackle rising pollution levels, with several states buying EV buses for public transport.

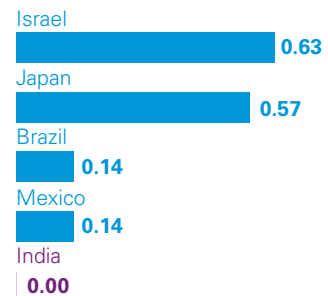
"India's strength lies in its innovation and technology. It could be the leading supplier of AV technology to the world and incubate an entire "SV for AV" — a Silicon Valley for Autonomous Vehicles. We hope to find unique and niche applications for AVs where they can help provide added value, safety and efficiency, such as in-plant logistics, in-campus movement and public transport."

Consumer opinion about AVs — score by country (top 5)



Source: KPMG International, 2019

AV department within government — score by country (bottom 5)



Source: KPMG International, 2019

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— Sameer Bhatnagar
Partner, IGH and Global Sector
Leader — Ports,
KPMG in India

25 | Brazil



Brazil's performance could be boosted by new tax incentive programs for vehicle manufacturers focused on efficiency, safety and research.

In November, Brazil's government passed Rota 2030, a 15-year program that will provide tax incentives to improve vehicles' fuel efficiency and safety, and for research and development. The program, which replaces a set of tax exemptions that expired at the end of 2017, is worth US\$560 million in 2019.¹²³

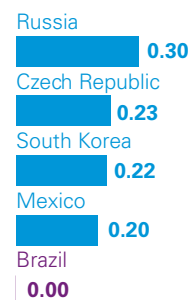
Although Rota 2030 has a broad base and covers Brazil's widely used 'Flex' engines that run on a mixture of fossil fuel and ethanol from sugar, it should also benefit EVs and AVs, according to Mauricio Endo, Head of Government and Infrastructure, KPMG in Latin America. He points out that around 40 percent of the price of a car can be taxation, meaning that tax breaks are a significant tool for influencing the industry.

Brazil has been outpaced by Russia, Mexico and India on the technology and innovation and infrastructure pillars, leading to its current position in

the AVRI. However, there are reasons for optimism, including work taking place within universities. In May 2017, the Intelligent Autonomous Robotic Automobile (Iara) project at the Federal University of Espírito Santo in Vitoria successfully used an AV on a 74-km journey that included urban and rural roads.¹²⁴ The Intelligent Robotic Car for Autonomous Navigation (Carina, based on its Portuguese name) project, at the São Carlos campus of the University of São Paulo, ran a first test-drive on city streets in October 2013.¹²⁵

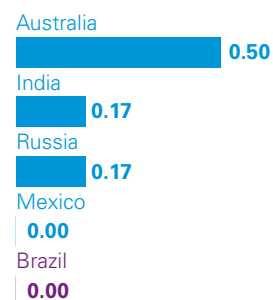
Endo points out that major vehicle manufacturers have factories in Brazil and that, in March 2018, Toyota announced a hybrid fuel model for the Brazilian market,¹²⁶ and the work manufacturers are doing on AVs elsewhere could be introduced quickly. Although infrastructure for EVs such as charging stations is currently poor, he says that there is potential for the country to adopt EVs and AVs quickly. "Brazil is usually an early adopter of new technologies. If the automakers and the government decide to adopt AVs and prices are competitive, then I think consumers will be quick to use them. Rota 2030 is the first step."

Effectiveness of the legislative process — score by country (bottom 5)



Source: World Economic Forum Networked Readiness Index, 2018

Government-funded AV pilots — score by country (bottom 5)

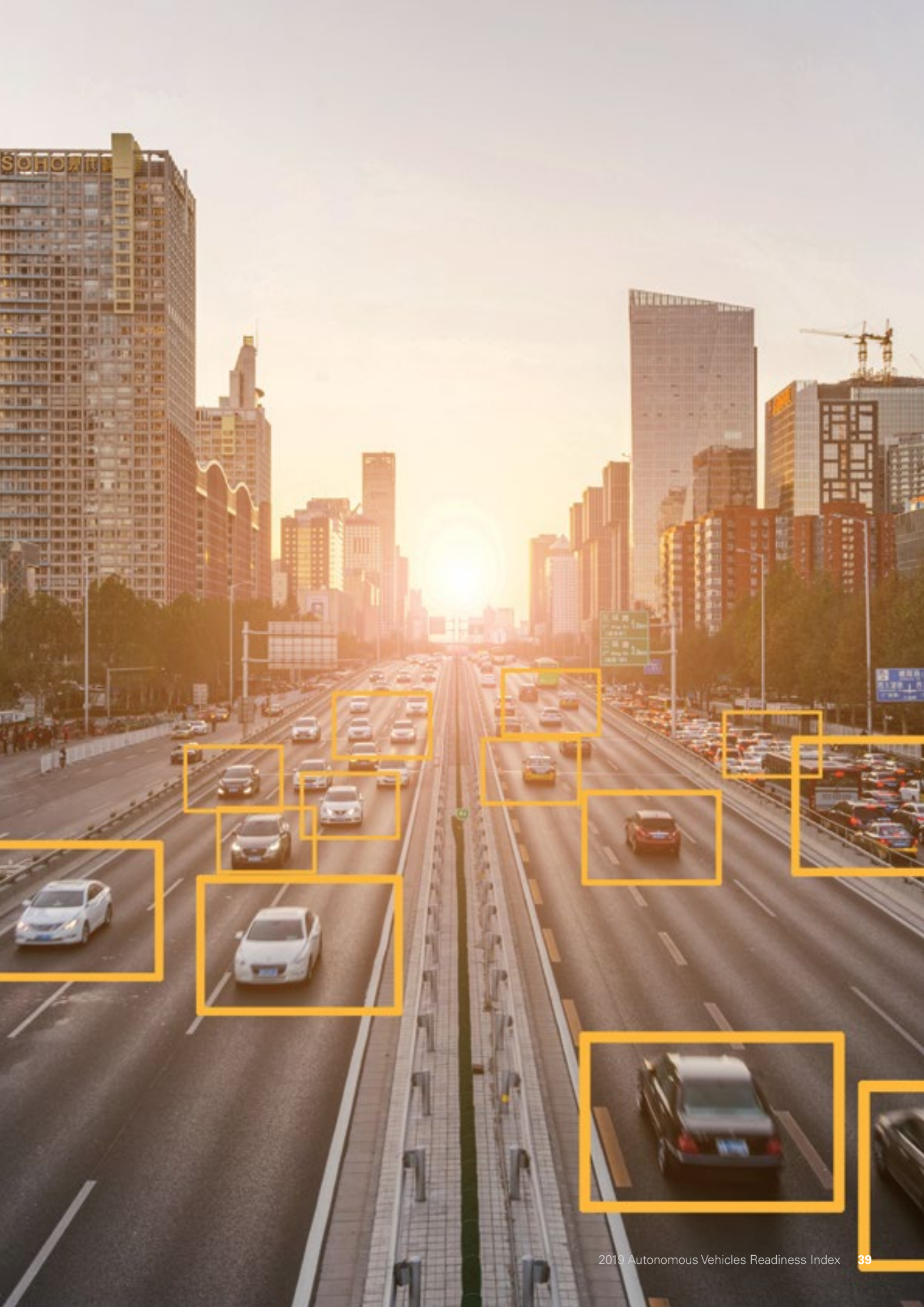


Source: KPMG International, 2019

“Brazil is usually an early adopter of new technologies. If the automakers and the government decide to adopt AVs and prices are competitive, then I think consumers will be quick to use them.”

— **Mauricio Endo**

Head of Government and Infrastructure, KPMG in Latin America





The road ahead

In the year since KPMG International published its first *Autonomous Vehicles Readiness Index*, countries across the world have made rapid strides in preparing for an AV future.

Governments have been drafting new rules, companies have been testing their vehicles, the media has been analyzing the benefits and risks of adoption, and consumers have been considering their willingness to ride a driverless car.

In the exciting months and years to follow, many governments will be eager to ensure that the policy environment, investment-attractiveness, infrastructure-readiness and consumer acceptance keep pace with evolving technology. Through this report, KPMG International hopes to have provided insight on best practices for developing autonomous technology and what countries can do to improve in a number of areas.

The road ahead: key insights for governments

- **Advanced AV markets could invest more in technology and innovation:** Countries like the Netherlands and Singapore, which are already at the top of the index, could far outpace other countries if they focused on Pillar 2. In particular, investing in AV-related firms and R&D, industry partnerships, and an innovation-friendly business environment could cement their position at the top.
- **Countries leading in technology and innovation could work on achieving greater policy and institutional clarity:** The countries that are leading the world in technology and innovation — Germany, Israel, Japan, Norway and the US — have middling scores in their AV regulatory environment and institutions. Adapting and revisiting their regulations, and establishing an AV-focused institution could take these countries to the top of the rankings.
- **Most countries that do well on infrastructure readiness should reform their policy and legislative environment:** Six of the 10 countries that lead the world on infrastructure readiness ([Pillar 3](#)) — Australia, Austria, Japan, South Korea, Sweden and the UAE — do not feature in the top 10 of policy/legislative environment ([Pillar 1](#)). Since these countries have some of the more capital-intensive parameters like network connectivity, 4G coverage, and roads in place, to improve their positions, they could work on relatively low-hanging fruit like establishing AV regulations and institutions.
- **Less-developed AV markets could take advantage of higher consumer interest in AVs if other areas, including policy and technology, are addressed:** Countries with the lowest overall scores like Brazil, India, Mexico and Russia, have the highest scores in our new survey testing respondents' willingness to ride in an AV. This is good news in the long term for AV manufacturers given the size of these consumer markets, but only if governments actively develop other areas.

Our role in your decisions

As AV technology evolves, stakeholders across sectors will have to strategically, flexibly and nimbly prepare for a transformation of the world as we know it.

- Transport authorities will develop and adapt governance and legislation to address complex themes like data security, safety, and the ethics of artificial intelligence.
- Infrastructure operators will grapple with an increasing pace of change and shorter planning horizons.
- Manufacturers will develop new operating models to be commercially viable.
- Investors will have to engage with new investment classes and design innovative value capture models.
- Consumers will come to understand a new transportation paradigm enabled by artificial intelligence.

KPMG member firms can help you explore your options and achieve your objectives. Our past and ongoing experience in the sector has prepared us to advise in the following areas.

- We help local, regional and national transport authorities and infrastructure providers develop and execute strategies to keep pace with AV disruption.
- We help local investment authorities identify and pitch to AV prospects for foreign direct investment.
- We help private sector companies and funds analyze and identify opportunities for investment and partnerships in the AV value chain.
- We produce cutting-edge research on AVs that enables a multitude of stakeholders to understand the dynamic and uncertain space.


About KPMG

KPMG's Global Public Sector Transport network works with public transport authorities to embrace emerging technologies to help increase capacity, optimize asset life cycle and leverage existing data. We help governments and transport providers to understand and shape the future of public transport, while supporting them in improving the experiences of customers today.

We understand that clients need to enhance their performance while cutting costs and using existing assets, and we support them through realizing the value of their land and increasing ancillary revenues, such as from digital advertising. Our teams also support them in helping to maximize opportunities from disruptive technologies including EVs mobility-as-a-service, service, smart assets and transport systems, data and analytics.

For more information, visit kpmg.com/publictransport.

KPMG's Global Government & Public Sector practice works to deliver meaningful results through a deep understanding of the issues, an appreciation of how the public sector works, and global and local insight into the cultural, social and political pressures facing governments today. Our network of professionals, many of whom have held senior public sector roles, consistently strive to combine their practical, hands-on experience with insight from our global network to help our industry clients implement transformational strategies, economically, efficiently and effectively. We understand the continuing impact of innovation and disruption on governments as they search for more efficient ways to deploy technology to empower change within their organizations. For further information, please visit us online at kpmg.com/government.



Appendix: Results and methodology

The 25 countries have been assessed on 25 different measures, gathered into four pillars. Four measures are scored for this index by KPMG International and **ESI ThoughtLab**, which used publicly available information, including media reports, press releases and other material. One measure uses a consumer survey carried out by Branded Research in each of the countries. A further 20 variables draw on existing research by KPMG International and other organizations.

The variables under the four pillars are combined to arrive at an aggregate score for each. All variables are given equal weight in arriving at the overall pillar score. Before the data is combined it is normalized, as the variables have different measurement units, using the min-max method. This converts the variables to a range between zero and one, by subtracting the minimum value and dividing by the range of the variable values. Therefore the top-ranked country receives one and the bottom country zero.

Pillars have differing number of variables, so each pillar score is scaled to give them the same maximum possible value. This means that each pillar has equal weight in the overall score for each country.





Policy and legislation

Overview

- Singapore leads this pillar overall and gains the highest scores on five of its seven measures, including a World Economic Forum assessment of effectiveness of lawmaking bodies and a KPMG measure of government change readiness.
- Singapore also shares the top rating in an assessment of its AV regulations with Australia, Finland and the Netherlands, and for having a single government entity for AV work with Hungary.
- Along with Canada, the Czech Republic and South Korea, Singapore also gains top marks in the assessment of government-funded AV pilots.
- The UK, second-placed in this pillar, leads on a new measure assessing the data-sharing environment, added as such sharing enables greater collaboration between government and companies in AV development.

Methodology

The pillar is calculated from seven equally weighted factors, one of which is new for the 2019 edition of the index.

AV regulations, government-funded AV pilots and AV-focused agency: each of these three factors is scored out of seven for this index based on a review of media articles, government press releases and government regulations.

On AV regulations, countries that have regulations that are supportive of AV use and place few restrictions on when, where and how testing of AVs may occur are scored higher and countries that place greater restrictions on testing are scored lower. The maximum score is awarded to Australia, Finland, Singapore and the Netherlands. The lowest scores go to Mexico, then Brazil and India.

A similar approach is taken for government-funded AV pilots. The maximum score is awarded to Canada, the Czech Republic, Singapore and South Korea. Brazil and Mexico receive the minimum score, followed by India and Russia.

With the AV-focused agency variable, governments that spread the responsibility for AVs across a large number of government entities are given lower marks; those that take the most common approach, of placing responsibility in an existing agency, gain middling marks; and those establishing an AV or transportation technology and innovation-focused agency that has sole responsibility gain the highest marks. As well as providing innovators with a single point of contact, such focus demonstrates a government's commitment. Hungary and Singapore are awarded maximum marks, followed by Austria, New Zealand and the UAE. India gets the minimum score, followed by Brazil and Mexico.

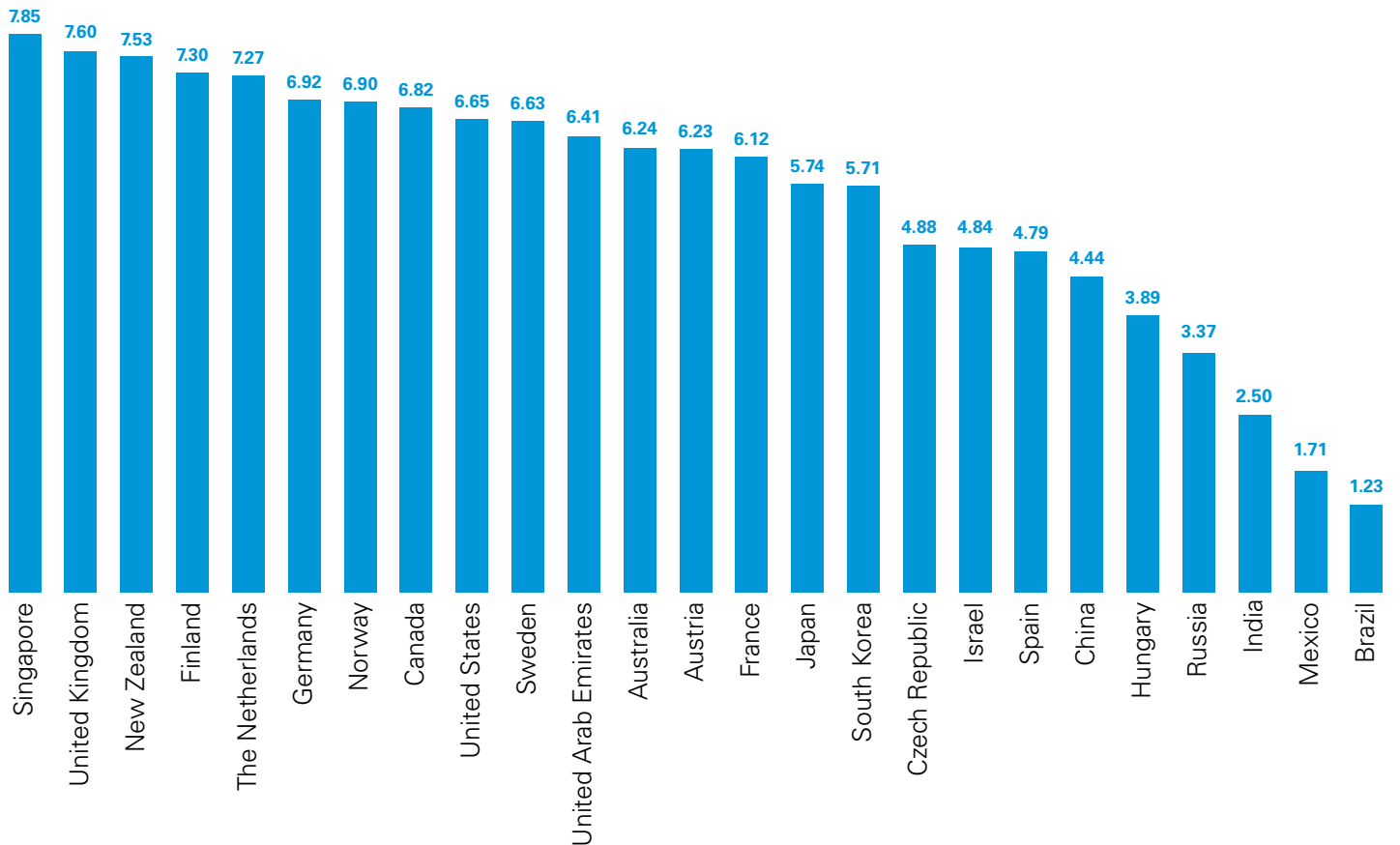
Government readiness for change: scores are based on KPMG International's *2017 Change readiness index*, updated for 2018.¹²⁷ This is a composite index that assesses regulation, government strategic planning and the rule of law among other measures. Singapore, the UAE and Sweden receive the highest scores and Brazil, Mexico and Russia the lowest.

Effectiveness of legislative process and efficiency of the legal system in challenging regulations: both from the World Economic Forum's Networked Readiness Index for 2018, as judged by business executives in each country.¹²⁸ The effectiveness of the legislative process is included to measure a country's ability to pass regulations necessary for the development of AVs. Singapore, New Zealand and the UK gain the highest scores, while Brazil, Mexico and South Korea receive the lowest.

The measure on challenging regulations through the legal system is included to gauge the ability of AV manufacturers and others to challenge unfavorable government rules. On this, Finland, the US and New Zealand receive the highest scores while Hungary, Brazil and the Czech Republic get the lowest ones.

Data-sharing environment: from the World Wide Web Foundation's *Open data barometer* for 2016, the latest edition which covers all 25 AVRI countries.¹²⁹ Countries adopting open and shared data approaches score higher, as this enables greater collaboration between government and private industry to encourage AV development. The UK, Canada and France rank highest while China, Hungary and the UAE rank lowest.

Pillar 1: aggregate scores by country



Pillar 1: (Policy and legislation) normalized indicator values by country

Country	AV regulations	AV department within government transportation dept.	KPMG Change Readiness Government Capability pillar	WEF – Effectiveness of lawmaking bodies	WEF – Efficiency of the legal system in challenging regulations	Number of government-funded AV pilots	Assessment of the data-sharing environment
Singapore	1.000	1.000	1.000	1.000	0.697	1.000	0.411
United Kingdom	0.917	0.857	0.673	0.847	0.781	0.833	1.000
New Zealand	0.917	0.929	0.845	0.882	0.874	0.667	0.743
Finland	1.000	0.714	0.892	0.786	1.000	0.833	0.451
The Netherlands	1.000	0.714	0.766	0.732	0.837	0.917	0.688
Germany	0.750	0.857	0.778	0.679	0.867	0.833	0.621
Norway	0.917	0.643	0.856	0.792	0.654	0.833	0.674
Canada	0.750	0.714	0.622	0.732	0.617	1.000	0.870
United States	0.833	0.714	0.527	0.422	0.986	0.917	0.771
Sweden	0.667	0.714	0.968	0.785	0.730	0.667	0.625
United Arab Emirates	0.833	0.929	0.990	0.748	0.739	0.667	0.081
Australia	1.000	0.714	0.663	0.622	0.592	0.500	0.765
Austria	0.833	0.929	0.648	0.456	0.518	0.833	0.629
France	0.750	0.714	0.480	0.624	0.545	0.833	0.815
Japan	0.333	0.571	0.537	0.780	0.720	0.833	0.691
South Korea	0.833	0.857	0.380	0.216	0.391	1.000	0.766
Czech Republic	0.833	0.714	0.484	0.231	0.225	1.000	0.309
Israel	0.667	0.643	0.435	0.364	0.572	0.750	0.331
Spain	0.833	0.714	0.341	0.425	0.245	0.500	0.668
China	0.500	0.643	0.367	0.460	0.564	0.917	0.000
Hungary	0.583	1.000	0.232	0.330	0.000	0.833	0.046
Russia	0.500	0.857	0.133	0.304	0.302	0.167	0.360
India	0.167	0.000	0.221	0.417	0.682	0.167	0.288
Mexico	0.000	0.143	0.093	0.200	0.225	0.000	0.670
Brazil	0.167	0.143	0.000	0.000	0.157	0.000	0.488

Source: KPMG International, 2019



Technology and innovation

Overview

- Israel is the clear leader with the top scores for industry partnerships, AV company headquarters and AV investments, all adjusted for population.
- Japan leads on number of AV-related patents, with data from PatSeer to August 2018 finding 5,272, followed by the US with 4,476 and China with 3,548. Japan also has the most patents per capita, the measure used in the index.
- The World Economic Forum finds that Finland has the best availability of the latest technology and the US has the best capacity for innovation.
- Norway has by far the highest market share for EVs of more than 39 percent. EVs are a precursor for AVs, which are expected to be mostly electric.

Methodology

The pillar is calculated from seven equally weighted factors, two fewer than in the 2018 AVRI.

Industry partnerships: the measure is scored out of seven for this index, based on a review of news coverage from local and global media, research from consulting firms and blogs maintained by AV industry experts. The rapid and disruptive nature of AV technology has made partnerships between vehicle makers and technology suppliers essential, and many have been formed recently. Those countries that are home to companies that have established a large number of partnerships are given higher scores. Canada, Germany, Israel, South Korea and the US all gain the maximum score while Mexico scores the lowest, followed by Brazil, India and Russia.

AV technology firm headquarters: based on a list of AV-related technology companies built from those published by Vision System Intelligence¹³⁰ and Comet Labs,¹³¹ updated for this edition with data from Crunchbase Pro on AV companies founded since the 2018 report.¹³² The US has the highest number of headquarters at 258 followed by the UK with 39 and Germany with 26. Numbers

are scaled by national population for the index, with the result that Israel, Finland and Sweden gain the highest scores and Czech Republic, Mexico, New Zealand and the UAE are ranked lowest.

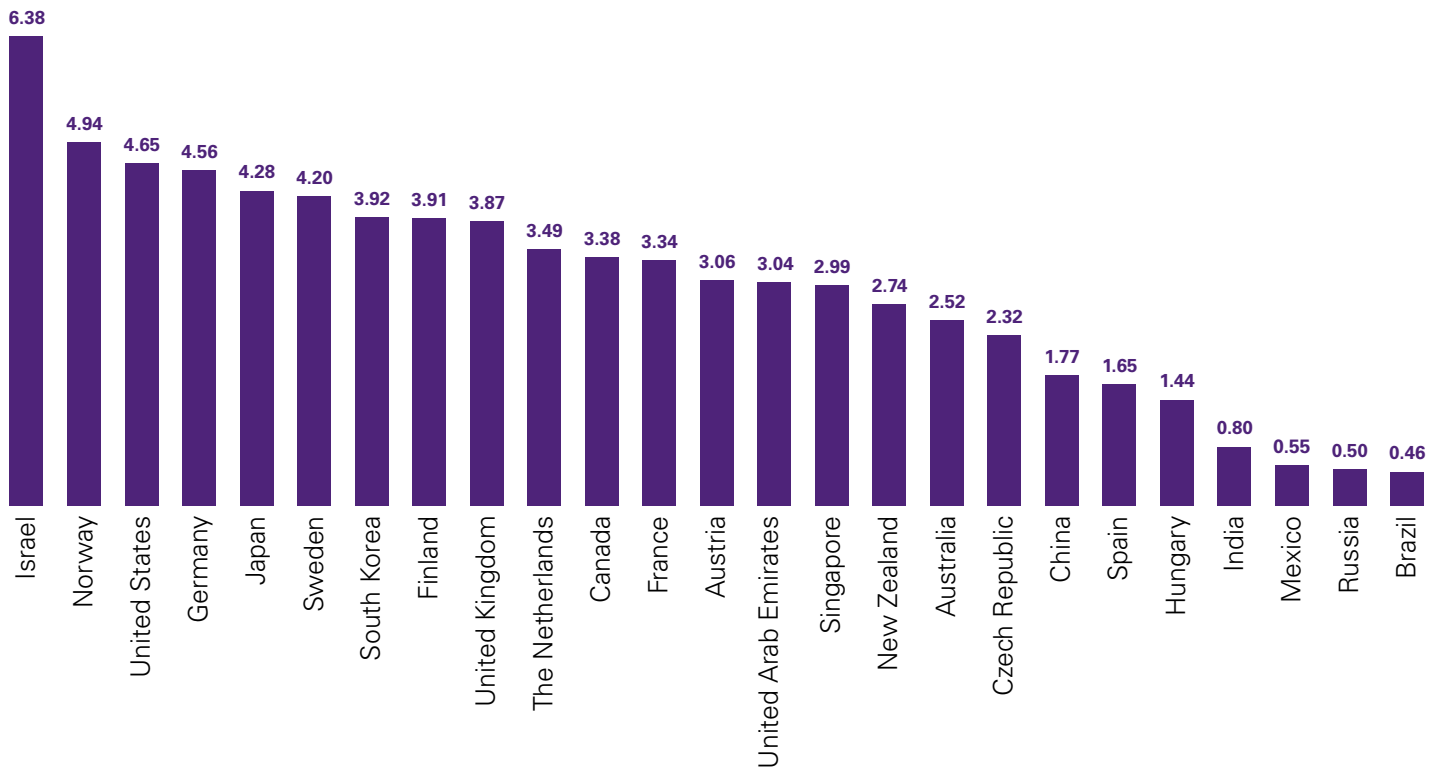
AV-related patents: this measure uses data from PatSeer¹³³ on all AV-related patents and patent applications made by August 2018 for the 25 countries. Numbers are scaled by national populations, and on this basis Japan, South Korea and Germany score highest while the Czech Republic, Singapore and the UAE all get the minimum score.

Industry investments in AV: using data from Crunchbase Pro covering investments since 2007, this measure is based on the countries of investing organizations, rather than where the investment is made. Again, this is scaled by national populations. The leading countries for investment on a per capita basis are Israel, Norway and the US while the Czech Republic, Finland, Hungary, Mexico, New Zealand and the UAE all get the minimum score.

Availability of the latest technology and capacity for innovation: both from the World Economic Forum's *Networked readiness index*, based on responses from business executives.¹³⁴ They judge that Finland, Norway and Israel have the greatest access to the latest technologies and so receive the highest scores while Russia, China and Brazil have the lowest. Executives see the US, Sweden and Israel as having the greatest capacities for innovation and Hungary, Brazil and Mexico as having the least.

Market share of electric cars: data for most countries comes from the International Energy Agency's *Global EV outlook 2018*¹³⁵ while information for other countries is gathered from country-specific data sources. Countries are scored more highly for bigger market shares for EVs, given that most AVs will be electric. Norway, Sweden and the Netherlands rank highest, while the Czech Republic, Hungary, Israel and Russia all get the minimum score.

Pillar 2: aggregate scores by country



Pillar 2: (Technology and innovation) normalized indicator values by country

Country	Industry partnerships	AV tech firm HQ	AV-related patents	Investment in AV-related firms	WEF — Availability of the latest technology	WEF — Capacity for innovation	Market share of electric cars
Israel	1.000	1.000	0.045	1.000	0.946	0.968	0.000
Norway	0.917	0.126	0.009	0.155	0.971	0.662	1.000
United States	1.000	0.176	0.340	0.141	0.931	1.000	0.031
Germany	1.000	0.069	0.752	0.030	0.751	0.901	0.041
Japan	0.833	0.029	1.000	0.009	0.843	0.588	0.026
Sweden	0.750	0.179	0.214	0.124	0.937	0.904	0.161
South Korea	1.000	0.043	0.863	0.040	0.633	0.438	0.033
Finland	0.917	0.199	0.044	0.000	1.000	0.813	0.066
United Kingdom	0.833	0.130	0.246	0.123	0.855	0.778	0.043
The Netherlands	0.667	0.129	0.016	0.071	0.907	0.855	0.069
Canada	1.000	0.109	0.097	0.034	0.782	0.576	0.028
France	0.833	0.044	0.119	0.044	0.735	0.780	0.043
Austria	0.667	0.050	0.131	0.046	0.685	0.797	0.004
United Arab Emirates	0.833	0.000	0.000	0.000	0.787	0.713	0.028
Singapore	0.833	0.039	0.000	0.073	0.771	0.606	0.002
New Zealand	0.667	0.000	0.026	0.000	0.743	0.666	0.028
Australia	0.500	0.055	0.184	0.068	0.576	0.573	0.003
Czech Republic	0.750	0.000	0.000	0.000	0.543	0.509	0.000
China	0.750	0.005	0.062	0.005	0.023	0.310	0.056
Spain	0.500	0.009	0.029	0.017	0.462	0.257	0.010
Hungary	0.667	0.067	0.017	0.000	0.371	0.000	0.000
India	0.167	0.003	0.002	0.002	0.121	0.322	0.002
Mexico	0.000	0.000	0.008	0.000	0.269	0.146	0.001
Russia	0.167	0.002	0.036	0.003	0.000	0.180	0.000
Brazil	0.167	0.001	0.009	0.002	0.046	0.136	0.001

Source: KPMG International, 2019



Infrastructure

Overview

- The Netherlands leads on infrastructure through having the most EV charging stations scaled by the size of its road network, as well as consistently high scores on the other measures.
- Singapore tops a measure of high-performance mobile network coverage from the GSM Association, while South Korea has the most extensive 4G coverage, with connectivity being essential for AVs.
- The UAE has the best-quality roads as assessed by the World Economic Forum, and leads on the change readiness of its technology infrastructure. Germany scores highest on a World Bank measure of road infrastructure focused on logistics and trucking.

Methodology

The pillar is calculated from six equally weighted factors, unchanged from the 2018 index.

Density of EV charging stations: data for most countries is from the International Energy Agency's *Global EV outlook 2018*¹³⁶ while information for other countries is gathered from the US Bureau of Transportation Statistics¹³⁷ and country-specific data sources. Numbers of chargers are scaled by length of paved roads in each country, using data from the CIA's *World factbook*.¹³⁸ As most AVs are likely to be EVs, their adoption will require the availability of electric charging stations, so countries with a higher density of charging stations score more. The highest-scoring countries are the Netherlands, Norway and South Korea, while the lowest are India, Brazil and Russia.

Quality of mobile internet: a measure of mobile internet infrastructure assessed by the GSM Association, which represents mobile network operators. The measure awards availability of high-performance mobile internet network coverage, speed, the number of servers and network bandwidth, given AVs need to receive and transmit data.¹³⁹ Singapore, Norway and Australia have the highest connectivity infrastructure scores while India, Russia and Mexico have the lowest.

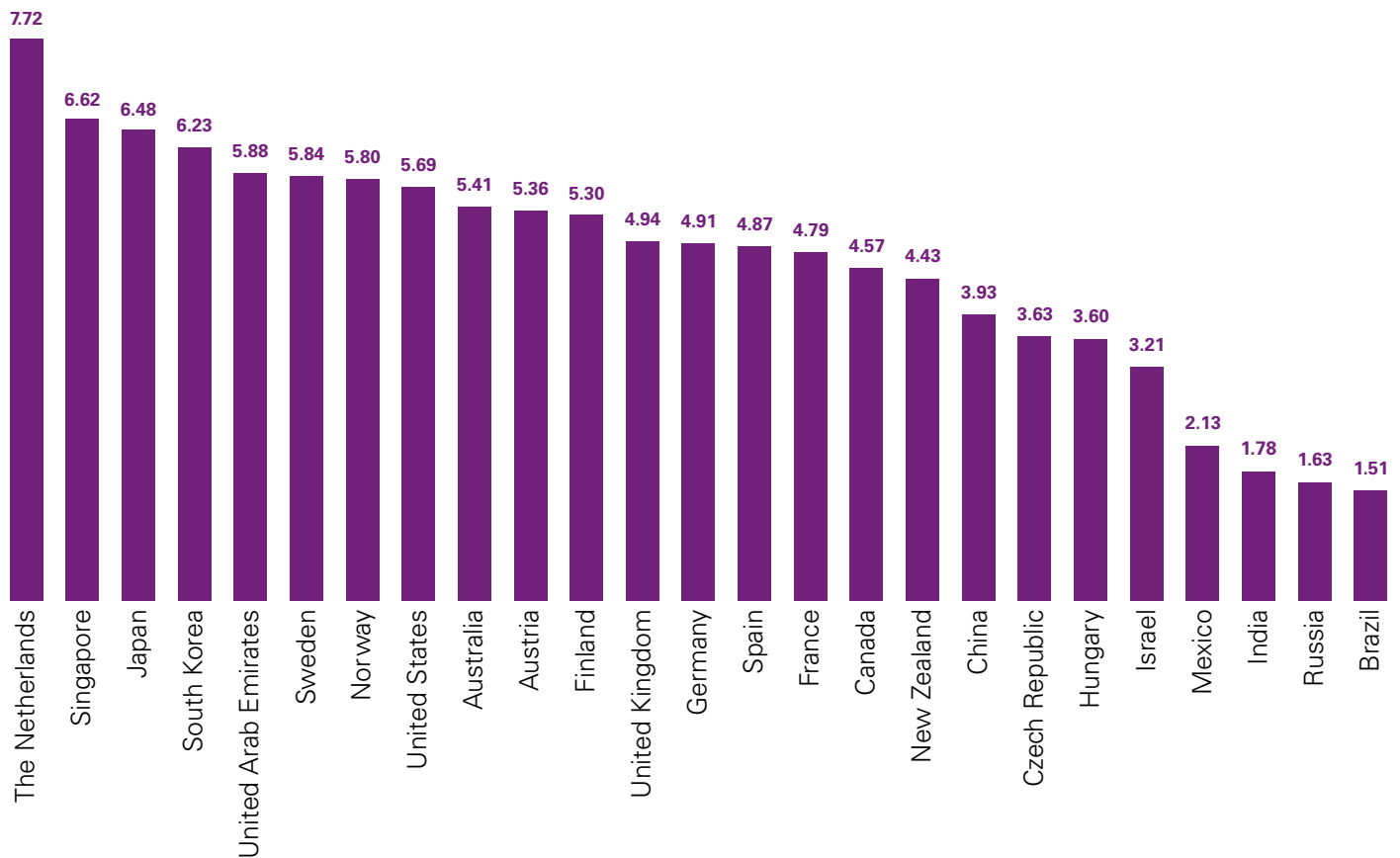
4G coverage: based on data from researcher OpenSignal, this measure is included to reflect the importance to AVs of wide access to mobile data networks.¹⁴⁰ Most countries are developing much-faster 5G networks, but so far only a few test networks are in place. South Korea, Japan and Norway have the most extensive 4G coverage while Brazil, Israel and Russia have the least.

Quality of roads: from the World Economic Forum's *Global competitiveness report*, assessed by business executives in each country.¹⁴¹ AVs will work better on high-quality roads and their absence will limit a country's adoption of them. The UAE, Singapore and the Netherlands have the best roads on this measure while Brazil, Russia and Hungary have the worst.

Logistics infrastructure: this measure considers the quality of roads specifically for logistics, using the World Bank's *Logistic performance index 2018*.¹⁴² It is included as freight is likely to be one of the first users of AVs. Germany, Japan and Sweden have the highest quality road infrastructure from a logistics perspective while Russia, Mexico and India have the lowest.

Technology infrastructure change readiness: scores are based on KPMG International's *2017 Change readiness index*, updated for 2018.¹⁴³ This measures the quality of the country's technology infrastructure, using a number of indicators, providing an additional measure of the technology infrastructure that will help support the use of AVs. The UAE, Singapore and the Netherlands lead this measure, with India, Mexico and China scoring least.

Pillar 3: aggregate scores by country



Pillar 3: (Infrastructure) normalized indicator values by country

Country	EV charging stations	GSMA global connectivity index – Infrastructure	4G coverage	Quality of roads from the WEF global competitiveness index	LPI infrastructure score	KPMG change readiness technology infrastructure score
The Netherlands	1.000	0.772	0.756	0.933	0.899	0.784
Singapore	0.090	1.000	0.640	0.994	0.805	0.882
Japan	0.121	0.690	0.923	0.875	0.925	0.784
South Korea	0.256	0.747	1.000	0.766	0.597	0.784
United Arab Emirates	0.102	0.549	0.488	1.000	0.780	1.000
Sweden	0.121	0.725	0.719	0.745	0.918	0.667
Norway	0.523	0.887	0.853	0.445	0.572	0.588
United States	0.044	0.649	0.780	0.445	0.799	0.706
Australia	0.005	0.862	0.696	0.508	0.748	0.784
Austria	0.039	0.675	0.396	0.835	0.881	0.745
Finland	0.008	0.806	0.594	0.653	0.767	0.706
United Kingdom	0.143	0.678	0.268	0.637	0.786	0.784
Germany	0.157	0.700	0.122	0.709	1.000	0.588
Spain	0.005	0.621	0.620	0.749	0.667	0.588
France	0.064	0.643	0.195	0.857	0.767	0.667
Canada	0.058	0.747	0.583	0.638	0.610	0.412
New Zealand	0.007	0.819	0.216	0.482	0.761	0.667
China	0.220	0.569	0.529	0.454	0.610	0.235
Czech Republic	0.057	0.590	0.721	0.268	0.428	0.353
Hungary	0.062	0.593	0.773	0.252	0.308	0.412
Israel	0.033	0.406	0.094	0.574	0.346	0.686
Mexico	0.046	0.294	0.433	0.429	0.044	0.176
India	0.000	0.000	0.690	0.413	0.082	0.000
Russia	0.003	0.187	0.105	0.067	0.000	0.725
Brazil	0.003	0.420	0.000	0.000	0.094	0.490

Source: KPMG International, 2019



Consumer acceptance

Overview

- Singapore scores highest overall, partly due to all of the city-state's population living in an AV test area.
- Indians, closely followed by Mexicans, are the most accepting of AVs according to research carried out for this report with 100 people in each of the 25 countries. Britons then Americans are the least accepting.
- Sweden leads on technology change readiness, based on KPMG research, with the Netherlands leading a World Economic Forum index on technology readiness.
- China leads on market penetration of ride-hailing, followed by the US and the UK, based on data from Statista on the proportion of people who have used a ride-hailing app.

Methodology

The pillar is calculated from five equally weighted factors, with consumer opinions added for this version of the AVRI and ride-hailing market penetration moved from the technology and innovation pillar.

Consumer opinions of AVs: Branded Research¹⁴⁴ asked 100 people from online panels in each of the 25 countries to respond to the following question: "What is your general opinion of autonomous vehicles?" Branded Research actively adjusts its overall audience and recruitment process to ensure that the natural fallout on consumer studies is generally representative of each country, with a minimal margin of error. Branded Research conducted its research in September 2018 for 24 of the 25 countries, and in India in October 2018. More positive opinions produce higher scores, reflecting the importance of public acceptance of AVs as to whether they will be adopted. Respondents in India, Mexico and the UAE were the most enthusiastic with those in the UK, the US and Canada the least.

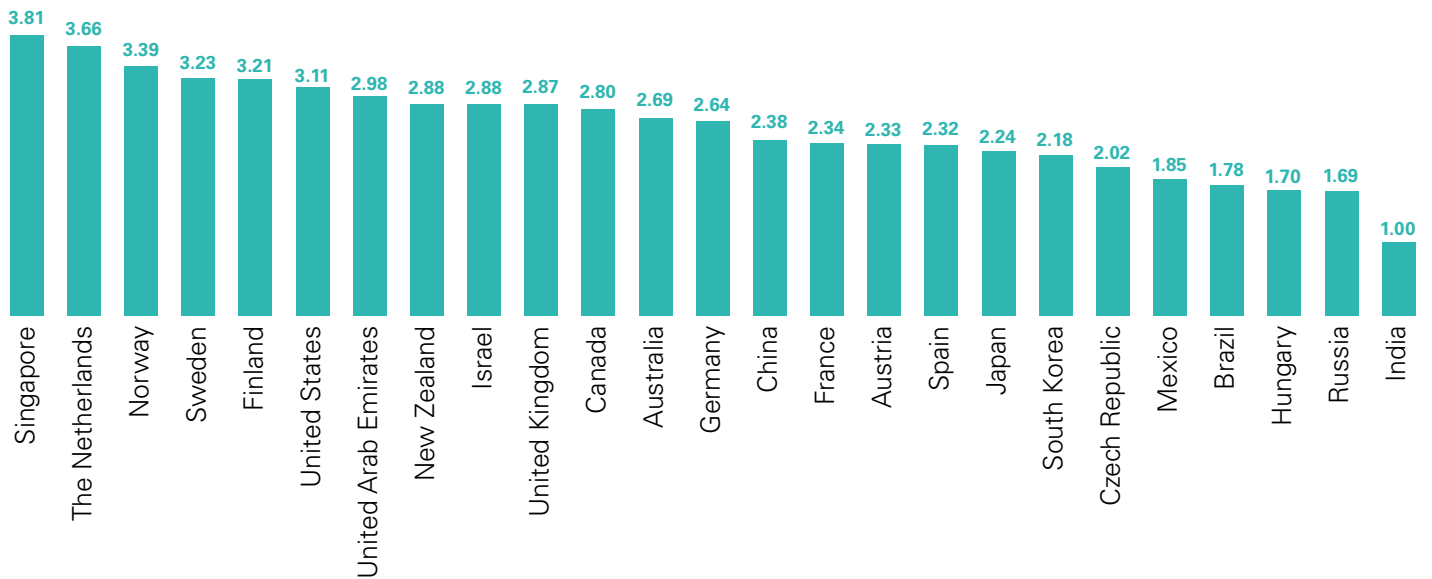
Population living in test areas: this measure uses data on cities carrying out AV testing collected by Bloomberg Philanthropies and Aspen Institute.¹⁴⁵ The proportion of national populations living in test areas is then calculated based on city populations from the McKinsey Global Institute's Urban World app.¹⁴⁶ The more people see AVs on the road, the more comfortable that they are likely to use them when they become available, so countries with a higher proportion of population that live in cities where AV pilots and testing are underway scored the highest. The countries with the highest proportions are Singapore, the Netherlands and Canada. There are currently no AV testing areas in Austria, Hungary, India and Mexico.

Civil society technology use: scores are based on this sub-indicator of KPMG International's *2017 Change readiness index*, updated for 2018.¹⁴⁷ This is included as the use of other types of consumer technology indicates the potential for consumers to embrace AVs. The leading countries are Sweden, the Netherlands and Norway while the lowest-scoring are India, Brazil and Russia.

Consumer adoption of technology: scored using the World Economic Forum's *Global competitiveness report*, which includes the availability of latest technologies, mobile broadband subscriptions, internet access and internet bandwidth.¹⁴⁸ The top countries are the Netherlands, the UK and Sweden while India, China and Mexico score the lowest.

Online ride-hailing market penetration: a new measure using data from Statista¹⁴⁹ on the percentage of people in each country who have used a ride-hailing service. Statista conducts nationally representative surveys in each country. People in China, the US and the UK are most likely to have used such a service, while those in India, Japan and Hungary are least likely to have done so.

Pillar 4: aggregate scores by country



Pillar 4: (Consumer acceptance) normalized indicator values by country

Country	Consumer survey data on AV acceptance	Percent of population living in test areas	KPMG change readiness technology use sub index	WEF technology readiness (GCI)	Ridesharing market penetration
Singapore	0.654	1.000	0.832	0.921	0.408
The Netherlands	0.466	0.775	0.985	1.000	0.429
Norway	0.599	0.339	0.960	0.931	0.565
Sweden	0.466	0.351	1.000	0.987	0.424
Finland	0.489	0.288	0.929	0.888	0.614
United States	0.103	0.355	0.852	0.966	0.832
United Arab Emirates	0.968	0.219	0.787	0.835	0.168
New Zealand	0.529	0.282	0.886	0.922	0.261
Israel	0.489	0.524	0.559	0.947	0.359
United Kingdom	0.000	0.298	0.924	0.995	0.652
Canada	0.201	0.670	0.848	0.856	0.223
Australia	0.372	0.366	0.884	0.806	0.261
Germany	0.372	0.133	0.932	0.946	0.255
China	0.783	0.043	0.222	0.330	1.000
France	0.364	0.209	0.685	0.862	0.217
Austria	0.348	0.000	0.792	0.884	0.310
Spain	0.693	0.000	0.571	0.793	0.266
Japan	0.442	0.301	0.505	0.895	0.098
South Korea	0.725	0.020	0.362	0.784	0.293
Czech Republic	0.560	0.000	0.529	0.738	0.196
Mexico	0.992	0.000	0.225	0.339	0.299
Brazil	0.834	0.103	0.174	0.450	0.223
Hungary	0.591	0.000	0.346	0.613	0.147
Russia	0.866	0.000	0.176	0.444	0.207
India	1.000	0.000	0.000	0.000	0.000

Source: KPMG International, 2019

Endnotes

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Publication name: 2019 Autonomous Vehicles Readiness Index | Publication number: 136024-G | Publication date: February 2019