GUIDELINES FOR THE REGULATORY FRAMEWORKS OF INTELLIGENT TRANSPORT SYSTEMS IN ASIA AND THE PACIFIC
3.1 Current ITS status in the region

More than 4 billion people live in the Asia-Pacific region, and Asia is expected to have more than 60 per cent of the total world population of 65-year-olds or older by the 2030s. The United Nations has projected that the world's population could add another 2.5 billion people to urban areas by 2050, with around 90 per cent of the increase located in Asia and Africa.

---


39 Business Insider, Asia is expected to be home to more than half of the elderly population worldwide by 2050. Available at https://www.businessinsider.com/asia-will-be-home-to-more-than-half-of-the-elderly-population-2017-9.

Such growth in population and urbanization will create traffic congestion and related negative impacts in the Asia-Pacific region. However, at the same time, more than 60 per cent of the world’s youth population live in the Asia-Pacific region.\textsuperscript{41}

This high percentage of the younger generation and their positive attitude on adopting technologies bring, in part, new opportunities to address these issues with regard to ITS. This type of situation requires the investigation of the potential of ITS in various categories. An analysis of the current strengths, weaknesses, opportunities and threats (SWOT) is given in this chapter in the context of ITS in the Asia-Pacific region (figure 3.1). Once strengths, weaknesses, opportunities and threats are identified, it will be easier to understand the ITS status in the Asia-Pacific region with regard to developing short- and long-term goals and policy recommendations for ITS regulatory frameworks.

### 3.1.1 Strengths

The Asia-Pacific region shows the most rapid economic growth in the world. About two-thirds of the world’s population lives in the region. Thus, there are enormous market

---

opportunities for ITS technologies in this region. To be specific, according to the analysis of ITS market size, the Asia-Pacific market is expected to grow constantly from US$ 4.55 billion in 2015 to US$ 14.37 billion by 2024 at a compound annual growth rate (CAGR) of 13.6 per cent. As of 2024, the Asia-Pacific market will replace Europe’s position (US$ 12.81 billion) as the second-largest market in the world.

Further, countries in Asia and the Pacific are highly motivated in adopting new technologies, in part led by the young generation as emphasized above. Also, some of these countries are leading the world in this field. For example, some countries in this region (e.g., China, Japan, the Republic of Korea and Singapore) have played significant roles in the development and usage of ITS technologies around the globe. In recent years, Hong Kong, China as well as Seoul, Singapore and Tokyo have been developing, testing and adopting state-of-the-art urban mobility approaches, such as MaaS, CVs and AVs, ahead of other countries. In adopting big data analytics, behavioural science, ride-sharing and electric vehicles, China and Singapore have become frontrunners.

As shown in the International Energy Agency (IEA) report, in 2017, 40 per cent of the world’s electric vehicles on roads were located in China. Many start-up companies utilizing new technologies can also be found in this region. A total of US$ 57 billion has been invested in startups by Chinese unicorns (startups that have attained the status of more than US$ 1 billion invaluation) over the last 5 years as of 2017.

There are many financial supporting opportunities in this region for propelling ITS-related activities through Official Development Assistance (ODA) agencies (e.g., the Japan International Cooperation Agency and Korea International Cooperation Agency) or Multilateral Development Banks (MDBs) (e.g., the Asian Development Bank, Asian Infrastructure Investment Bank and World Bank). Given that ITS development requires financial investment over a specified minimum level, these financial opportunities can trigger the adoption of ITS technologies in some countries in this region, which necessitates financial assistance.

3.1.2 Weaknesses

The successful operation of ITS generally requires a specific minimum level of expertise and technological fundamentals. Even though world-renowned ITS leading countries exist in this region, many other countries still suffer from the lack of fundamentals of experiences, infrastructure and expertise for ITS development. Naturally, a substantial gap in terms of technological readiness among such countries has been created which is in part proven by the recent study dealing with the technological readiness for smart cities in South-East Asia by comparing those in developed countries. From this study, among 10 countries in South-East Asia, only Singapore and, to a lesser extent, Malaysia are far ahead of all other South-East Asian countries, and close to the developed countries in terms of communications infrastructure extensiveness and quality as well as connectivity. Given that such a technological backbone is instrumental for ITS development, this lack of fundamental is hindering the wider deployments of ITS in some countries in Asia and the Pacific.

43 Ibid.
The lack of short- and long-term plans for ITS is also one of the weaknesses noticed in many countries in this region, which in part results from the weak regulatory foundations for ITS at the national and regional levels. Such plans will provide an overarching vision, detailed goals, and short-, medium- and long-term action plans for ITS development and operation. Given that several countries in the region are in the early stages of ITS development, this weakness will create challenges to implementing ITS in many ways. In connection to this weakness, common terminologies and standards need to be developed; regional terminologies and standards would facilitate efficient interactions among ITS applications and seamless services by enhancing the interoperability and compatibility between different systems.

One misconception that has pervaded Asian countries is that ITS requires costly systems that can be adopted only in developed countries. However, given that ITS has been perceived as a cost-effective solution, this misconception could be another weakness resulting from the low institutional understanding of ITS, and the lack of proper knowledge among policymakers.

3.1.3. Opportunities
As already noted above, the Asia-Pacific region has a high percentage of the young generation. More than half of the world’s population using the Internet live in the region, of which more than 70 per cent own a smartphone. For example, the Republic of Korea (at 87.8 per cent) and Japan (at 82.3 per cent) have a high level of Internet penetration among their total populations. The number of smartphone users in the region is expected to reach 1.81 billion by 2021. Considering that the new generation of ITS will be based on mobile technology, this rapid adoption of smartphones in the Asia-Pacific region will provide immense opportunities to expand ITS-related industries.

In addition, various efforts have been implemented to improve transport connectivity, such as the Asian Highway network, the Trans-Asian Railway network, the ASEAN Highway network, and Belt and Road Initiative, all of which will bolster transport-related investments including ITS. Such efforts also deliver improved connectivity between countries, which will forge increased collaboration in ITS roll-outs. In this regard, in recent years various ITS-related activities have been observed at the subregional level such as the ASEAN Smart Cities Network, the Greater Mekong Subregion (GMS) Transport Sector Strategy 2030, the ASEAN ITS Policy Framework, the ASEAN Transport Development, and the FITSRUS project (Finland-Russian Federation).

Increasing demand for new mobility services, such as smart mobility, is another opportunity in the Asia-Pacific region that, in part, will serve users’ needs for better convenience, accessibility and energy efficiency (also related to environmental issues). This is particularly relevant, given the fact that since 2016 Asian cities have experienced severe traffic congestion, with a 30 to 50 per cent increase in overall travel times when...

53 ASEAN Singapore 2018, ASEAN smart cities network. Available at https://www.asean2018.sg/Newsroom/ASCN.
compared to a free-flow situation. As a result, new mobility services utilizing ITS technologies have been considered as alternatives for dealing with the problem.

### 3.1.4 Threats

Compared to other regions, the Asia-Pacific region is multi-cultural, multi-religious and multi-linguistic, which frequently lead to passive international collaboration and cooperation. This rationale is also applicable to the enhancement of ITS development at the regional level. It is obvious that even leading ITS countries in this region have weak relationships in collaborating and cooperating in ITS services. Looking ahead, the new ecosystem of C-ITS, CVs, AVs and smart mobility should therefore be considered with this threat in relation to ITS expansion.

Many countries in the Asia-Pacific region rely heavily on foreign inputs because of the lack of ITS technology skills in their own workforce. Undiscerning adoption from the outside might generate inconsistent and unreliable ITS services, which would eventually prohibit the full utilization of ITS technologies in this region. Representatively, without overall direction or multifarious discussions, various investments in ITS development in less developed countries have sometimes been made by MDBs and ODA agencies.

Even though ITS is a cost-effective solution and relatively inexpensive compared with the construction of new infrastructure, it requires a certain amount of investment, which might be burdensome in terms of costs in some countries in the region. In the near future, the situation will occur in which new ITS technologies, such as C-ITS, CVs, AVs and smart mobility, require greater investment by the public and private sectors; therefore, the Asia-Pacific region countries need to be prepared. Further, as defined in this study, ITS is an aggregate of diverse technologies where many companies are currently competing and are expected to increase around the globe. To ensure successfully sustained use of ITS, domestic or regional experience from ITS technologies should be acquired and cultivated to some degree, which will naturally mean competing with others from outside this region.

### 3.2 Emerging ITS trends

Countries in the Asia-Pacific region have introduced ITS at different times and might have differing interests in, and needs from ITS technologies. Given that there are a variety of ITS technologies in place around the world, exploring prevailing or forthcoming ITS applications and technologies would provide guidance on formulating policy recommendations for ITS regulatory frameworks. In this regard, each section of this chapter reviews details of ITS applications and technologies (i.e., traffic management centres, smart mobility, C-ITS and CVs, and AVs) with practical examples from North America, Europe, and Asia and the Pacific.

#### 3.2.1 Traffic Management Centres

With growing urbanization, many metropolitan areas around the globe have tried to set up Traffic Management Centres (TMCs) to handle traffic issues. The term TMC, in general, refers to a centre that is equipped with ATMS. However, recently TMCs have adopted new technologies such as an open platform, an open application program interface (API) and advanced security technologies to upgrade to Advanced Traffic Management Centres.

The basic functions of a TMC includes real-time detection, traffic monitoring, adaptive traffic signal and control management, and wireless communications for maximizing capacity of roadway networks, minimizing the impact of incidents to users and proactively managing...
traffic flows. A TMC pursues security and redundancy without creating potential failures in monitoring traffic conditions, responding timely to traffic issues, influencing the operation of traffic signals, disseminating timely/accurate information (e.g., VMS), and interacting with other transport modes and agencies. Open API is also being incorporated for better monitoring of traffic operations and detecting vehicles, bicycles, and pedestrians by piloting new detection technology.

In the United States, the majority of TMCs began operating during the 1990s and 2000s and many metropolitan areas now have multiple traffic management centres. For example, the Georgia Department of Transportation in the United States operates an ATMS called Georgia NaviGAtor (figure 3.2). This system includes traffic cameras, VMS, ramp meters and traffic speed sensors. All the devices are linked by fibre-optic systems that are connected to the TMCs.

In Europe, the functions of TMCs are similar to the ones in the United States, which are usually operated by public authorities and road operators. The core roles of TMCs in Europe include strategic corridor and network management, section control, incident management, speed control, ramp metering and hard shoulder running. Some examples are Sytadin (France) (figure 3.3), Trafik Stockholm (Sweden), and Traffic Wales (United Kingdom).

In many countries of the Asia-Pacific region, TMCs are also quite common, but they are at varying levels of development. One recent example can be found in Singapore. An intelligent incident management tool in Singapore, called the Expressway Monitoring Advisory System (EMAS), detects crashes and other incidents promptly, ensures fast response to restore traffic flows, and provides real-time information of travelling times from the entry point to the expressway to selected exits via textual messages and VMS. The Land Transport Authority of Singapore operates a TMC, which is well-entrenched in the city's transportation infrastructure.


63 Metro Atlanta area, Metro Austin area, Metro Baltimore area, Metro Baton Rouge area, Metro Boston area, Metro Charlotte area, Metro Chicago area, Metro Cincinnati area, Metro Dallas area, Metro Denver area, Metro Detroit area, Metro Houston area, Metro Jacksonville area, Metro Kansas City area, Metro Los Angeles area, Metro Miami area, Metro Nashville area, Metro New Haven area, Metro New York area, Metro Orlando area, Metro Philadelphia area, Metro Phoenix area, Metro Salt Lake City area, Metro Sacramento area, Metro San Antonio area, Metro San Diego area, Metro San Francisco area, Metro Seattle area, Metro St. Louis area, Metro Tampa area, Metro Tucson area, Metro Virginia Beach area, and Metro Washington DC area.


65 United States of America, Georgia Department of Transportation, Available at http://www.511ga.org.

66 Ibid.


69 France, SYTADIN. Available at http://www.sytadin.fr/.

70 Sweden, Trafiken.nu. Available at https://trafiken.nu/stockholm/.

Transport Authority has extended the EMAS scheme to 10 major arterial road corridors for better information dissemination and traffic flow on the road network island-wide. Another example is in Australia. There has been a recent announcement of a major upgrade to the TMC in Sydney, New South Wales, which proposes to predictively manage disruption by 2020 with real-time autogenerated congestion alerts to customers.

3.2.2 Smart mobility
In the past, smart mobility only referred to environmentally-friendly modes of transport, but the meaning of smart mobility has been expanded to one which includes accessibility by any mode to create seamless, efficient and flexible services in response to the user’s demands. Combining the concept of smart mobility with various new technologies, such as mobile (i.e., smartphones), multimodal and on-demand mobility services, and electric and autonomous vehicles, is encouraged in order to maximize its benefits.

Almost the first tool for smart mobility was the smart card system, which is now quite common in many cities around the world. As shown by the case in London, since adopting the Oyster card in 2003, users have experienced more convenient trips by subway without physically purchasing tickets. Similar examples exist, such as the Breeze card in Atlanta, CharlieCard in Boston, Clipper in San Francisco, SmartTrip in Washington, D.C., Access card in Stockholm, Navigo in Paris, and OV-Chipkaart in the Netherlands. According to the advancement of ICT, such initial tools with public transport services have been upgraded by incorporating real-time routing, booking and ticketing services, which have saved countless hours for passengers and provided seamless multimodal services.

The mobile-based mobility service is a representative example of the smart mobility concept, considering the fact that the use of smartphones is constantly growing around the world (e.g., the number of smartphone users is estimated to have reached 224.3 million in the United States in 2017, 240.3 million in Western Europe in 2016, and 167.2 million in 2018).

72 France, SYTADIN. Available at http://www.sytadin.fr/
75 Siemens, Smart Mobility – a tool to achieve sustainable cities (München, 2015).
in Central and Eastern Europe in 2016, and 1139.8 million in Asia and the Pacific in 2016 because it does not require large-scale public investments and conventional ITS infrastructures. Various applications are available for mobile-based services, including real-time multimodal services, personalized travel information, trip navigations, public transit booking, and payments.

In terms of mobile ticketing, as of 2015 in the United States nearly one-in-five consumers (around 19 per cent) paid for parking fees via mobile applications such as “ParkMobile” and “PayByPhone”, which also give a driver the option of paying and managing meter time. In the Miami Coconut Grove in Florida, mobile payment for parking accounted for 70 per cent of all payments for parking in 2016. In most European countries, the use of e-payment for parking is increasing rapidly. As of 2015, these payment methods already accounted for more than 50 per cent (and, in some instances, more than 80 per cent) of payment methods in the majority of the northern European countries. There are many examples from private companies such as ParkMobile, JustPark, RingGO, Parkopedia, PayByPhone, EasyPark, and ParkU.

In Asia and the Pacific, in October 2018, the Ministry of Land, Infrastructure, and Transport in the Republic of Korea partnered with mobile service developers in starting the development of pedestrian safety services using ITS technologies. This service will allow pedestrians to receive nearby vehicle-related information on their smartphones in certain areas, such as bus stops, traffic lights and traffic complexes. In Australia, the Advisory Intelligent Speed Assist (ISA) system, which warns over-speeding vehicles, is utilized through smartphones. Australia also has Right Move Perth, developed by the Department of Transport (the Government of Western Australia), providing information including roadworks, crashes, traffic signal faults, train and bus service disruptions, major events and weather warnings.

The concept of smart mobility also contributes to the creation of new business models with a sharing economy concept. The on-demand ride services (e.g., Uber and Lyft), real-time ride-sharing services (e.g., Carma and Zimride), car-sharing programmes (e.g., Zipcar and car2go), bike-sharing programmes (e.g., Capital Bikeshare in Washington D.C., Divvy in Chicago and Citi Bike in New York, and BIXI in Montreal, Canada), and scooter sharing (e.g., Bird, Lime and Spin) are representative examples of smart mobility services using the sharing economy concept.


Another emerging concept of smart mobility is MaaS. Recent changes in technology, socio-demography, and user behaviour are helping a move towards multimodal transport services – combining existing transport modes (e.g., individual vehicles, buses, trains, bicycles, walking and shared modes). MaaS offers a seamless service across all existing transport modes by providing customized trip information and services. MaaS is based on the concept of “using” transport services, not “owning” transport modes. Considering the fact that ITS industries rely heavily on the cooperation of the public and private sectors, MaaS is expected to provide cost-efficient mobility options to the users, thus reducing expenditures associated with personal vehicle purchase and maintenance.103

In the United States, Bridj is providing an on-demand commuter shuttle service with a smartphone application, allowing users to ride a shuttle between home and work during commuting hours. Based on demand, Bridj optimizes pick-ups, drop-offs and routing, which offers a 40-60 per cent more efficient trip than traditional transit. In Canada, some municipal transport authorities offer mobility packages that include bike-sharing and car-sharing which allow a user to save the regular price of public transport by subscribing to the BIXI-AUTO-BUS package.

In Europe, there are also good examples of MaaS pilots. In Finland, a user can access a variety of transport options, from taxis to rental cars, public transport and bike share through a subscription-based integrated mobile application, called Whim. In Germany, Qixxit application provides all travel options including car-sharing, ride-sharing and bike-sharing which users can compare and choose according to their needs.

In Asia and the Pacific, Singapore is implementing the smart mobility concept. Beeline is a smart mobility platform based on the open cloud, which offers demand-based shuttle bus services for commuters through data analysis tools. Users can reserve seats on buses registered by private bus companies and find the location of the buses with suggested travel routes. With the concept of AVs, Singapore has been developing the concept of Mobility-on-Demand (MoD) as one of the solutions to the first-and-last mile problem. It has tried to integrate existing technologies with new methodology to provide MoD by AVs. A self-driven electric car is used to demonstrate the MoD system, which has been operational since January 2014. In Australia, there are a number of MaaS trials in development with both transport authorities and industries investigating the strong potential for MaaS projects – for example, one research project has been released recently which provides an evidence base to help prepare for the major changes anticipated in the concept of MaaS.

3.2.3 Cooperative-ITS and connected vehicles (V2I, V2V and V2X)

The concepts of Vehicle-to-Infrastructure (V2I), Vehicle-to-Vehicle (V2V) and Vehicle-to-Everything (V2X) are simple...
telecommunications technology that conducts the wireless exchange of data between vehicle and road infrastructure (V2I), vehicle and vehicle (V2V) and vehicle to various objects (V2X). Enabled by various forms of hardware, software and firmware, these technologies are used to mitigate congestion, reduce fuel consumption and emissions, and increase reliability, mobility and road safety by communicating with infrastructure, vehicles and other objects in response to road conditions.\textsuperscript{102}

In the United States, for more than a decade the National Highway Traffic Safety Administration (NHTSA) has been working with the automotive industry and academic institutions on V2V technologies. In 2012, NHTSA launched a pilot safety study (Safety Pilot Model Deployment\textsuperscript{103}) with tests on nearly 2,800 vehicles mostly with V2V technologies. A total of 27 roadside units along 75 miles of roadway were also installed in this study to test the V2I technologies for traffic signal timing and emergency vehicles. In 2017, the United States Department of Transportation (USDOT) issued a Notice of Proposed Rulemaking (NPRM) that will enable V2V technologies on all new light-duty vehicles. The NPRM had a 90-day comment period and NHTSA received 450 comments that included technology strategy, implementation timing, detailed technical information, cost estimates, potential health effects, privacy and security.\textsuperscript{104} Although extensive studies regarding the benefits of these technologies currently do not exist, research by NHTSA found that the combination of V2V and V2I technologies potentially addressed 81 per cent of unimpaired-driver crashes in all types of vehicles and 83 per cent in all light-vehicles.\textsuperscript{105}

In Europe, the CAR2CAR consortium of leading European vehicles manufacturers is working on V2V, V2I, and V2X technologies in order to create interoperable standards for all vehicle classes, across borders and brands. For this, the CAR2CAR consortium is working in close cooperation with the European Telecommunications Standards Institute (ETSI) and European Committee for Standardization (CEN).\textsuperscript{106} Given that congestion in the European Union costs about €100 billion annually, V2X application is projected to reduce road congestion by 15 per cent.\textsuperscript{107}

Connected vehicles (CVs) refers to cars that “access, consume, and create information and share it with drivers, passengers, public infrastructure, and machines including other cars”.\textsuperscript{108} By using V2V, V2I and V2X technologies, CVs enable various functions, mainly with regard to safety (e.g., red-light violation warnings and forward collision warnings), mobility (e.g., dynamic speed harmonization and cooperative adaptive cruise control), environment (e.g., dynamic eco-routing and eco-approach/departure at signalization intersections) and weather (e.g., weather response traffic information).\textsuperscript{109}

To benefit from this technology, USDOT has selected three sites to test CVs on improving


\textsuperscript{103} United States of America, Department of Transportation, Connected vehicle safety pilot. Available at http://www.its.dot.gov/research_archives/safety/safety_pilot_plan.htm.


\textsuperscript{105} United States of America, Department of Transportation, Frequency of target crashes for IntelliDrive safety systems. Report No. USDOT-HS-811-381 (Washington, D.C., 2010).


\textsuperscript{108} Your Connected Vehicle is Arriving, MIT Technology Review (2012).

\textsuperscript{109} United States of America, Department of Transportation, CV Pilot Deployment Program. Available at https://www.its.dot.gov/pilots/cv_pilot_apps.htm (accessed on 8 April 2017).
vehicle and pedestrian safety as well as traffic flow through Phase 1 of Connected Vehicle Pilot Deployment Programme up to 50 months. A total of US$ 178.8 billion in societal benefits annually is expected if connected vehicle safety applications are deployed across the entire United States vehicle fleet.110 On top of that, Connected Vehicle Reference Implementation Architecture (CVRIA) has been established in the United States. CVRIA provides “the basis for identifying the key interfaces across the connected vehicle environment which will support further analysis to identify and prioritize standards development activities.”111 Because CVs have the potential to dramatically reduce the number of fatalities and serious injuries, USDOT is, in particular, focusing on preventing crashes using this technology. USDOT Intelligent Transportation System Joint Program Office (ITS JPO) and NHTSA are working with the connected vehicle industry to develop more efficient and safe connected car environments.112 USDOT is planning to fund nearly US$ 3.9 billion over 10 years to promote large-scale deployment pilots to test connected and autonomous vehicle systems.113

CVs are also a multifaceted industry, with thousands of companies involved. Those industries and companies include automated driving (Bosch, Daimler, Google, Uber etc.), connected cloud service (Amazon, Airbiquity, Cisco Jasper, etc.), connected data (Hortonworks, Qualcomm, etc.), connected fleet management (Accenture, Autosist, Fleetmatics, etc.), connected truck (Bosch, Daimler, Mercedes-Benz etc.) and head-up displays (Carloudy, Corning, Garmin, etc.)114

In response to sensitively user’s various demands, a new concept of ITS, called Cooperative-ITS (C-ITS) which surmounts the limited functions of ITS in silos, was created that integrates each ITS application into a fully-connected network, based on V2V, V2I, and V2X technologies.115 With a comparison of current ITS, in C-ITS, each vehicle communicates with each other, infrastructure and other objects by V2V, V2I, and V2X technologies, respectively. All necessary information is shared with vehicles which can respond quickly to unexpected events on roads. Based on the recent study, experiments on the potential impact of using such technologies showed positive benefits in reducing crashes and fatalities on roads.116 C-ITS takes transport systems a step further as it takes advantage of the latest enhancements and additional services implied by the connection of systems together.

C-ITS is a European Commission’s initiative to develop a transport automation strategy for the European Union that would provide safer, more efficient and informed road experience for all road users.117 The European Commission has established a dedicated C-ITS platform to bring representatives from a wide range of stakeholders. This platform has a goal to build a shared vision of options to support the deployment of C-ITS. The European Union has conducted various studies involving research, consultation and data collection exercise, together with the definition of deployment

114 Ignite, Top technology companies driving the connected car revolution. Available at https://igniteoutsourcing.com/automotive/connected-car-companies/.
scenarios in conjunction with members of this C-ITS platform.\textsuperscript{118}

More recently, in a plan called “A European Strategy on Cooperative Intelligent Transport Systems”, the European Commission stated that the full-scale deployment of C-ITS services would be implemented with C-ITS enabled vehicles starting from 2019.\textsuperscript{119} In line with this strategy, the European Transport Safety Council recommended setting targets between 2019 and 2029 in the gradual European Union-wide deployment of C-ITS.\textsuperscript{120}

In Asia and the Pacific, even though only leading ITS countries are proactively developing technologies for C-ITS and CVs (including V2V, V2I and V2X), many such activities are currently being developed. For example, for V2V, V2I and V2X technologies, the Republic of Korea is implementing 5G mobile communication networks that enable data transmission faster than 20 Gbps and mutual transmissions between base stations and devices every 1/1000 seconds.\textsuperscript{121} Seoul has created traffic communication networks on 5G Wave, and Cellular-V2X, offering opportunities for various communication technologies to be tested on real roads.\textsuperscript{122} China is also moving forward with the development of 5G mobile communication technology with the Government’s strong drive and has been actively making progress on establishing international standards on V2X.\textsuperscript{123}

In terms of C-ITS and CVs, countries in the Asia-Pacific region have recently begun research activities, and initiated relevant plans and strategies. For example, the Republic of Korea has initiated strategic plans on promoting the commercialization of C-ITS. According to the National ITS Master Plan 2020, the Republic of Korea is planning to conduct field operation tests of such technologies on highways and urban areas.\textsuperscript{124} The C-ITS pilot project for verification of next-generation ITS technology and service started in July 2014 and will run until 2020.\textsuperscript{125} This pilot project consists of 88 km of road extensions and expressways, national roads and urban roads in Daejeon and Sejong cities. The pilot project\textsuperscript{126} aims to improve driver safety through V2V and V2I technologies.

In China, technology studies on vehicle and road cooperation (e.g., on-board, roadside, communication and control systems) were conducted from 2011 to 2014.\textsuperscript{127} Two national standards (China V2X standards) for C-ITS were released in 2014, and automobile manufacturers, Internet companies (e.g., Baidu, Alibaba and Tencent) and research institutions are currently working together to promote intelligent driving technology.\textsuperscript{128}

In Japan, the concept of C-ITS was verified through regional trials concerning Smartway, Advanced Safety Vehicles and Driving Safety Support Systems (DSSS). In launching the C-ITS projects nationwide, 15 locations had been selected for DSSS as of 2010, and by 2011, 1,600 locations had been selected for the ITS Spot project which was renamed as ETC 2.0 in 2014.\textsuperscript{129}
As of March 2018, the number of ETC 2.0 device is roughly 3.7 million.\textsuperscript{130}

C-ITS projects in Australia started in December 2013 when the National Transport Commission (NTC) released its final policy paper on C-ITS. This paper views road safety as the most prominent opportunity for C-ITS with efficiency, productivity and environmental benefits.\textsuperscript{131} Based on Austroads’ Cooperative ITS Strategic Plan, Australia has continued working to commercialize the deployments of such technologies with some projects,\textsuperscript{132} such as a small-scale proof of concept in South Australia in 2010 and the provision of advance warning of approaching trains at level crossings. Further, recently, there are more trials in a number of jurisdictions with three projects in particular testing a range of technologies and platforms – Cooperative and Automated Vehicle Initiative (CAVI) in Queensland, Cooperative Intelligent Transport Initiative (CITI) in New South Wales, and Australian Integrated Multimodal EcoSystem (AIMES) in Melbourne.\textsuperscript{133}

3.2.4 Autonomous vehicles

In principle, the autonomous vehicle (AV), also called “self-driving” or “driverless” vehicle, is able to travel without human intervention. Technically, the AV uses satellite positioning systems and diverse sensors (i.e., radar, ultrasonic, infrared, laser etc.) to detect the surrounding environment.\textsuperscript{134} Identified information is interpreted to find appropriate paths considering obstacles and traffic signage by using wireless networks, digital maps, automated controls in vehicles, and communication with smart infrastructure and the control centre.\textsuperscript{135}

In the United States., at least 41 States and Washington, D.C. have been considering legislation related to AVs since 2012.\textsuperscript{136} Governors of 11 States have issued executive orders, while 29 States and Washington, D.C. have enacted legislation related to AVs.\textsuperscript{137} In addition to the legislation, USDOT is pursuing a variety of activities for AVs. In 2017, USDOT selected 10 proving ground pilot sites to encourage testing, validation and information sharing around automated vehicle technologies.\textsuperscript{138} In 2018, USDOT published \textit{Preparing for the Future of Transportation: Automated Vehicles 3.0 (AV 3.0)} to provide a framework and multimodal approach to the safe integration of AVs into the surface transport system.\textsuperscript{139} In 2018, USDOT published a Comprehensive Management Plan for Automated Vehicle Initiatives for the implementation of a plan to manage initiatives related to AVs within variously related administrations, such as NHTSA, FHWA, the Federal Motor Carrier Safety Administration and the Federal Transit Administration.\textsuperscript{140}

\textsuperscript{130} Japan, ETC General Information Portal Site, About ETC 2.0. Available at https://www.go-etc.jp/index.html (accessed on 14 May 2019).

\textsuperscript{131} ITS Australia, C-ITS. Available at https://www.its-australia.com.au/.


\textsuperscript{133} ITS Australia, ITS Australia project dashboard. Available at https://dashboard.its-australia.com.au/.

\textsuperscript{134} ESCAP, Review of developments in transport in Asia and The Pacific (Bangkok, 2017).

\textsuperscript{135} ESCAP, Policy Framework for the Use and Deployment of Intelligent Transport Systems in Asia and the Pacific – Study Report (Bangkok, 2018).


\textsuperscript{137} Ibid.

\textsuperscript{138} United States of America, Department of Transportation, Automated vehicle proving grounds to encourage testing of new technologies. Available at https://www.transportation.gov/briefing-room/dot1717.


In Europe, research projects on autonomous driving, called City Alternative Transport and CityMobil, have been initiated. Germany introduced the concept of automated driving as an objective for 2020 in a Round Table organized by the Federal Ministry of Transport and Digital Infrastructure. The United Kingdom invested £33 million for “driverless car” trials in four cities in 2014 and completed the regulatory review (titled “the pathway to driverless cars”) in 2015.

In addition, the European Commission supports the introduction and deployment of connected and automated mobility by developing policy initiatives, roadmaps and strategies, developing standards at the European level, co-funding research and innovation projects, and infrastructure pilot projects. In 2016, the European Commission members signed the “Declaration of Amsterdam on Cooperation in the Field of Connected and Automated Driving” to establish shared objectives, a joint agenda and proposed actions both for member States and the European Commission in the area of connected and automated driving. In March 2017, 29 European countries signed a Letter of Intent committing to work together on large-scale testing and demonstrations for automated driving.

The letter addressed connectivity, spectrum, data, cybersecurity and artificial intelligence for AV operation. In September 2017, the Commissioners agreed to strengthen cross-border collaboration on AV testing, in particular new testing in Finland, Norway and Sweden.

Because AVs are technology-intensive, many private automobile manufacturers and Internet-oriented technology companies are actively driving towards research and development. For example, vehicles with a limited autonomous driving function are already available on the market (Levels 1 and 2 vehicles by the definition of the Society of Automotive Engineers International), while some Level 3 vehicles are commercially available in certain leading ITS countries. More and more countries are testing Levels 3 and 4 vehicles and some will be available by 2020. The key players in the AV market are mostly the United States and European-based companies, including Google LLC, General Motors Company, Volkswagen, BMW (Bayerische Motoren-Werke), Ford Motor

145 Amsterdam, Cooperation in the field of connected and automated driving. Available at https://www.regieringen.no/contentassets/ba7ab6e2a61e33b9a775f25f5f8d14/2016-04-08-declaration-of-amsterdam---final14/00661.pdf.
150 “Level 0: The human driver does all the driving. Level 1: An advanced driver assistance system (ADAS) on the vehicle can assist the human driver with either steering or braking/accelerating. Level 2: An ADAS on the vehicle can control both steering and braking/accelerating under some circumstances. The human driver must continue to pay full attention (“monitor the driving environment”) at all times and perform the rest of the driving task. Level 3: An automated driving system (ADS) on the vehicle can perform all aspects of the driving task under some circumstances. The human driver must be ready to take back control at any time the ADS requests the human driver to do so. In all other circumstances, the human driver performs the driving task. Level 4: An ADS on the vehicle can itself perform all driving tasks and monitor the driving environment – essentially, do all the driving – in certain circumstances. The human need not pay attention in those circumstances. Level 5: An ADS on the vehicle can do all the driving in all circumstances. The human occupants are just passengers and need never be involved in driving.” See the details at http://autocaat.org/Technologies/Automated_and_Connected_Vehicles/.
Company, Tesla, Inc. and Audi AG, among others. In Asia and the Pacific, China aims to implement autonomous driving technology for all private cars in a cutting-edge metropolis near Beijing by 2035. A new city project is planned exclusively for AVs in Xiongan, which will be a model district designated for developing autonomous driving technology based on artificial intelligence, by providing support for related industries. In Japan, an automated driving system programme was selected in 2014 as part of the Cross-Ministerial Strategic Innovation Promotion Programme for the purpose of developing new technologies that avoid crashes and alleviate congestion. Japan has launched verification tests on autonomous taxis and aims to commercialize autonomous taxis by the 2020 Olympics and Paralympics in Tokyo. In the Republic of Korea, the Ministry of Land, Infrastructure and Transport is building a testbed, called K-City, in which AVs could be tested on real roads. In Australia, the first driverless shuttle bus, “IntelliBus”, which has been going through trials in Perth, is able to carry 11 people at a maximum speed of 45 km/h in controlled environments. South Australia also held the first on-road trials of driverless cars in 2015. The Land Transport Authority in Singapore established the first test site for self-driving vehicle technologies and mobility concept in 2015.

### 3.3 Development opportunities in the Asia-Pacific region

It should be noted that although the Asia-Pacific region is facing many of the challenges indicated in SWOT analysis, many strengths and opportunities to cancel out such challenges were found that hold strong potential for better integration of ITS technologies, and more efficient and effective ITS development and operation. Growing populations, potential markets, lessons learned, and young resources have the region well-positioned for the successful development of ITS.

Furthermore, as analysed in section 3.2, there are various new ITS technologies currently under development around the world. Some countries in Asia and the Pacific also provide good examples of the use of such technologies, implying that other countries in the region will use them properly sooner or later. Taking into consideration the findings in chapters 1 and 2, development opportunities from the Asia-Pacific perspective are presented below:

- Traffic management centres. It was found that traffic management centres are becoming widespread around the world, including many countries in the Asia-Pacific region. As pointed out by the SWOT analysis, some world-renowned leading ITS countries are in the Asia-Pacific region that already have good experience in establishing traffic management centres and are now advancing the functions of the centres with new technologies. Such advantages can be utilized properly to operate more traffic management centres in the region with...
cooperation from subregional ITS-related activities. Given that the Asia-Pacific region has good transport connectivity networks, such as the Trans-Asian Railway, Asian Highway and Dry Ports, the pursuit of traffic management centres will operationalize these networks. Further, considering the importance of TMCs as a hub for ITS services, including new mobility options, less ITS-developed countries could utilize the opportunity to gain ODA support from United Nations agencies and MDBs for establishing TMCs.

- Smart mobility. As pointed out in the SWOT analysis, the high percentage of the young generation in the Asia-Pacific region can easily adopt new mobile technologies. Given that the concept of smart mobility is mainly based on mobile technologies, which do not require traditional investment and fundamentals, this strength can help promote the concept of smart mobility in most of the countries in this region (regardless of the level of technological readiness), particularly where fundamental infrastructure, funding resources and good experience in ITS services are lacking. In addition, the growing number of start-ups and increasing demands for new mobility services in the region can create more opportunities for developing and implementing the concept of smart mobility. In particular, some countries in the region that suffer from limited accessibility and connectivity of transport services could benefit from new mobility options by providing easy, seamless and convenient services to users. Further, from the government perspective, the concept of smart mobility might mean relatively cheap operational costs in offering transport services from the public sector.

- Autonomous vehicles. Because of the flexibility of developing and least developed countries in adopting new ITS technologies in the Asia-Pacific region, it is expected that the concept of AVs will be smoothly introduced step-by-step in most countries of the region in the future. Given that there are many financial opportunities for technical and capacity-building assistance in this region, the understanding and preparedness of AVs can be enhanced through various activities by MDBs, the United Nations and ODA agencies. In addition, leading ITS countries in this region have already initiated necessary actions including introducing relevant regulations, plans and standards that would be good references for other countries in the region that are lagging behind. In addition, various attempts at start-ups by the young generation and steady efforts for increasing self-development capabilities would contribute to lowering the likelihood of failure. As the Asia-Pacific region is experiencing rapid economic growth and growing ITS market size, the adoption of AVs will create a great synergy effect in addressing traffic and socio-economic issues.
ASSESSMENT OF DEVELOPMENT OPPORTUNITIES FOR INTELLIGENT TRANSPORT SYSTEMS IN ASIA AND THE PACIFIC