ERIA Research Project Report FY2023 No. 22

Vision for the Digitalisation of Supply Chains in ASEAN and Japan

50th Anniversary Commemorative Project of ASEAN–Japan Friendship and Cooperation

Edited by

Keita Oikawa
Fumitaka Machida

Vision for the Digitalisation of Supply Chains in ASEAN and Japan

50th Anniversary Commemorative Project of ASEAN–Japan Friendship and Cooperation

Economic Research Institute for ASEAN and East Asia (ERIA)
Sentral Senayan II 6th Floor
Jalan Asia Afrika No. 8, Gelora Bung Karno
Senayan, Jakarta Pusat 10270
Indonesia

ERIA Research Project Report FY2023 No. 22
Published in February 2024

Preface

This final report was developed through multiple discussions with diverse experts in ASEAN Member States. The experts included professors from local universities, senior executives from industry associations, senior executives from chambers of commerce, and senior executives from the private sector. In-depth desk research was also conducted, as were multiple interviews with industry experts for the target industries, in which specific challenges in supply chains were discussed. Through these discussions and interviews, the authors were able to arrive at a better understanding of the pain points of focus countries and target industries, identify a priority agenda for supply chains, and build consensus on the direction of the vision for digitalisation of supply chains. By reflecting the unique context and situation of the ASEAN and East Asia region, the authors agree with the expert group on the necessity of establishing a unique vision for the digitalisation of the supply chain.

List of Project Members

Expert Panel Members[1]

Indonesia

Nita Kartikasari
Chair, Permanent Committee, Indonesian Chamber of Commerce and Industry (KADIN), and lead, Japan Office, KADIN

Singapore

Teng Theng Dar
Member, Business Alliance for Sustainable Economy

Ariel Goh
Deputy director, Logistics and Wellness, School of Business and Services, ITE College East

Bee Lock Oh
Chief executive officer, Singapore Logistics Association (SLA)

Thailand

Archanun Kophaiboon
Associate professor, Faculty of Economics, Thammasat University

Piti Srisangnam
Faculty of Economics, Chulalongkorn University, and executive director, ASEAN Foundation

Viet Nam

Le Thi Thu Thuy
Deputy director, Enterprise Development Foundation

Truong Gia Binh
Chair and chief executive officer, FPT Corporation

[1] They are responsible for providing advice, guidance, input, and feedback on the report.

Secretariat Team Members[2]

Keita Oikawa
Economist, Economic Research Institute for ASEAN and East Asia (ERIA)

Fumitaka Machida
Senior fellow and financial expert, ERIA

Koichi Hasegawa
Managing director and partner, Boston Consulting Group (BCG)

Seungwook Oh
Partner and director, BCG

Kenya Nii
Project leader, BCG

Hyejun Lee
Consultant, BCG

Liwen Zhu
Consultant, BCG

[2] They are responsible for providing administrative support and coordination for the project, managing discussions amongst the experts, and documenting the report.

Table of Contents

List of Figures

Chapter 1

Environment and Current Challenges of Supply Chains

The current supply chain agenda has grown increasingly complex due to a multitude of disruptions and uncertainties stemming from shifts in the global economy, politics, and societal trends. These global trends have had a huge impact on supply chains, increasing risks and vulnerabilities. These trends can be categorised into six groups: (i) the changing geopolitical environment, (ii) diversification of customers and rise of high-tech industries, (iii) increasing risks due to global-scale pandemics and the war in Ukraine, (iv) new social values, (v) increasing challenges for food security, and (vi) rising interest in green production.

1. Changing Geopolitical Environment

Over the past few decades, the Association of Southeast Asian Nations (ASEAN) region has developed within a geopolitical environment that has remained relatively stable. However, this stability has recently been undermined, with countries that had previously endorsed free trade and investment now pursuing greater autonomy over their economic activities. This shift is exemplified by the United States (US)–China trade war, which involves substantial tariff hikes as well as restrictions on imports and exports, causing significant disruptions to global supply chains. The altered geopolitical context surrounding the ASEAN region and East Asia thus necessitates the formulation of novel strategies and greater regional cooperation to confront the challenges that lie ahead.

2. Diversification of Customers and Rise of High-Tech Industries

Customer demands are becoming more diverse and sophisticated, prompting companies to manage increasingly personalised products and services. This trend, coupled with a surge in digital purchasing behaviours, has amplified the complexity of supply chain management. In addition, product life cycles are becoming shorter, and digitalisation is transforming products and services. These rapid shifts are exerting additional pressure on supply chain decisions, requiring companies to adapt swiftly and to exhibit flexibility. In light of this dynamic and diverse environment, it is crucial for management to consider new supply chain models. To do so, a way to leverage digital technology in supply chains must be found.

3. Increasing Risks

The COVID-19 pandemic and the subsequent outbreak of the war in Ukraine have significantly disrupted global supply chains, leading to widespread economic uncertainty. The pandemic led to drastic changes as many countries enforced cross-border movement restrictions, which negatively impacted a variety of industries. The ensuing economic uncertainty and heightened supply chain risks were marked by increased unemployment, reduced productivity, production shutdowns, and disarray in logistics. Then, the war in Ukraine added another layer of complexity, causing direct disruptions in Russia and Ukraine, including interrupted physical transport and

destroyed infrastructure. Moreover, it sent shockwaves throughout the global economy, causing severe consequences for various industries.

A notable example is the semiconductor industry, which has had to find alternative suppliers for crucial materials, such as neon and palladium, for which Russia and Ukraine are significant contributors. Additionally, sanctions against Russia have also disrupted the energy industry, forcing countries and companies to find alternative sources for oil and gas. This disruption has resulted in soaring energy prices worldwide, leading to further instability.

These global events have exposed the vulnerabilities inherent in supply chains. Consequently, governments and the private sector have prioritised building resilience in an effort to mitigate and to minimise the escalating supply chain risks.

4. New Social Values

The rising awareness of social issues, such as environmental sustainability and human rights, is prompting governments, customers, and related associations to take decisive action. Regulations and measures to address human rights and climate change are increasingly being introduced. For example, the United Nations Human Rights Council approved guiding principles on business and human rights, signalling societal concern over unjust practices, such as child labour and the mistreatment of immigrant workers. Concurrently, many countries are setting carbon-neutrality targets and developing specific initiatives and guidelines for private sector involvement.

The private sector is participating in these carbon-neutral initiatives, taking steps such as monitoring emissions across their supply chains and reconfiguring their business activities to support decarbonisation. Given the increasing awareness of customers and enhanced standards tied to these new social values, companies must enhance their compliance and environmental, social, and governance management across their supply chains. This transformation requires greater collaboration amongst all stakeholders within the supply chain ecosystem.

5. Increasing Challenges for Food Security

Population growth and food waste, coupled with the adverse effects of climate change on crop harvests causing regional instability, have raised significant concerns regarding future food demand and supply risks. Consequently, the importance of physical availability of food, economic and physical access to food, food utilisation, and food stability over time, is increasing.

These prevailing global trends have intensified pressures on food security within the ASEAN region, magnifying countries' susceptibility to dependency on food imports and helping rethink their supply chain strategies for food. Optimising supply chains with the implementation of digital technologies helps address the issue of physical availability of food by enhancing the efficiency and reliability of food distribution, mitigating the risk of food shortages and stockouts and fostering sustained improvement of food security within the ASEAN region. Leveraging technologies such as sensors, blockchain, and radio frequency identification (RFID) for real-time monitoring and traceability of food products will enhance transparency throughout the entire supply chain as well.

6. Rising Interest in Green Production

Green production encompasses the utilisation of green energy, eco-friendly processes, and the creation of environmentally sustainable products. It asks companies to focus on reducing emissions, effluents, accidents, consumption of virgin materials, non-renewable energy, and overall life-cycle costs associated with products or services. Interest in green production is increasing because it helps companies make substantial contributions to sustainability objectives and gain economic advantages such as cost savings, increased profits, and enhanced shareholder value. Companies also need to integrate eco-friendly processes into traditional supply chain management to adapt to green production. While green production aims to minimise environmental footprints throughout the entire supply chain, it may necessitate additional capital spending, potentially impacting short- and medium-term progress on the transformation of traditional supply chains.

7. Other Challenges to Supply Chains

Many companies are struggling to deal with supply chain disruptions and are working towards building resilient supply chains. They continue to face multiple challenges, often caused by limited transparency and visibility of supply chain information or data as well as a lack of capability and infrastructure to make well-informed decisions. There are cases where certain countries or industries struggle with limited visibility within the supply chain structure and flow, making it difficult to identify alternative suppliers or sources and to track the status of procured items and product deliveries. All of these challenges increase inefficiency and risks in supply chains. A lack of digital capability also exacerbates the difficulties in managing supply chain risks.

Companies need to develop cross-divisional, data-driven supply chain plans while monitoring broader end-to-end supply chain performance. However, in many companies, organisations and processes are not properly established to make timely company-wide supply chain decisions. Solving these challenges is not easily achieved through individual company efforts. As the scope of supply chains is broadened, cross-industry or cross-regional collaborations become increasingly necessary; collective efforts at the industry ecosystem level are more effective. At the same time, governments can support the private sector to address these challenges by developing policies and standards to promote digitalisation in supply chains or forming better trade agreements to mitigate challenges from geopolitical issues.

In fact, many industry- or regional-level movements are already underway. Most of these initiatives focus on building a digital ecosystem in the supply chain, either region- or industry-specific, with the primary objective of establishing more effective and seamless data-sharing infrastructure and connected supply chains. The goal is to bolster supply chain resilience in industry ecosystems, with specific use cases (i.e. detailed descriptions of the behaviour of a system in which actual data are exchanged and used amongst stakeholders for a specific purpose). The description of how a data-sharing platform works for emissions data across the value chain in the automotive industry is a good example of a use case.

In the US, mega information technology (IT) players such as Amazon, Apple, Facebook, and Google are expanding their platform deployments and supporting the digitalisation of various industries. Similarly, in China, mega IT players such as Alibaba, Baidu, and Tencent are leading the creation of digital ecosystems. These firms accumulate customer data through their service

platforms, using them to reconstruct the supply chains for more customer- or demand-centric models, thereby redefining current industry and supply chains. Europe, in contrast, lacks such mega IT platforms and is wary of their expansion within the region. As a response, Europe is focussing on building digital ecosystems through public–private sector collaborations (Figure 1.1).

These European initiatives define a digital ecosystem via two components. The first component is a 'data ecosystem', in which the International Data Space Association (IDSA) played a key role in developing standardised data exchange rules and protocols via the Reference Architecture Model to enhance data exchange in the region. The model is composed of several layers required for a data ecosystem (i.e. business layers defining stakeholders' roles and responsibilities, functional layers defining required functionalities, and process layers defining standardised data exchange and onboarding processes). The second component is a 'infrastructure ecosystem' in which Gaia-X, an initiative aligned with the European Commission, helped build a federated infrastructure that enables secure, reliable data exchange amongst stakeholders. Gaia-X developed federation services that enable the connection of different infrastructure (i.e. identity and trust services, sovereign data exchange, federated catalogue, and compliance). Furthermore, the Catena-X initiative represents a specific data space for the automotive industry, based on the Reference Architecture Model and utilising Gaia-X federation services.

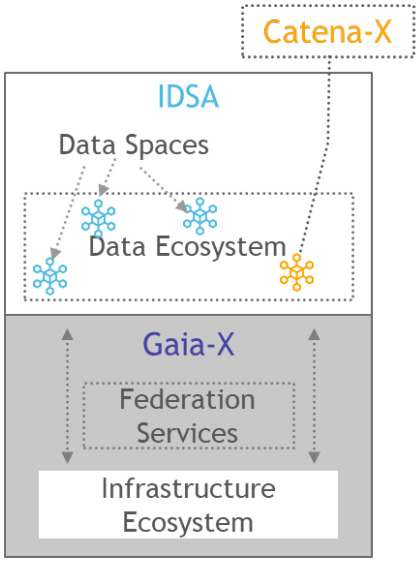
Efforts to develop digitisation are underway in Asia. For example, Singapore has embarked on Smart Nation Singapore to build a digital government and economy. Amongst its priorities are the acceleration of economic growth by digitalising industries and businesses as well as ensuring a secure – yet open – data marketplace.[3] One of the initiatives is SGTraDex, which aims to develop digitalised trade and region-wide connectivity in logistics.

Thailand aims to build nationwide digital infrastructure, shift to e-government, develop digital talent, and build trust in digital technology through the *Thailand Digital Economy and Society Development Plan* (Siriruchatapong, 2016). Similarly, Indonesia and Viet Nam are working to accelerate nationwide digital transformation through their respective initiatives, *Indonesia Digital Roadmap* (Government of Indonesia, Ministry of Communication and Information Technology, 2021) and National Digital Transformation Program (Government of Viet Nam, Ministry of Information and Communications, 2020).

Despite the progress made through these initiatives in the ASEAN region, however, there is still a gap when compared to Western economies' digitalisation of supply chains. Furthermore, there is yet to be a cohesive, region-wide initiative in Asia. Given the current global trends and state of digitalisation in Asia, the timing is opportune to develop a future direction for the digitalisation of supply chains in Asia. Through ASEAN and Japan's collaboration on supply chains, a vision for the digitalisation of supply chains in ASEAN and Japan can be developed.

[3] Smart Nation and Digital Government Office, Transforming Singapore through Technology.

Figure 1.1. European Union Initiatives to Establish a Regional Digital Ecosystem



Overview

INTERNATIONAL DATA SPACES ASSOCIATION

IDSA's goal is to create a data ecosystem in which all players can realise the value of their data through secure and sovereign data exchange.

- IDSA created standardised data exchange rules and protocols, known as the Reference Architecture Model, for secure, sovereign data exchange.
- IDSA brings together 130+ company representatives, scientists, lawmakers, and other relevant stakeholders in an open, non-profit coalition.

gaia-x

Gaia-X is an initiative aligned with the EU that develops infrastructure and architecture for data exchange based on federation services (i.e. data sharing through a decentralised and distributed structure).

- Gaia-X developed federation services for connections and collaboration amongst different infrastructure (i.e. identity and trust services, sovereign data exchange, federated catalogues, and compliance).
- Gaia-X ensures an open, transparent, and secure federated digital ecosystem and infrastructure.

Catena-X Automotive Network

Catena-X is the first collaborative, open data space for the automotive industry, linking global players into end-to-end value chains.

- Catena-X is Gaia-X's first implementation project.
- Catena-X is a collaborative effort with many stakeholders. The goal is to establish a globally active network. All companies can achieve new value creation through cross-company use and exploitation of data.
- Catena-X will increase the resilience and flexibility of supply chains (e.g. through end-to-end digital documentation to determine carbon footprints).

EU = European Union, IDSA = International Data Spaces Association.
Sources: Langdon (2021); Catena-X, https://catena-x.net/en/

Chapter 2

Supply Chains in ASEAN

Given the expansive nature of supply chain topics as well as the significant differences that exist from country to country, it is more constructive to focus on selected countries and industries as a starting point. The discussion can then be expanded as progress is made. For the primary analysis, therefore, Indonesia, Singapore, Thailand, and Viet Nam were chosen as they maintain substantial trade volumes and direct investment relationships with Japan. Within each, one representative industry has been selected as a starting point. This chapter explores these industries in these countries, examining specific pain points related to supply chains in each.

The specific pain points are slightly different for each country and industry, but there are also common challenges – their carbon footprints, strong demand for supply chain visualisation, opportunity to improve quality and competitiveness, and need for collaboration to upgrade research and development (R&D) capability in the long term. These common challenges should be prioritised and addressed when developing a vision and use cases.

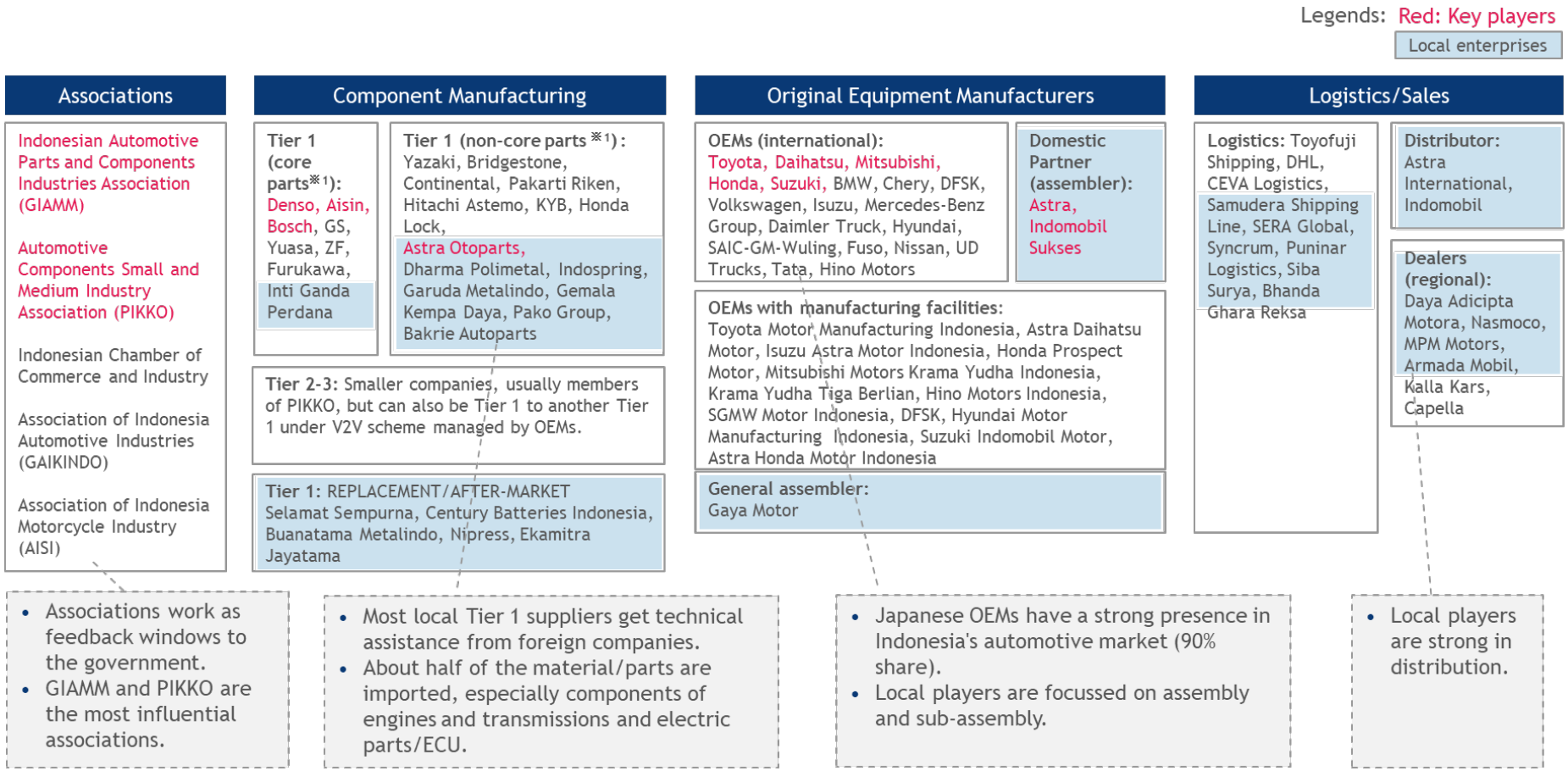
1. Indonesia

This analysis focusses on the automotive industry, which is vital to the country's economy. In 2021, it contributed approximately 4% to the country's gross domestic product (GDP), making it one of the largest economic contributors in the manufacturing sector (Japan Bank for International Cooperation, 2022). Furthermore, it is expected to continue to grow with increasing demand from Indonesia's large population, strong government support, and sufficient natural resources (EMIS, 2022a). Indonesia is the world's 14th largest motor vehicle manufacturing country and the 2nd largest in South-East Asia after Thailand.[4] Indeed, the automotive industry has created 1.5 million direct jobs and 4.5 million indirect jobs (KADIN, 2022). The government is pushing the automotive industry as a key driver for economic development as well (Government of Indonesia, Ministry of Industry, 2018).

There are significant opportunities for Indonesia and Japan to collaborate in the automotive industry. Japanese original equipment manufacturers (OEMs) have a very strong presence in the market and partnerships with local suppliers and manufacturers as production joint ventures. Given the importance of the Indonesian economy and the potential opportunities to collaborate with Japan, the automotive industry has become an ideal initial focus in this vision project.

[4] IOMVM, 2021 Production Statistics.

Figure 2.1. Industry Landscape of Indonesia's Automotive Industry



ECU = electronic control unit, OEM = original equipment manufacturer.
Note: Core parts are electronics, batteries, and drivetrains. Non-core parts are bodies, tires, wire harnesses, and other small parts.
Sources: Expert interview 1 (2022), Expert interview 2 (2023).

As shown in Figure 2.1, Japanese OEMs dominate the market with about a 90% share. Major players, such as Toyota (32% market share), Daihatsu (17%), Honda (13%), Mitsubishi (12%), and Suzuki (10%), leverage local production bases to cater to burgeoning local demand, capitalising on low labour costs (Asian Automotive Analysis, 2020). While local manufacturers, such as Astra International and Indomobile Sukses, exist, they focus on assembly processes. Although a robust local supplier cluster also exists, core parts are imported, such as engine components, transmissions, electronic parts, and electronic control units (ECUs). Additionally, most Tier 1 suppliers rely on technical support from foreign OEMs.

The government is dedicated to supporting the further growth of the automotive industry (Government of Indonesia, Ministry of Industry, 2018). For example, the automotive industry was selected as one of the five focal sectors under the *Making Indonesia 4.0* initiative, and the government provides multiple tax benefits to automotive companies.

The transition to electric vehicles (EVs) is also a priority for the government. Although in its early stages, this transition is expected to gain rapid momentum and to contribute significantly to total vehicle production (IHS Markit, 2021). The country aims to establish an integrated EV supply chain and to emerge as a battery producer. However, challenges have arisen due to the lack of a domestic battery industry and necessary infrastructure development, hindering the realisation of a self-sufficient and competitive EV supply chain.

Indonesia's automotive industry faces multiple challenges as well. Major challenges or pain points are related to its carbon footprint, traceability of goods, supply chain visualisation in the short term, and design or R&D capability in the long term.

(i) **Carbon footprint.** Lack of clear understanding regarding data quality standards and calculation procedures for emissions has resulted in limited transparency and accountability in sharing and reporting emissions. Consequently, this hinders the identification of emissions reduction areas and implementation of precise mitigation strategies. Given Indonesia's heavy dependence on fossil fuels, the need to reduce emissions is urgent. In fact, Indonesia is the largest carbon dioxide emitter in the ASEAN region, accounting for 60% of South-East Asia's emissions and 5% of global emissions. While the government has implemented regulations such as Presidential Regulation No. 98 of 2021 to reduce emissions, more detailed action plans and standards need development (Expert interview 2, 2023). Suppliers need to submit emissions data for a greenhouse gas emissions reduction certificate to avoid administrative sanctions from the government (Situmorang and Putri, 2022). However, many suppliers are not confident of the accuracy of their emissions data (Expert interview 2, 2023).

(ii) **Traceability of goods.** Due to inadequate logistics infrastructure, local suppliers often fail to meet on-time delivery deadlines, leading to longer lead times. Japanese OEMs require just-in-time delivery to avoid production delays. Hence, frequent delays could weaken the competitiveness of local suppliers, necessitating efficient monitoring and tracking of delivery status to meet OEM expectations.

(iii) **Supply chain structure.** Japanese OEMs aim to localise their supply chains to cope with the logistics disruptions caused by the COVID-19 pandemic and to build more resilient supply chains. For example, Japanese OEMs are trying to replace currently imported parts and components with those from local suppliers. However, due to limited visibility into the local

supply chain structure and insufficient information on local suppliers, it is difficult for OEMs to identify alternative local suppliers offering quality, cost-competitive products.

(iv) **Design and R&D capability.** The technological capabilities of local suppliers are not sufficiently advanced, restricting their ability to diversify their product portfolios into core parts and components. Most of these, such as engines, transmissions, electric parts, and ECUs, are imported or produced by global suppliers based in Indonesia. Given the huge local market potential, local suppliers need to enhance their R&D capabilities to expand their product portfolios.

2. Thailand

As the largest and the most developed car manufacturing base in South-East Asia, Thailand is the 10th largest car manufacturing country in the world.[5] The automotive industry is the largest contributor to Thailand's economy in the manufacturing sector, accounting for approximately 12% of Thailand's GDP (Thailand Board of Investment, 2015). Due to its importance in Thailand's economy, the government has identified the automotive industry as a key driver for economic development under its *Thailand 4.0* initiative, announced in 2015 (Thailand Board of Investment, 2015). The strong market presence of Japanese OEMs – who hold an 80% market share[6] – coupled with their strong partnerships with local suppliers, underscore the sector's potential for further collaboration between Thailand and Japan. Therefore, as a starting point, the automotive industry is the focus due to its economic magnitude and collaborative potential with Japan.

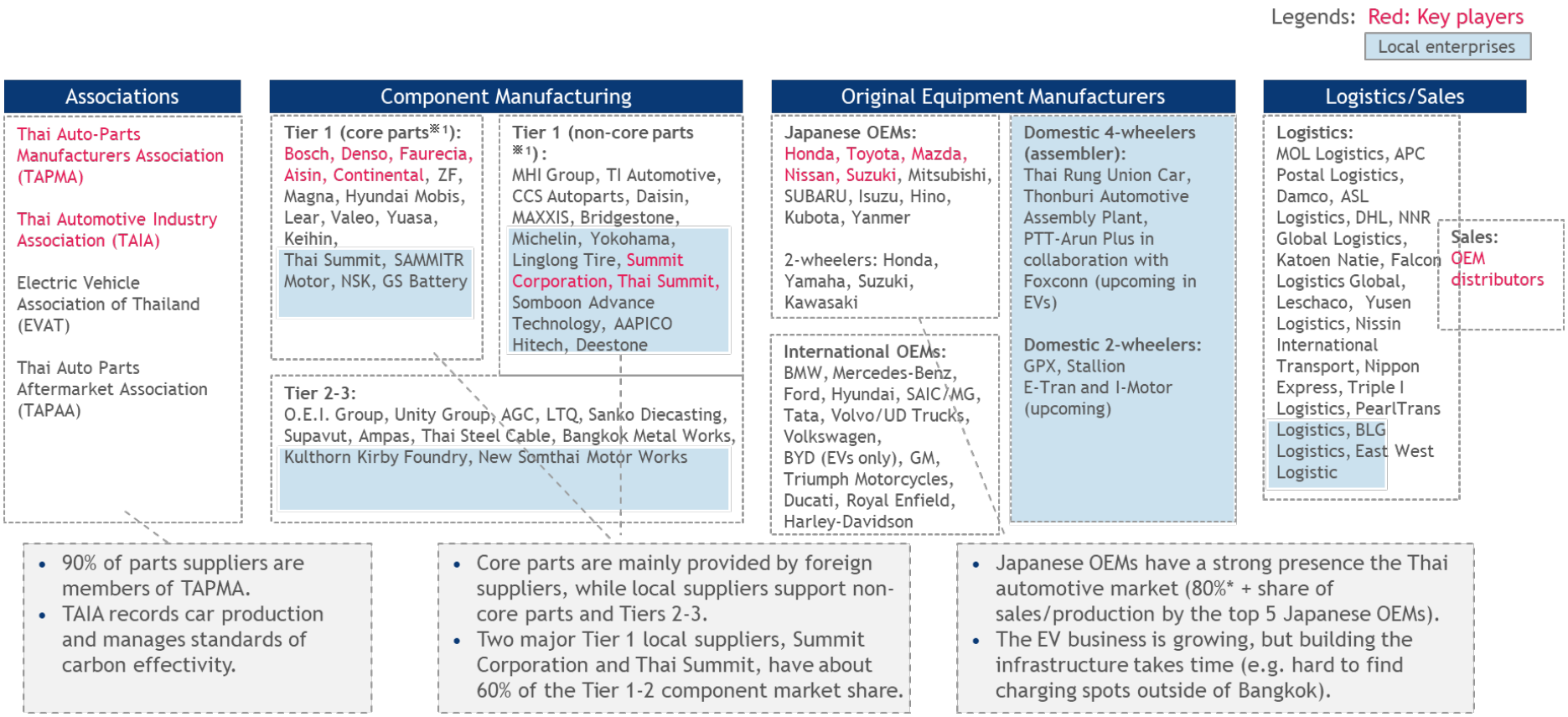
Thailand has a developed supplier cluster (Figure 2.2). Most of parts can be sourced locally; it can become a manufacturing hub for the automotive industry in the region. Local major Tier 1 suppliers, such as Thai Summit, provide mostly non-core parts to OEMs. Core parts, in contrast, are mainly provided by multi-national companies based in Thailand (Expert interview 4, 2023). For the OEM segment, the top five Japanese OEMs dominate the market with an 80% share.[7] As for EV transition, EV production is expected to grow quickly (IHS Market, 2021). Government policy support is strong, which includes reduced import tariffs and exemptions on import duties for core electrical parts, such as batteries, traction motors, compressors for battery EVs, battery management systems, drive control units, and reduction gear (Government of the US, Department of Commerce, 2022). However, challenges remain due to the high dependence on imports for the referenced core components and the need for infrastructure development, including EV-charging stations.

[5] IOMVM, 2021 Production Statistics.

[6] MarkLines, Thailand – Automotives Sales Volume 2021.

[7] Ibid.

Figure 2.2. Industry Landscape of Thailand's Automotive Industry



EV = electric vehicle, OEM = original equipment manufacturer.
Note: Core parts are electronics, the battery, and drivetrain. Non-core parts are the body, tires, wire harnesses, and other small parts.
Source: Expert interview 3 (2022), Expert interview 4 (2023).

The automotive industry in Thailand is well developed, but there are still multiple challenges to address. These challenges are risk prediction, carbon footprint, and quality control in the short term, and design and R&D capability in the long term.

(i) **Risk prediction.** Thailand has been exposed to many disasters, which have caused disruptions in supply chains. In the rainy season, supply chains are often impacted by floods, deliveries are frequently delayed, and companies need to maintain a higher level of inventory to avoid production interruptions. Since the disastrous 2011 floods, many companies have taken steps to improve their supply chains to make them more resilient and reliable by relocating their production bases to safer regions or implementing measures against floods. However, further improvements are needed to predict supply chain risks such as delivery disruptions from floods based on accumulated data on past flood damages.

(ii) **Carbon footprint.** The government announced a net-zero emissions target by 2065 and defined climate actions including preparation of a roadmap for implementation by sector, including a greenhouse gas emissions reduction target on a voluntary basis (Government of Thailand, Ministry of Natural Resources and Environment, 2022). However, companies still require standardised guidelines and a system to collect, calculate, and share relevant data in the value chain to enhance transparency and accountability for emissions reduction (Expert interview 4, 2023).

(iii) **Quality control.** Although Thailand's Tier 1 suppliers maintain good quality in production, defects have been found; most are from Tier 2 suppliers. Japanese OEMs regularly provide quality and service training to their Tier 1 suppliers, resulting in significant quality improvement. Tier 1 suppliers could transfer their knowledge to Tier 2 suppliers and below, but better understanding of structured methodologies and standards is required.

(iv) **Design and R&D capability**. Local manufacturers can improve their competitiveness with OEM support to enhance their R&D capabilities. As a well-established manufacturing base, Thailand's automotive industry is now looking to expand to upstream value chains to capture more value-added processes such as R&D. Reinforcement of R&D capabilities is needed not only in the current internal combustion engine-centric industry but also to prepare potential structural change in the automotive industry with rapid technology development in hybrid, hydrogen, and battery EVs.

3. Viet Nam

Viet Nam's electronics industry has grown rapidly in recent years, driven by the government's promotion of foreign investment and low labour costs. Also, the repercussions of the US–China trade dispute has triggered production base transfers from China to South-East Asia – especially to Viet Nam – under the China Plus One Strategy, which aims to reduce dependency on China and to diversify production bases (Samuel, 2020).

The electronics industry is one of the largest contributors to Viet Nam's exports. Telephones, smartphones, and associated parts represent 17% of exports, and computers and associated parts represent 15% (Japan External Trade Organization, 2022). Japanese electronics makers have a strong presence in the market, especially in the home appliance segment (Expert interview 6, 2023).

Viet Nam's electronics industry has a diverse landscape across segments (Figure 2.3). Global set makers dominate the market with different players in each segment. Specifically, the smartphone segment is influenced by those from the US, South Korea, and China, while the audio and video segment is characterised by Japanese and Korean players. In the realm of home appliances, the market is shared amongst Korean, Japanese, and Chinese players, whereas the semiconductor segment features the participation of those from the US, South Korea, and Taiwan.

Despite the existence of local set makers, their overall influence remains limited. For parts and components, local suppliers focus on commodity products, such as plastics and mechanicals. Most global set makers procure core components from global suppliers selected by their headquarters. Furthermore, many common electronics components are sourced from China, leveraging tariff advantages, competitive transport costs, and efficient lead times.

Despite the recent rapid growth and potential of Viet Nam's electronics industry, multiple challenges and pain points persist. Major pain points are risk prediction, quality control, and supply chain structure in the short term and design and R&D capability in the long term.

(i) **Risk prediction.** The industry heavily relies on parts and components sourced from China, which exposes it to geopolitical risks in terms of sourcing stability. The COVID-19 pandemic further highlighted vulnerabilities, as many set makers experienced severe disruptions in raw materials and component supplies due to lockdowns in China.

(ii) **Quality control**. Elevating the quality control capabilities of local suppliers to align with the standards of global set makers remains imperative. Attracting more investment from foreign players and facilitating knowledge transfers are needed for local suppliers to enhance their quality control.

(iii) **Supply chain structure.** The establishment of a more robust local supplier cluster is important. The government offers tax benefits to foreign companies that are investing in the technology sector and generating local employment to promote industry development.[8] However, limited visibility of local suppliers in the country poses challenges for foreign companies to obtain information about them.

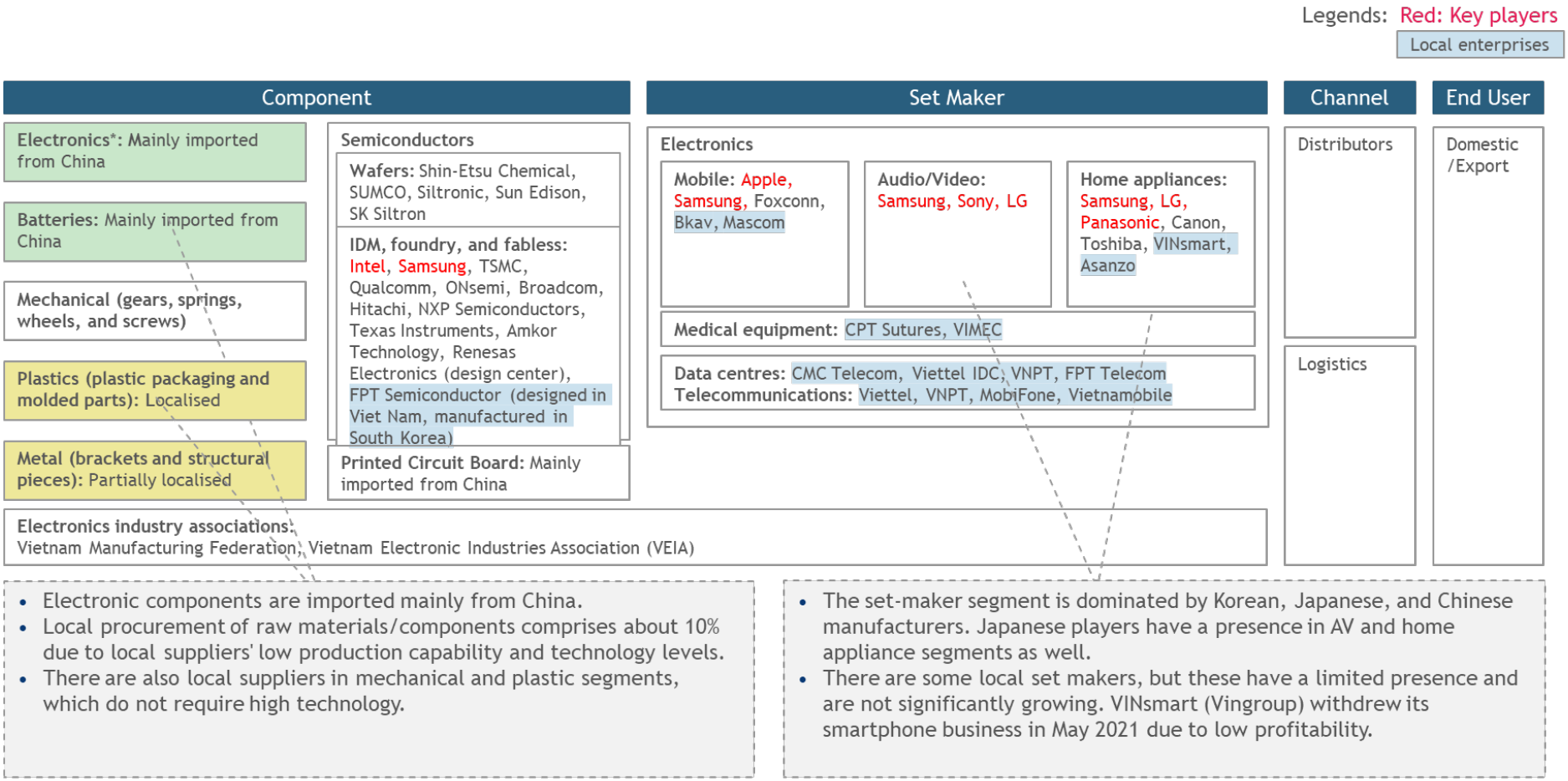
(iv) **Design and R&D capability.** Local suppliers focus on manufacturing commodity components with limited activities in R&D. The industry needs to enhance R&D capabilities to expand product portfolios toward high-end and value-added segments.

A recent global value chain study was conducted to understand the current situation and challenges of Viet Nam businesses in global value chains; it encompassed more than 500 enterprises in the manufacturing and process industry in Viet Nam (VCCI, 2022). Many challenges were pointed out in relation to supply chains; Vietnamese companies desire to improve their dynamic adaptability to identify new global sources of supply and innovation to further collaborate with external institutions (Figure 2.4).

Also, Vietnamese companies exhibited a high demand for connectivity with suppliers and leading enterprises and for support on access to new markets and new technology, which is aligned with pain points found in the electronics industry (Figure 2.5).

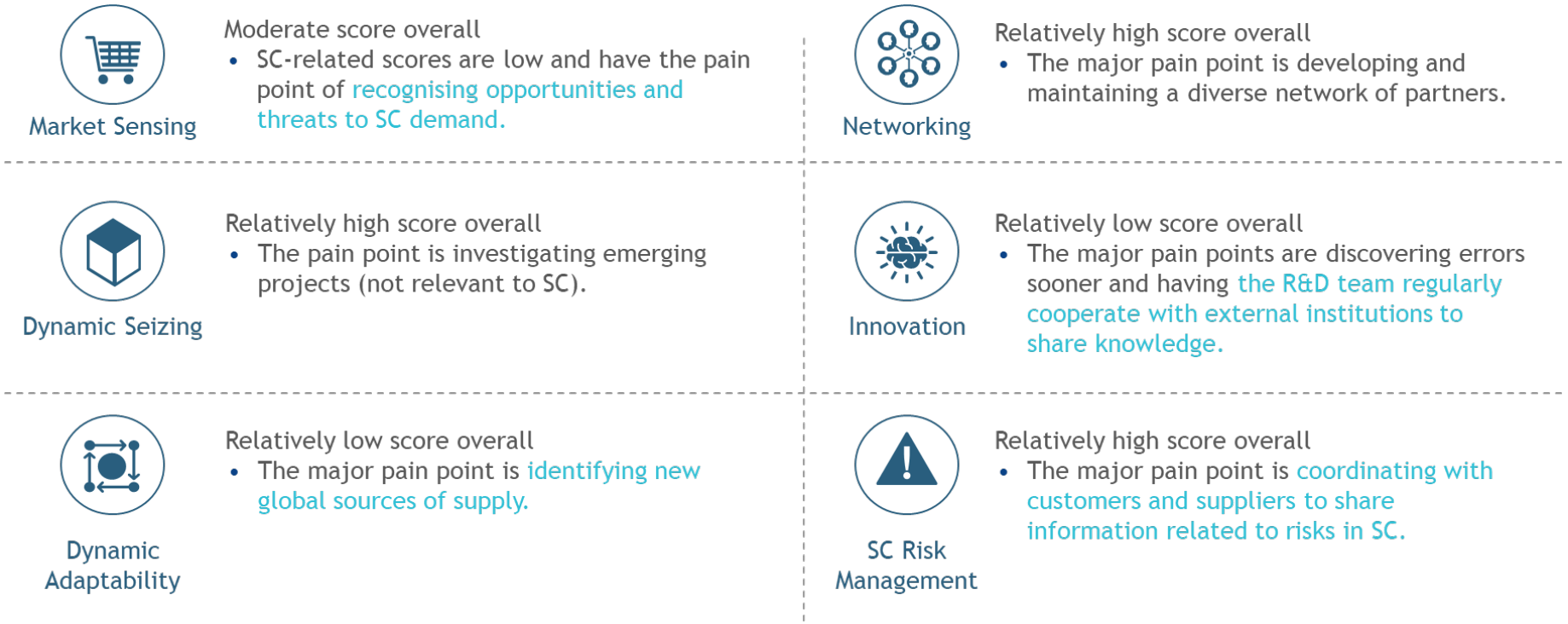
[8] Vietnam Briefing, Tax Incentives for Foreign Enterprises in Vietnam.

Figure 2.3. Industry Landscape of Viet Nam's Electronics Industry



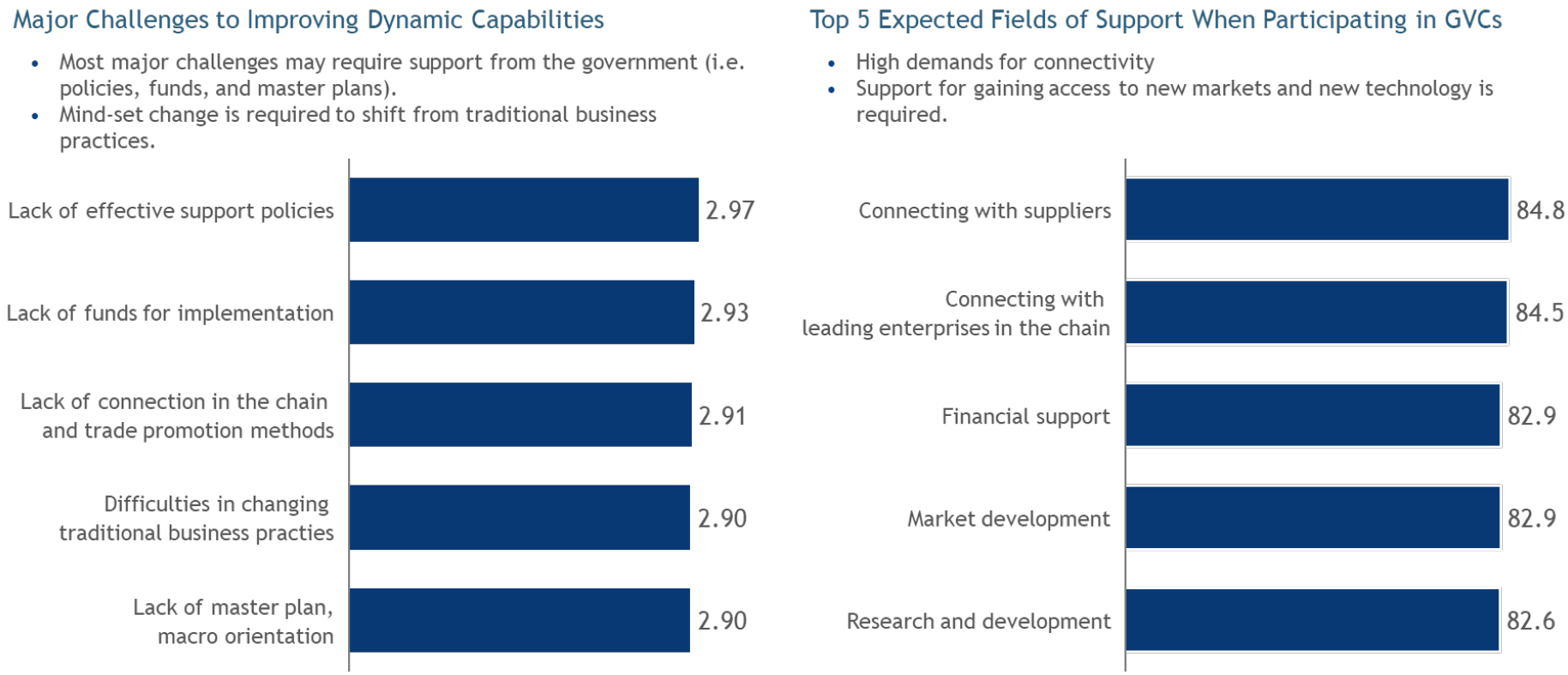
Note: Electronics include displays, resisters, capacitors, and sensors.
Source: Expert interview 5 (2022); Expert interview 6, Expert interview 7 (2023).

Figure 2.4. Survey Results on Dynamic Capabilities



R&D = research and development, SC = supply chain.
Source: VCCI (2022).

Figure 2.5. Key Findings from the Global Value Chain Study



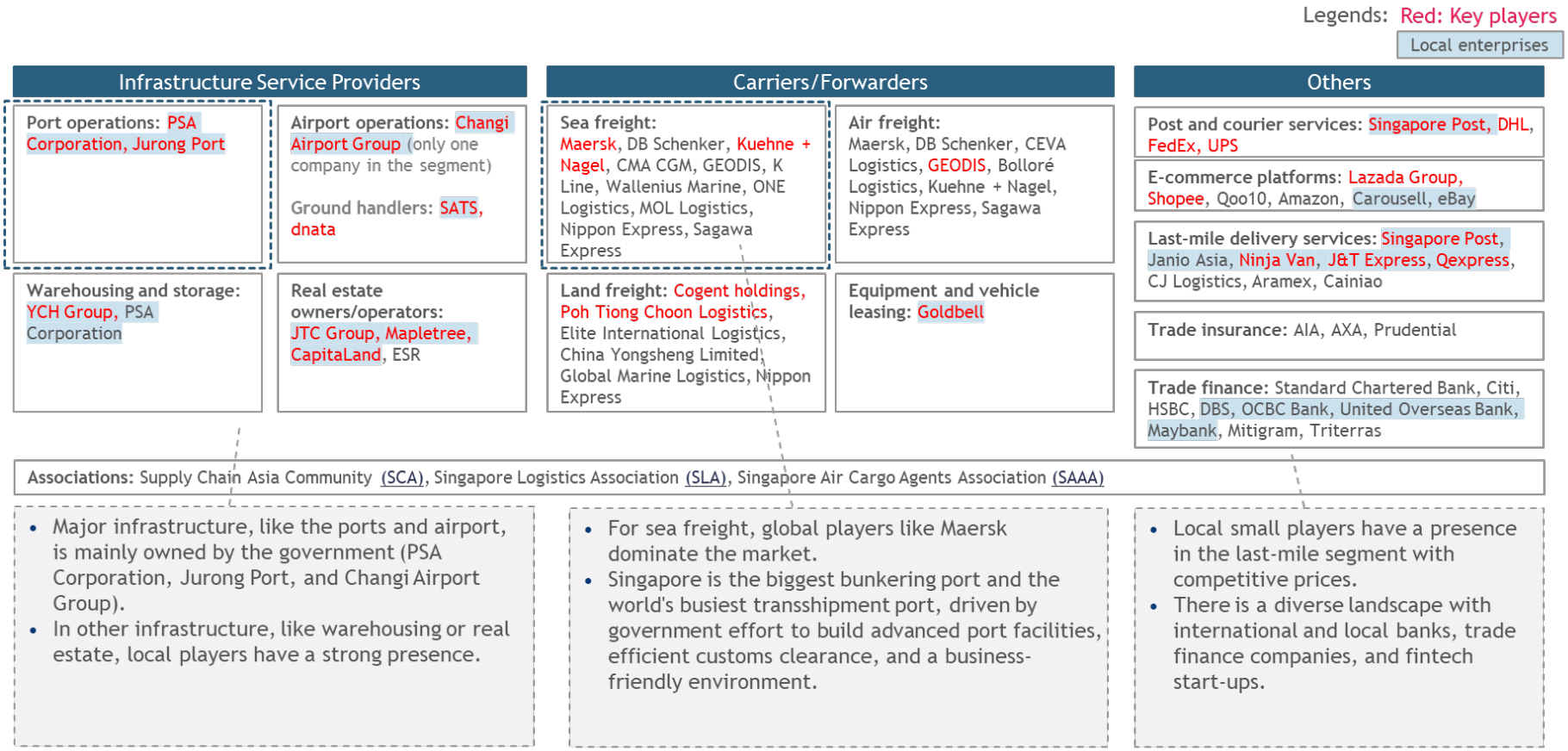
GVCs = global value chains.
Source: VCCI (2022).

4. Singapore

Singapore's logistics industry was chosen based on the importance it has in the country's economy and its large demand to digitalise supply chains. Singapore is the world's second biggest cargo seaport and is the leading logistics hub in Asia. The government has been aiming to develop infrastructure and a business-friendly environment for the logistics industry, which is the core of Singapore's economy. The industry has undergone dynamic changes, such as volatility in freight rates due to the COVID-19 pandemic, emergence of the issue of sustainability, and the shift of production bases in Asia. There are opportunities for collaboration between Singapore and Japan in the logistics sector to address current supply chain challenges.

As shown in Figure 2.6, the logistics industry consists of infrastructure service providers, carriers, and forwarders as well as other businesses, including post and courier services, and trade finance and insurance businesses. Infrastructure service providers are mainly state-owned enterprises, operating the port and airport (EMIS, 2022b). In addition, local players have a strong presence in warehouse and storage operation (Expert interview 8, 2023). Carrier and forwarder businesses are dominated by global giants, including some Japanese players with a strong presence in the sea freight segment (Expert interview 8, 2023). Post and courier services are driven by global players, while small local players are enhancing their presence in last-mile delivery services (Expert interview 9, 2023). Finally, the landscape is characterised by a diverse array of international and local banks, along with trade finance companies, operating within trade insurance and trade finance businesses (Government of the US, Department of Commerce, International Trade Administration, 2022).

Figure 2.6. Industry Landscape of Singapore's Logistics Industry



Sources: Expert interview 8, Expert interview 9 (2023).

Amidst the dynamic changes caused by the pandemic, Singapore's logistics industry faces multiple challenges such as the traceability of goods and financial transactions, carbon footprint, and operational capacity.

(i) **Traceability of goods and financial transactions**. The intricacies of the logistics routes have been compounded by external factors, such as the border lockdowns due to the pandemic and the war in Ukraine. The industry has experienced significant volatility and a decrease in physical product flows during the pandemic. In particular, the sea freight business went through significant delays caused by port congestion and shortages of containers. In the current evolving landscape, logistics players aspire to become virtual supply chain hubs, diminishing reliance on physical flows by handling information and financial transactions in the region.

(ii) **Carbon footprint.** The logistics industry is one of the largest carbon dioxide emitters in Singapore, as it utilises various forms of transport that use fossil fuels. The provision of sustainability reports is mandatory for all listed companies in Singapore. However, there is still lack of accuracy in emissions data. The industry needs detailed guidelines and standards for emissions calculations. For example, sea and air freight carriers use their own rules provided by their headquarters, while e-commerce and last-mile delivery providers face bigger challenges with more complicated delivery routes and emissions structures.

(iii) **Operational capacity.** Foreign labour accounts for roughly 40% of the labour force in Singapore, servicing multiple industries such as the maritime, manufacturing, construction, and service industries (ILO and UN Women, 2020). The majority of the workforce commutes from Malaysia, and there was a large labour shortage due to border closures during the pandemic, leading to more discussions of automation as a potential solution.

Chapter 3

Vision for the Digitalisation of Supply Chains

The vision aims to establish reliable supply chains that ensure transparency, connectivity, sustainability, and competitiveness, with collaboration between ASEAN and Japan. The goal is to address the current major pain points faced by each ASEAN country, while promoting collaboration between ASEAN and Japan. This will be accomplished through the implementation of the vision, which is threefold: (i) establishing a clear mission and value proposition, (ii) identifying essential requirements and enablers, and (iii) developing specific use cases to realise tangible benefits.

1. Mission and Value Proposition

The mission is:

Through collaboration between ASEAN and Japan, establish a digitalised and sustainable supply chain that is trusted and reliable; cost and time efficient; and has transparency, traceability, connectivity, and interoperability to enable the seamless movement of goods and services between ASEAN and Japan.

As stated, 'transparency', 'traceability' 'connectivity', 'interoperability', 'sustainability', 'competitiveness', 'collaboration', and 'reliability' are core values. The value proposition adopts lessons from global initiatives while reflecting the different context and uniqueness of ASEAN and Japan.

(i) **Transparency.** Provide increased visibility in supply chains, and build trust amongst all the stakeholders with adequate, accurate, and secure data and information sharing.

(ii) **Traceability.** Enhance the reliability and quality of the data, facilitating compliance adherence and proper quality management by tracking the path and change history of data.

(iii) **Connectivity.** Improve supply chain efficiency by promoting connections across suppliers, manufacturers, and customers through digital and data exchange.

(iv) **Interoperability**. Enable different systems or platforms to be compatible, facilitating seamless data integration and sharing.

(v) **Sustainability.** Drive ethical and environmental responsibility in each industry ecosystem by actively pursuing emissions reduction and human rights protection with harmonised standards.

(vi) **Competitiveness.** Build supply chain resilience by predicting and mitigating supply chain risks as well as enhancing functional capabilities of supply chain stakeholders to further improve efficiency.

(vii) **Collaboration.** Promote collaboration across ASEAN countries and Japan and between large enterprises and small and medium-sized enterprises by exchanging best practices and know-how.

(viii) **Reliability.** Provide disciplined standards and governance for secure data exchange with security, and ensure the accuracy and confidentiality of information.

Catena-X serves as an important global initiative that can be referenced for benchmarking. It aims to be an open data ecosystem for the automotive industry of the future, linking global players into end-to-end value chains. Figure 3.1 describes the value proposition of Catena-X, which aims to improve sustainability and traceability; provide specific services and functions around quality management, digitalised manufacturing, and operation; and contribute to a circular economy. These are aligned with the core of the value proposition.

Yet the value proposition extends beyond these areas. Competitiveness, collaboration, and reliability are emphasised to accommodate the unique context and needs of this region. The objective is not only to foster intra-regional collaboration but also to encourage closer ties amongst ASEAN countries and Japan. These factors differentiate this initiative and uniquely suit it to specific regional dynamics and requirements. At the same time, an Asian digitalised supply chain ecosystem is needed to reflect the different context and needs of the region:

(i) **Industry landscape and pain points.** Those of ASEAN are different from that of developed economies. The vision needs to reflect these differences and focus on improving local pain points through target use cases.

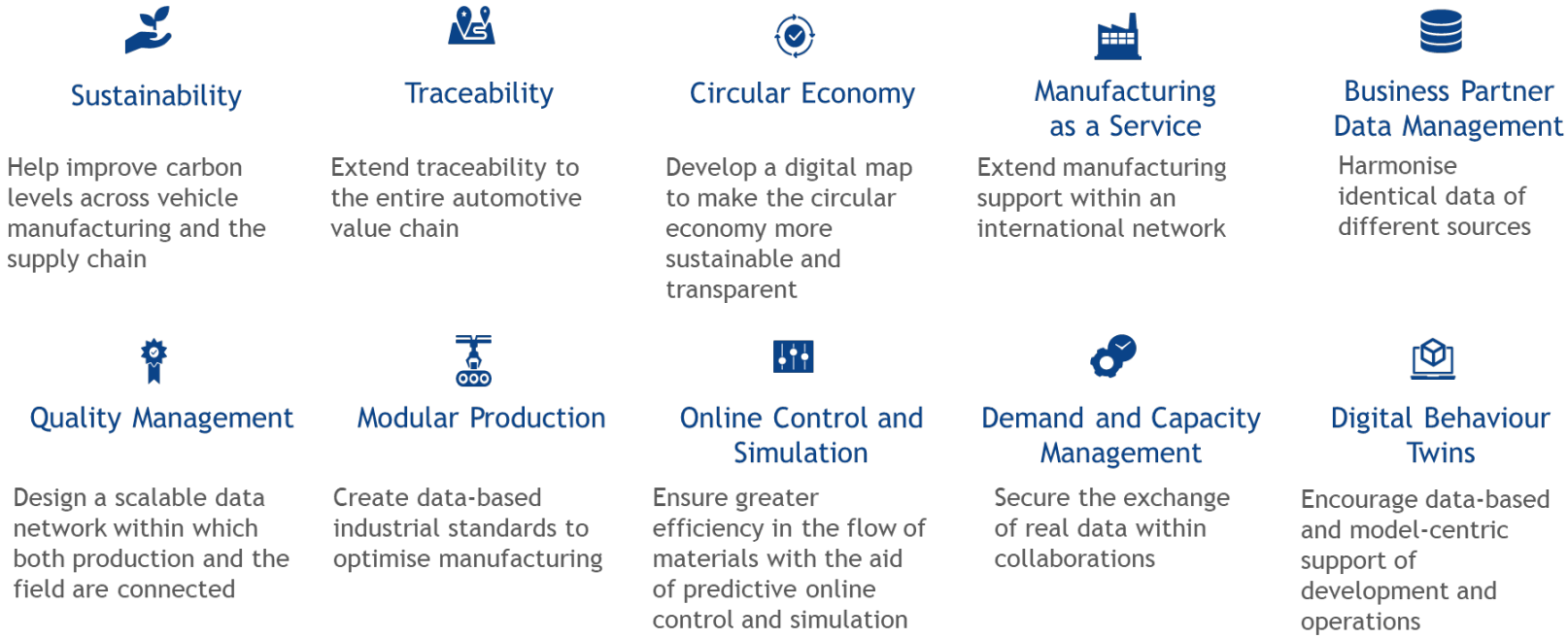
(ii) **Data sharing**. The degree of acceptance regarding data openness within ASEAN may be different from that of other continents. Realistic guidelines for data sharing must be developed based on the realities of ASEAN situation.

(iii) **Data sovereignty.** This must be a priority when implementing the vision for digitalisation of supply chains. It is imperative to establish a clear definition regarding the ownership, control, and protection mechanisms of data sharing, aligning with the region's own standards.

(iv) **ASEAN–Japan relationship**. Finally, ASEAN and Japan have been deepening their relationship, building an economic cluster by increasing trade volume and foreign direct investment from Japan to ASEAN.[9] Given the close relationship between ASEAN and Japan, a unique digitalised supply chain ecosystem must be established that can represent maximum value and benefits for the region.

[9] JETRO, Japan's Foreign Direct Investment.

Figure 3.1. Value Proposition of Catena-X



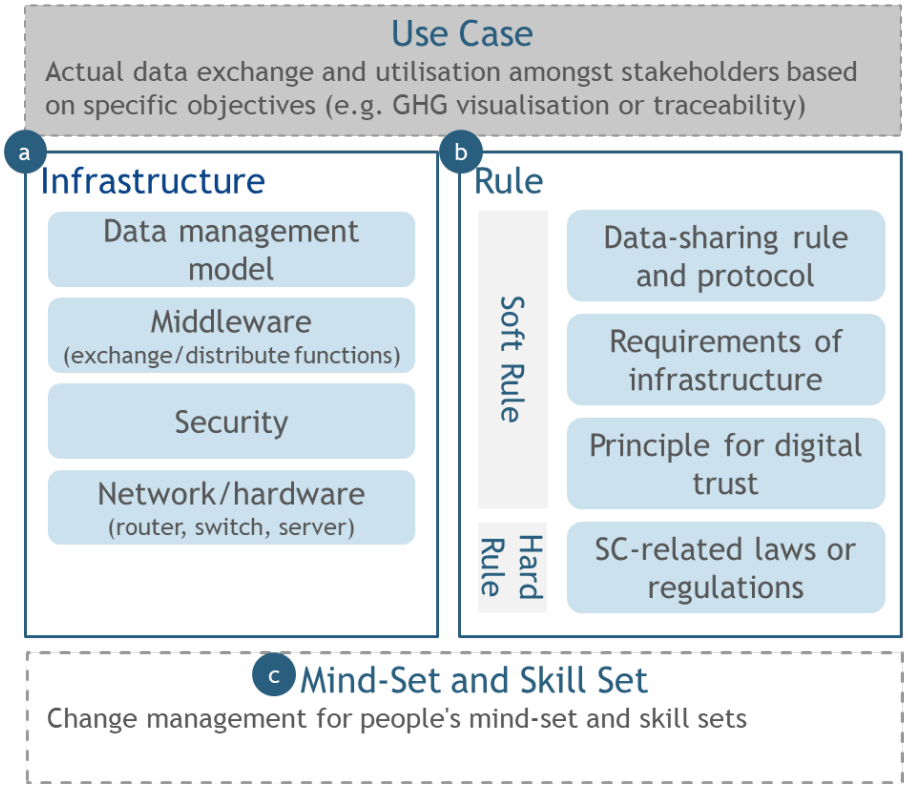
Source: Catena-X, https://catena-x.net/en/

2. Essential Requirements and Enablers

To realise the vision for digitalisation across ASEAN and Japan, multiple requirements and enablers need to be defined. These are depicted as three building blocks – infrastructure; rules; and mind-set, digital literary, and skill sets (Figure 3.2). These building blocks are key to accelerate the creation of use cases.

The infrastructure block provides the necessary IT functionalities for data exchange. The rules block provides standardised protocols and definitions to facilitate harmonisation across various stakeholders. Lastly, the mind-set, digital literacy, and skill set block provides change management and training initiatives to improve digital literary and skills for both enterprises and their workers.

Figure 3.2. Essential Components and Enablers



a **Infrastructure**

Data management model
- Definition of standard data set and quality

Middleware
- Functionalities in infrastructure to support exchange data (i.e. data exchange connector)

Security
- Functionalities to ensure security in infrastructure

Network and Hardware
- Physical components of infrastructure

b **Rule**

Data-sharing rule and protocol
- Standard rules/processes for data sharing

Requirements of infrastructure
- Standard specification of infrastructure or systems

Principle for digital trust
- Digital ID or certification for ensure trust in cyberworld

SC-related laws/regulations
- Related laws or regulations in the region (e.g. ESG, data protection)

ESG = environmental, social, and governance; GHG = greenhouse gas; SC = supply chain.
Source: Authors.

Regarding infrastructure, the technological prerequisites to enable data exchange and functionality to achieve the objectives of use cases include:

(i) **Data management model.** A standardised structure and set of protocols for datasets, data quality, and interfaces are necessary to allow for inter-industry data exchange. For example, Europe's Industrie 4.0 initiative defines a data model, the Asset Administration Shell.[10] Assets include all elements connected to Industrie 4.0 – machines, production modules, systems, software, and human resources. The shell defines a standardised data structure to electronically describe elements for each asset, enabling easier data exchange amongst industrial assets and stakeholders.

(ii) **Middleware.** This encompasses software tools that provide functionalities to support data exchange and data distribution, such as application programming interfaces and data exchange connectors.

(iii) **Security.** This involves functionalities that ensure data security and confidentiality in the database and platform, such as endpoint security management, log tracking, and data checking.

(iv) **Network and hardware.** These are the physical components of IT infrastructure, such as servers, routers, and switches, which store and exchange data.

(v) **Rules.** These define the disciplined, compliant operation of the system and promote harmonisation across countries and industries. Key aspects include:

  (a) **Data-sharing rules and protocol.** These are standard rules and processes defined for data exchange and sharing, including definitions of data exchange models, stakeholders' roles, data exchange processes, and on-boarding methods. The IDSA Reference Architecture Model is an example of a standardised data-sharing rule and protocol.

  (b) **Requirements of infrastructure**. These include setting standards specifications of infrastructure and systems to fulfil the required functionalities and securities.

  (c) **Principle for digital trust.** This includes digital identity management, trust management of data, and the concept of a trusted platform to ensure data trust.

  (d) **Supply chain-related laws and regulations.** Related laws and regulations in countries and industries (e.g. environment and data protection.) can differ by country and must be harmonised while allowing for localisation.

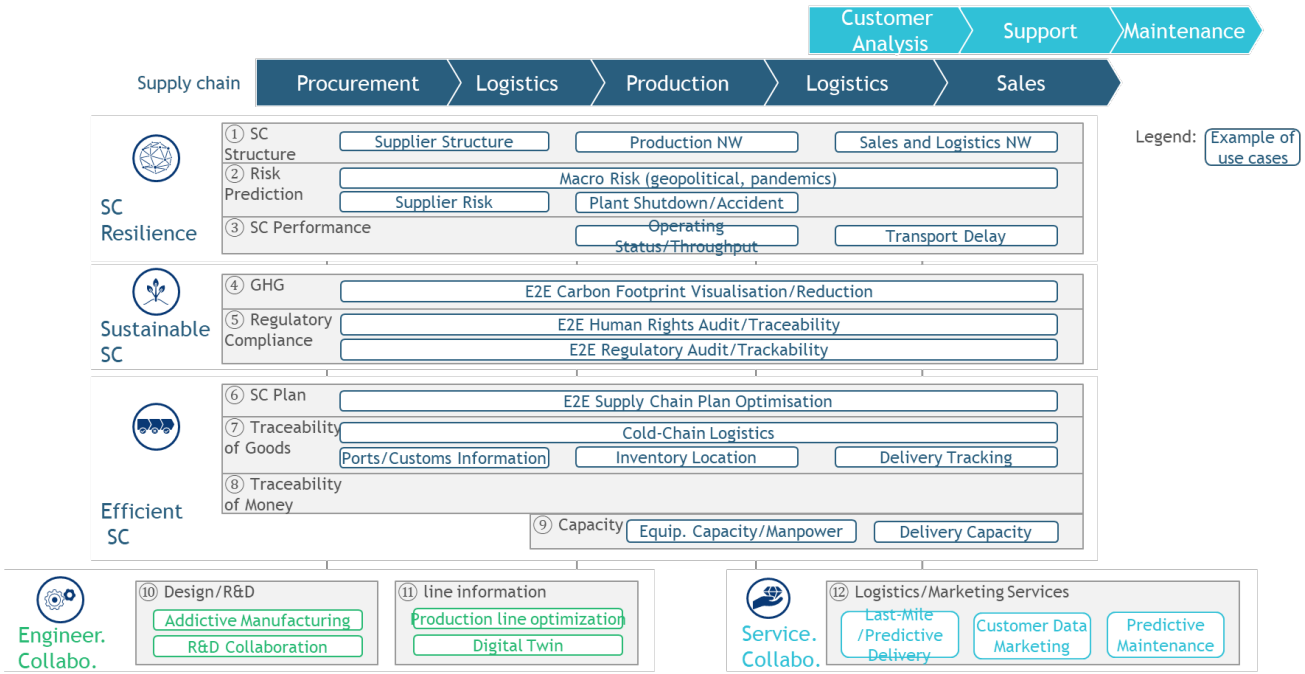
  (e) **Mind-set, digital literacy, and skill set.** These include change management, education, and training to improve readiness, willingness, and ability to utilise digital technology and to enhance digital capability and digital literacy. It is important to provide proper training and education to improve digital literacy and skills for enterprises and workers, including activities such as marketing the digital infrastructure, providing online and offline training, and sharing best practices.

[10] Government of Germany, Federal Ministry for Economic Affairs and Climate Action, What Is Industrie 4.0?

Chapter 4
Potential Use Cases

To translate the vision into tangible benefits, it is crucial to implement specific use cases. After analysing the current pain points in ASEAN, several potential use cases were identified (Figure 4.1). Of these, four can be prioritised for immediate implementation: (i) visualisation of the supply chain structure, (ii) risk prediction, (iii) visualisation of an end-to-end carbon footprint, and (iv) design and R&D data sharing.

Figure 4.1. Supply Chain Use Case Map



E2E = end-to-end, GHG = greenhouse gas, NW = network, PO = purchasing order, R&D = research and development, SC = supply chain.
Source: Authors.

1. Visualisation of the Supply Chain Structure

This use case aims to develop a platform and database through which industry stakeholders can share and access information about supply chains. As illustrated in Figure 4.2, this platform is designed to facilitate the sharing of data and information about the value chain structure of the industry, key players, and participants in each segment as well as detailed profiles of players such as production capacity, quality and cost qualification, product specification and performance, and product availability. Participants can include finished product manufacturers, Tier 1 suppliers, and Tier 2 and lower suppliers, thereby providing complete visibility into the supplier network.

This platform would support more efficient supply chain decisions of manufacturers to identify alternative suppliers in the region and to make better supplier choices with time and cost savings. It would also provide more commercial opportunities to suppliers by effectively marketing their competitiveness and offering it to their potential buyers.

Figure 4.2. Visualisation of Supplier Structure

Collaboration Purpose/Needs

Many manufacturers want to have clearer visibility on the supplier network and make timely supply chain decisions by understanding the right profile and qualification of suppliers.

Currently working to visualise the supplier structure by hearing from individual suppliers, but it is difficult to cover all the suppliers due to limitation on FTE; data visualisation and sharing across industries are needed.

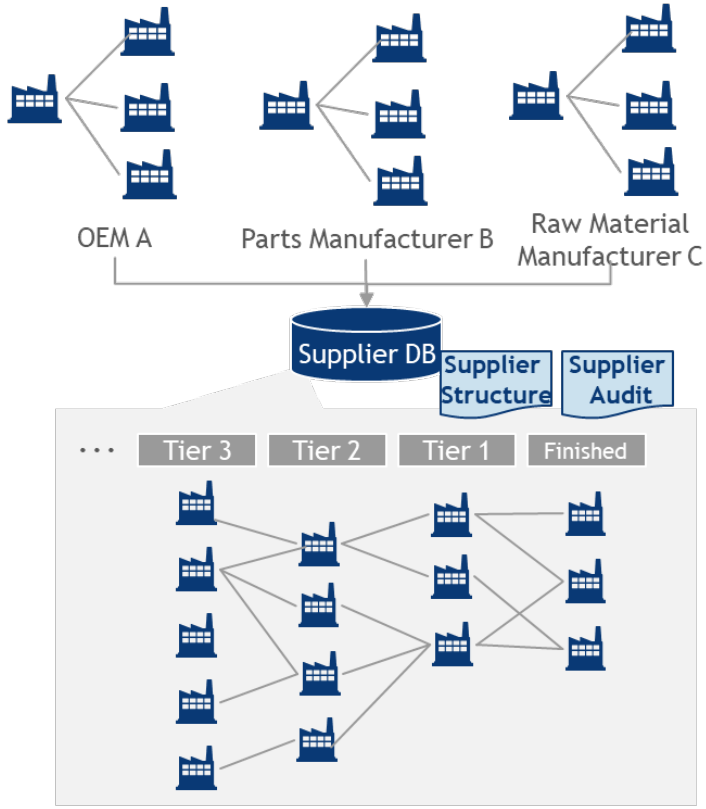
Stakeholders

- Finished product manufacturer
- Tier 1 supplier
- Tier 2 supplier and beyond

Data Items

- Supplier structure data
- Internal information
- Transaction information

Illustration



Impact/Output

- Reduced FTE and time for making inquiries and collecting information to/from suppliers
- Reduced procurement risks by identifying alternative suppliers with better cost and timing
- More commercial opportunities to suppliers by effectively marketing their competitiveness and offering it to their potential buyers

DB = database, FTE = full-time equivalent, OEM = original equipment manufacturer.
Source: Authors.

2. Risk Prediction

This use case aims to develop a digital tool that can convey existing and potential events and activities that can negatively impact a supply chain, so that individual stakeholders can anticipate potential risks and devise ways to mitigate or prevent the potential risks. The tool can cover a broad range of information, from macro-level risks such as disasters, geopolitical issues, forecasts on the macroeconomy, and volatility in the commodities market, to specific information about individual supplier events such as plant shutdowns, material shortages, and employee strikes. The tool can expand the boundaries of functionality to quantification and prediction of risks by leveraging advanced analytics with accumulated data. In addition, risk prediction can be used in combination with visualisation of the supply chain structure. Stakeholders can then precisely understand the influences on their supply chains by overlaying risk information onto the defined supply chain structure.

3. Visualisation of an End-to-End Carbon Footprint

This use case aims to develop a platform where stakeholders can access and share accurate and granular emissions data with defined rules and standards for calculation. Stakeholders can comply with country and industry regulations by using primary emissions data derived from actual supply chains. By standardising measurement and reporting, they can make comparisons to emissions across supply chains. As show in Figure 4.3, this use case helps stakeholders better understand emissions from their own business activities as well as those linked to current or potential suppliers. It can also provide commercial opportunities for suppliers to market their sustainability to buyers and customers who value sustainability and the environment.

Figure 4.3. Visualisation of End-to-End Carbon Footprint

Collaboration Purpose/Needs

Visualisation/reduction of E2E carbon emissions in the supply chain including Scope 3 is needed amidst increasing demand and need for decarbonisation by the market/customers.

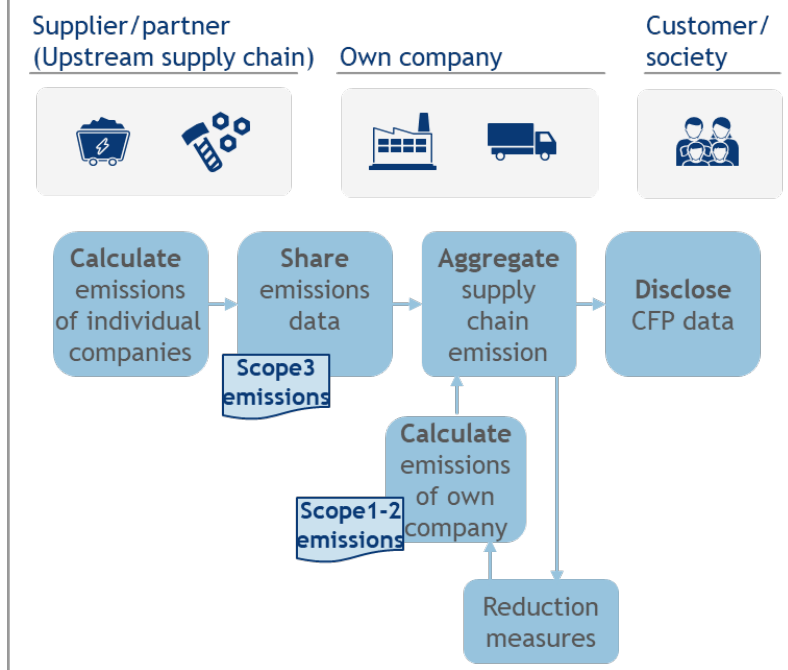
Currently measures are promoted by industry/companies; there is a need for promoting fair and transparent data sharing by establishing common rules and protocols.

Stakeholders

- Internal departments (e.g. sales, procurement, manufacturing)
- Partner companies/suppliers

Data items

Illustration



Impact/Output

- Understanding accurate CO_2 emissions of own company/ promotion of external collaboration
- Consistent calculation of CO_2 emissions across the value chain with established standards
- Visualisation and reduction of CO_2 emissions across the supply chain including partners

CFP = carbon footprint, CO_2 = carbon dioxide, E2E = end-to-end.
Source: Authors.

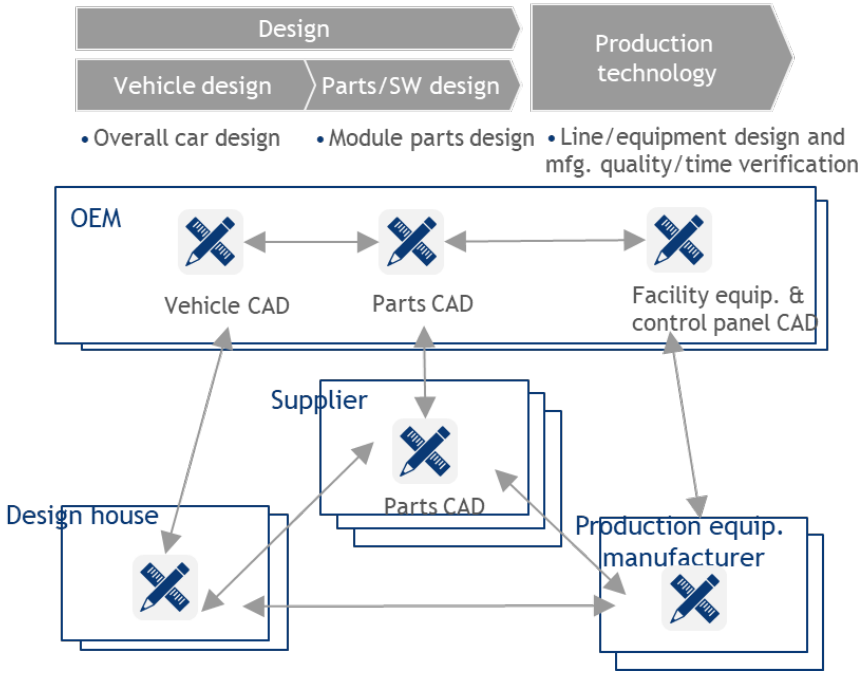
4. Design and R&D Data Sharing

This use case aims to promote the relatively longer-term collaboration of stakeholders compared to other use cases. The use case can provide a broader range of offerings, such as joint design and R&D, supplier matching and quotations, and a platform for sharing and transferring know-how and expertise from leading companies to local suppliers and partners. Figure 4.4 shows examples of R&D digital twin and joint design, and supplier matching and quotations. For example, companies can share design and computer-aided design data on the platform and drive more efficient and faster development activities with direct stakeholders. Furthermore, the platform can facilitate efficient connections between buyers and suppliers by matching design specifications from buyers with supplier qualifications. Another example could be building a knowledge database of business partners, fostering mutual learning and knowledge transfer for mutually beneficial relationships. Additionally, product design and development collaboration amongst industry stakeholders, aimed at enhancing reusability of material for circular economy initiatives, could be a good example.

Figure 4.4. Use Cases in Design and Research and Development Areas

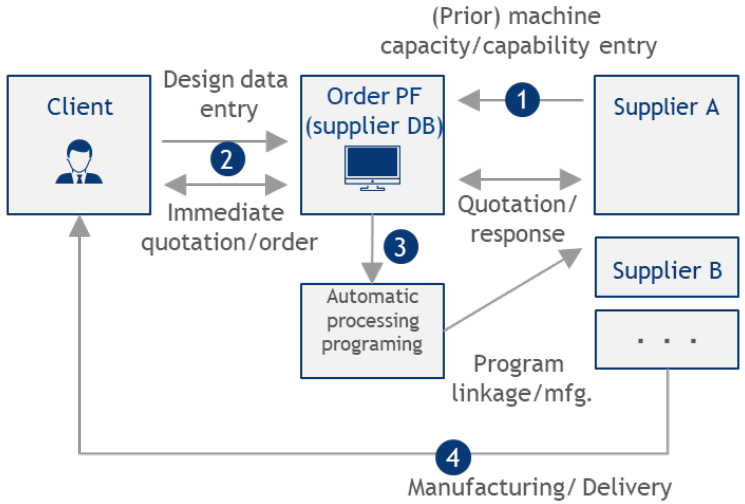
R&D Digital Twin and Joint Design

- Standardise design and CAD data sharing amongst OEMs, design houses, suppliers, and equipment manufacturers to enable digital twin and joint design activities



Supplier Matching and Quotation

- Aggregate supplier capacity and processing capacity in the supplier DB, and input design data to enable matching and automatic quotations



CAD = computer-aided design, DB = database, OEM = original equipment manufacturer, PF = platform, SW = software.
Source: Authors.

Chapter 5
Action Plan and Next Steps

As an immediate next step, the vision will be shared at the ASEAN–Japan Commemorative Summit in December 2023. Following the finalisation of the vision and consensus-building in the region, the implementation of the project will be planned and executed in 2024 and beyond (Figure 5.1).

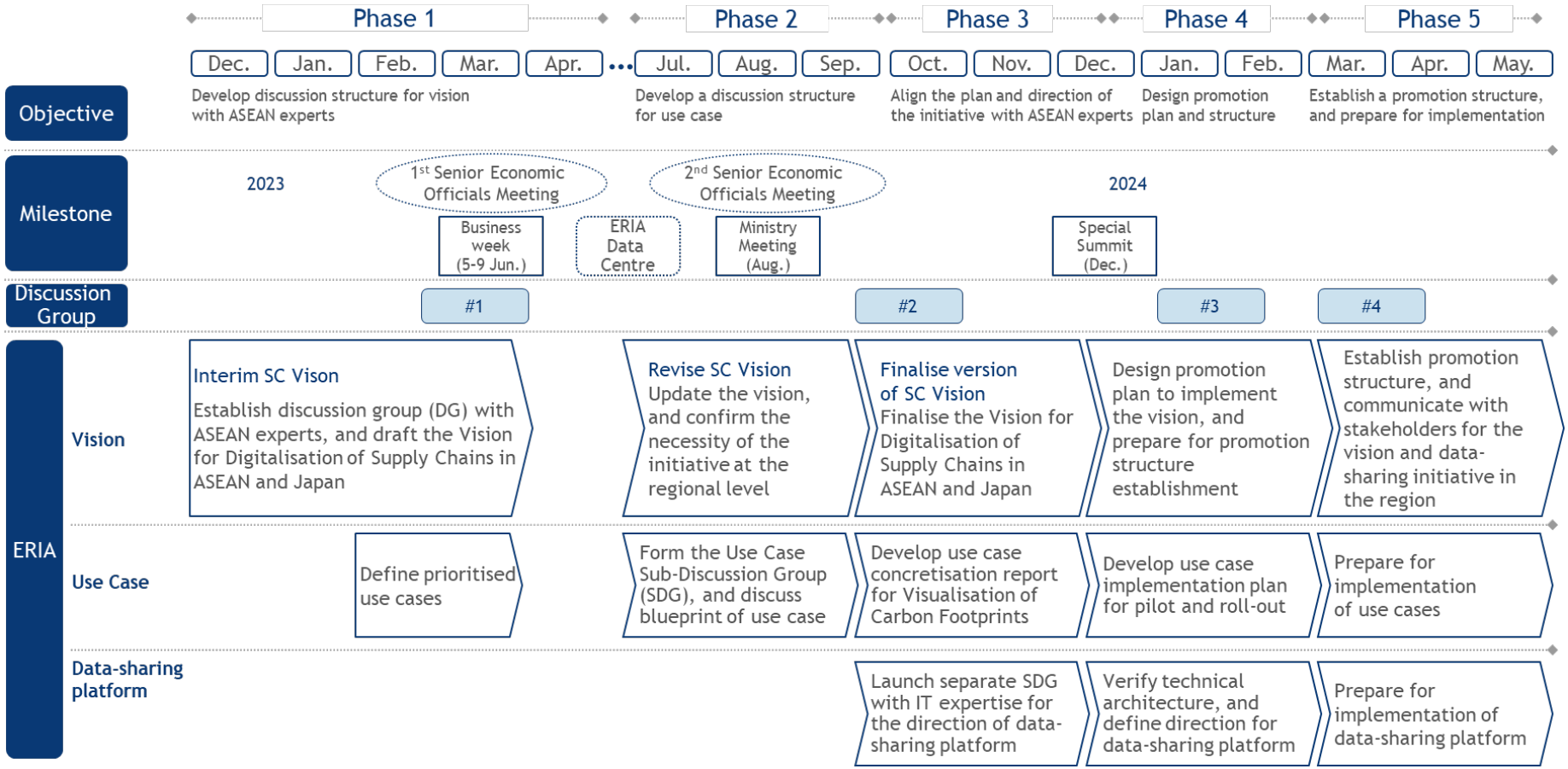
The key actions for implementation are as follows.

(i) Design a promotion plan to implement the vision (by early March 2024).
   (a) Design organisation, and define required roles and responsibilities to communicate and market overall direction of the vision and use cases.
   (b) Define contents and targets to market the vision and use cases.
   (c) Develop a collaboration strategy with other initiatives, including options to collaborate and the value proposition.

(ii) Prepare for promotion structure establishment (by end of May 2024).
   (a) Identify potential candidates for core members in promotion structure.
   (b) Start contacting the candidates, and identify their interest.
   (c) Invite and confirm the members for promotion organisation.
   (d) Concretise workplan of promotion structure.

(iii) Establish promotion structure and prepare execution (second half of 2024).
   (a) Allocate roles and responsibilities to core members.
   (b) Align and communicate with use case and data-sharing platform implementation organisations.
   (c) Execute communication and marketing strategies with external target stakeholders.

Figure 5.1. High-Level Roadmap



ASEAN = Association of Southeast Asian Nations, DG = discussion group, ERIA = Economic Research Institute for ASEAN and East Asia, SC = supply chain, SDG = sub-discussion group.
Source: Authors.

In parallel with the development of the vision report, the 'visualisation of carbon footprint' use case was chosen as the initial focus. Multiple experts in ASEAN are currently in discussion, and the details of use case concretisation report will be shared at the ASEAN–Japan Commemorative Summit. The progress and key actions for use case concretisation are as follows.

(i) Form the Use Case Sub-Discussion Group (SDG) with experts from ASEAN and Japan, and conduct multiple discussions to define the use case blueprint.

(ii) Develop use case concretisation report for the visualisation of carbon footprint through SDG discussions.

(iii) Develop a use case implementation plan.

(iv) Prepare for implementation of the use case by designing rules and technical specifications for the use case and identifying potential stakeholders to implement the use case.

Finally, the data-sharing platform will be discussed, with a focus on technical architecture and IT requirements necessary to implement the vision. The IT SDG is being launched, consisting of those with IT expertise and backgrounds related to data sharing. Discussions regarding the implementation of the data-sharing platform will soon begin.

(i) Launch separate SDG with IT expertise to discuss the direction of the data-sharing platform.

(ii) Verify technical architecture and IT requirements for data-sharing platform with IT SDG, and define directions for data-sharing platform implementation.

(iii) Prepare for implementation of the data-sharing platform by designing rules and technical specifications and identifying potential stakeholders to implement the data-sharing platform.

References

Anuroj, B. (n.d.), 'Thailand 4.0: A Value-Based Economy', presentation.

Asian Automotive Analysis (2020), 'Indonesia's Automobile Market in 2019: Overall Sales Declined 10.5% to 1.03 Million Units', 30 March.

Broom, D. (2022), 'Net-Zero: The Cost of $3.5 Trillion a Year', World Economic Forum, 28 January.

Catena-X.

Delta Thailand (2022), 'Empower Your Driving with DC Fast Charging', 31 May.

EMIS (2022a), *Indonesia Automotive Sector Report 2022–2023*, Rawdon, UK.

——— (2022b), *Singapore Infrastructure Sector 2021–2022*, Rawdon, UK.

Food and Agriculture Organization of the United Nations (FAO) (2008), *An Introduction to the Basic Concepts of Food Security*, Rome.

Government of Germany, Federal Ministry for Economic Affairs and Climate Action, What Is Industrie 4.0?

Government of Indonesia (2021), *The Implementation of Carbon Pricing to Achieve the Nationally Determined Contribution Target and Control over Greenhouse Gas Emissions in the National Development*, 29 October.

Government of Indonesia, Ministry of Communication and Information Technology (2021), *Indonesia Digital Roadmap,* Jakarta.

Government of Indonesia, Ministry of Industry (2018), *Making Indonesia 4.0*, Jakarta.

Government of Thailand, Ministry of Natural Resources and Environment (2022), *Thailand's Long-Term Low Greenhouse Gas Emission Development Strategy (Revised Version),* Bangkok.

Government of the United States, Department of Commerce (2022), Thailand Duty on Electric Vehicles, 21 March.

Government of the United States, Department of Commerce, International Trade Administration (2022), Singapore – Country Commercial Guide

Government of Viet Nam, Ministry of Information and Communications (2020), *National Digital Transformation Program*, Ha Noi.

IHS Markit (2021). ASEAN Powertrain and Electrified Vehicle Outlook

Indonesian Chamber of Commerce and Industry (KADIN) (2022), 'Overview of Automotive Sector in Indonesia', 13 March.

International Data Spaces Association (IDSA), Our Mission and Vision.

International Labour Organization (ILO) and UN Women (2020), 'Public Attitudes towards Migrant Workers in Singapore', *Research Briefs,* December, Bangkok.

International Organization of Motor Vehicle Manufacturers (IOMVM), 2021 Production Statistics.

Japan Bank for International Cooperation (2022), Trends of Major Industries and Effect of FTA.

Japan External Trade Organization (JETRO), Japan's Foreign Direct Investment.

——— (2022), 'Trade, Import and Export Values in 2021 Hit Record Highs', 1 February.

Lagas, B. (2015), 'Five Benefits of Embracing Sustainability and Green Manufacturing', National Institute of Standards and Technology, 10 September.

Langdon, C.S. (2021), 'Catena-X with GAIA-X: Will Data Space Be the Word of 2021?', press release, International Data Spaces Association, 3 March.

MarkLines, Thailand – Automotives Sales Volume 2021.

——— (2023), 'Arun Plus: The Beginning of the Electric Vehicle Industry in Thailand', 20 March.

MBA Skool (2011), Green Production: A Competitive Advantage for the Next Decade, 8 December.

Moret, B. and A. Schwertner (2020), 'Sustainable Manufacturing: Economic and Ethical Considerations', World Economic Forum, 4 August.

Nagle, K. (2022), 'What Is Green Manufacturing and Why Does It Matter?', Evocon, 26 May.

The Nation (2022), 'Plugging into the Future with EV Mobility', 13 May.

Organisation for Economic Co-operation and Development (OECD), About Sustainable Manufacturing and the Toolkit.

Samuel, P. (2020), 'US-China Trade War Inspires Vietnam Growth', *Vietnam Briefing,* 24 January.

Shrivastava, P. and S. Hart (2000), 'Greening Organizations', *International Journal of Public Administration,* 17(3&4), pp.607–35.

Siriruchatapong, P. (2016), Thailand Digital Economy and Society Development Plan, presentation for the International Telecommunication Union, April.

Situmorang, M. and A. Putri (2022), 'The Implementation of Carbon Economic Value in Indonesia: Key Points of Presidential Regulation No. 98 of 2021', Mondaq, 9 June.

Smart Nation and Digital Government Office, Transforming Singapore through Technology.

Teng, P. (2022), *Food Import: Reducing ASEAN's Dependency,* Singapore: S. Rajaratnam School of International Studies, Nanyang Technological University.

Thai News Agency (2022), 'Thailand to Build Nearly 1,400 EV Charging Stations by 2030', 7 August.

Thailand Board of Investment (2015), Thailand's Automotive Industry*:* The Next-Generation, Bangkok.

Tsui, J. (2019), 'Six Ways That Supply Chains Are Turning to Green Solutions', SupplyChainBrain, 26 November.

United States Environmental Protection Agency (EPA), Sustainable Manufacturing.

Vietnam Briefing, Tax Incentives for Foreign Enterprises in Vietnam.

Viet Nam Chamber of Commerce and Industry (VCCI) (2022), *Dynamic Capabilities of Vietnam Businesses: The Current Situation, Position in Global Value Chains and Implications for Multi-Stakeholder Partnerships,* Ha Noi.

Willard, B. (2012), *The New Sustainability Advantage: Seven Business Case Benefits of a Triple Bottom Line,* Gabriola Island, British Columbia: New Society Publishers.

World Food Programme, (2015), Hunger Map 2015.

Appendix

Expert Interview Details

1. Indonesia's Automotive Industry

Expert Interview 1

Date: 14 December 2022

Interviewee: Anonymous (The names are intentionally not indicated, since we have not obtained consent from the experts regarding the disclosure of personal information.)

Expert's job experience: Former vice president, PT Bridgestone Astra Indonesia

Questions:

- Who are the key players in each value chain?
- What is the current issue?
- Do the companies have good IT infrastructure and capabilities?
- What are major obstacles of promoting data sharing?

Expert Interview 2

Date: 6 January 2023

Interviewee: Anonymous

Expert's job experience: Former logistics supervisor, Astra International

Questions:

- Who are the key players in each value chain?
- What is the current issue?
- Do the companies have good IT infrastructure and capabilities?
- What are major obstacles of promoting data sharing?

2. Thailand's Automotive Industry

Expert Interview 3

Date: 15 December 2022

Interviewee: Anonymous

Expert's job experience: Former general manager operations, Summit Auto Seats Industry (Delhi)

Questions:

- Who are the key players in each value chain?
- What is the current issue?
- Do the companies have good IT infrastructure and capabilities?
- What are major obstacles of promoting data sharing?

Expert Interview 4

Date: 5 January 2023

Interviewee: Santosh Kumar Pandey

Expert's job experience: Head, Business Development Overseas, Thai Summit; general manager, Business Development, Purchase, and Human Resources, Thai Summit India

Questions:

- Who are the key players in each value chain?
- What is the current issue?
- Do the companies have good IT infrastructure and capabilities?
- What are major obstacles of promoting data sharing?

3. Viet Nam's Electronics Industry

Expert Interview 5

Date: 20 December 2022

Interviewee: Anonymous

Expert's job experience: Former supply chain system analyst, Onsemi

Questions:

- Who are the key players in each value chain?
- What are the major pain points in Viet Nam's electronics industry?
- What are major obstacles of promoting data sharing?

Expert Interview 6

Date: 16 January 2023

Interviewee: Anonymous

Expert's job experience: Head of business at global electronics maker

Questions:

- Who are the key players in each value chain?
- What are the major pain points in Viet Nam's electronics industry?

- What are major obstacles of promoting data sharing?

Expert Interview 7

Date: 18 January 2023

Interviewee: Anonymous

Expert's job experience: Former head, Research and Development, Samsung

Questions:

- Who are the key players in each value chain?
- What are the major pain points in Viet Nam's electronics industry?
- What are major obstacles of promoting data sharing?

4. Singapore's Logistics Industry

Expert Interview 8

Date: 7 February 2023

Interviewee: Anonymous

Expert's job experience: Former head, International Post and Parcel, Singapore Post

Questions:

- Who are the key players in each value chain?
- What is the current issue?
- Can Singapore's logistics industry solve current problems by data sharing?
- Do Singapore's logistics industry taking actions to monitor and to reduce carbon footprint?

Expert Interview 9

Date: 13 February 2023

Interviewee: Anonymous

Expert's job experience: Former director, Global Business Development E-Commerce, DB Schenker

Questions:

- Who are the key players in each value chain?
- What is the current issue?
- Can Singapore's logistics industry solve current problems by data sharing?
- Do Singapore's logistics industry taking actions to monitor and reduce carbon footprint?