Chapter 12

The Role of the Automotive Sector in Regional Economic Development

Fusanori Iwasaki
Executive Assistant to the President/Senior Research Associate, ERIA

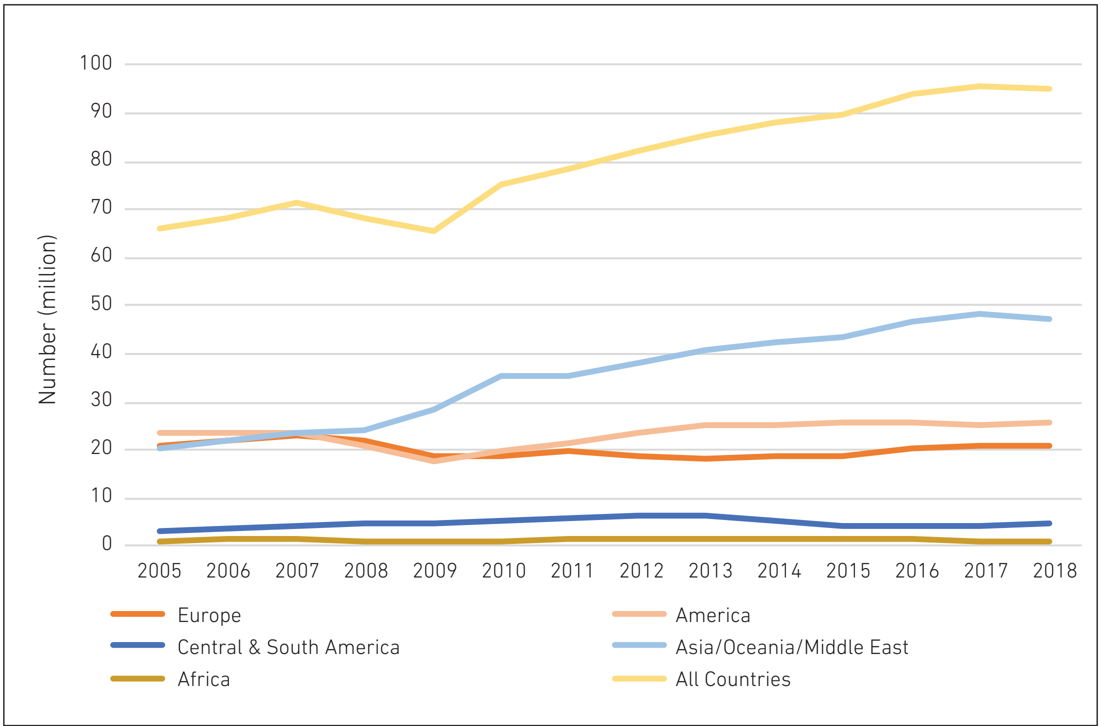
Yasushi Ueki
Senior Research Fellow, IDE-JETRO; Research Fellow, ERIA

Iwasaki, F. and Y. Ueki (2022), 'The Role of the Automotive Sector in Regional Economic Development', in ERIA (eds.) *The Comprehensive Asia Development Plan 3.0 (CADP 3.0): Towards an Integrative, Innovation and Sustainable Economy.* Jakarta: ERIA, pp. 353-376.

Introduction

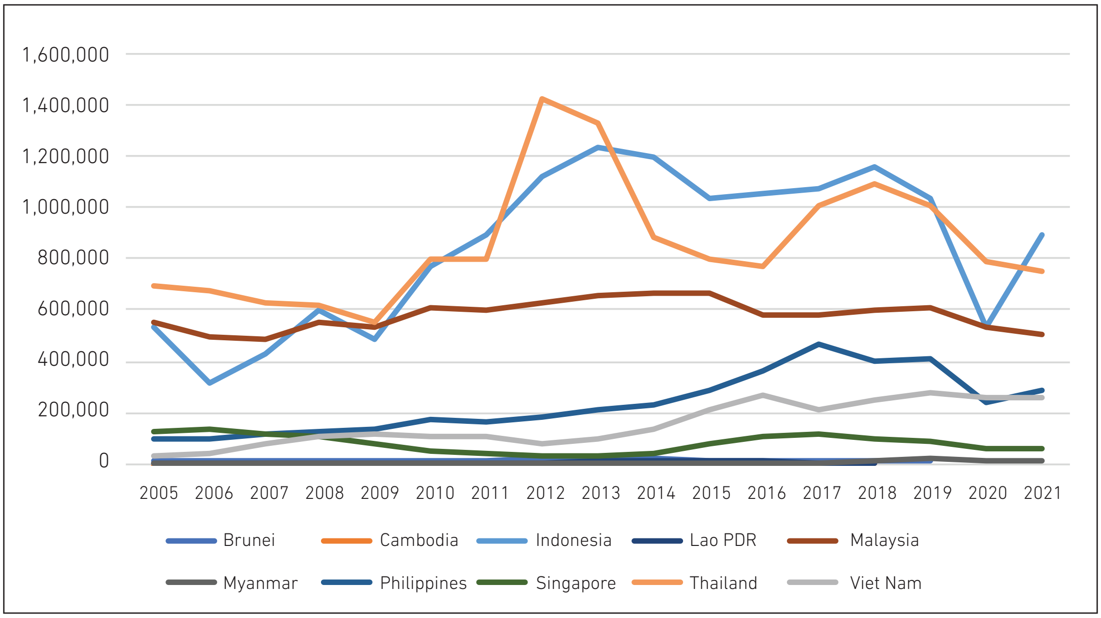
By 2040, almost all Association of Southeast Asian Nations (ASEAN) Member States (AMS) will be high-income countries, constituting a growth centre in the world economy (ERIA, 2019). Due to increasing incomes, the transportation sector will grow dramatically until 2040. According to the International Organization of Motor Vehicle Manufacturers (OICA), automotive sales and production have increased dramatically in the last decade (Figure 12.1). Figure 12.1 shows that global vehicle sales (including commercial and passenger cars) reached 95 million units in 2018, driven by the considerable growth rate of Asia, Oceania, and the Middle East. However, Figure 12.2 shows that some AMS (e.g. Thailand and Indonesia) slowed the increase in sales from 2014 to 2018, while the Philippines and Viet Nam maintained robust high growth rates. In terms of AMS production, only five countries – Indonesia, Malaysia, the Philippines, Thailand, and Viet Nam – produce a significant number of vehicles and maintain a stable growth rate, with some fluctuations (except in Malaysia). Thailand produces about twice the average number of sales, while others produce less than the domestic market demand.

Figure 12.1 Total Global Vehicle Sales in All Countries



Source: OICA (n.d.), Global Sales Statistics. https://www.oica.net/category/sales-statistics/ (accessed 26 November 2021).

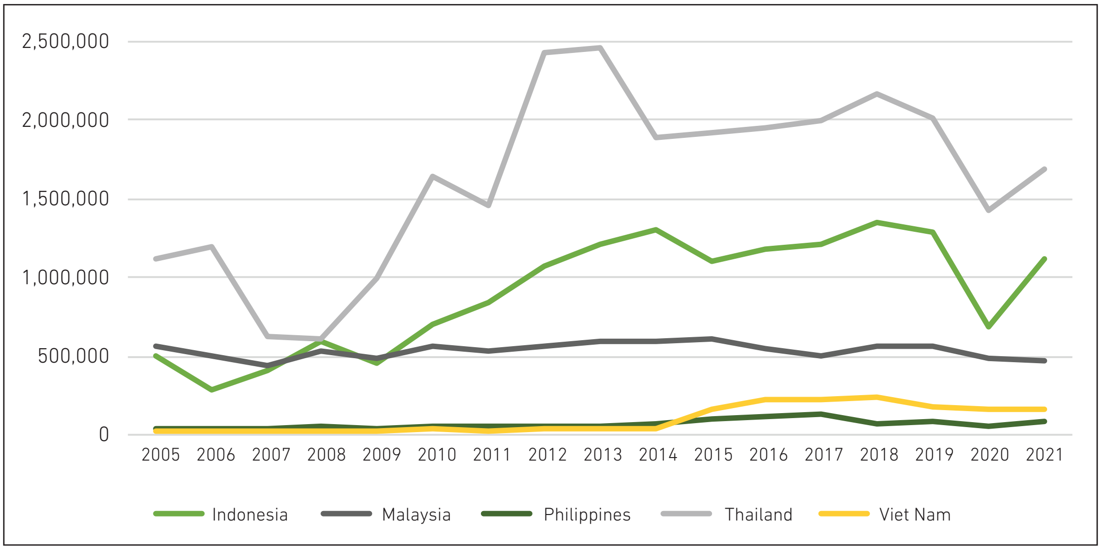
Figure 12.2 Total Number of Vehicle Sales in ASEAN



ASEAN = Association of Southeast Asian Nations.

Source: OICA (n.d.), Global Sales Statistics. https://www.oica.net/category/sales-statistics/ (accessed 26 November 2021). ASEAN Automotive Federations (AAF), https://www.asean-autofed.com/index.html (accessed 17 July 2022). (The data on Brunei (2020-2021), Cambodia (2019-2021), and Lao PDR (2019-2021) are no data.)

Figure 12.3 Total Number of Vehicles Produced in ASEAN



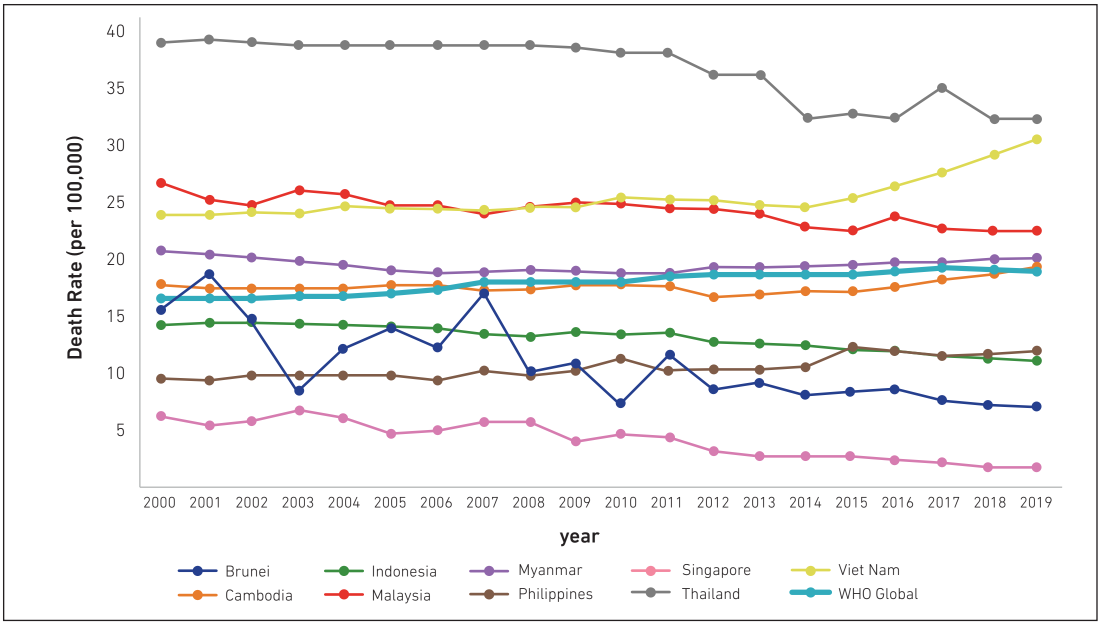
ASEAN = Association of Southeast Asian Nations.

Source: OICA (n.d.), data base. AAF statistics (n. d.). (Accessed 20 July 2022).

To achieve a prosperous and healthy society by utilising the potential of automobiles, AMS should upgrade manufacturing and pursue sustainable industrial development through innovation. The automotive sector, which is one of the largest manufacturing segments, faces a massive transformation due to digitalisation such as the internet of things (IoT), artificial intelligence (AI), autonomous driving, and electrification, by using big data. This is not only a challenge for automotive companies but also a great opportunity for the development of the manufacturing sector as well as the software industry.

The other challenge for AMS is to realise sustainable mobility. Automotives and the 'motorisation society'[1] also have massive negative impacts on society (Uzawa, 1974). The digitalisation of the automotive industry has the potential to mitigate such social costs. Figure 12.4 and 12.5 illustrate the ratio of traffic deaths in ASEAN and the East Asia Summit (EAS) 6 countries.[2] While deaths in the EAS 6 countries are below the World Health Organization (WHO) global level, deaths in some AMS are quite high. Vehicle sales in AMS are still increasing, so transportation infrastructure, laws, and traffic regulations need to be developed and implemented as designed in the motorisation society.

Figure 12.4 Death Rate of Automotive Traffic Accidents in ASEAN



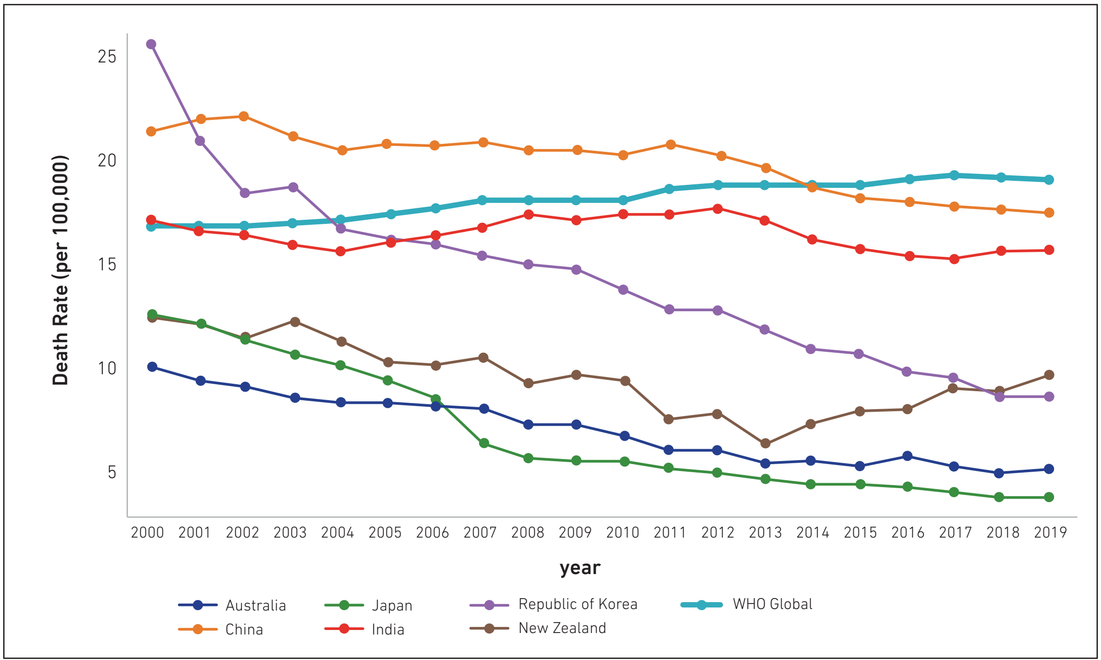
ASEAN = Association of Southeast Asian Nations, WHO = World Health Organization.

Source: WHO (n.d.), The Global Health Observatory: Estimated Road Traffic Death Rate (per 100,000 population). https://www.who.int/data/gho/data/themes/topics/sdg-target-3_6-road-traffic-injuries (accessed 26 November 2021).

[1] 'Motorisation' here refers to the social change that occurs when many people can purchase their own cars due to the rapid increase in income level.

[2] EAS 6 countries in this paper refer to Australia, China, India, Japan, New Zealand, the Republic of Korea – the original members of the EAS except the 10 AMS.

Figure 12.5 Death Rate from Automotive Traffic Accidents in the EAS 6 Countries*



ASEAN = Association of Southeast Asian Nations, EAS = East Asia Summit, WHO = World Health Organization.

* Australia, China, India, Japan, New Zealand, and the Republic of Korea.

Source: WHO (n.d.), The Global Health Observatory: Estimated Road Traffic Death Rate (per 100,000 population). https://www.who.int/data/gho/data/themes/topics/sdg-target-3_6-road-traffic-injuries (accessed 26 November 2021).

Digital technologies enable many companies to strengthen their own automotive and auto-parts businesses and to create value chains for these industries to achieve innovation, establish new initiatives, and create a sustainable, efficient, and environmentally friendly automotive society in the region. Global trends in the automotive industry – connected, autonomous, shared/service, and electrified (CASE) and Mobility as a Service (MaaS) – will realise the potential of digital technologies. These new waves will also change the landscape of three dimensions of connectivity: physical, institutional, and people to people. Based on the digital transformation in the automotive sector, the ASEAN and East Asia regions need to develop complex infrastructure for electrification and autonomous driving, but also various laws and regulations, as well as human resources initiatives, for the new technologies.

This chapter investigates the development of the automotive industry in the ASEAN region in conjunction with digitalisation. First, it describes the automotive industry's social cost and how digitalisation such as the CASE could mitigate the risk. Second, it focuses on using digital technologies in the automotive industry for further development in the region. Third, it presents challenges for the ASEAN region to address common issues for the three aspects of connectivity in terms of automotive policies.

Social Costs of Motorisation

The rapid progress of the automotive and motorisation society has massive negative impacts on our communities. Uzawa (1974) pointed out the importance of internalising the social costs of motorisation and automotive industry development. Internalisation of the social costs means that car users cover installing and maintaining the infrastructure required to protect fundamental human rights in society (Uzawa, 1974; Nishitateno, 2014).

Several AMS are still emerging economies on the way to realising the motorisation society. Motorisation also entails several social costs, such as increasing traffic accidents, noise, air pollution, and climate change risks due to greenhouse gas emissions (Uzawa, 1974). Some big cities, including the capitals of AMS, suffer from significant traffic congestion and air pollution.[3] Traffic congestion also causes losses in terms of time, business costs, productivity, and output levels (Weisbrod, Vary, and Treyz, 2003). It is necessary to consider these external negative costs to mitigate or internalise the motorisation society.

While the automotive sector creates some negative impacts for society, the technologies of CASE and MaaS have great potential to mitigate these risks. Table 12.1 lists the high external costs of the automotive society and the technologies that have the potential to diminish these costs.

[3] For example, Jakarta was the third most affected city in the world by traffic congestion, after Mexico City and Bangkok, in 2018. People in Jakarta spend 22 days a year stuck in traffic compared with citizens of other major Asian cities (19 days on average), according to a study by Uber and Boston Consulting Group (ASEAN Post, 2019).

Table 12.1 External Costs of Motorisation and Mitigation Technologies

External costs	Technologies
Accidents	Advanced driver-assistance system (ADAS) Connected and autonomous vehicles
Air pollution	Electrification
Climate change	Well-to-wheel zero-emission vehicles (ZEVs)
Noise	Electrification
Congestion	Connected, sharing, and a large share of electric autonomous vehicles
Well-to-tank emissions	Renewable energy, energy efficiency

Source: Authors, based on Uzawa (1974).

To solve the issues in Table 12.1, we can consider using CASE technologies. For example, the increase in connected vehicles promotes the advanced driver-assistance system (ADAS).[4] Using a variety of devices that support communication amongst vehicles on the road, vehicle-to-vehicle (V2V) communication will dramatically reduce the number of road accidents in both private and public transportation.[5] Through IoT technologies and connected vehicles, V2V technologies will prevent collisions of vehicles and pedestrians and improve energy efficiency.

Electric vehicles (EVs) are regarded as an alternative towards a cleaner transportation sector. Due to the absence of exhaust gas emissions, the electrification of vehicles helps to mitigate localised pollution such as nitrogen oxides (NOx) and sulphur oxides (SOx), which is particularly important in overpopulated urban areas (Cassals et al., 2016). In addition, electrification reduces noise. However, greenhouse gas (GHG) emissions need to be carefully considered because they are directly related to a country's primary energy mix for electricity generation. Woo, Choi, and Ahn (2017) calculated the GHG emissions of battery electric vehicles (BEVs) in 70 countries, including the Asia and the Pacific region, which are highly reliant on fossil fuels in their mix and produce strong GHG emissions. Electrification does not cut all carbon dioxide (CO_2) emissions, as it depends on how the electricity is created.[6] Therefore, the use of renewable energy such as solar photovoltaic (PV) or wind power generation promotes zero-emission vehicles (ZEVs).

[4] ADAS refers to technologies that help reduce human error and prevent car accidents. By using sensors, ADAS provides information on the surrounding environment of a car and supports drivers to take adequate action to avoid accidents. Although ADAS is part of autonomous driving technologies, the level of autonomous driving is not high (level two).

[5] See RGBSI (n.d.). Devices supporting V2V technologies include radio-frequency identification (RFID) readers, signage, cameras, lane makers, streetlights, and parking meters.

[6] ERIA (2019) illustrated how the vehicle type depends on CO_2 emissions by well-to-tank and tank-to-wheel.

Connected and fully autonomous vehicles can reduce traffic congestion. Especially in the major urban areas of ASEAN, traffic congestion provides negative opportunity costs such as time loss and logistics deficiencies and causes air and noise pollution due to the rapid increase in vehicle accumulation.[7]

To sum up, the new waves in the automotive industry provide a pathway to solve the social problems derived from a more motorised society. Rapidly emerging countries in the ASEAN and East Asia region have a great opportunity to use the new technologies of digitalisation. The CASE and MaaS trend, described in the next section, is a clear example of automotive digitalisation.

Development of the CASE and MaaS Concepts

Concepts of CASE and MaaS have become popular worldwide and are the near-future direction of the motorisation society in developed countries. Some developed countries will use new types of vehicles – including EVs, autonomous driving systems, and connected cars – as well as sharing services in the 2020s. Hopefully, in the 2030s, emerging countries, particularly AMS, will also start to install such new technology in the automotive sector (Nakanishi, forthcoming). The trend of CASE and MaaS is one of the significant achievements of the digital transformation of the automotive parts sector and makes this sector more competitive due to the entry of different industries such as electronics and software development firms.

CASE is a concept of a digital revolution in the industry from the standpoint of the automotive sector. The term is an acronym for four crucial trends in the automotive industry – 'C' for connected (a vehicle that is constantly connected to the network), 'A' for autonomous (autonomous driving), 'S' for shared and service, and 'E' for electric. German-based Daimler coined CASE in 2008, and it has been widely used since the mid-2010s (Nakanishi, forthcoming). The critical point is that each element of CASE is not independent, but strongly linked to enhancing the effectiveness of driving.

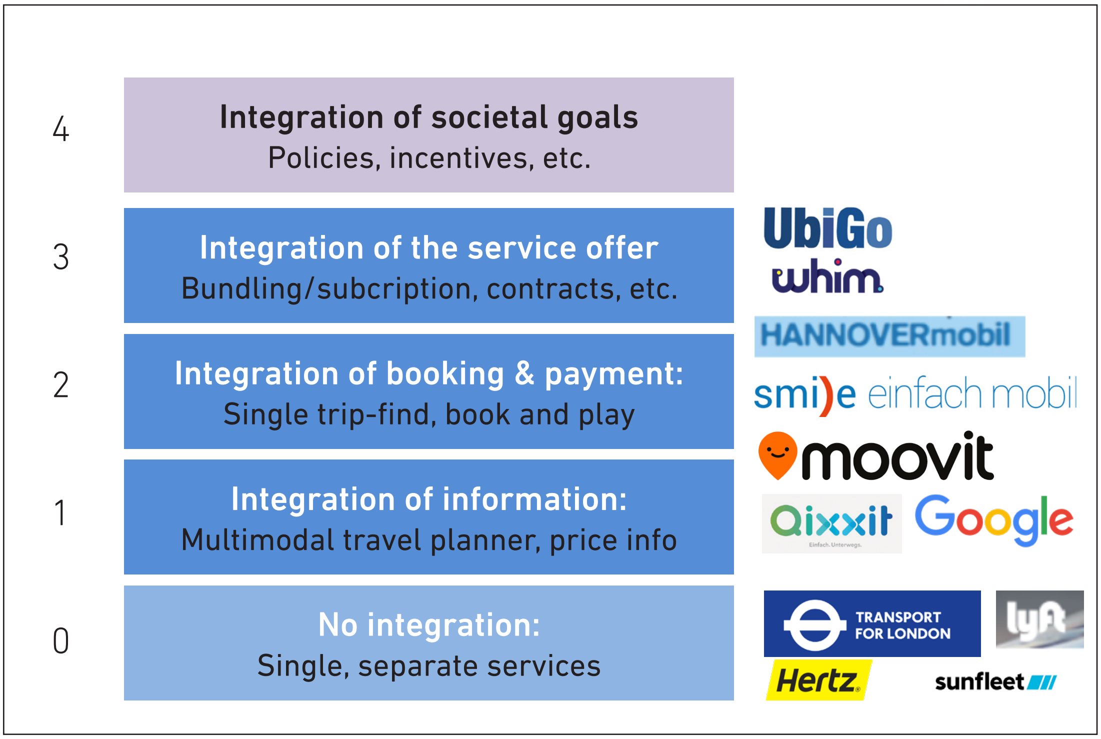
[7] For the example of Jakarta, see ASEAN Post (2019).

Connected cars refer to vehicles that are linked to the network and communicate with road infrastructure as well as other vehicles on the road through the network. Although the connectedness is an essential element of the autonomous driving system, connected cars also provide passengers with some services through online bases. The autonomous attribute enables passengers to drive vehicles without human intervention. Although full automation driving (level 5) has still not been achieved, a lower level of automation (e.g. ADAS) can reduce the risk of traffic accidents and enables people with disabilities to drive vehicles by themselves.[8] Sharing and service have great potential to disrupt the use of a vehicle from ownership to sharing. Car sharing encourages passengers to view vehicles as a transportation service tool. Therefore, like MaaS, transportation systems are linked through online applications and passengers can choose their optimal transportation mode. Finally, the electrified feature means that the vehicle consists of an electric battery for energy storage, an electric motor, and a controller (Larminie and Lowry, 2012). EVs are not limited to BEVs, as they also include hybrid EVs, plug-in hybrid EVs, and fuel cell vehicles (Schröder and Iwasaki, 2021).

MaaS is a broader concept that incorporates CASE. However, we define MaaS as part of the concept of CASE ('S' for service). MaaS is an integrative concept that bundles different transport modalities into a single, seamless service to provide tailored mobility solutions that cater to users' travel needs (Mukhtar-Landgren et al., 2016; Karlsson et al., 2017; and Smith, Sochor, and Sarasini, 2018). For example, MaaS Global, established in 2015, started the first subscription style transportation in Finland. Through the mobile application, users combine their optimal transportation choices, including buses, taxis, trains, and car sharing. MaaS provides solutions for the so-called 'last mile' problem by providing optimal connections from public transportation to taxis or car sharing to the destination (Figure 12.6).

[8] Level 0: no automation, level 1: driver assistance, level 2: partial automation, level 3: conditional automation, level 4: high automation, and level 5: full automation (Rivard, 2018).

Figure 12.6 Proposed Topology of MaaS



MaaS = Mobility as a Service.

Note: Includes levels 0–4 (left) and examples (right).

Source: Smith, Sochor, and Sarasini (2018).

MaaS encompasses everything from social transportation to urban planning and helps solve social issues. It improves our quality of life and the quality of the towns and cities we live in by enabling people to travel efficiently, redistributing road space more efficiently (Nakanishi, forthcoming).

Therefore, the new trends of CASE and MaaS have great potential to mitigate the social costs of the motorisation society. Rapidly developing AMS need to integrate these waves into their automotive industry policies. However, several negative impacts of CASE need to be considered (Table 12.2).

Table 12.2 Costs and Benefits of CASE

Negative impacts of CASE	
• **Connected**	Security and privacy issues
• **Autonomous**	Lack of reliable technologies and necessary institutions
• **Service/Shared**	Inconsistency with the current institutions
• **Electrified**	Lack of a profitable business model
Benefits of CASE	
• **Connected**	Infrastructure for autonomous driving and sharing
• **Autonomous**	Enhanced safety
• **Service/Shared**	Users do not need to own cars, connecting to another services New business opportunities
• **Electrified**	Reduction in carbon and greenhouse gas emissions

CASE = connected, autonomous, shared/service, and electrified.

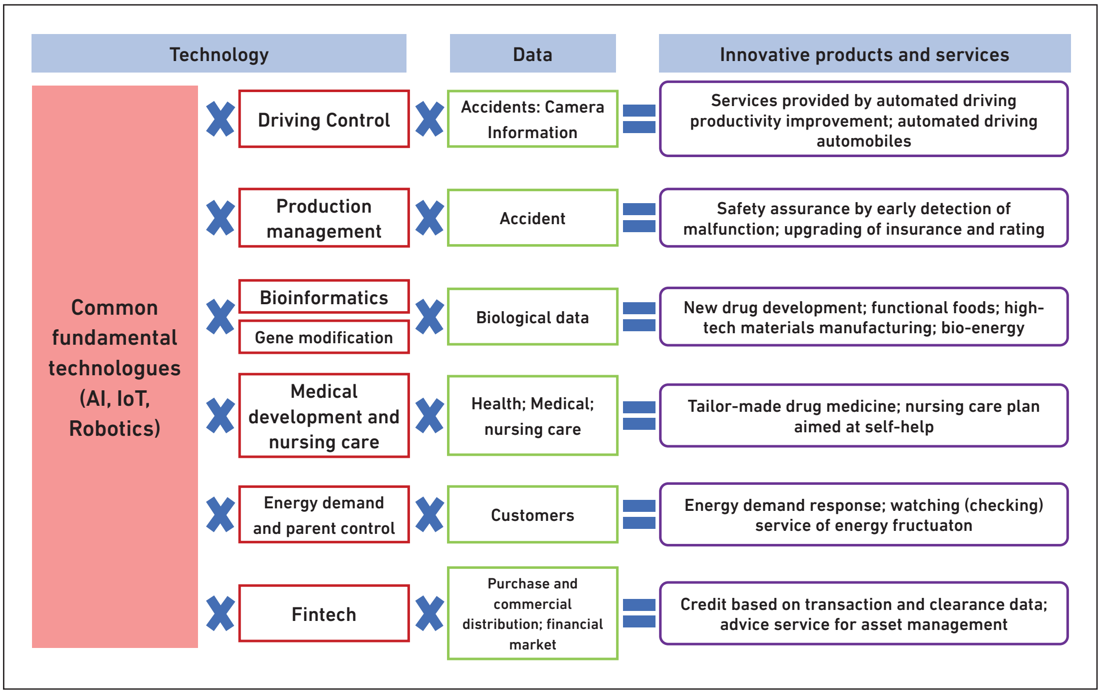
Source: Authors.

Connected cars will provide the basis of autonomous driving, but robust security and privacy protection are also necessary. For example, in line with the European Union's General Data Protection Regulation (2016), the European Data Protection Supervisor released a report on connected cars and data protection.[9] Connected cars are linked with diverse direct and indirect individual data, and the amount of data is much larger than before. Regarding autonomous driving systems, it is still quite a hurdle to achieve total autonomous driving due to lack of reliable technologies and necessary institutions. Large-capacity data communication facilities are still nascent, particularly in emerging countries. The service and shared aspect of CASE also poses significant challenges as an economically viable or profitable business model. Although some ride-share companies provide other services (e.g. delivery of goods and services and financial services) through their application platforms, it is challenging for conventional automotive and parts companies to maintain their existing profitable business models. Finally, electrification requires further development of battery technologies to achieve massive cost reductions. Battery charging stations or other charging technologies and infrastructure must be installed for further EV penetration.

[9] BearingPoint Institute (n.d.); and European Data Protection Supervisor (2019).

Nishimura et al. (2019) showed that new technologies, which constitute the core of the Fourth Industrial Revolution, are the common technological foundation for next-generation industries to emerge and prosper (Figure 12.7). To fill the gap between using new technologies and producing innovative products and services, a tight association is indispensable amongst various existing technologies (IoT, big data, AI, and robotics) and relevant and abundant data.

Figure 12.7 Examples of the Combinations of Technologies and Data



Source: Nishimura et al. (2019)

Nakanishi (forthcoming) states that:

> the foundation for CASE is 'Connected' (as in connected cars). Data accumulated from connected vehicles become big data, which will be analysed using AI. The analysed data (and analysis results) will be fed back into the real world as automated driving and mobility services. This continuous cycle allows for seamless connections that form CASE innovations.

Nakanishi (forthcoming) projects that almost all new vehicle sales in advanced countries will be 'connected cars' and about 1 billion vehicles will be connected with the network by 2030.

Digitalisation has great potential not only to facilitate the economic transformation of ASEAN based on new technologies but also to markedly increase society's ability to address social problems and promote social progress in a more efficient and effective manner. Digitalisation and CASE provide great opportunities to achieve sustainable motorisation and further economic growth simultaneously. Enhancing connectivity, including the digital aspects, is an effective way to improve social welfare in each country and in the region as a whole. The next section touches upon each aspect of connectivity – physical, institutional, and people to people – in terms of the development of the automotive sector.

The next section classifies the transformation of ASEAN's automotive industry in line with the concept of connectivity.

Development of Physical Connectivity in the Automotive and Parts Sectors

The last Comprehensive Asia Development Plan (CADP) 2.0 (ERIA, 2015) listed 176 automotive-related infrastructure projects (e.g. roads and bridges) out of a total of 779 projects (see Chapter 11 of this report).

The data for physical connectivity show that some AMS still have a low level of complex infrastructure to cope with motorisation. To facilitate motorisation, it is essential to install sufficient complex infrastructure such as roads, parking spaces, traffic light systems, and institutional infrastructure (e.g. laws and regulations of traffic rules, and car insurance); and to enhance drivers' awareness of and compliance with traffic rules. Some AMS could immediately deploy such infrastructure.

Some developed countries will use new types of vehicles – including EVs, autonomous driving systems, connected cars, and sharing services – in the 2020s. Currently, these movements are classified under technologies such as CASE and MaaS. Some AMS are promoting the penetration of new types of vehicles, in particular EVs. The governments of Indonesia, Malaysia, and the Thailand have released their targets for EVs in the 2030s–2040s (Schröder, Iwasaki, and Kobayashi, 2021).

New energy vehicles (NEVs) also require hard and soft (institutional) infrastructure. Although institutional aspects (e.g. laws and regulations) need to be harmonised in the region,[10] complex infrastructure is needed but still limited. The complex infrastructure required includes bright road marking systems, wireless networking, electric suppliers (V2V and vehicle-to-grid), digital maps for autonomous driving, and sufficient charging stations (grid-to-vehicle and vehicle-to-grid).

Some AMS lag significantly in infrastructure development, but the absence of existing infrastructure would allow them to build new infrastructure (e.g. charging stations) from scratch for NEVs. For example, it is necessary to install many charging stations for EVs. Although we consider charging stations a type of petrol station, future technologies will try to design wireless (non-contact) charging on the road, mainly through highways (Autoevolution, 2021). Problems related to fixed charging stations (similar to petrol stations) include the need to (i) increase the battery capacity; (ii) set up charging stations at regular intervals; and (iii) supply a large amount of power at high speed, making it unsuitable for EVs with a short cruising range. In developed and emerging cities where petrol stations are already widespread, this can be dealt with by refurbishing gas stations as charging stations.[11] However, in developing countries, new technologies such as non-contact charging could be installed on the street. Since the spread of power supply helps to minimise the number of batteries, a dramatic increase in EVs would be possible if it spreads in line with new urban development.

Another essential issue is autonomous driving and connected vehicles. Although it is hard to rapidly accomplish level 4 or 5 of the autonomous driving system, AMS could introduce assistance for minimising traffic accidents. Vehicle-to-Infrastructure (V2I) technologies are desirable in ASEAN to harmonise autonomous vehicles and infrastructure.[12] Urban areas need to be designed for autonomous driving. New urbanisation – smart city projects – should include V2I technologies and infrastructure. New and existing drivers also need to be trained in the new technology and driving systems.

Some Asian countries have proposed a target for EV penetration. For example, the Government of China targeted reaching a certain number of EVs by 2020 and created a development strategy for EV charging infrastructure (Blatt, 2018). Half are expected to be NEVs – electric, plug-in hybrid, or fuel cell-powered; and the other half will be hybrids (Tabeta, 2020).

[10] Institutional connectivity will be discussed in section

[11] For example, Shell has expanded its EV charging networks by acquiring the largest EV charging network in the United Kingdom: ubitricity (Reuters, 2021).

[12] V2I roadside units are one of the technologies for autonomous driving systems that help transmit traffic light information to vehicle locations and these locations to walking people's smartphones. (Kyocera, n.d.).

Regarding the penetration of EVs in ASEAN, Schröder, Iwasaki, and Kobayashi (2021) described the current EV situation in the region. According to the review, charging stations are crucial infrastructure for EV penetration. The Government of Malaysia has proposed increasing the number of charging stations to 125,000 by 2030. The Government of Indonesia targets 1,000 charging stations by 2025 and 10,000 by 2050 (Tempo, 2017). In 2021, the Government of Indonesia set ambitious targets for EV production: 600,000 units of production per year by 2030 (Kompas, 2021).

In terms of charging infrastructure, Pertamina and Shell have established EV charging station services in Jakarta (Tempo, 2020; Harsono, 2021). Indonesia will require more than 31,000 charging stations, according to the road map of the State Electricity Company (PLN) (Harsono, 2020).

Infrastructure development for the automotive industry is still nascent in Asian developing countries, but many infrastructure construction projects are being developed. Both physical and institutional connectivity need to be developed to implement CASE and MaaS in ASEAN. The next section discusses institutional connectivity.

Developing and Strengthening Institutional Connectivity

Institutional connectivity covers laws and regulations, international agreements, procedures, and capacity building programmes (ASEAN, 2010). In terms of the development of the automotive industry, many regulations cover the safety of automotive transportation as well as environmental issues (exhaust gas emissions). Some AMS have adopted the international standard on exhaust gas emissions, e.g. Thailand adopted the Euro 4 standard on light-duty vehicles in 2012 and Indonesia adopted Euro 4 for gasoline vehicles in 2018. Many AMS plan to implement more stringent regulations in the coming years.[13]

Although the new waves of CASE and MaaS provide opportunities to meet environmental regulations and international standards, regulatory harmonisation and management should be considered to promote the introduction of new technologies in the automotive industry. The major institutional challenges for development of the automotive industry are listed below:

[13] The European Commission introduced emissions regulations in 1992 (Euro 1) to protect air quality and reduce greenhouse gases (European Commission, n.d.). The regulations were tightened to Euro 6 in September 2015. AMS use these standards for national emissions regulations. For example, Viet Nam and Malaysia have installed the Euro 5 standards and Thailand is installing the Euro 6 standard in 2022 (EU–ASEAN Business Council, 2021).

- *Environmental standards*: AMS need to take advantage of innovation and lead the global automotive industry by promoting the circular economy in the automotive sector. AMS should introduce adequate environmental standards (e.g. exhaust gas emissions and noise) to realise a sustainable mobility society in each country.
- *EVs*: Due to the transition to ZEVs, EVs are increasingly attractive in both developed and developing countries. EVs promote the development of renewable energy technologies. Regulating the reuse and recycling of used batteries is another crucial issue.[14]
- *CASE and MaaS*: Various kinds of hard and soft infrastructure need to be introduced, such as sustainable and stable telecommunication lines, intelligent transportation systems, and high-speed charging stations and related technology. Ride-share systems, for example, use web applications (e.g. Grab and Gojek) as well as regulation for safety management and deregulation for the existing transportation system.

Vehicle Type Harmonisation

Regarding the harmonisation of automotive production, a recent achievement in institutional harmonisation is the adoption of the ASEAN Mutual Recognition Arrangement on Type Approval for Automotive Products in 2019 (ASEAN, 2019). The ASEAN Automotive Council, which will comprise one representative from each AMS, will be established to monitor the effective functioning of this arrangement. The arrangement will facilitate mutual recognition of conformity assessments for new automotive products (Table 12.3) (ASEAN 2019: Article 4: Scope and Coverage, 1).

Table 12.3 List of Automotive Products Within the Scope of the Arrangement

No.	Automotive products	United Nations regulations
1	Braking system	R13
2	Braking system	R13H
3	Safety-belt anchorage	R14
4	Safety-belt and restraint system	R16
5	Seats	R17
6	Head restraints	R25
7	Audible warning device	R28
8	Pneumatic tyre	R30
9	Speedometer	R39

[14] See Nakanishi (forthcoming).

No.	Automotive products	United Nations regulations
10	Exhaust emission	R40
11	Noise	R41
12	Safety glazing materials and their installation	R43
13	Devices for indirect vision	R46
14	Exhaust emission	R49
15	Sound emission	R51
16	Pneumatic tyre	R54
17	Pneumatic tyre	R75
18	Steering equipment	R79
19	Exhaust emission	R83

Note: United Nations regulations refer to the automotive type regulation based on United Nations Economic Commission for Europe (n.d.)
Source: ASEAN (2019: Annex 1).

Although only Malaysia and Thailand have adopted the United Nations regulation, the ASEAN arrangement will help to reduce the number of tests and procedures for parts certification in other countries, leading to a decrease in time and costs, advancing vehicle technologies and regulations, and facilitating the export of certificated automotive parts and products both regionally and globally (MLIT and JASIC, 2021).[15]

Smart City Development

The development of smart cities, through city planning, is key to the promotion of an environmentally friendly transportation system. ASEAN adopted the ASEAN Smart Cities Network in 2018 to discuss and encourage the development of smart cities in the region (ASEAN, 2018). Various definitions of smart cities have been proposed, but the consensus is that adopting information and communication technology and an integrated infrastructure system enhances urban transport operations and services and improves quality of life (Anbumozhi, 2020). The ASEAN Smart Cities Network has six components: (i) smart governance, (ii) smart living, (iii) smart economy, (iv) smart people, (v) smart environment, and (vi) smart mobility.

[15] United Nations (2017).

Box 12.1 **Smart City and Energy Efficiency Project in the Philippines***

SoftBank Corporation, with financial support from the New Energy and Industrial Technology Development Organization (NEDO), implemented a demonstration project on a new mobility system in Manila from 2016 to 2018. The objective of the project was to attain efficient public transportation and energy conservation effects by introducing an EV mobility system. The information technology system provides the operation management, asset management, charging management and service platform system. Each EV had communication devices to send real-time data on the location, driving, battery, and passenger boarding record to central management.

Source: NEDO (2018), 'Completion of Demonstration Project in the Philippines on Next-Generation Public Transportation System Using Electric Tricycles', News article, 30 October. https://www.nedo.go.jp/english/news/AA5en_100398.html.

Box 12.2 **Urban Transit System with Electric Buses in Malaysia***

The New Energy and Industrial Technology Development Organization (NEDO) and Putrajaya implemented a demonstration project on urban transit systems by introducing large electric buses in 2015. The objective of the project was to demonstrate an electric bus with a super-fast charging system and a large-capacity battery. The project was expected to be replicated in Kuala Lumpur to realise the vision of a low-carbon, green capital city in Malaysia, with potential for replication throughout the ASEAN region.

A full charge requires 10 minutes and allows a bus to operate for 6–8 hours. Lithium titanate oxide (LTO) batteries enable safe operations, a long lifespan, low-temperature performance, rapid charging, high input/output power, and large effective capacity.

Source: NEDO (2017), 'Demonstration Project for Large EV Bus System Launches in Malaysia', News article, 28 August. https://www.nedo.go.jp/english/news/AA5en_100258.html.

People-to-People Connectivity: Human Resources Development

The third aspect of connectivity is people to people, which includes education and tourism (ASEAN, 2016). Regarding the development of the automotive industry, education and human resources development will be crucial.

Through international industry–academia–government collaboration and self-help, each AMS needs to upgrade its technology educational system at each level (e.g. polytechnics, universities, technical and vocational education and training, and graduate schools) to train engineers for mass production with high-quality standards. In the future, graduates of such programmes will be good candidates for dealing with new manufacturing technologies, such as automation, IoT, and AI. Some AMS should install essential technologies from foreign companies to increase their international competitiveness. Training of automotive service technicians and infrastructure engineers is also a future challenge for new market development.

Increasing technology transfer from multinational corporations is another issue that AMS need to address. To upgrade the productivity of local firms, especially small and medium-sized enterprises, these firms should strengthen their linkages with multinational corporations and increase their participation in global value chains. Connections amongst engineers are also inevitable to achieve such a development model.

Conclusion

This chapter analysed infrastructure development, with a focus on the automotive transportation sector. It discussed four essential elements:

(i) The development of a motorisation society in ASEAN through rapid economic growth.

(ii) Utilisation of digital technologies to mitigate the negative impacts of motorisation (CASE and MaaS).

(iii) Sustainable automotive industry development to improve social and environmental welfare (the Fourth Industrial Revolution (4IR) and Society 5.0).[16]

(iv) Development of a standard platform for the automotive industry (policy) (physical, institutional, and people-to-people connectivity)

The aim of this paper is to raise awareness of the rapid changes in the automotive sector in the 21st century and the necessity of infrastructure development for achieving it.

The transportation sector needs to mitigate greenhouse gas emissions to achieve carbon-neutral status and meet the United Nations Sustainable Development Goals. CASE and MaaS, driven by the advancement of digital technologies, will play a vital role as the automotive infrastructure of the 21st century for reducing social costs. AMS should consider the deployment of necessary infrastructure for EVs and autonomous vehicles in particular in the 2030s.

16 Society 5.0 is a concept proposed by the Government of Japan, meaning 'a human-centered society that balances economic advancement with the resolution of social problems by a system that highly integrates cyberspace and physical space' (Government of Japan Cabinet Office, n.d.).

References

Anbumozhi, V. (2020), 'A Dialogue on Realizing Smart Cities', Virtual Public Dialogue, 14 May. Jakarta: Economic Research Institute for ASEAN and East Asia. https://www.eria.org/uploads/media/0.-Realizing-Smart-Cities---Anbu-PPT.pdf. (Access 20 July 2022)

ASEAN (2010), *Master Plan on ASEAN Connectivity*. Jakarta: ASEAN Secretariat.

ASEAN (2016), *Master Plan on ASEAN Connectivity 2025*. Jakarta: ASEAN Secretariat.

ASEAN (2018), ASEAN Smart Cities Network Smart City Action Plans, as of 18 July 2018, https://asean.org/storage/2019/02/ASCN-Consolidated-SCAPs.pdf. (Access 20 July 2022).

ASEAN (2019), 'ASEAN Mutual Recognition Agreement on Type Approval for Automotive Products'. Jakarta: ASEAN Secretariat. http://agreement.asean.org/media/download/20210205131820.pdf. (Access 20 July 2022).

ASEAN Post (2019), 'Jokowi Wants Jakartans to Use Public Transport', 10 February. https://theaseanpost.com/article/jokowi-wants-jakartans-use-public-transport.

Autoevolution (2021), 'Sweden Successfully Tests Wireless Charging Road Set to Revolutionise Mobility', 27 January. https://www.autoevolution.com/news/sweden-successfully-tests-wireless-charging-road-set-to-revolutionize-mobility-155137.html.

Bakker, S. et al. (2017), 'Low-Carbon Transport Policy in Four ASEAN Countries: Developments in Indonesia, the Philippines, Thailand and Vietnam', *Sustainability*, 9(7), 1217.

BearingPoint Institute (n.d.), 'Connected Cars and Privacy: Shifting Gear from GDPR?'. https://www.bearingpoint.com/files/BEI008_06_GDPR_Connected-cars-and-privacy-shifting-gear-for-GDPR_final.pdf?download=0&itemId=434626.

Blatt, D.N. (2018), 'Law and Policy on the Development and Promotion of the New Energy Vehicle (NEV) Market in China', *Journal of Asian Electric Vehicles*, 16(1), pp.1781–88.

Cassals, L.C., E. Martinez-Laserna, B.A. García, and N. Nieto (2016), 'Sustainability Analysis of the Electric Vehicle Use in Europe for CO_2 Emissions Reduction', *Journal of Cleaner Production*, 127, pp.425–37.

ERIA (2015), *The Comprehensive Asia Development Plan 2.0 (CADP 2.0): Infrastructure for Connectivity and Innovation*. Jakarta: Economic Research Institute for ASEAN and East Asia. https://www.eria.org/ERIA-RPR-FY2014-04.pdf (Access 20 July 2022).

ERIA (2019), *ASEAN Vision 2040: Towards a Bolder and Stronger ASEAN Community*. Jakarta: Economic Research Institute for ASEAN and East Asia, https://www.eria.org/uploads/media/0.AV2040_VOL1.pdf (Access 20 July 2022).

EU–ASEAN Business Council (2021), *Advancing ASEAN's Fuel Economy & Emissions Standards, Post Pandemic, June 2021*. https://www.eu-asean.eu/wp-content/uploads/2022/02/Advancing-ASEANs-Fuel-Economy-Emissions-Standards-Post-Pandemic-2021.pdf. (Access 20 July 2022)

European Commission (n.d.), Emissions in the Automotive Sector. https://ec.europa.eu/growth/sectors/automotive-industry/environmental-protection/emissions-automotive-sector_en. (Access 20 July 2022)

European Data Protection Supervisor (2019), 'TechDispatch #3: Connected Cars', 20 December. https://edps.europa.eu/data-protection/our-work/publications/techdispatch/techdispatch-3-connected-cars_en. (Access 20 July 2022)

Government of Japan, Cabinet Office (n.d.), Society 5.0. https://www8.cao.go.jp/cstp/english/society5_0/index.html. (Access 20 July 2022)

Harsono, N. (2020), 'Indonesia Needs 31,000 Charging Stations to Reach Electric Vehicle Goals', *The Jakarta Post*, 4 September. https://www.thejakartapost.com/news/2020/09/04/indonesia-needs-31000-charging-stations-to-reach-electric-vehicle-goals.html. (Access 20 July 2022)

Harsono, N. (2021), 'Shell Opens Its First EV Charging Station in Indonesia', The Jakarta Post, 5 April. https://www.thejakartapost.com/news/2021/04/05/shell-opens-its-first-ev-charging-station-in-indonesia.html. (Access 20 July 2022)

Karlsson, M. et al. (2017), 'Mobility-as-a-Service: A Tentative Framework for Analysing Institutional Conditions', Presented at the 45th European Transport Conference, Barcelona, 4–6 October.

Kompas (2021), Bahas Rencana Menjadikan Indonesia Pemain Utama Mobil Listrik, 16 July 2021, https://otomotif.kompas.com/read/2021/07/16/094200315/bahas-rencana-menjadikan-indonesia-pemain-utama-mobil-listrik?page=all (Access 17 May 2022).

Kyocera (n.d.), 'Rosokuki no Kaihatsu de Mezasu "Jiko nonai Koutsu Shakai"' (Aiming for an "Accident-Free Traffic Society" through the Development of Roadside Devices). https://www.kyocera.co.jp/be_innovation/mobility/interview2/ (accessed 10 April 2021).

Larminie J. and J. Lowry (2012), *Electric Vehicle Technology Explained*, Second Edition. Chichester, UK: John Wiley & Sons.

MLIT and JASIC (2021), 'Toward Expanding International Harmonization of Vehicle Regulations and Reciprocal Recognition of Approvals'. Tokyo: Ministry of Land, Infrastructure, Transport and Tourism and Japan Automobile Standards International Center. https://www.jasic.org/j/08_publication/pamphlets/pdf/harm.pdf. (Access 20 July 2022).

Mukthar-Landgren, D. et al. (2016), 'Institutional Conditions for Integrated Mobility Services (IMS): Towards a Framework for Analysis', *K2 Working Papers*, No. 2016:16. Lund, Sweden: K2 (National Centre for Research and Education on Public Transport).

Nakanishi, T. (forthcoming), CASE: New Waves in the Automotive Industry in Viet Nam, by ERIA Vietnamese Automotive Industry Policy Studies.

Nishimura, H., M. Ambashi, F. Iwasaki, and M. Maeda (2019), 'Harnessing New Technologies for Social and Economic Progress Toward ASEAN 2040', in F. Kimura, V. Anbumozhi, H. Nishimura (eds.) *Transforming and Deepening the ASEAN Community*. Jakarta: Economic Research Institute for ASEAN and East Asia, pp.50–71.

Nishitateno, S. (2014), 'Internalization of the Social Costs of Automobiles as Seen from International Perspectives', *RIETI Policy Update,* No. 058 Tokyo: Research Institute of Economy, Trade and Industry. https://www.rieti.go.jp/en/special/policy-update/058.html. (Access 20 July 2022)

Orlovska, J., F. Novakazi, C. Wickman, and R. Soderberg (2019), 'Mixed-Method Design for User Behavior Evaluation of Automated Driver Assistance Systems: An Automotive Industry Case', in *Proceedings of the 22nd International Conference on Engineering Design (ICED19)*, Delft, the Netherlands, 5–8 August.

Poullikkas, A. (2015), 'Sustainable Options for Electric Vehicle Technologies', *Renewable and Sustainable Energy Reviews,* 41, pp.1277–87.

Reuters (2021), 'Shell to Acquire UK's Largest Electric Vehicle Charging Network', 25 January. https://www.reuters.com/article/us-ubitricity-m-a-shell-idUSKBN29U0TC. (Access 20 July 2022)

RGBSI (n.d.), 'What Is Vehicle to Infrastructure V2I Technology?', Blog. https://blog.rgbsi.com/what-is-v2i-technology#:~:text=Vehicle%2Dto%2Dinfrastructure%20(V2I,and%20parking%20meters%20among%20others (accessed 6 October 2020).

Rivard, G. (2018), 'Understanding the Various Levels of Autonomy in Vehicles: From 0 to 5, Where Are We At?', Auto123.com, 2 June. https://www.auto123.com/en/news/vehicle-autonomy-levels-explained/64372/. (Access 20 July 2022)

Schröder, M. and F. Iwasaki (2021), 'Current Situation of Electric Vehicles in ASEAN', in M. Schröder, F. Iwasaki, and H. Kobayashi (eds.) Promotion of Electromobility in ASEAN: States, Carmakers, and International Production Networks. Jakarta: Economic Research Institute for ASEAN and East Asia (ERIA), pp.1–32.

Schröder, M., F. Iwasaki, and H. Kobayashi, eds. (2021), *Promotion of Electromobility in ASEAN: States, Carmakers, and International Production Networks.* Jakarta: Economic Research Institute for ASEAN and East Asia (ERIA).

Smith, G., J. Sochor, S. Sarasini (2018), 'Mobility as a Service: Comparing Developments in Sweden and Finland', *Research in Transportation Business & Management,* 27, pp.36–45.

Sochor, J., H. Arby, M. Karlsson, and S. Sarasini (2017), 'A Topological Approach to Mobility as a Service: A Proposed Tool for Understanding Requirements and Effects, and for Aiding the Integration of Societal Goals', Conference Proceedings of 1st International Conference on Mobility as a Service (ICOMaaS), Tampere, Finland, 28–29 November.

Tabeta, S. (2020), 'China Plans to Phase Out Conventional Gas-Burning Cars by 2035', *Nikkei Asia*, 27 October. https://asia.nikkei.com/Business/Automobiles/China-plans-to-phase-out-conventional-gas-burning-cars-by-2035. (Access 20 July 2022)

Tempo (2017), 'Pemerintah Tetapkan Empat Target Percepatan Kendaraan Listrik' (The Government Sets Four Targets for the Acceleration of Electric Vehicles), Gooto.com, 25 August. https://www.gooto.com/read/903001/pemerintah-tetapkan-empat-target-percepatan-kendaraan-listrik. (Access 20 July 2022)

Tempo (2020), 'Pertamina's First Electric Vehicle Charging Station Starts Operating Today', 10 December. https://en.tempo.co/read/1413431/pertaminas-first-electric-vehicle-charging-station-starts-operating-today. (Access 20 July 2022)

United Nations (2017), 'Agreement Concerning the Adoption of Harmonized Technical United Nations Regulations for Wheeled Vehicles, Equipment and Parts which can be Fitted and/or be Used on Wheeled Vehicles and the Conditions for Reciprocal Recognition of Approvals Granted on the Basis of these United Nations Regulations'. https://unece.org/fileadmin/DAM/trans/main/wp29/wp29regs/2017/E-ECE-TRANS-505-Rev.3e.pdf. (Access 20 July 2022)

United Nations Economic Commission for Europe (n.d.), Status of the 1958 Agreement (and of the annexed regulations). https://unece.org/status-1958-agreement-and-annexed-regulations (accessed 24 July 2021).

Uzawa, H. (1974), *The Social Costs of Automotives* (in Japanese). Tokyo: Iwanami Shoten.

Weisbrod, G., D. Vary, and G. Treyz (2003), 'Measuring Economic Costs of Urban Traffic Congestion to Business', *Transportation Research Record*, 1839(1), pp.98–106.

Woo J., H. Choi, and J. Ahn (2017), 'Well-to-Wheel Analysis of Greenhouse Gas Emissions for Electric Vehicles Based on Electricity Generation Mix: A Global Perspective', *Transportation Research Part D: Transport and Environment*, 51, pp.340–50.

Ziebinski, A., R. Cupek, D. Grzechca, and L. Chruszczyk (2017), 'Review of Advanced Driver Assistance Systems (ADAS)', AIP Conference Proceedings, 1906:120002, https://doi.org/10.1063/1.5012394.