CHAPTER 1

Enhancing ASEAN Connectivity through Space and Geospatial Technology

Space and geospatial technology (SGT) is an intelligence technology that enables the global monitoring of a wide range of parameters such as the distribution of facilities and buildings; the movements of cars, ships, aircraft, and people; environmental change; or post-disaster economic development processes. While geospatial technology was originally developed for military and security use, it has been, in recent years, quickly advanced as a general civil technology. It is now widely applied in the field of public services (e.g. disaster response, social infrastructure management, traffic management), business support (e.g. marketing), and personal mobility services (e.g. navigation). The extensive use of low-cost and high-performance mobile devices such as smartphones has further accelerated its popularisation all over the world. Subsequently, the development of the Internet of Things (IoT) and Artificial Intelligence technologies have enabled researchers to conduct deeper analyses and quicker and broader information collection. In this regard, geospatial technology is expected to expand its utilisation and development much further.

This chapter is organised as follows:

1. Define and introduce generally the potential of SGT in various fields.
2. Present the original application of SGT (disaster management) and its wider potential for economic strengthening.
3. Develop more concrete considerations on the use of SGT and data sharing to advance towards a data-driven Association of Southeast Asian Nations (ASEAN).

The Immense Potential of SGT

This section aims to introduce the concept of SGT and briefly present its general applications.

What is SGT?

The rise of intelligence technologies resulted in the development of the following three technological areas of space infrastructure:

- Satellite-based earth observation technology – monitoring occurrences all over the world;
- Positioning technology – measuring and tracking precise positions in real time; and
- Communication technology – connecting almost instantly every single part of the world.

The most important application of space infrastructure (observation, positioning, and communication) is what is called geospatial technology. Geospatial technology is a global information technology that provides services anywhere using dynamic information on physical aspects, socio-economic demographics, and environmental aspects of the world. The technology is very naturally enhanced by space infrastructure, as illustrated in Figure 1, to cover the world in a seamless manner. Therefore, the improvement in the performances of space infrastructure directly leads to geospatial services. It is then primordial to simultaneously advance the research and development, operations, and use of the both technologies. SGT is the combination of space infrastructure with geospatial technology, which constitutes the core of this book.

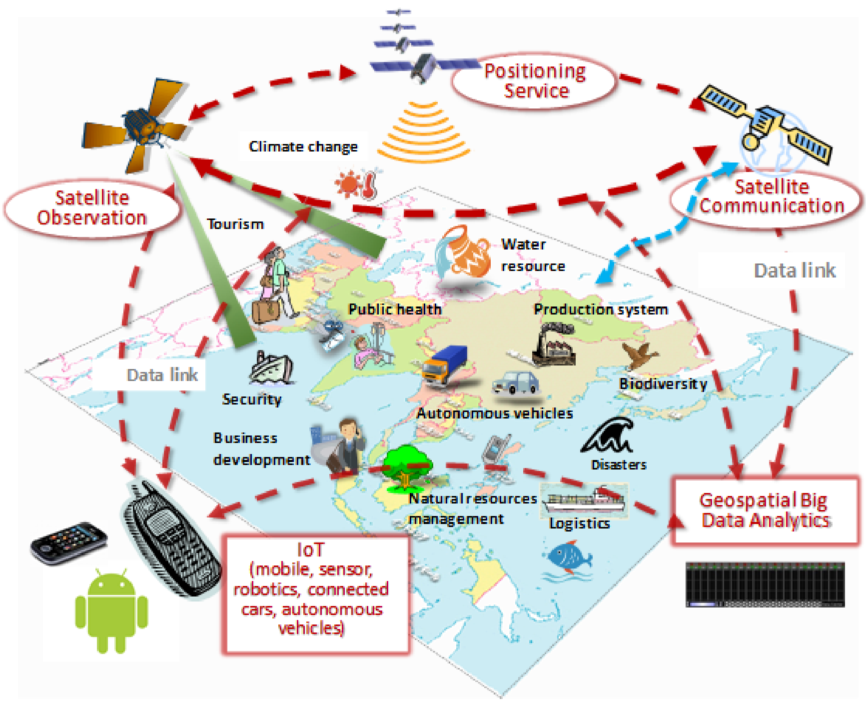
SGT could provide diverse information services using 'real-world data'. More concretely, in the context of this book, the major services and contributions of SGT could be summarised in the following four aspects:

1. Real-time localisation and tracking of people, cargoes, and vehicles (air, sea, and land).
2. Real-time monitoring of environmental and contextual information covering all land and sea such as: dynamic maps (traffic, congestion, people flow, and city changes) or environmental changes (weather, water and air quality, and greenery) from which events, accidents, and disasters

can be extracted. Silent but meaningful changes such as climate change and crustal deformation can be included.

3. 'Ubiquitous' data communication at any time/anywhere with small IoT devices to collect data from and send instructions/guidance to people and machines in the field.
4. High-precision mapping of three-dimensional (3D) space and landscape framing activities of people and autonomous vehicles/machines, which could include very slowly moving phenomena like crust movement monitoring.

Figure 1: Space Infrastructure and Technologies Supporting SGT



IoT = Internet of Things, SGT = Space and Geospatial Technology.

Source: Prepared by the authors.

Satellite observation is extremely flexible and globally applicable compared with the airborne observation performed by aircraft or drones, which are limited by airspace restriction, small coverage, and limited flight time. Real-time positioning by satellites can be performed by compact and inexpensive portable terminals, currently installed in almost all smartphones as well as in most vehicles, airplanes, or ships. Therefore, the mobility data of people, vehicles, ships, and aircraft are widely available.

Geostationary satellites are commonly used for data communication. However, the sufficient miniaturisation of ground transceivers combined with the use of the low earth orbit satellites constellation will increase access to efficient communication and dramatically reduce costs in the near future. Therefore, data communication services or IoT-based data collection and dissemination will be available everywhere, as long as the sky is visible.

Generic example of SGT application

Such a technological environment can be simultaneously established all over the world, allowing the promotion of a broad range of services in various countries and regions.

For instance, small portable terminals equipped with Global Navigation Satellite Systems (GNSS) receivers are commonly distributed on land and sea, such as the smartphones that are widely distributed in most countries around the world. Also, the use of black boxes on most ships and aircraft – devices that combine a GNSS receiver with a wireless communication system, which constantly transmits its position – improved the collection of locational information of commercial vehicles. Finally, the development of IoT has allowed the collection and dissemination of data from various sensors scattered in fields.

As described above, the use of space infrastructure enables us to understand the movements of individual persons, vehicles, and cargoes. Furthermore, satellite imagery analysis helps visualise the background information or reasons behind people's behavioural changes such as traffic congestion, disaster situations, construction of buildings and infrastructure, and changes in agricultural land.

While the easy gathering of production-related information within factories has greatly contributed to the optimisation of production processes, the collection of information related to external environment changes such as traffic jams, people flow, and disasters, was hard to obtain. This is the reason the optimisation of industrial activities and production processes is limited to the inside of factories and not the entire production system consisting of factory networks and logistics. SGT can help collect this kind of information to better understand the overall situation and facilitate tighter cooperation between the various actors of the manufacturing and logistics sectors, leading to optimisation of industrial activities on a broader scale.

Finally, for actors that are mostly involved in outdoor tasks such as construction, agriculture, fishery, and forestry, SGT enables the acquisition of very accurate locational and situational information for further optimisation and automation

The Various Roles of SGT

One of the original targets for the general civil application of SGT is disaster response. Based on an extensive number of previous studies and famous achievements in this field, it has been confirmed that SGT can be applied to the strengthening of the socio-economic system and the development of efficient Disaster Risk Management (DRM) in ASEAN.

In this section, we first examine the use of SGT in the field of DRM and then discuss more generally the importance of data sharing in ASEAN countries.

SGT for disaster management in ASEAN

The Asia–Pacific region, the most populated region on Earth with more than 4.5 billion people, is also the daily theatre of the planet's deadliest disasters. The strong impacts of disasters in the Asia–Pacific region do not simply refer to the intensity of these unfortunate events but also to the set of systemic weaknesses of Asian countries: economic and financial fragility, galloping urbanisation, exploding demography, or lack of proper land use planning.

One of the main reasons for the vulnerability of the Asia–Pacific region to disasters is its demography. According to the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP), the Asia–Pacific is the most populated area in the world, with more than 4.5 billion inhabitants in 2016 (UNESCAP, 2016). The region has most of the world's largest metropolises. In 2016, the United Nations estimated that 18 of the world's 31 megacities (cities with more than 10 million inhabitants) were in Asia–Pacific and that this number is expected to reach 24 out of 41 in 2030 (UNESCAP Population Division, 2016). These high densities of population, often located around riverside flood areas, along coastlines at risk of tsunami, or at the base of landslide-prone mountains, put large numbers of human life in jeopardy.

In its 2015 Asia–Pacific Disaster Report, UNESCAP drew a sad portrait of the region. Between 2005 and 2014, 1,625 incidents had been reported. Most of these disasters were floods, followed, in order, by storms, earthquakes, tsunamis, and landslides.

These disasters had a dramatic impact on the region's human security by killing almost half a million inhabitants and directly affecting the lives of approximately 1.4 billion people (see Table 1). Moreover, beyond long-term economic impact due to the loss of workforce as well as the increase in spending for health-related issues, the 1,625 disasters generated direct economic damage amounting to US$523 billion.

Table 1: Human Impact of Disasters in Asia and the Pacific, 2005-2014

Disaster type	Lives lost	People affected (millions)
Earthquakes and tsunamis	199,418	74
Storms	166,762	321
Floods	43,800	771
Others	73,722	199
Total	483,752	1,366

Source: The Asia–Pacific Disaster Report 2015, Disasters without Borders, United Nations Economic and Social Commission for Asia and the Pacific.

Finally, the UNESCAP report stressed that although these numbers are enormous, they may be underestimated due to a lack of reliable disaster data gathering initiative (UNESCAP, 2015).

Beyond natural disasters, strengthening food and water security is a priority for development organisations operating in the region. According to an Asian Development Bank (ADB) report on food security, in 2010 more than 700 million people in the Asia–Pacific survived on less than US$1.25 per day in an environment where high and volatile food prices caused 537 million of these people (62% of the world population) to suffer from hunger (ADB, 2013). Moreover, as 80% of water resources are still exclusively used for agriculture, the region is particularly affected by water insecurity: 1.7 billion people do not have access to basic sanitation, 80% of wastewater is directly dumped into rivers, lakes, or seas with almost no treatment (ADB, 2016). In terms of economic development, it is estimated that the annual global cost of water insecurity is US$500 billion, corresponding to a loss of more than 1% of global gross domestic product (Sadoff et al., 2015). It goes without saying that the dramatic advance and intensification of climate change will considerably amplify all these issues as well as many others, including water level increase, desertification, scarcity of available water resources, climate refugees/migrations, or the intensification of large-scale meteorological disasters. Finally, the United Nations Children's Fund recently raised an alarm about the increasing dangers posed by air pollution. According to the UN agency's data, more than two billion children live in areas where outdoor air pollution levels exceed the World Health Organization's guidelines, including 1.07 billion in Asia–Pacific. Moreover, every year air pollution kills 600,000 children under 5 years old.

It is therefore very important for ASEAN to develop and implement ambitious disaster risk management policies and strategies based on SGT. The following steps describe how SGT will contribute to DRM via real-time tracking, monitoring, mapping, and ubiquitous data communication capabilities:

- Monitoring and forecasting hazards at the local to regional scale, typically heavy rainfall, flooding, typhoon, drought, and tsunami, allowing governments and people to know what could happen.
- Anticipating risks or damage to human lives and economic activities by overlaying the hazard prediction on the data of people distribution/activity information, vehicle movement, and economic activity distribution/intensity.
- Mitigating damage by guiding the evacuation of people based on people distribution data and helping in the reconstruction of people's lives and economic activities.
- Improving preparedness by providing realistic simulations and trainings on DRM based on the historical records of disasters and reconstruction processes.

The capabilities described above are made possible by sharing data amongst governmental agencies, private industries, non-profit organisations, and people. In this regard, SGT and more generally data sharing can play a prominent role, as clearly stated in the ASEAN Agreement on Disaster Management and Emergency Response (AADMER) Work Programme 2016–2020 (ASEAN Secretariat, 2016):

> *Promote regional standards, including methodologies and tools to assess, record, calculate the disaster losses and damage, and share non-sensitive data and create common information system to enhance interoperability, ensure unity of action, and strengthen resilience.*

It should therefore be smartly and strongly designed, not only for disaster management, but for multipurpose uses, aimed at strengthening the regional socio-economic environment. Furthermore, beyond the impact of the system, it should be made in an economically sustainable way, which is a significant challenge.

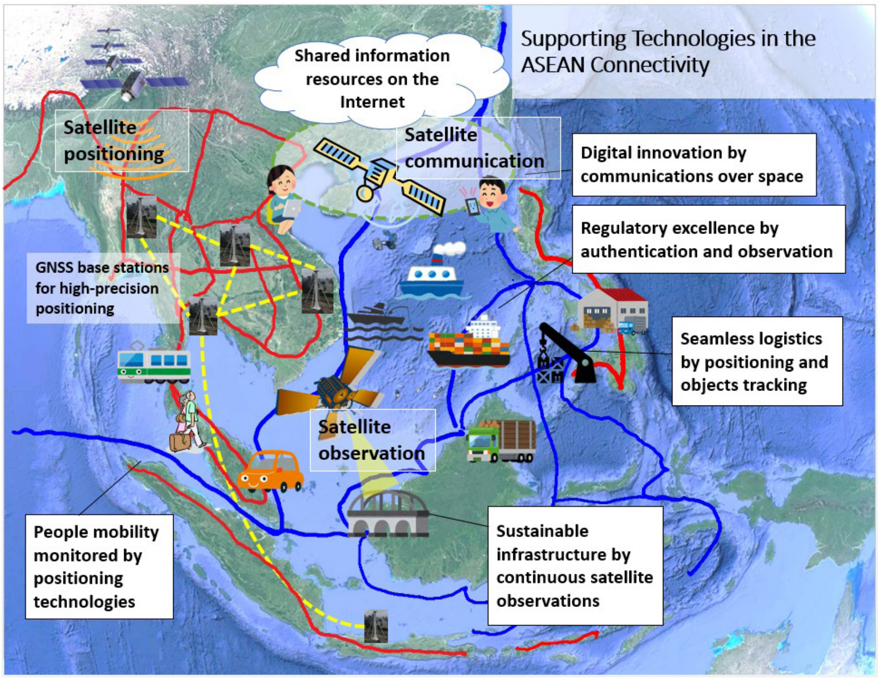
SGT for economic strengthening through enhanced connectivity

As explained above, the potential of SGT incites users to go further than immediate issues like disaster by using it as an ambitious tool at all levels of the economy.

SGT largely contributes to decision-making processes amongst governments, companies, communities, cities, and individuals in various contexts by providing necessary information. As SGT enhances the economy and facilitates 'smartification' or 'optimisation' across various kinds of 'borders', such as the border between the inside and outside of a factory, and borders amongst companies and regions/countries, it is extremely effective to connect all actors of ASEAN more tightly. Therefore, this study examines the possible contributions of the SGT system and data infrastructure to strengthen ASEAN connectivity.

Furthermore, strengthening ASEAN connectivity is also essential for the cross-border utilisation of SGT. Therefore, the study also provides policy recommendations aimed at the enhancement of ASEAN connectivity, such as transboundary data transfer policy to maximise the use of SGT.

Figure 2: Supporting Technologies in the ASEAN Connectivity



ASEAN = Association of Southeast Asian Nations, GNSS = global navigation satellite systems.

Source: Prepared by the authors.

Therefore, this book addresses a common platform and infrastructure of SGT to enhance ASEAN connectivity and help realise human development, resiliency, and sustainable development. The sustainability of the system will reside in its value-creation process.

The approach of this book is perfectly in line with the ambitious Master Plan on ASEAN Connectivity 2025 or MPAC-2025 (ASEAN Secretariat, 2016). Adopted in 2016, it targets the following sectors as main contributors to ASEAN connectivity strategies: sustainable infrastructure, digital innovation, seamless logistics, regulatory excellence, and people mobility. SGT can contribute to these strategies by addressing common issues, developing common interests, and creating common infrastructures.

In addition, in the ASEAN Socio-Cultural Community Blueprint 2025 or ASCCB-2025 (ASEAN Secretariat, 2016), SGT is expected to make ASEAN more:

- Sustainable through its application to biodiversity conservation, climate change, urbanisation, production, and consumption.
- Resilient through disaster response and health care.
- Dynamic through science and technology development.

These strategies and solutions can be efficiently expanded to the entire ASEAN region, thanks to the extensiveness, immediacy, and transboundary nature of space technologies.

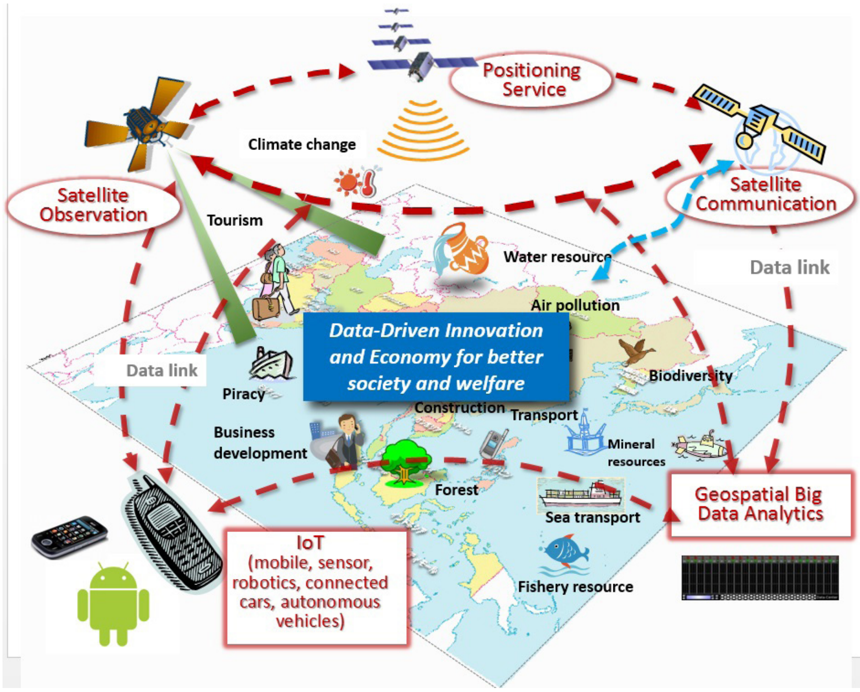
Specifically, while levels of ground infrastructure maintenance greatly vary with the degree of economic development, a space system can provide the same information and services to the whole region. Therefore, strategies and good practices obtained from MPAC-2025 and ASCCB-2025 can be freely applied to ASEAN countries by overcoming national infrastructural limitations.

Towards a Data-driven ASEAN

At the end of 2015, the Organisation for Economic Co-operation and Development (OECD) published a major report entitled Data-Driven Innovation – Big Data for Growth and Well-Being. It stated that 'digitalisation' and data conversion of various activities will advance innovation, and that a new economy will be developed accordingly (OECD, 2015).

The existing common infrastructures (communication and meteorological satellites) and the traditionally dynamic interactions (trade, information sharing, and interaction) in the ASEAN region make ASEAN the perfect place for the emergence of the upgraded version of data-driven innovation economy (DDIE). By removing physical restrictions, SGT will support ASEAN transformation into a DDIE 2.0.

Figure 3: Data-Driven Innovation and Economy through SGT



IoT = Internet of Things, SGT = Space and geospatial technology.

Source: Prepared by the authors.

The tremendous economic potential of SGT

To better understand the prominent role that could be played by SGT in promoting innovation in ASEAN, let us look again at MPAC-2025. In its focus on digital innovation, it claims that:

Disruptive technologies (particularly mobile Internet, big data, cloud technology, the Internet of Things, the automation of knowledge work and the Social-Mobile-AnalyticsCloud or SMAC) could unleash some US$220 billion to US$625 billion in annual economic impact in ASEAN by 2030 (ASEAN Secretariat, 2016).

In other words, it is SGT that will help unleash these hundreds of billions of US dollars, which may be generated from increased efficiency, new products and services, and much more.

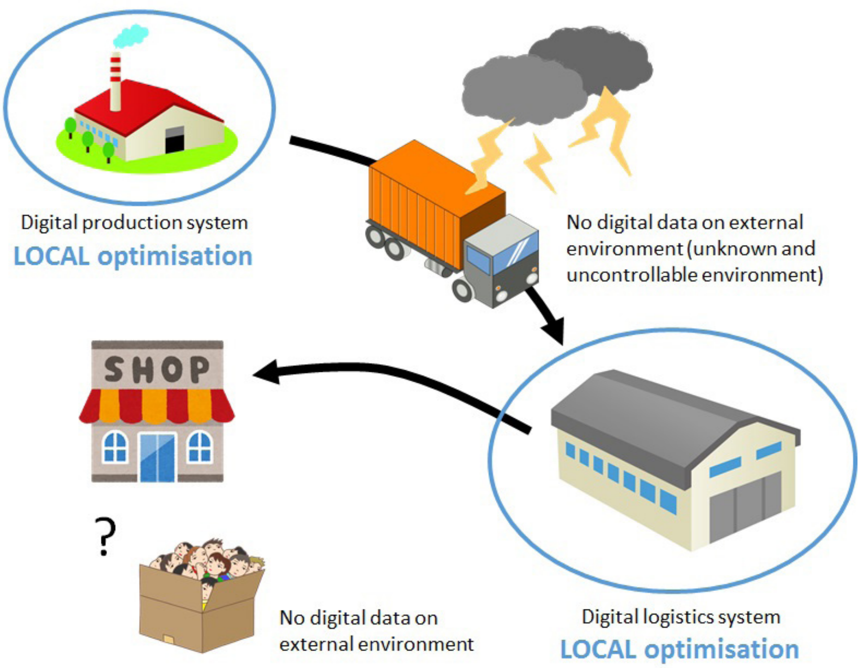
From local to global optimisation

As briefly explained above, one of the greatest strengths of SGT is its capacity to go beyond local optimisation, at factory level, to achieve global optimisation – considering dynamically changing external factors and interrelations.

The use of digital technology for monitoring and control within factories is already well developed, allowing an optimal use of resources and means of production for the production system in a factory.

However, information sharing such as logistics between the factory and its partners (distributing networks, providers, etc.) is very insufficient. Any logistical irregularity will impact the whole production system independently from the quality of the local optimisation within the factory.

Figure 4: Local Optimisation



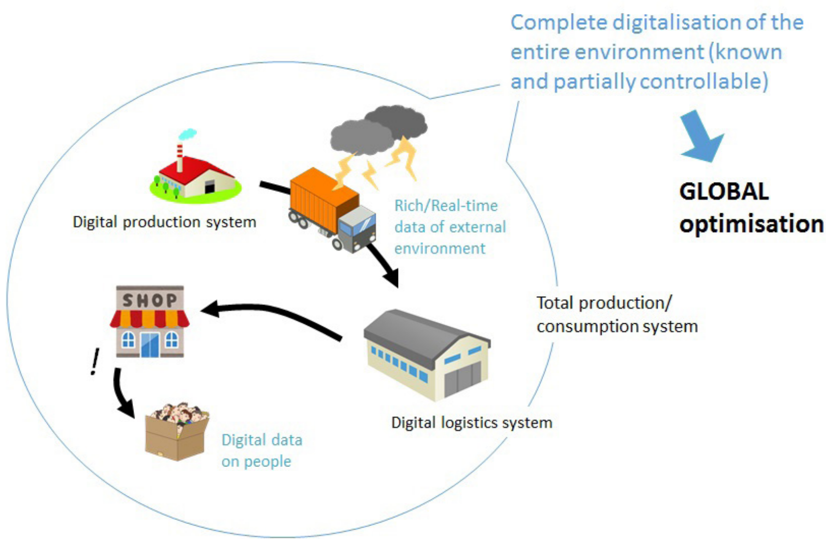
Source: Authors.

Therefore, changes in the external environment can be major risks when data cannot be obtained, showing the limits of local optimisation, as described in Figure 4. While the external environment cannot be directly controlled, if real-time data can be obtained, the production system can be adapted to the changes and the risks can be significantly reduced.

Furthermore, in sectors organised around outdoor activities, such as construction, agriculture, forestry, and fishery industries, sufficient information required for production cannot be easily obtained.

SGT seamlessly digitalises all spaces including external environments. It is therefore possible to optimise the entire system by considering external environmental changes. Figure 5 expresses this idea.

Figure 5: Global Optimisation

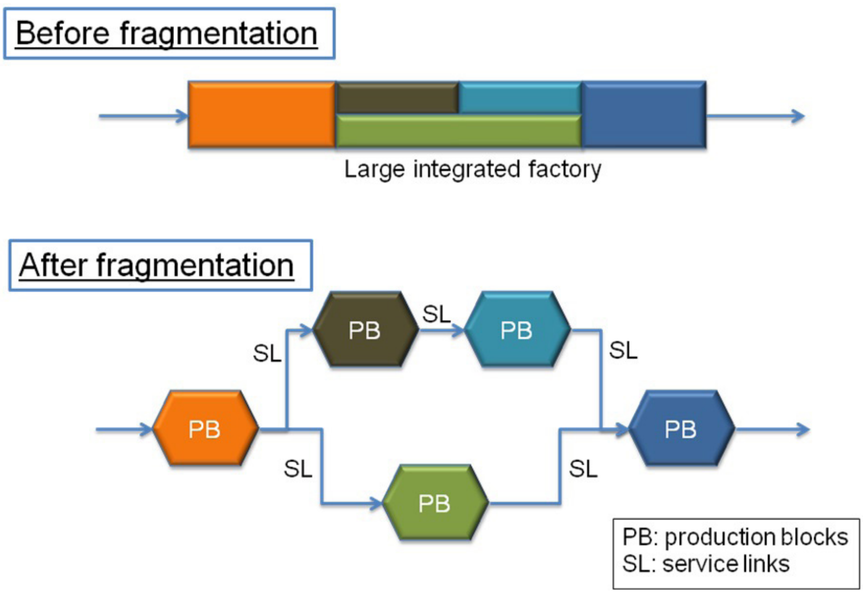


Source: Authors.

Achieving the third unbundling

In the current ASEAN situation, without widespread SGT applications, the optimisation process of the whole production system connecting companies is extremely complicated as the external environment is largely unknown. As a result, companies try to optimise their own production as much as possible by incorporating into a single organisation (e.g. factory) all productive actors, thereby drastically reducing unbundling. Figure 6 shows the concept of unbundling in production and industrial systems.

Figure 6: The Concept of Unbundling



PB = production blocks, SL = service links.

Source: Comprehensive Asia Development Plan Research Team, Economic Research Institute for ASEAN and East Asia.

However, if sufficient digital data on the external environment are obtained, it is possible to control the whole production system for optimisation by incorporating the external changes. As a result, it is not required to build up each component of a production system in the company. Unbundling of the production system can be advanced to a large scale.

While a change in logistics, thanks to SGT, accelerates the second unbundling – the spatial separation of production blocks – it is expected that the spatial separation of engineers and managers involved in the production will also be further accelerated. This third unbundling will be achieved through the digitalisation of production systems, which is the digitalisation of people, goods, and real-time monitoring.

Conclusion: Enhancing ASEAN digitalisation and connectivity with SGT

In summary, data-driven innovation as proposed by the OECD is a general concept stating that industrial innovation will be developed through data utilisation.

On the other hand, SGT effectively facilitates the optimisation of the whole economic system – production, consumption, services, etc. – by digitalising the external environment of individual production and business activities.

In ASEAN, where sudden external environmental changes, such as disasters, frequently occur, DDIE associated with SGT plays a significant role. Understanding such changes is not only important for the optimisation of production systems but is also essential for improving social welfare, including life stability and safety of local populations.

It can therefore be said that SGT will rapidly strengthen the interconnectivity of ASEAN countries. As a result, it will strongly support industrial innovation, economic advancement, and social welfare.

In short, SGT will create immense value through the realisation of the Data-Driven Innovation and Economy 2.0 and the Third Unbundling in ASEAN.