Research Office
Legislative Council Secretariat

Fact Sheet

Smart mobility in selected places

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1. Introduction

1.1 Rapid urbanization, population growth and climate change challenge the sustainability of cities worldwide, and smart cities are built to address the challenges ranging from traffic congestion and pollution to waste disposal and energy management[1]. In the Asia-Pacific region, Singapore, Tokyo and Melbourne are among the top echelon in smart city development. They ranked second, sixth and 10th respectively in the 2017 Smart Cities Index[2], being the only Asia-Pacific cities included among the top 10 in the index.

1.2 Smart mobility is an important tool to achieve a sustainable city, enabled by multimodal transportation which combines a city's current multiple modes of public and private transport, with new modes of transportation (e.g. automated and connected vehicles), to create a seamless, customer-centric travel experience that accommodates the needs of various commuters. This fact sheet studies smart mobility in Singapore, Tokyo and Melbourne in terms of their existing intelligent transport system ("ITS") and projects underway to further develop the system. ITS hereunder refers to new road transport systems designed to integrate people, roads and vehicles via cutting-edge information and communication technology to enhance the safety, efficiency, comfort and convenience of road transport.

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1 While there is no universal definition of what constitutes a smart city, it is often associated with a city making use of information and communication technology infrastructure and innovative solutions to improve its economic, social and environmental sustainability.

2 The index was compiled by a Stockholm-based smart parking company, EasyPark, which ranked the top 100 smart cities around the world based on 19 factors related to smart city technology, including transport and mobility. See EasyPark Group (2017).

2. Singapore

2.1 Singapore has a total land area of approximately 720 sq km and a population of around 5.6 million. With population density almost reaching 7 800 per sq km, Singapore has an abiding interest in adopting effective land use planning scheme for sustainable development. In the sector of transportation, Singapore has since 1995 implemented ITS to optimize its limited road space for securing efficient, safe and reliable travel across various modes[3]. In recent years, Singapore launched the Smart Nation initiative[4] in 2014 focusing on five key domains in which digital technology takes on a key role in the future development of Singapore. One of the five key domains is "transport"[5] that involves the development of self-driving vehicles, mobility on demand, and open data and analytics for urban transportation.

ITS development in Singapore

2.2 Major components of Singapore's ITS network include Expressway Monitoring and Advisory System, Green Link Determining System, Junction Electronic Eyes, TrafficScan, Parking Guidance System, Green Man+, Electronic Road Pricing, and smart bus stop.

Expressway Monitoring and Advisory System ("EMAS")

2.3 EMAS is an expressway incident management system that monitors traffic along expressways. It keeps motorists informed of the traffic conditions via electronic signboards placed near the entrance to the expressway, along the expressway, and adjacent to some major arterial roads. Information provided includes estimated travel times from the expressway entrance to major exits and message pertaining to accidents on the expressway, whereby motorists can better plan their routes to avoid congested and accident areas.

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[3] In 1995, Singapore set up the Land Transport Authority as a statutory board of the Ministry of Transport with a mission of producing a world class transport system for Singapore.

[4] In November 2014, Prime Minister Lee Hsien Loong launched the Smart Nation initiative as a whole-of-nation movement to harness digital technologies to improve citizens' lives.

[5] The other four key domains are "home and environment", "business productivity", "health and enabled ageing", and "public sector services".

Green Link Determining System ("GLIDE")

2.4 GLIDE is a computerized traffic signal system that optimizes the efficiency of road network by adjusting green light time at junctions according to the vehicle and pedestrian volume. GLIDE also provides "green wave" along main roads links by linking and adjusting adjacent traffic signals to allow vehicles to travel from one junction to another with minimal stops.

Junction Electronic Eyes ("J-eyes")

2.5 J-eyes is a system of surveillance cameras installed at major junctions to spot and rectify causes of traffic congestions, thereby allowing the traffic control centre to implement appropriate action plans to improve traffic flow at major road intersections.

TrafficScan

2.6 TrafficScan is an ITS application which uses taxis equipped with the Global Positioning System to monitor traffic conditions. The information gathered from those taxis, such as their locations and travel speeds, is then used to calculate average traffic speeds along major roads. Travel information from TrafficScan can be found online to help motorists plan their journeys.

Parking Guidance System

2.7 Parking Guidance System provides real-time data on parking lots availability and displays such data on 29 electronic information panels located across the city. This helps motorists reduce the amount of circulating traffic searching for available parking lots in a particular area, as well as promoting a more efficient use of existing parking facilities.

Green Man+

2.8 Green Man+ scheme assists the elderly and pedestrians with disabilities who may require more time (i.e. the green man time) to cross the road. They can expect up to 13 seconds more of green man time when they tap their senior citizen concession cards or Green Man+ cards on the card reader on the traffic light pole.

Electronic Road Pricing ("ERP")

2.9 Singapore is the first country in the world to manage road traffic by implementing an ERP that charges motorists when they use the priced road during peak hours. Trials to test the efficacy of the next generation satellite-based ERP system are currently being tested by the Land Transport Authority. The new system charges motorists for the distance they travel on congested roads, rather than a flat fee once they enter an ERP zone.

Smart bus stop

2.10 Singapore has recently implemented a one-year pilot scheme featuring the launch of a new smart bus stop equipped with an overhead air cooling and filtration system to improve commuters' waiting experience. Cooled and fresh air is channelled through nozzles in air ducts near the roof of the bus stop and direct at commuters waiting at the bus stop, helping them beat heat and air pollution.

ITS projects underway

2.11 With the aim of developing a more comprehensive and sustainable ITS in Singapore, the Singapore government launched the *Smart Mobility 2030* in 2014 as a master plan outlining how Singapore will develop its ITS over the next 15 years. It also seeks to develop a leading transportation system with the deployment of autonomous vehicles ("AVs") for first-mile and last-mile commuting by 2022[6].

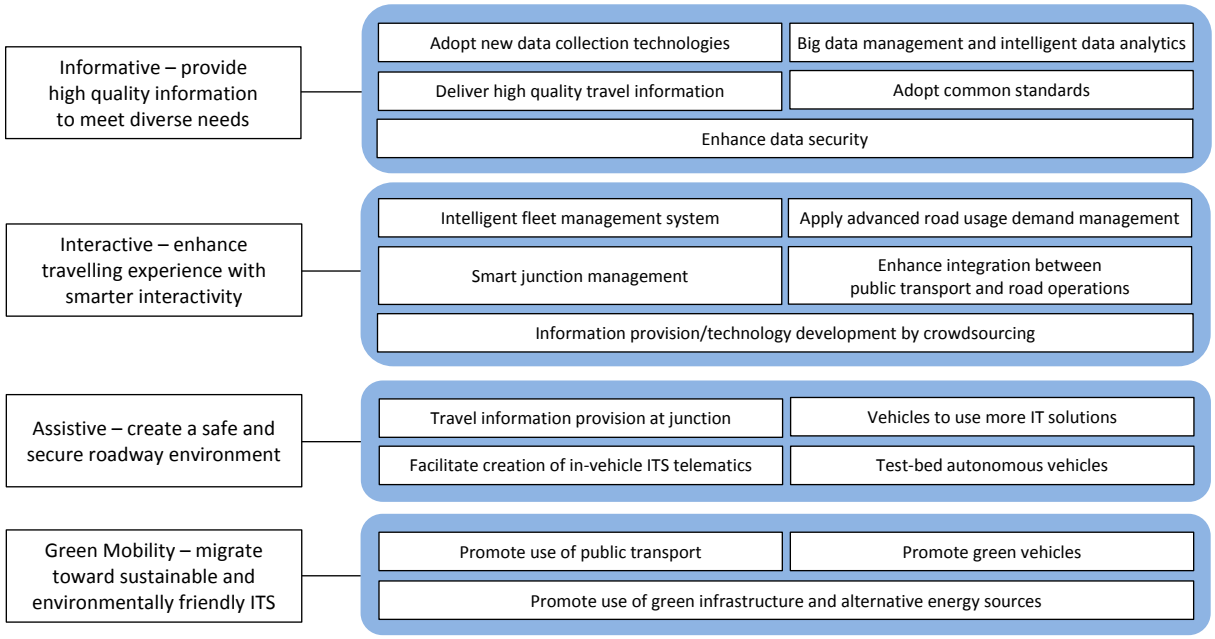
[6] The "first mile" is the first part of the trip from a starting location (e.g. commuter's home) to the start of the transportation network (e.g. a bus stop), whereas the "last mile" is the final leg of trip connecting the end of the transportation network to the final destination (e.g. commuter's workplace).

Smart Mobility 2030

2.12 The vision of *Smart Mobility 2030* is "moving towards a more connected and interactive land transport community" which is delivered by the implementation of the following three key strategies: implementing innovative and sustainable smart mobility solution; developing and adopting ITS standards; and establishing close partnerships between the public and private sectors.

2.13 The above strategies are integrated with four focal areas, namely Informative, Interactive, Assistive and Green Mobility. As shown in the **Figure**, these four focal areas emphasize the need to (a) leverage ITS initiatives to provide high quality information to meet diverse needs (Informative); (b) enhance travelling experience with smarter interactivity (Interactive); (c) create a safe and secure roadway environment with making use of advanced feature of future ITS to assist travellers with their daily commute (Assistive); and (d) migrate towards a sustainable and environmental friendly ITS (Green Mobility).

Figure – Outline of *Smart Mobility 2030*



Source: Asia-Pacific Economic Cooperation (2015).

Autonomous vehicles

2.14 In Singapore, several initiatives have been established between the government, research, academic and industry communities to spearhead the development of AVs. These include (a) the setting up of the Committee on Autonomous Road Transport[7] in Singapore in 2014 to study AV applications, regulation and implementation; (b) the signing of a Memorandum of Understanding between the Land Transport Authority and Singapore's leading research and development agency, A*STAR, in 2014 to set up the Singapore Autonomous Vehicle Initiative to explore the technological possibilities that AVs can create for Singapore; and (c) the opening of Singapore's first AV test centre in 2017.

2.15 Most recently, the Land Transport Authority has announced to pilot the deployment of autonomous scheduled buses and autonomous on-demand shuttles in Punggol, Tengah and Jurong from 2022 to provide convenient first-last mile connectivity for commuters living in these three towns. Autonomous scheduled buses will complement human-driven public buses and initially travel on less crowded roads. Autonomous on-demand shuttles will allow commuters, particularly the elderly, families with young children and the less mobile, to hail on-demand shuttles via their mobile phones.

3. Tokyo

3.1 According to Japan's latest 2015 population census, the population density in Tokyo reached 6 200 per sq km, which was the highest among all prefectures in Japan and almost 18.1 times the national average. As a densely populated city like Singapore, Tokyo has developed ITS to resolve its traffic congestion and other transport problems. As early as in 1996, the Japanese government adopted the "Grand Plan to Promote Intelligent Transport System", which set the stage for the take-off of ITS development among various prefectures in the country. Tokyo has since then progressively implemented ITS as the centrepiece of efforts to develop its transport system.

[7] The Committee, headed by the Permanent Secretary of the Ministry of Transport, is made up of the public sector members from the relevant planning agencies, international experts, academics and industry members.

ITS development in Tokyo

3.2 Major components of Tokyo's ITS network include Public Transportation Priority System, Smartway, "s-park" services, Automated Guideway Transit System, and pedestrian information and communication system.

Public Transportation Priority System ("PTPS")

3.3 PTPS gives priority to public buses by means of exclusive bus lanes, warnings to private vehicles which are illegally running in the bus lane, and a priority signal control system. The signal control system can adjust the display time of the signal (e.g. green light extension) to make public buses pass through the signalized intersection without stopping or with minimized delay.

Smartway

3.4 Smartway is a road transport system that connects people, vehicles and roads with the primary aim of ensuring traffic safety and reducing traffic congestion. It features a high-speed, high-volume two-way communication between a car navigation system and "ITS Spots". "ITS Spots" are roadside devices that can transmit and receive information related to:

(a) traffic avoidance – providing real-time road traffic congestion information on a car navigation system;

(b) safe driving – alerting drivers with safety precautions such as identification of obstacles on roads, a slow-running automobile at the end of congestion, and pictures of the road conditions ahead; and

(c) drivers' behaviour – collecting traffic data/information (e.g. car locations and speeds) accumulated in a car navigation system for traffic management.

"s-park" services

3.5 "s-park" services is a smart system providing information on the location of parking facilities in Tokyo and their availability status to motorists via website, smartphones and car navigation system. Motorists can make use of information provided to easily locate and secure vacant parking space at any parking facilities convenient to them.

Automated Guideway Transit ("AGT") System

3.6 New Transit Yurikamome is Tokyo's first AGT system connecting the centre of Tokyo with a new subcentre on the Tokyo Bay waterfront. It is a driverless train running on a dedicated, elevated track using dual lateral guides. The carriages run on rubber wheels instead of steel, resulting in smaller environmental impact in terms of lower vibration and noise in travelling.

Pedestrian information and communication system ("PICS")

3.7 PICS provides blind and low vision pedestrians with the status of traffic signal to cross streets safely. When they approach an intersection where PICS is installed, an FM radio messages (in vibration or speech mode) will be sent to the special receivers worn by them. A vibration indicates the presence of a signalized intersection, and a voice message identifies the location of intersection and pedestrian light status[8]. Another function of PICS is to lengthen the time the green light is on when it detects a person wearing a special receiver crossing the road.

ITS projects underway

3.8 Japan amazed the world at the 1964 Tokyo Olympics as it debuted the world's first high-speed rail line, Shinkansen or bullet trains, only days before the opening of the Olympics. When Tokyo hosts the 2020 Olympics, Japan aims once again to showcase its innovative technologies and revitalized

[8] The following voice message will be read to blind and low vision pedestrians: "You are at intersection XX. The traffic signal is equipped with the pedestrian information and communication system. The walk signal has turned red."

economy. Implementing an innovative transport system and self-driving technology would be a key achievement for Japan.

3.9 Against the above, Prime Minister Shinzo Abe has launched a "Reform 2020" project which makes use of the 2020 Olympics as an opportunity to accomplish six core projects by the year 2020. These include the adoption of next generation transport system and automatic driving technology[9] with (a) a smart mobility system – Advanced Rapid Transit – to be used during the 2020 Olympics; (b) a transportation infrastructure accessible to everyone, including those using wheelchairs or baby buggies; and (c) trucks platooning where two or more trucks are electronically linked up to travel in convoy form.

Advanced Rapid Transit ("ART")

3.10 ART aims to build a stress-free transport network during the 2020 Olympics to ferry people between central Tokyo and the hitherto less serviced waterfront area where many of the events will be held. The network includes:

(a) ART in towns – creating a smooth-running urban infrastructure which (i) gives priority to public buses by monitoring their locations and controlling traffic lights accordingly; and (ii) alerts bus drivers to prepare for the boarding of passengers using wheelchairs or baby buggies waiting at the next bus stop;

(b) ART at bus stops – facilitating the boarding and alighting of passengers using wheelchairs or baby buggies through (i) precise docking control to minimize the gap between buses and boarding platforms; and (ii) "kneeling device" which tilts or lowers the bus at the front axle down to normal curb height; and

(c) ART in buses – developing a smooth acceleration/deceleration control technology similar to that of Shinkansen to prevent in-vehicle falling-related accidents.

[9] Other core projects also include futuristic programmes (e.g. cutting-edge robotics) and initiatives to promote economic growth (e.g. increased tourism and expanded foreign direct investment).

Truck platooning

3.11 Japan has a shrinking and ageing population, which creates labour shortages in many sectors. The lack of drivers is a particular concern in the logistics industry. Achieving truck platooning on a large scale for long-distance transport can encourage more trucking activities to be carried out at off-peak hours. The technology involves a lead human-operated truck and following unmanned trucks electronically linked on expressways, whereby allowing the driver to command more trucks and carry more containers. The trucks are equipped with adaptive cruise control, a system combining vehicle-to-vehicle communication and sensors (such as cameras and radar) to automatically adjust a truck's speed to maintain a safe distance from vehicles ahead.

Self-driving technology

3.12 In May 2017, the Japanese government released the Public-Private ITS Initiative/Roadmaps 2017, which lays out scenarios up to 2025 for realizing highly automated driving and focuses on preparing the regulatory system with a view to strengthening and commercializing the technologies. By 2020, a highly advanced (Level 2) automated driving system is planned to come in place, including automated lane maintaining and changing functions[10]. It will be followed by the commercialization of Level 3 automated driving by or around 2020, with fully automated Level 4 system available by 2025.

4. Melbourne

4.1 In Australia, Melbourne has been an active adopter of ITS with the use of advanced traffic management system and electronic tolling system[11] to enhance the quality of its transport system. The city has also made use of the ITS network to ensure efficiency of freeways in providing a safe and reliable travel from one place to another. Freeway traffic management is crucial to

[10] SAE International defines five different levels of autonomy in vehicles, namely Level 1 (driver assistance required), Level 2 (partial automated driving), Level 3 (highly automated driving), Level 4 (fully automated driving), and Level 5 (completed self-driving with no input from driver). SAE International is a global association of engineers and related technical experts in the automotive, commercial-vehicle and aerospace industries.

[11] Melbourne was among the first cities in the world to introduce multi-lane free flow tolling that collects tolls without the use of toll booths. Toll charges are levied electronically as vehicles pass through toll plazas.

Melbourne, as it is a car-dependent city and its freeway network is one of the largest in Australia.

ITS development in Melbourne

4.2 Melbourne uses two primary types of ITS for traffic management, namely the Sydney Coordinated Adaptive Traffic Systems for pedestrians and intersections and STREAMS for freeways. Added to this, Melbourne has installed automated pedestrian counting sensors across the city, which records pedestrian movements 24 hours every day. The information is all publicly available on the Internet for research and analysis purposes. Furthermore, Melbourne also releases online parking space availability data from 4 300 in-ground city parking sensors installed in most central business districts, reducing the need for motorists to circle for parking space.

Sydney Coordinated Adaptive Traffic System ("SCATS")

4.3 SCATS was developed in New South Wales in the 1970s and has been used in Melbourne since 1982. SCATS is a sophisticated and dynamic ITS capable which can adapt traffic signal timing to (a) give priority to public transport to pass through signalized intersections; and (b) manage unexpected conditions and minimize delays caused by events and on-road incidents.

STREAMS network

4.4 Melbourne has implemented STREAMS since 2007 as traffic management system in some of the freeways of the city. STREAMS provides the following tools for freeway traffic management:

(a) ramp metering — using freeway ramp signals[12] to manage the number of vehicles allowed to enter the main carriageway of a freeway, thereby smoothing congestion and preventing flow breakdown;

(b) variable speed limits — controlling speed limits on freeways at any time of the day based on traffic and weather conditions;

[12] Freeway ramp signals are traffic lights installed on entry ramps to meter traffic entering the freeway.

(c) lane management — used to dynamically open or close lanes in response to traffic conditions. Lane management can also be used during an incident to close a lane and provide a lane for emergency services to quickly attend the scene;

(d) variable message boards — making use of message boards to inform road users about incidents, travel time, diversions, or to display road safety messages or public service announcements; and

(e) real-time traffic information — displaying drive time signs to inform motorists about expected travel times, and using a colour-coded indicator of congestion levels on major freeways with green for light traffic, yellow for medium, and red for heavy.

ITS projects underway

4.5 According to the City of Melbourne[13], the key technologies that are likely to drive change in mobility demand and the transport system over the coming decades include increasing automation of vehicles and mobility services through the development of driverless or automated vehicles[14].

4.6 Indeed, there has been a wide range of initiatives undertaken in Victoria, the state in which Melbourne is located, to spearhead the development of AVs. These include the partnership of the state government with Bosch, VicRoads and the Transport Accident Commission[15] to build the first vehicle in Australia with self-driving capabilities. The state government has also teamed up with ConnectEast, Australian Road Research Board and La Trobe University[16] to test cars with driver-assistance technology on EastLink, one of the busiest toll roads in Victoria. Added to this, ITS grant

[13] The City of Melbourne is the local government authority of Melbourne.

[14] See City of Melbourne (2018b).

[15] The Germany-based Bosch is a leading global supplier of automotive technology and services, whereas VicRoads is the statutory road and traffic authority in Victoria. Meanwhile, the Transport Accident Commission is owned by the state government and tasked with, among other things, promoting road safety in Victoria.

[16] ConnectEast is the toll road operator of EastLink, whereas Australian Road Research Board is an Australian research agency that provides applied research and consulting services for Australian and New Zealand state road agencies and communities.

programmes are provided by the state government for research projects relating to AV-enabled mobility.

4.7 Most recently, Victoria amended the Road Safety Act 1986 in February 2018 to allow trial of automated vehicles across the state. The amendment allows VicRoads to grant permits to individuals or organizations planning to conduct on-road trials of automated vehicles. Nevertheless, all driverless vehicle trials will require a human supervisor to monitor the vehicle from either inside or outside the vehicle. Once it has been established a vehicle can drive safely, this condition may be removed to allow the vehicle to drive in automated mode in limited circumstances without a supervisor.

Research Office
Information Services Division
Legislative Council Secretariat
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Tel: 2871 2146

References

Singapore

1. International Telecommunication Union. (2017) *Singapore: Smart City on the Horizon.* Available from: https://www.itu.int/en/publications/documents/tsb/2017-u4ssc-enhancing-innovation/index.html#p=25 [Accessed June 2018].

2. Land Transport Authority. (2014) *Smart Mobility 2030*. Available from: https://www.lta.gov.sg/content/dam/ltaweb/corp/RoadsMotoring/files/SmartMobility2030.pdf [Accessed June 2018].

3. Land Transport Authority. (2017a) *Factsheet: Leveraging Technology for a Smarter and Greener Transport System*. Available from: https://www.lta.gov.sg/apps/news/page.aspx?c=2&id=e09102cd-acd5-469e-8234-777b68e4e18a [Accessed June 2018].

4. Land Transport Authority. (2017b) *Joint News Release by the Land Transport Authority (LTA) & MOT – Autonomous Vehicle to Transform Intra-Town Travel by 2022*. Available from: https://www.lta.gov.sg/apps/news/page.aspx?c=2&id=39787c15-ad56-4d1a-8ba9-4ea14860f9b4 [Accessed June 2018].

5. Land Transport Authority. (2018) *Intelligent Transport Systems*. Available from: https://www.lta.gov.sg/content/ltaweb/en/roads-and-motoring/managing-traffic-and-congestion/intelligent-transport-systems.html [Accessed June 2018].

6. OpenGov. (2018) *Smart Bus Stop being trialled in Singapore to improve commuter experience*. Available from: https://www.opengovasia.com/articles/smart-bus-stop-being-trialled-in-singapore-to-improve-commuters-experiences [Accessed June 2018].

7. Prime Minister's Office Singapore. (2015) *Transcript of Speech by Prime Minister Lee Hsien Loong at Founders Forum Smart Nation Singapore Reception on 20 April 2015.* Available from: http://www.pmo.gov.sg/newsroom/transcript-speech-prime-minister-lee-hsien-loong-founders-forum-smart-nation-singapore [Accessed June 2018].

8. Viajeo Plus. (2016) *Singapore City Showcase Report*. Available from: http://viajeoplus.eu/Documents/d8-4-singapore-city-showcase-report/ [Accessed June 2018].

Tokyo

9. Cabinet Office. (undated) *ART (Advanced Rapid Transit) system population.* Available from: http://www8.cao.go.jp/cstp/tyousakai/olyparatf/project/pj4_en.pdf [Accessed June 2018].

10. Ministry of Land, Infrastructure, Transport and Tourism. (2014) *Roads in Japan*. Available from: http://www.mlit.go.jp/road/road_e/pdf/ROAD2015web.pdf [Accessed June 2018].

11. Ministry of Land, Infrastructure, Transport and Tourism. (undated) *ITS*. Available from: http://www.mlit.go.jp/road/road_e/p1_its.html [Accessed June 2018].

12. Prime Minister of Japan and His Cabinet. (undated) *Reform 2020*. Available from: https://www.kantei.go.jp/jp/singi/keizaisaisei/pdf/kaikaku2020_gaiyouen.pdf [Accessed June 2018].

13. Statistics Bureau. (2017) *Statistical Handbook of Japan 2017*. Available from: http://www.stat.go.jp/english/data/handbook/c0117.html [Accessed June 2018].

14. Tokyo Metropolitan Government. (2014) *The Action Plan for 2020*. Available from: http://www.metro.tokyo.jp/english/about/plan/documents/pocket_english.pdf [Accessed June 2018].

15. Tokyo Metropolitan Government. (2017) *Tokyo Tech Book*. Available from: http://www.metro.tokyo.jp/english/about/tech/index.html [Accessed June 2018].

16. UTMS Society of Japan. (2018) *Functions and Services of UTMS*. Available from: http://www.utms.or.jp/english/system/pics.html [Accessed June 2018].

Melbourne

17. City of Melbourne. (2018a) *Melbourne as a smart city*. Available from: http://www.melbourne.vic.gov.au/about-melbourne/melbourne-profile/smart-city/Pages/smart-city.aspx [Accessed June 2018].

18. City of Melbourne. (2018b) *Transport Strategy refresh*. Available from: https://participate.melbourne.vic.gov.au/transportstrategy [Accessed June 2018].

19. Intelligent Transport System Australia. (2017) *Smart Transport for Australia.* Available from: https://www.its-australia.com.au/wp-content/uploads/Smart-Transport-for-Australia.pdf [Accessed June 2018].

20. Law Library of Victoria. (2018) *Road Safety Amendment (Automated Vehicles) Act 2018*. Available from: https://www.lawlibrary.vic.gov.au/legal-research/legislation/victorian-acts/road-safety-amendment-automated-vehicles-act-2018 [Accessed June 2018].

21. Trade Victoria. (2018) *Intelligent Transport Solutions capabilities*. Available from: http://trade.vic.gov.au/victorias-capabilities/industry-sectors/digital-technologies/intelligent-transport-solutions-capabilities [Accessed June 2018].

22. VicRoads. (2018) *Intelligent Transport Systems*. Available from: https://www.vicroads.vic.gov.au/~/media/files/documents/business%20and%20industry/internationalintelligenttransportsystems.ashx [Accessed June 2018].

23. Victorian Auditor-General's Office. (2014) *Using ICT to Improve Traffic Management*. Available from: https://www.audit.vic.gov.au/report/using-ict-improve-traffic-management [Accessed June 2018].

Others

24. Arcadis. (2017) *Sustainable Cities Mobility Index 2017*. Available from: https://www.arcadis.com/en/global/our-perspectives/sustainable-cities-mobility-index-2017/ [Accessed June 2018].

25. Asia-Pacific Economic Cooperation. (2015) *Quality Transport Vision*. Available from: https://www.apec.org/Publications/2016/04/Quality-Transport-Vision [Accessed June 2018].

26. EasyPark Group. (2017) *2017 Smart Cities Index*. Available from: https://easyparkgroup.com/smart-cities-index/ [Accessed June 2018].

27. Economist. (2018) *Special Report on Autonomous Vehicles*. 1 March.