Chapter 5

Measuring Cross–Cutting Factors Influencing Institutional and Innovation Efficiency for I4R

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CHAPTER 5

Measuring Cross-Cutting Factors Influencing Institutional and Innovation Efficiency for Industry 4.0 and the Circular Economy

Jootae Kim and Ick Jin

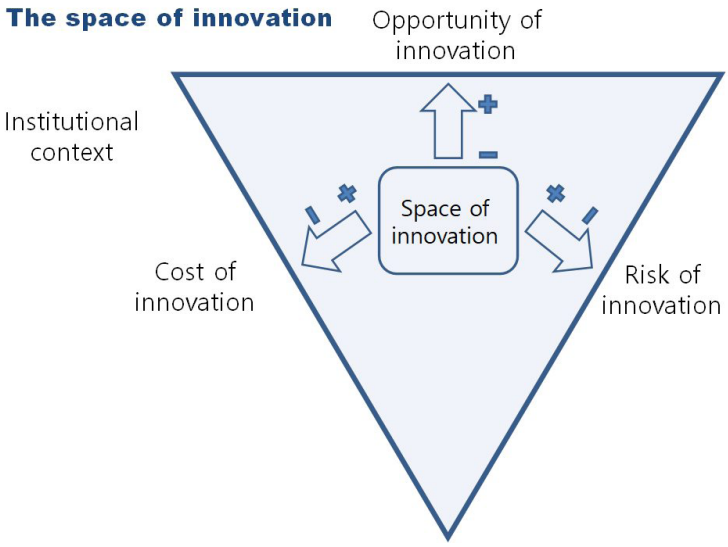
1. Introduction

The objective of this chapter is to develop a series of measurement frameworks to show how ready a country is for Industry 4.0 (I4) and the circular economy (CE). I4 reflects the degree of digital transformation of a country, and the CE is a path leading to sustainable development. Sustainability is a very critical topic for the current human society. The circular economy is an umbrella term used for industrial processes and business models that do not generate waste but instead reuse natural resources repeatedly. At its core, the circular business is about economics and competitiveness (Anbumozhi and Kimura, 2018). At the firm level, higher resource efficiency is sought through the '3Rs': reduce consumption of resources, reuse resources, and recycle the by-products. New, digitally-enabled technologies include advances in production equipment, such as 3D printing and advanced robotics; smart finished products, such as connected cars and home appliance systems using the Internet of Things (IoT); advanced analytics, such as big data analytics and analytics across the global value chain; and human–machine interfaces, such as picking technology using augmented reality and artificial intelligence, etc. These digital technologies can contribute towards the circular economy. Most aspects of human life will be changed from the adoption of digital technologies, and resource circularity is also an area where these technologies can contribute.

1.1. Institutional Efficiency

Some countries are prepared for the introduction of I4 and the CE, but other countries lack good environments to enable these innovations. There are many cross-cutting factors that influence the readiness for I4 and the CE of a country. Some cross-cutting factors are proxies to measure institutional efficiency and innovation efficiency in a country. In a country with high institutional efficiency, the introduction of I4 and the CE may be easier. Many cross-cutting factors can be considered to measure institutional efficiency. I4 is achieved from continuous innovative efforts and exponential growth. The overall institutional environments of a country can influence the performance of automation and connections through information and communications technology (ICT) technologies (North, 1991). Some factors in a country may be helpful for innovation, but other factors may be obstacles against innovation (Peng, 2002). Institutional efficiency in a country can be evaluated. Figure 5.1 explains the relationship between institutions and innovation. The performance of innovative efforts is determined in the context of an institutional environment. Innovations can create technologies that can transform the circularity of economic activities. But, institutions are needed to create business practices, market design, regulation, and policy instruments, as well as finance to make innovation happen. Institutional efficiency for designing I4 and the CE necessitates consumer engagement, supply-side management, and demand responses. Generally, institution environments are made up of formal institutions, such as laws and regulations, and informal institutions, such as culture. As shown in Figure 5.1, these institutions can function as the opportunity, cost, or risk for the success of innovative efforts. As an example, the Uber service is widespread in many countries, but in some countries, it is prohibited or delayed by the government because of pressure from the stakeholder groups of taxi drivers. In this case, the interests of taxi drivers and the law are the cost or risk for the introduction of Uber. Car-sharing services, such as Uber, use digital technologies and contribute to resource saving and carbon emission reduction.

Figure 5.1: Innovation and Institutions

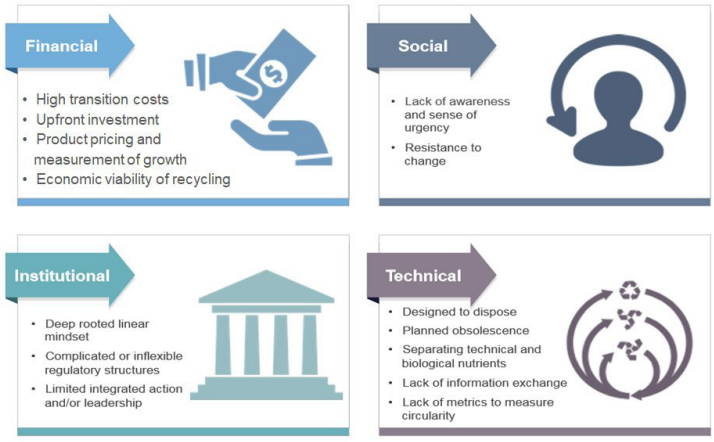


Source: Zhu, Wittmann, and Peng (2012).

1.2. Common Obstacles

To find the diverse institutional factors to determine the readiness for I4 and CE, we must consider what obstacles usually exist against the introduction of I4 and the CE. Figure 5.2 and Figure 5.3 show the major obstacles to successfully introducing I4 and the CE.

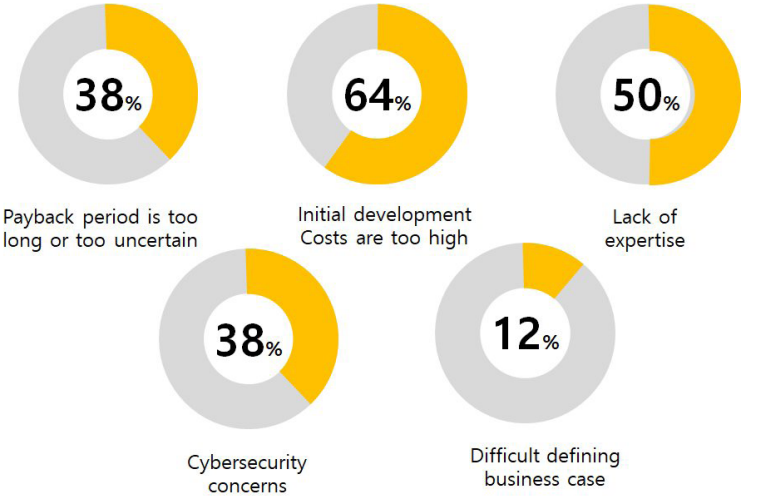
Figure 5.2: Obstacles to the Circular Economy



Source: World Economic Forum (2018).

There exist four categories of challenges against pursuing the circular economy. The first obstacle is the financial hurdle. To achieve any innovation in our society, financial investment is the key requirement. The CE is a new approach in human society, and, therefore, it requires an economic paradigm shift for changes in human behaviour and attitudes. Lack of awareness or social resistance should be considered as possible responses from ordinary people. An existing linear mindset or regulatory structure can limit the adoption of new concepts. Another basic problem is the need for innovative technologies. A large volume of investments is required to obtain advanced technologies.

Figure 5.3: Obstacles to Industry 4.0



Source: Churchill (2018).

The obstacles to a successful I4 in Figure 5.3 are summarised as financial, technology, and security concerns.

1.3. Institutional Efficiency in the ASEAN Region

The main objective of this book is to analyse the readiness for I4 and the CE in Association of Southeast Asian Nations (ASEAN) countries. The ASEAN region is one of the fastest-growing regions in the world, with a population of over 625 million and a combined nominal gross domestic product (GDP) of over US$2.6 trillion in 2015. Of the 10 ASEAN nations, Singapore and Brunei Darussalam are classified by the

World Bank as high-income (non-Organisation for Economic Co-operation and Development (OECD) countries); Malaysia and Thailand as upper-middle-income countries; Indonesia, the Lao People's Democratic Republic (Lao PDR), Myanmar, the Philippines, and Viet Nam as lower-middle-income countries; and Cambodia as a low-income country. This suggests that there is heterogeneity amongstst the ASEAN Member States from an economic development perspective (Ramanathan, 2018). The institutional efficiency of ASEAN countries seems to be lower than that of other advanced economies such as Japan or the European Union (EU). Unstable political systems, inconsistency of government policies, less-developed economies, different cultural environments, and low-level industry/technology advancement represent the institutional limitations of ASEAN countries in limiting the successful implementation of I4 and the CE (Kim, 2018a). The Global Competitiveness Report (2015–2016) (World Economic Forum, 2016) provides considerable information on the status of critical indicators of what it refers to as the 'pillars of development' of nations. Basic requirements are measured by the items of institutions, infrastructure, macroeconomic environments, and health and primary education. The overall ratings from this measurement are above 5.0 for Japan, Germany, the Republic of Korea (henceforth, Korea), and China, with the highest being 7, but for ASEAN countries except Malaysia and Singapore, the overall ratings are below 5 (Ramanathan, 2018). China has been experiencing very rapid economic development during the last 3 decades. The Chinese government is trying to upgrade the institutional environment to increase the speed of economic development. It is said that the formal institutions, such as laws and regulations, can be modified relatively quickly, but it takes a long time to change the informal institutions, such as culture. Most countries try to change their laws to adapt to new environments. Even if laws or formal processes are changed by the government quickly, it takes time to spread the changes to the real lives of ordinary people. Many ASEAN Member States may perform institutional transition, but for the real transition, the recognition and preparation of the ordinary people must be made. Table 5.1 evaluates various institutional aspects of China in relation to innovation efficiency. China has been working significantly for its institutional transition, and the institutional efficiency of China is understood to be slightly better than that of ASEAN. The summary of the institutional obstacles in China in Table 5.1 can give some implications for the understanding of ASEAN institutions and, furthermore, for the improvement of them.

Table 5.1: Institutional Barriers to Innovation in China

	Cost of Innovation	Risk of Innovation	Opportunity for Innovation
Competition Fairness			
No priority for government procurement	+		-
Difficult to start a business	+		-
Poor enforcement of the Unfair			
Competition Law	+	+	-
Regional protectionism	+		-
Access to Financing			
Difficult to get bank credit	+		-
High barrier for capital market	+		-
Lack of venture capital, especially angle capital		+	-
Hard to access to public sources of funding	+		
Tax Burden			
Current value-added tax (VAT) system	+		-
Pro-innovation tax system	-	-	+
R&D tax credit policy	-	-	+
Laws and Regulations			
Extra entry barriers	+		-
Unclear assess to intangible collateral	+	+	-
Weakness of property rights			-
Lack of regulations and/or concrete regulations at operational level	+	+	-
Ambiguity of property rights and			
creditors' rights in the event of bankruptcy	+	+	-
Inconsistent policies		+	
Lack of regulations to protect non-technological innovation	+	+	-

	Cost of Innovation	Risk of Innovation	Opportunity for Innovation
Public Supporting Systems			
Lack of infrastructure	+		-
Lack of linkages with public research institutes	+	+	-
Deficiencies in the availability of external services	+	+	-
Lack of information on markets	+	+	-
Lack of information on technology	+	+	-
Short of training and education	+		-
Lack of intermediary to provide services for SMEs	+	+	-

R&D = research and development, SME = small and medium-sized enterprise.
Source: Zhu, Wittmann, and Peng (2012).

2. How Do Cross-cutting Factors Relate to the Overall Industry 4.0 Readiness Measurement and the Enabling Environment?

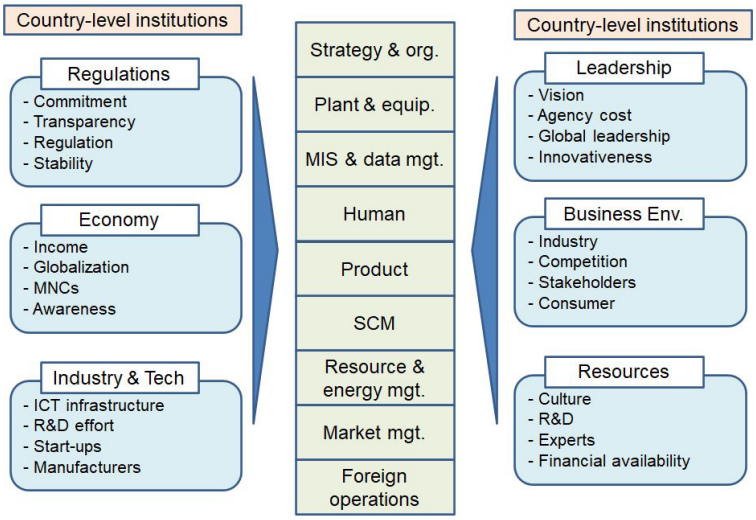
To exploit the full potential of I4 and the CE, cyber-physical systems need to be communicated internally within modular structured factories and offices, along with cooperation across participants in the value chain. In a corporation, I4 and the CE are realised through the internal processes in factories and offices. The adoption of digital technologies in the manufacturing process and office environment can bring about not only cost reductions but also resource savings and recycling effects. I4 and the CE can also occur in transportation and storage. For raw material sellers and distribution channels existing within the value chain, I4 and the CE need to be realised. This is one of the reasons why we try to measure the institutional readiness for I4 and the CE. A model is presented to measure such institutional readiness for I4 and the CE for ASEAN Member States.

The institutional readiness model is based on six dimensions for I4 and the CE. The six dimensions correspond to universally applicable dimensions to be taken into account: the first 3 dimensions at country (macro) level (regulations, economy, and industry and technology), and other the dimensions at the corporate (micro) level (leadership, business environment, and resources). Each of these six dimensions is further delineated into four factors to be operationalised with the appropriate indicators.

They form the basis for measuring the institutional readiness for I4 and the CE of ASEAN Member States.

Figure 5.4 provides an overview of the institutional readiness model: six boxes show the six basic dimensions. The bullets in each box show the items associated with each of the six dimensions. A total of 24 items are evaluated using the appropriate qualitative and quantitative indicators. The green pillar at the centre represents the relevant factors at the corporate level discussed in the previous chapter.

Figure 5.4: Cross-cutting Factors for the Readiness for Industry 4.0 and the Circular Economy



MIS = management information system, MNC = multinational corporation, R&D = research and development, SCM = supply chain management.
Source: Authors.

The vision of I4 and the CE and the path to this vision will be different for each country. Not every country has a short-term ambition to implement the full target vision of I4. Countries define their own interim and final goals based on their own background and status quo. For this reason, 24 factors of I4 and the CE are used to develop a five-level score for measuring the readiness. Each of the five readiness levels (0–4) includes minimum requirements that must be met to complete the level.

The five levels of the institutional readiness model can be described as follows. Level 0 describes the situation where countries have done nothing or very little to plan or implement I4 and CE activities with respect to the relevant item. A country at this level does not meet any of the requirements for I4. Level 0 is also automatically assigned to those companies that indicated I4 and the CE were either unknown or irrelevant for them. In contrast, Level 4 describes the situation where countries have successfully implemented all I4 and CE activities in terms of the item. In other words, Level 4 of the model means a state of full implementation of the target vision when entire value chains are integrated in real-time and can interact.

2.1. Country-level Factors

1) Regulation

a. Political leadership (or presidential commitment)

For the institutional readiness of I4, the political leadership (or presidential commitment) is an important item in the regulation dimension. The strong vision and commitment of a leader are necessary. At Level 0, the political leadership does not show any interest in I4. At Level 1, the political leadership comments on I4 and the CE sometimes, but does not have a critical agenda on it. At Level 2, the political leadership stresses the importance of I4 but does not offer various programmes for it. At Level 3, the political leadership presents various plans for I4, but those plans are not feasible to be implemented. At Level 4, the political leadership formulates quite realistic and feasible plans for I4.

b. Transparency (and democracy)

For the institutional readiness of I4, the transparency of the political system (and democracy) is another important item in the regulation dimension. At Level 0, a country faces severe corruption and unfair competition. At Level 1, a country is trying to reduce corruption, but some adaption to corruption is inevitable for businesses in reality. At Level 2, a country recognises that some informal factors affect competition. At Level 3, corruption is sometimes found but it is not a serious problem any longer. At Level 4, competition is transparent by and large and the level of corruption related with business operations is very low.

c. Business regulations

In many developing countries, it is said that too many regulations exist and lessen the effect of the innovative efforts of the private sector. Governments should try to reduce unnecessary regulations to make innovative efforts easier. At Level 0, business regulations are a serious hurdle to private firms and many experts advise that a regulation reform is necessary. At Level 1, businesspeople make many complaints about the business regulations. At Level 2, businesspeople sometimes raise concerns about regulatory inefficiency. At Level 3, businesspeople hardly feel the regulations as an obstacle to business. At Level 4, overall laws and regulations are regarded to be efficient for business.

d. Security (and stability)

Security and political stability are another requirement to make private firms more productive and effective. At Level 0, the security for businesses is very unstable and stable business operations are impossible. At Level 1, there exists a possibility of war, coup d'état, strike or demonstration. At Level 2, some factors cause an unstable society or some people worry that society will become unstable. At Level 3, security threats can exist, but they are not significant for business operations. At Level 4, there exists no security problem any longer.

2) Economy

a. Economic development

Economic development is one of the most prominent items in the economy dimension for the institutional readiness for I4. GDP per capita is the most apparent and established indicator. At Level 0, GDP per capita is less than US$1,000. At Level 1, GDP per capita lies between US$1,000 and US$5,000. At Level 2, GDP per capita is greater than US$5,000 but less than US$10,000. At Level 3, GDP per capita falls into the range of US$10,000 and US$30,000. At Level 3, GDP per capita exceeds US$30,000.

b. Globalisation (and openness)

Globalisation (and openness) is one of the necessary items in the economy dimension for the institutional readiness for I4 and the CE. At Level 0, the interest in global standards is minimal. At Level 1, attempts to accept global standards begin to be taken, but those efforts are not effective yet.

At Level 2, institutional transition is active through trying to keep global standards. At Level 3, most global standards are relatively common. At Level 4, a country is regarded to be a global leader.

c. Performance of multi-national corporations

The performance of multi-national corporations (MNCs) is another measurement item for the institutional readiness for I4. Having excellent multinational corporations represents the global capability of the economy. Most competitive MNCs are from advanced economies. At Level 0, there are few domestic MNCs, and only a few foreign MNCs exist in a country. At Level 1, there are still few domestic MNCs, but many foreign MNCs invest in the domestic market. At Level 2, a country starts to produce successful MNCs and those MNCs begin to open foreign factories and subsidiaries. At Level 3, some MNCs are globally competitive and most MNCs have many sub-activities operate overseas. At Level 4, a country has many globally leading MNCs.

d. Overall consumer awareness

Overall consumer awareness is also a fundamental factor in introducing I4 and the CE successfully. The need of consumers for I4 and the CE should exist to make firms invest in these areas. I4 and the CE represent a range of new technologies that aim to combine various types of consumers on the physical, digital, and biological domains. From time to time, the resistance from some consumers on a particular domain can be a serious obstacle against any innovative attempts in markets. At Level 0, most consumers do not have any knowledge about I4 and the CE. At Level 1, consumers only in leading positions understand I4 and the CE. At Level 2, most consumers are aware of I4 and the CE, but they are not significantly interested in them. At Level 3, many consumers recognise the importance of I4 and the CE, but they are hardly willing to buy the related products or services. At Level 4, most consumers want to buy products or services related with I4 or CE.

3) Industry and Technology

a. ICT infrastructure

ICT infrastructure is the most critical factor necessary for the success of digital transformation. In our study, the smartphone penetration rate (SPR) is used as a

practical indicator. At Level 0, the existing ICT infrastructure only partially satisfies future integration and communications requirements. SPR is less than 50% for this level. At Level 1, the ICT infrastructure does not satisfy all the requirements for future expansion. This level goes along with SPR between 50% and 70%. At Level 2, the ICT infrastructure is upgradable to accommodate future expansion. SPR is greater than 70% and less than 80% for this level. At Level 3, further expansion is possible since the ICT infrastructure already satisfies future integration requirements. SPR falls into the range of 80% and 90% in this case. At Level 4, the ICT infrastructure satisfies all the requirements for integration and system-integrated communications. Now, SPR exceeds 90%.

b. R&D effort

For the institutional readiness of I4, the R&D effort of a country is one of the most frequently monitored items in the industry and technology dimension. The ratio of the amount of R&D to GDP (RDGR) is a typical indicator. At Level 0, a country is involved in I4 and the CE through R&D investments in a single area. The RDGR is under the global top 70 for this level. At Level 1, R&D investments relevant to I4 and the CE are being made in a few areas. This level goes along with RDGR between the global top 70 and global top 50. At Level 2, a country is making I4-related R&D investments in multiple areas. The RDGR is greater than the global top 50 and less than the global top 30 for this level. At Level 3, R&D investments are being made in nearly all relevant areas. The RDGR falls into the range of the global top 30 and global top 10 in this case. At Level 4, I4 and CE strategy and monitoring is supported by R&D investments throughout the country. Finally, the RDGR is in the global top 10.

c. Support for start-ups and entrepreneurs

Currently, business innovation, job creation, and economic development can be achieved from the support for start-ups and entrepreneurs. The ICT industry has been led by famous start-ups such as HP, Apple, Google, and Amazon. At Level 0, a country shows no stress on or interest in start-ups. At Level 1, it is recognised that start-ups are necessary for the economy but the policy for nurturing start-ups is not very strong. At Level 2, a country stresses the importance of start-ups, but there are few successful start-ups. At Level 3, start-ups are active in many areas and nurturing programmes supported by the government are found. At Level 4, many start-ups are globally successful and play critical roles in their national economy.

d. Strength of the manufacturing industry

For the institutional readiness of I4, we cannot miss the strength of the manufacturing industry as one of the most fundamental items in the industry and technology dimension. At Level 0, a country has no ability to develop its own manufacturing industries, and most industries depend on foreign firms. At Level 1, many foreign MNCs invest in the domestic markets, and the capability of domestic firms is weak. At Level 2, most domestic manufacturing firms are dominant in local markets, but they are not competitive in global markets. At Level 3, domestic manufacturing firms are trying to produce and sell in foreign markets, but their global capability is still insufficient. At Level 4, several local manufacturing industries are competitive in global markets.

2.2. Corporate-level factors

1) Leadership

a. Managerial entrenchment (agency problems)

In the current business research, the management entrenchment is recognised to influence the ineffectiveness of firm management. Some business research asserts that the agency problems of management tend to reduce the R&D activities of a firm. At Level 0, governance reform is strongly required by stakeholders. At Level 1, it is agreed that governance reform is necessary and protests to the management are seen. At Level 2, managerial entrenchment is regarded as a critical problem for decreasing corporate competitiveness. At Level 3, agency problem and entrenchment exist but they are not considered to be serious problems. At Level 4, the agency problems of management are negligible.

b. Global leadership

Corporate managers should have global talent and vision. At Level 0, the leadership has little experience in foreign environments. At Level 1, most of the past careers of leadership were made in domestic environments. At Level 2, the leadership is familiar with foreign markets, but it lacks much in global competence, including business languages such as English. At Level 3, the leadership can lead a foreign subsidiary with the help of local people, although it has some limitations as a global leader.

At Level 4, it is believed that the leadership has global talent and vision and can work with any foreign employees.

c. CEO innovativeness

CEO innovativeness is one of the most frequently addressed items in the leadership dimension for the institutional readiness for I4. At Level 0, CEOs dislike risk-taking situations and they avoid any projects with high uncertainty. At Level 1, CEOs tend to be risk-averse and they pursue only a stable management style. At Level 2, CEOs accommodate risk-taking behaviour from employees. At Level 3, CEOs have some experience of innovative performance during their past careers. At Level 4, CEOs have led the introduction of new products or business models.

d. Corporate vision

The corporate vision is an indispensable item in the leadership dimension for the institutional readiness of I4. At Level 0, a corporate vision is not presented, or it is seen as neither clear not realistic. At Level 1, many employees have strong concerns or complain about the corporate vision. At Level 2, the current corporate vision looks so ambiguous that it is not understood or supported by employees. At Level 3, a clear corporate vision is offered but it needs to persuade employees. At Level 4, a clear and feasible vision is offered, and most employees are motivated by the vision.

2) Business environment

a. Industry condition

The industry condition, as a business environment factor, can influence a firm's institutional readiness for I4. At Level 0, an industry is in the declining stage and its exit should be considered. At Level 1, few technological innovations are observed and the industry is mature. At Level 2, marginal innovations are happening frequently. At Level 3, technology change is regarded as a critical driver and start-ups and M&A are active for the development of new technologies. At Level 4, innovations in products and business models are prevalent.

b. Competition and rivalry

For the institutional readiness of I4, the competition structure and rivalry are significant items in the business environment dimension. At Level 0, the business environment is dominated by a monopoly of an inefficient firm. At Level 1, the business environment is dominated by a monopoly of an efficient firm. At Level 2, there are many players in the market but the competition is not fierce. At Level 3, several firms compete and they are sensitive to others' strategies and performances. At Level 4, competitive pressure is strong, the competition amongst many firms is fair, and competition occurs globally.

c. Stakeholder pressure

For the institutional readiness of I4, stakeholder pressure is one of the underlying items in the business environment dimension. At Level 0, there is no interest from stakeholders in I4 and the CE. At Level 1, I4 and the CE are stressed in society, but individual firms are not pressed to adopt them. At Level 2, pressure on I4 and the CE is strong, but the corporate response is superficial in a sense that it only takes place for advertising effect. At Level 3, the pressures from stakeholders on I4 and the CE are strong and management is trying to follow them. At Level 4, the pressure from diverse stakeholders for I4 and the CE is strong and the relevant responses are made as well as monitored.

d. Consumer expectation

For the institutional readiness of I4, the consumer expectation is one of the most important items in the business environment dimension. At Level 0, consumers have little knowledge of I4 and the CE and their needs in society are small. At Level 1, consumers have heard about I4 and the CE but they do not understand them in detail. At Level 2, consumers understand the importance of I4 and the CE but they are not interested in the effective responses of firms. At Level 3, consumers understand that I4 and the CE should be reflected in the corporate management process. At Level 4, consumers are eager to purchase products satisfying the requirements of I4 and the CE.

3) Resources

a. Corporate culture and creativity

Corporate culture and creativity are one of the fundamental requirements as a corporate resource for facilitating the introduction of I4. At Level 0, the technology level is very low and independent management without foreign firms' help is hard. At Level 1, companies can survive only in the domestic or regional market, and the traditional management system is dominant. At Level 2, the transition from a traditional culture to a creative one is discussed amongst companies. At Level 3, some companies are changing to a creative culture, they are successful in catching up with the leading products and technology, and they compete well with global leaders. At Level 4, many companies introduce innovations in products, production, or other management processes and then they become leaders in the global market.

b. R&D input

The R&D input is one of the most recognised items in the resources dimension to improve institutional readiness for I4. The ratio of the R&D amount to sales (RDSR) is a typical indicator. At Level 0, companies are involved in I4 and the CE through R&D investments in a single area. The RDSR is under 5% for this level. At Level 1, R&D investments relevant to I4 and the CE are being made by companies in a few areas. This level goes along with an RDSR between 5% and 10%. At Level 2, companies are making I4-related R&D investments in multiple areas. The RDSR is greater than 10% and less than 15% for this level. At Level 3, R&D investments are being made by companies in nearly all relevant areas. The RDSR falls into the range of 15% to 20% in this case. At Level 4, I4 and CE strategy and monitoring is supported by R&D investments by most companies. Finally, the RDSR is over 20%.

c. Ability of experts

The ability of experts is one of the most indispensable items in the resources dimension to improve the institutional readiness for I4. At Level 0, there are no experts in I4 and the CE. At Level 1, the ability of experts lags behind compared with that of experts in the leading firms. At Level 2, experts understand the top-level technologies, but they can only introduce and imitate them. At Level 3, the ability of experts is at the global top level, but they have not produced many innovations in the global market.

At Level 4, experts in I4 and the CE are at the top level compared with any experts in the world and they lead innovations in the world market.

d. Financial availability

Financial availability is one of the most critical items in the resources dimension to improve the institutional readiness for I4. At Level 0, companies are in significant difficulty for financial availability. At Level 1, companies have a high level of debt and they cannot invest in long-term innovation, such as for I4 and the CE. At Level 2, companies hold only a limited amount of funds to be invested in innovative projects. At Level 3, many companies are recognised as sound ones in terms of their financial availability. At Level 4, the financial availability of companies is not a concern at all for the development of I4 and the CE.

3. Case Application: The Republic of Korea

To evaluate the content and structure of our institutional readiness model, a case study for Korea is conducted. Korea is positioned between developed nations and developing nations. ASEAN Member States, as developing economies, can benchmark Korea rather than Japan or the United States. Korea has achieved economic success during the short time of 50 years. The history and current situation of the Korean economy can provide valuable lessons for ASEAN Member States. Korea will ramp up its investment in R&D for promising technologies that will accelerate the advent of I4 and the CE. Such technologies include autonomous cars, IoT-fitted electronics, semiconductors and displays, bio-health, and renewable energy. The Korean government will increase its R&D spending on those industries to 50% of the country's total R&D spending by 2022 from the current 30%.[1] To successfully implement this formidable strategy, however, Korea also faces many challenges to overcome on six dimensions for I4 and the CE: regulations, economy, industry and technology, leadership, business environment, and resources. The evaluation results from two Korean experts[2] are presented for testing the practical usability of our assessment tool.

[1] According to statistics announced by the Ministry of Trade, Industry and Energy (MTIE) in March 2018, the Korean government has allocated about W900 billion (US$844 million) to the five sectors out of this year's total R&D spending of W3.16 trillion.

[2] The two Korean experts are researchers in economics and have a speciality in sustainability, such as the environment, climate change, and recycling. The first expert is a professor in business in a Korean university, and the other is a chief economist in a Korean national research institute.

3.1. Scores in Country-level Factors

1) Regulation dimension

Expert A rates the presidential commitment of Korea as Level 4, evaluating that the political leadership formulates quite realistic and feasible plans for I4. Expert B is more pessimistic on this item of Korean political leadership, and rates it as Level 2, where the political leadership stresses the importance of I4 and the CE but does not offer various programmes for it. Next, both experts evaluate the transparency of Korea as Level 2, which implies that the country recognises that some informal factors affect competition. Then, both experts evaluate the business regulations of Korea as Level 2 because both think that businesspeople in Korea frequently raise concerns about regulatory inefficiency. Finally, expert A shows a strong concern for the security of Korea by rating it as Level 0, which means that the security for business in Korea is so unstable that stable business operations are impossible. In contrast, expert B provides a more favourable rating for the security concern item by evaluating it as Level 2, where some factors cause Korea to be unstable or some people worry about it. Applying equal weights over the four items, the weighted average score is 1.5 from expert A and 1.75 from expert B.

Table 5.2: Scores for the Regulation Dimension for the Republic of Korea

Item	Weight (%)	Expert A	Expert B
Political leadership	25	4	2
Transparency	25	2	2
Business regulations	25	1	1
Security concern	25	0	2
Weighted average	100	1.5	1.75

Source: Authors.

2) Economy

Since the GDP per capita of Korea was US$29,745 at the end of the year 2017, both experts rate the economic development of Korea as Level 3, which falls into the range of $10,000 and $30,000. Next, expert A evaluates the globalisation of Korea as Level 3 based on the thought that most global standards are relatively common in Korea. Expert B gives a lower rating of Level 2, where institutional transition is active through trying to keep with global standards. Then, expert A regards the MNC performance of Korea as Level 3, i.e. the status shows that some MNCs are globally competitive and most MNCs have many sub-activities and operate overseas. Expert B is less favourable by rating this item as Level 2, where a country starts to produce successful MNCs, and those MNCs begin to open foreign factories and subsidiaries. Lastly, expert A also gives a generous rating as Level 3 for the consumer awareness of Korea, believing that many consumers recognise the importance of I4 and the CE, but they are hardly willing to buy the related products or services. In contrast, expert B gives a relatively low rating for the item as Level 1, implying that consumers only in a leading position understand about I4 and the CE. With equal weights on each of four items, the weighted average score of 3.0 from expert A is higher than 2.0 from expert B as shown in the table 5.3.

Table 5.3: Scores for the Economy Dimension for the Republic of Korea

Item	Weight (%)	Expert A	Expert B
Economic development	25	3	3
Globalisation	25	3	2
MNC performance	25	3	2
Consumer awareness	25	3	1
Weighted average	100	3.0	2.0

MNC = multinational corporation.
Source: Authors.

3) Industry and technology

For the item of ICT infrastructure, expert A gives the highest score of Level 4, suggesting that the ICT infrastructure satisfies all the requirements for integration and system-integrated communications and that the SPR exceeds 90%. Expert B gives Level 3 to the item, meaning that further expansion is possible since the ICT infrastructure already satisfies the future integration requirements because the SPR falls into the range of 80%–90%. The difference in this rating seems to result from the discrepancy in statistics referenced by the experts. Next, both experts evaluate the R&D effort of Korea as the highest rate of Level 4, reflecting the statistics to show that Korea has an RDGR of about 4.24% and is ranked second in the world. However, both experts give a low rating of Level 2 for start-up support, which indicates that Korea stresses the importance of start-ups but there are few successful start-ups. Finally, both experts also highly score the strength of Korean manufacturers as Level 2, based on the observation that several local manufacturing industries are competitive in global markets. These scores are summarised in Table 5.4.

Table 5.4: Scores for the Industry and Technology Dimension for the Republic of Korea

Item	Weight (%)	Expert A	Expert B
ICT infrastructure	25	4	3
R&D effort	25	4	4
Support for start-ups	25	2	2
Strength of manufacturers	25	4	4
Weighted average	100	3.5	3.25

ICT = information and communication technology, R&D = research and development.
Source: Authors.

3.2. Scores in Corporate-level Factors

1) Leadership

First, expert A assigns the lowest grade of Level 1 to the managerial entrenchment item for Korea. The rating shows that governance reform is necessary and protests against management are seen. Expert B has the opinion that managerial entrenchment is regarded as a critical problem for decreasing corporate competitiveness, and, thus, the rate is a bit more positive as Level 2. Next, expert A's grade for the global leadership of Korea is Level 3, meaning that the leadership can lead foreign subsidiaries with the help of local people, although it has some limitations as a global leader. The grade from expert B is lower at Level 2, which implies that the leadership is familiar to foreign markets but lacks much in global competence, including business languages such as English. Next, both experts' grades on CEO innovativeness in Korea are low at Level 1. Both experts seem to agree that Korean CEOs tend to be risk-averse and they pursue only a stable management style. Lastly, both experts also have the same view of Level 2 for the corporate vision in Korea. There seems to be a consensus between two experts about the view that current Korean corporate visions look so ambiguous that they are not understood or supported by employees. Overall, the weighted average scores from both experts are equal to 1.75. These scores are summarised in Table 5.5.

Table 5.5: Scores for the Leadership Dimension for the Republic of Korea

Item	Weight (%)	Expert A	Expert B
Managerial entrenchment	25	1	2
Global leadership	25	3	2
CEO innovativeness	25	1	1
Corporate vision	25	2	2
Weighted average	100	1.75	1.75

CEO = chief executive officer.
Source: Authors.

2) Business environment

There is agreement between the two experts on the grade for the industry condition in Korea. The consensus is Level 2, which represents the intermediate situation of Korea where marginal innovations are happening frequently. Next, the grade of Level 3 on the competition item is also the same between the two experts. Both experts think that several firms compete in Korea and they are sensitive to each other's' strategies and performances. Then, the item of stakeholder pressure in Korea receives the same grade of Level 2 from the two experts. Both experts seem to agree that the pressure on I4 and the CE is strong in Korea, but the corporate response is superficial because they are only used for advertising effects. Finally, expert A gives a grade of Level 3 to the consumer expectation item for Korea. Expert A seems to believe that consumers understand that I4 and the CE should be reflected in the corporate management process. In comparison, expert B has a lower expectation on the item of consumer expectation. The grade from expert B is Level 1, which describes the situation where consumers have heard about I4 and CE but they do not understand them in detail. As a result, the weighted average score from expert A is 2.5 and that from expert B is lower at 2.0. These scores are summarised in Table 5.6.

Table 5.6: Scores for the Business Environment Dimension for the Republic of Korea

Item	Weight (%)	Expert A	Expert B
Industry condition	25	2	2
Competition	25	3	3
Stakeholder pressure	25	2	2
Consumer expectation	25	3	1
Weighted average	100	2.5	2.0

Source: Authors.

3) Resources

First, the item of corporate culture in Korea is graded at Level 2 by both experts. The result shows that Korea stays at the stage where the transition from a traditional culture to a creative one is discussed amongst companies. Next, both experts give a relatively high grade of Level 3 for the R&D input item. Such evaluations seem to be based on the observation that R&D investments are being made by companies in nearly all relevant areas, and the RDSR falls into the range of 15%–20% for Korea. Then, both experts give a rating of Level 2 for the ability of experts in Korea. The result represents the common evaluation that Korean experts understand the top-level technologies but they can only introduce and imitate them. Lastly, expert A's view of Level 3 on financial availability in Korea is Level 3, which is different from that of Level 2 from expert B. Expert A seems to think that many Korean companies are recognised as sound ones in terms of their financial availability, whereas expert B seems to think that Korean companies hold only a limited amount of funds to be invested in innovative projects.

Table 5.7: Scores for the Resources Dimension for the Republic of Korea

Item	Weight (%)	Expert A	Expert B
Corporate culture	25	2	2
R&D input	25	3	3
Ability of experts	25	2	2
Financial availability	25	3	2
Weighted average	100	2.5	2.25

R&D = research and development.
Source: Authors.

According to the evaluation example for Korea presented above, Korea is likely to be a 'learner' at both the macro level and the micro level. Note that the final score from expert A is close to the edge of 'leader' in this explanatory grouping scheme. It implies that Korea would progress towards 'leader' with a little improvement in some of the 24 items for institutional readiness for I4 and the CE.

Table 5.8: Grouping Example for the Republic of Korea

Dimension	Weight (%)	Expert A	Expert B
Regulation	16.7	1.50	1.75
Economy	16.7	3.00	2.00
Industry and technology	16.7	3.50	3.25
Leadership	16.7	1.75	1.75
Business environment	16.7	2.50	2.00
Resources	16.7	2.50	2.25
Weighted average	100	2.57	2.18
Financial availability	25	3	2
Weighted average	100	2.5	2.25

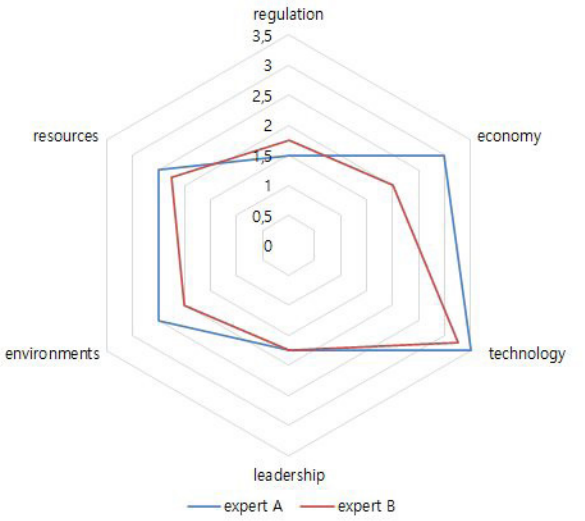
R&D = research and development.
Source: Authors.

The overall evaluation results of the two Korean experts are shown as a graph in Figure 5.5, and the findings from the analysis are summarised as follows.

- First, the scores for the regulation environment and corporate leadership are relatively low. In the regulation environment, we measured presidential commitment, political transparency, business regulations, and national security. Even if democracy in Korea has improved significantly compared with the 1970s and 1980s, some obstacles still exist to deter the innovative capabilities of private companies. Corruption between government officials and large corporations should be eliminated. Fewer regulations on business operations and open environments for start-ups are prepared in Korea.
- Second, the score for industry technology was higher than for other scores. This factor was measured by ICT infrastructure, R&D effort, support for start-ups, and the competitiveness of manufacturers. Except for the support for start-ups, the other elements are good in Korea. The other 3 factors are seen to be the strengths of Korean industries. Especially in relation to information technologies, Korea has achieved excellent performance.

- Third, the scores on the national economy, corporate environment, and firm resources are modest. The overall status of Korea is seen to be as a learner, which is between 2 and 3. These 3 dimensions are of a similar status. The national economy, corporate environment, and corporate resources are not at the top levels. However, they have been improved significantly and are expected to reach the top levels in the near future.

Figure 5.5: Scores for the Republic of Korea



Source: Authors.

3.4. Considerations for Implementation

As described by Schumacher, Erol, and Sihn (2016), measuring the readiness based on our institutional model may follow a procedure that can be integrated into an easy-to-handle and software-supported tool. First of all, the readiness evaluation on the prescribed 24 items may be conducted by using a standardised questionnaire consisting of one closed-ended question per item. Each question may be designed to require an answer with a Likert scale reaching from Level 0 to Level 4. It is important to provide respondents with sufficient information on the concepts of I4 and the CE because respondents can only properly answer the questionnaire when they understand the concepts well. External consulting would help increase the accuracy of

the institutional readiness model. Responses to the questionnaire can then be put as inputs into the software tool to calculate the readiness level.

In the next step, the readiness level of the dimension can be calculated from the weighted average of the readiness level over the four items within each dimension. The weighting factor may reflect the average importance rating from experts for each item. Since all items do not seem to have the same contribution to readiness for I4 and the CE, it would be better for expert ratings to be systematically incorporated into the development procedure. The practical importance of each item can also be graded on a Likert scale, and then the evaluation results through our institutional model are likely to be considered meaningful if the overall average of the ratings for the items is sufficiently high. Such an approach would help us find out an item's readiness contribution as well as validate the readiness item's practical meaningfulness.

Then, the level of detail and mode of representation may be adjusted to the practical needs of stakeholders. It would be desirable to transform the institutional model into an easy-to-use assessment tool that can be used by countries to self-assess their readiness for I4 and the CE. For that purpose, it is worthwhile integrating the questionnaire into a webpage, receiving responses from as many experts as possible, processing those responses in an automated manner, calculating the results systematically, and summarising the final outcomes in a compact report. The first page could contain the readiness dashboard depicting all readiness levels in six dimensions at a glance. The concise dashboard could be followed by definitions of the readiness levels, determinations for each item, and the overall characteristics.

In the end, countries can be categorised based on their readiness levels to help stakeholders better understand the evaluation results. Such a grouping also makes it easier to identify specific action items with regards to the progress toward I4 and the CE. If countries have a low score smaller than 1.33, then they may be labelled as 'beginners'. This group represents countries that have done either nothing or very little to deal with I4 and the CE. When countries are in the middle with a score between 1.33 and 2.67, then they may be labelled as 'learners' as those countries that have already taken some steps in implementing I4 and the CE. Likewise, if countries have a score higher than 2.67, then they can be labelled as 'leaders'. This benchmark group include countries that are already well on their way to implementing I4 and the CE.

4. How Can the Republic of Korea Improve?

From the case study on Korea above, the following issues can be discussed to analyse the country's situation and make some remedies to improve its institutional efficiency and innovation efficiency. Table 5.9 evaluates Korea's situation by looking at what the country has done and strategies for future improvements.

Table 5.9: The Republic of Korea's Situation

Past Performance	Future Strategies
• Economic growth - Government leadership - Corporate entrepreneurship - People's capacity building • ICT infrastructure and industry technologies - Electronics, auto, steel - Internet infrastructure, R&D investment	• Transparent leadership - Decrease in political corruption - Responsibility of 'chaebol' owners • Proactiveness of sustainability - Reduction in greenhouse gas emissions - Resource circularity - Environmental protection

ICT = information and communications technology, R&D = research and development.
Source: Authors.

4.1. Competitiveness of Private Firms

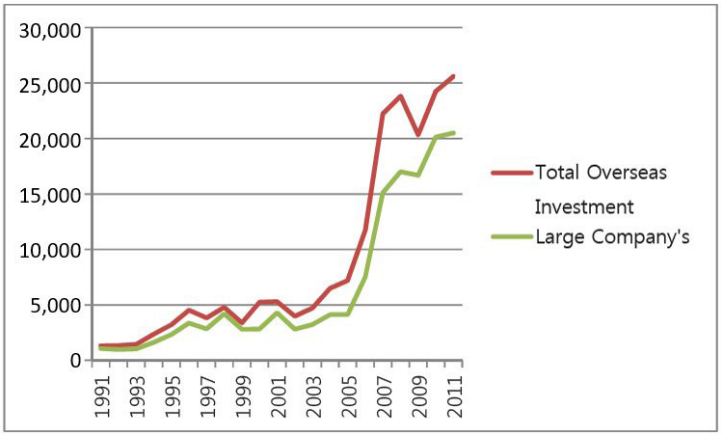
Innovative performance for I4 or the CE is mostly made by private firms. The leading firms in Korea are competitive in global markets, and these firms can lead the transformation to a digital and sustainable economy. Most of the private firms in Korea are called 'chaebol', which is a large business group in Korea. Samsung, Hyundai, and LG are the top Korean chaebols. These chaebols played a major role in developing the rapid Korean economy from the 1970s and after the 1990s, they have obtained competitive power even in global markets. To be a rich economy, Korea must have several firms that have excellent competitiveness in global markets. Most of the competitive multinational corporations are from developed countries such as the US, EU, or Japan.

The success of the Korean economy during the last five decades originates from the competitive evolution of Korean chaebols. As shown in the case analysis of Korea above, the scores in the economic environment are relatively high. This can be

explained by the successful economic development of Korea from the combination of the leadership of the government, the entrepreneurship of firms, and the sincerity of ordinary people (Cho and Kim, 2007). The economic achievement of Korea was enormous and large Korean chaebols have evolved into competitive global players. As a result, the openness and globalisation of the Korean economy are quite good. The performance in industry and technology development has been remarkable. The level of R&D is high, even compared with other advanced economies (Kim, 2017). The electronics and auto industries are very competitive globally, and the ICT infrastructure in Korea is highly developed.

The most successful Korean chaebols are Samsung, Hyundai, and LG. Samsung Electronics, which is the largest firm in Korea, is leading the global market for televisions, semiconductors, and smartphones. Hyundai Motor Company is one of the top five automakers in the world. LG Electronics is also a global leader in home electronics. POSCO, a steel manufacturer, is one of the largest steel companies in the world. These Korean companies grew as imitators of Japanese companies in the 1970s and 1980s, but now they have stronger competitive powers than their Japanese counterparts. Under the last President Park, the Korean government and firms tried to transform themselves from imitators to creators. It is expected that many innovative performances in global markets can be created by these Korean large companies. As shown in Figure 5.6, most of the overseas investment and exports in Korea are performed by the large corporations.

Figure 5.6: Overseas Investment of Korean Companies (US$'0,000)



Source: Moon (2017).

4.2. Leadership Crisis

Efficient and transparent leadership is required for both governments and corporations. Recently, corporate governance is one of the important areas in management research (Moon, 2017). The stewardship of top leaders can determine the competitiveness of nations or corporations. In Korea, the lack of successful leadership is recognised by both the government and firms. Since the 1990s, Korea has achieved political democracy and has had six presidents from either the republican or the democratic parties. The current president, Moon, is the sixth leader, and the last five presidents were not free from corruption scandals. In particular, former President Park was impeached due to her corruption scandal in 2017. It is usually said in Korea that the economy is at a high level, but the country's politics are at a low level. In chaebols, the agency problems of the controlling shareholders are discussed as governance issues (Cho and Kim, 2007; Moon, 2017). Usually, agency problems in US firms are recognised between CEOs and shareholders, but in Korean firms the agency problems come from selfish decision-making by the controlling shareholders with the sacrifice of the minority shareholders' interests.

After completing rapid economic growth during the last 40 years, Korea is facing the issue of the fair and transparent distribution of wealth. Political and economic leaders are pressed to achieve both continuous economic growth and the fair distribution of the fruits from economic development. The current President Moon, who is from the Democratic Party, tries to lead the economy by distributing wealth more fairly and widely and increasing the income of the ordinary people. He believes that the increased income of the ordinary people will increase consumption in the market and result in the increased production of companies. Currently, the international politics surrounding Korea are very complex. High uncertainty exists from the threat of North Korea's nuclear weapons and its recent moves to talk with Korea and the US on the rapid economic development of China and the trade war between the US and China. Except for Japan, Korea is the only Asian country that has achieved both economic prosperity and political democracy. Successful leadership in government and private corporations is required to upgrade Korea to a new advanced economy with GDP per capita higher than US$30,000.

4.3. ICT Infrastructure and Resource Circularity

The overall ICT infrastructure and the performance in resource circularity in Korea are quite good. ITU News reported about the achievement of Korea in the ICT sector as follows (ITU News, 2018):

> 'Korea has a well-earned reputation as a global information and communication technology (ICT) leader, and it's not hard to see why. Home to world-leading electronics and ICT companies such as Samsung, LG, SK, and KT – Korea's economic growth is digitally delivered. The Republic of Korea has some of the world's fastest Internet speeds. It's in the race to be first with 5G. And it leads the world in Internet penetration rates, with nearly every household online. These are some of the reasons why the Republic of Korea has ranked in the top three of ITU's Global Information and Communication Technology (ICT) Development Index (IDI) in each of the past 5 years. In addition, the country reigns supreme in the Bloomberg Index of 'Most Innovative Economies'.

It is also indicated that Korea's ICT infrastructure remains the best in the world. As a result of a comprehensive assessment conducted by the International Telecommunication Union (ITU) on the ICT infrastructure level, including the ICT access, use, and skills of 167 countries around the world, Korea reclaimed the first place in 2015, after heading the list in both 2012 and 2013 and stepping down by one place in 2014 (Table 5.10).

Table 5.10: The Republic of Korea's Rankings in the ICT Development Index, 2013–2015

	2013	2014	2015
	Rank	Rank	Rank
ICT Development Index (Overall)	1	2	1
ICT Access	11	8	9
· Fixed-telephone subscriptions per 100 inhabitants	1	3	4
· Mobile-cellular telephone subscriptions per 100 inhabitants	70	79	71

	2013	2014	2015
	Rank	Rank	Rank
· International Internet bandwidth (bit/s) per Internet user	63	82	71
· Percentage of households with a computer	21	28	37
· Percentage of households with Internet access	1	1	1
ICT Use	2	3	4
· Internet users per 100 inhabitants	15	17	15
· Fixed broadband Internet subscriptions per 100 inhabitants	5	6	6
· Wireless broadband subscriptions per 100 inhabitants	5	9	13
ICT Skills	1	2	2
· Gross enrolment: Secondary	48	51	54
· Gross enrolment: Tertiary	1	2	2
· Adult literacy rate	15	20	22

ICT = information and communications technology.
Note: The total number of countries surveyed was 157 in 2013, 166 in 2014, and 167 in 20l5.
Source: ITU (2017).

Korea shows excellent performance in resource circularity, too. As shown in Table 5.11, Germany, Korea, Slovenia, and Austria are the world leaders in recycling, according to the World Economic Forum (2018). In all of these countries, less than half of the total waste output is sent to landfills. In comparison, the US recycles only 35% of its waste.

Table 5.11: Recycling Rates in the World

Country	Recycling Rate (%)
Germany	67
Republic of Korea	59
Austria	58
Slovenia	58
Belgium	55
Australia	41
United Kingdom	43
Italy	41

Country	Recycling Rate (%)
France	38
United States	34
Canada	24
Japan	20
Israel	19
Mexico	5

Source: World Economic Forum (2018).

4.4. Recognition of the Circular Economy

Today, sustainable management is required for most corporations. In addition to profit maximisation, corporations should perform ethical management, environmental protection, reduce GHG emissions, and resource circularity. The circular economy is part of a sustainable economy. The efforts to realise the circular economy can be a cost burden on corporations, at least on a short-term basis. Achieving a circular economy is a duty pressed on private companies and consumers. The role of governments is critical to make corporations and consumers respond positively and proactively toward the issue of circularity.

In Korea, the government has developed some regulations and processes to realise the circular economy and, as result, its performance in resource recycling is outstanding, as shown in Table 5.11. Large firms have made significant efforts to support the government's policies for the circular economy. For example, POSCO, a large Korean steel company, has been doing quite well in this area. POSCO is trying to achieve low-carbon management (Kim, 2018). In the annual report of POSCO, low-carbon management consists of four areas: green steel, green business, green life, and green partnership. In green steel, POSCO reduces GHG emissions by recycling the by-products from the steel manufacturing process. The proactiveness of Korea towards the circular economy is led by the government and large corporations. The commitment of SMEs and the increased recognition of ordinary people should be added, too.

- Green steel: This addresses how POSCO makes attempts to reduce carbon emissions in the steel production process. An example of these activities is improving energy efficiency.

- Green business: The necessity for climate change responses and carbon emissions reduction may be a burden on a firm's costs, but new business opportunities can be made through strategic reactions.

- Green life: As a GHG emission reduction project, POSCO's carbon-neutral programme was launched in 2009 with support from diverse societal groups, such as students, civic organisations, and housewives. If participants propose new ideas to offset carbon emissions, they can apply for programme sponsorship that chooses the most doable suggestion.

- Green partnership: Since 2003, POSCO has been participating in the Dow Jones Sustainability Indexes and the Carbon Disclosure Project and has disclosed activities related with climate change and CO2 emissions. By doing so, POSCO received positive evaluations from external institutions.

5. What Are the Lessons for ASEAN?

This chapter intends to measure the institutional efficiency and innovation efficiency related with the successful introduction of I4 and the CE. Various cross-cutting factors are developed that influence institutional efficiency and innovation efficiency. To create better environments for pursuing I4 and the CE, the cross-cutting factors are developed in two dimensions: country-level factors and corporate-level factors. The country-level factors are political commitment and transparency, economic development and globalisation, and technology development in major industries. The corporate-level factors are the innovative leadership of the top management, major stakeholders as the business environment, and corporate culture and resources. While all of these factors should be seriously considered in ASEAN, the following four issues are addressed to give policy implications for ASEAN Member States.

5.1. Strong Leadership of Governments

Successful leadership by political leaders is critical. The strong commitment of leaders is necessary to pursue digital transformation and achieve a sustainable society nationwide. In Korea, the past government from 2008–2013 showed a strong

commitment to green growth policy and created the national green growth committee to lead these policies in the country. The strong interest of the president pressed many firms to reduce their carbon emission amounts through their manufacturing and management processes. The recent economic recovery of Japan or the US seems to be the result of the various policies of Prime Minister Abe or President Trump. The political leaders of ASEAN should study how they can perform innovations in their countries by introducing I4 and the CE.

Generally, the degree of democracy and transparency in ASEAN countries seems to be low. Singapore, the richest ASEAN Member State, is also limited in its political democracy. Democracy can guarantee the freedom of economic activities. For example, in Korea, the large firms have become competitive in global markets, but their close link with Korean politicians is still one of the serious problems to be solved in the future.

- A committee working for I4 and the CE that reports to the president directly can be set up.
- Governments intervene to measure how well firms realise I4 and the CE and provide the rewards to some firms based on the evaluation results.

5.2. Competitiveness of Domestic Firms

Porter (1990) asserted that the wealth of a nation is created when it has several competitive industries. To have competitive industries, good corporations are critically required to create successful industries. In many developing countries, there are few competitive domestic firms. The most famous firms in the world were born in North America, the EU, or Japan. Korea which is an example of economic success from a poor country 60 years ago, has borne several top-level corporations, such as Samsung, Hyundai, and LG. China, which has enjoyed very rapid economic evolution, has produced good companies such as Alibaba, Huawei, and Xiaomi. The economies of most ASEAN Member States are dependent upon foreign corporations for their domestic production and exports. For example, in Viet Nam, Samsung Electronics, a Korean multinational, exports about 25% of the total Vietnamese export amount. In Dalat of Viet Nam, where the weather is very adequate for flower production, only Dutch and Japanese firms export the flowers of the region.

- Governments require multinationals in their markets to raise or be linked with domestic SMEs.
- Attractive incentives are given to domestic firms showing high growth potential.

5.3. Infrastructure Investment for Digital Transformation

For digital transformation, investment in ICT infrastructure is important. The investments should be made by both governments and private organisations. Efficient mechanisms for public–private partnerships for improvement in ICT infrastructure need to be created in ASEAN Member States. International cooperation can be helpful, too. As shown in ITU (2017), the degree of overall ICT development in ASEAN area is comparably low in the world.

Efforts to improve ICT development have been made in ASEAN Member States, and some positive results have been obtained (ASEAN, 2015). For example, the ASEAN ICT Masterplan (AIM) 2015 launched various investments in the following areas:

- Economic transformation
- People engagement and empowerment
- Innovation
- Infrastructure development
- Human capital development
- Bridging the digital divide

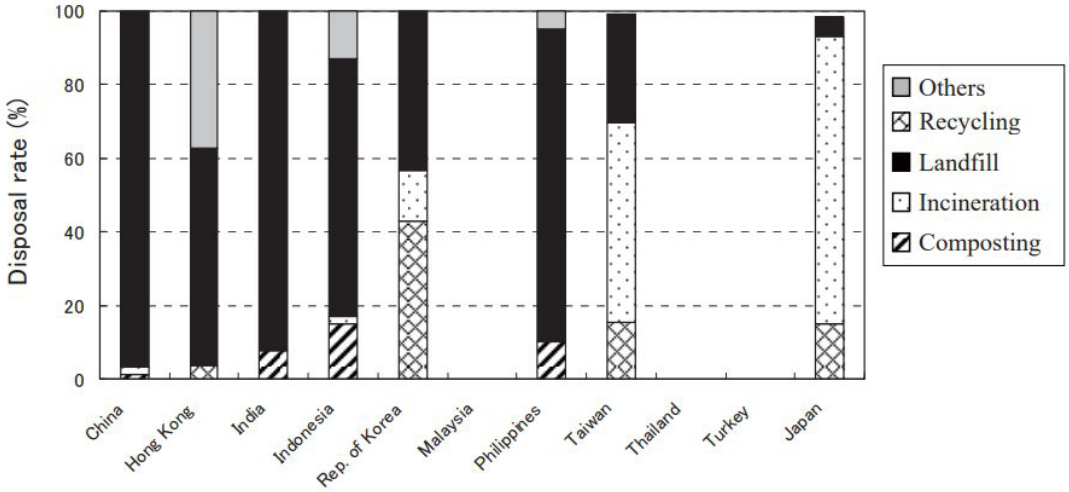
- Firms investing in ICT infrastructure development are provided with tax reductions.
- Firms are evaluated on their degree of digital transformation, and some incentives can be given based on their performance.

5.4. Proactiveness for the Circular Economy

Achieving the circular economy brings about cost burdens for governments and corporations, at least in the short term. Therefore, a proactive attitude towards sustainability is important. Generally, rich countries tend to lead sustainability policies. In responding to the threat from climate change and reducing carbon emission amounts, the EU is the most advanced region. In contrast, the US seems

to be reluctant to deal with the climate change issue and has exited from the Paris Agreement. Figure 5.7 shows the structure of waste disposal in Asian countries. It is evident that the richer the country, the higher the recycling ratio. In developing nations, economic development may take priority over sustainability policies. They may not own the sufficient resources to be invested in sustainability areas. Leaders in developing nations should be able to attain economic goals through satisfying the sustainability needs.

Figure 5.7: Comparison of Waste Disposal Amongst Countries



Source: Terazono et al. (2005).

- Corporate cases on how investment in resource circularity can lead to better firm performance are developed and distributed nationwide.
- Education programmes about the circular economy and its link with the national economy and firm competitiveness are prepared for both corporate managers and ordinary citizens.

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Appendix 1: A Framework for Assessing Industry 4.0 Readiness for the Circular Economy

Assessment Criteria	Readiness Level				
	Level 0	Level 1	Level 2	Level 3	Level 4
Country-level Factor 1: Politics and Regulations					
Presidential commitment	No interest.	Comment sometimes, not a critical agenda.	Stress the importance, but not offer various programmes.	Present various plans, but they are not feasible.	Present various plans and programmes. They are quite realistic and feasible.
Democracy and transparency	Corruption and unfair competition is severe.	Trying to reduce corruption. In reality, proper adaption to corruption is necessary for business.	Recognised that some informal factors affect competition.	Not a serious problem and only sometimes found.	Competition is transparent. Corruption related with business operations is very low.
Business regulation	Many experts advise that regulation reform is necessary. Serious hurdle to private firms.	Many complaints are made from business people.	Sometimes hear criticisms of regulatory inefficiency.	Hardly feel regulation is an obstacle to business.	Laws and regulations are regarded to be efficient for business.
Security and stability	Very unstable. Stable business operations are impossible.	Possibility of war, coup d'état, strikes, or demonstrations.	Some factors cause an unstable society. Some people worry about an unstable society happening.	Security threats can exist but they are not significant.	No security problems are felt.
Country-level Factor 2 : Economic Environment					
Economic development	Gross domestic product (GDP) per capita < US$1,000	US$1,000 < GDP per capita < US$5,000	US$5,000 < GDP per capita < US$10,000	US$10,000 < GDP per capita < US$30,000	GDP per capita > US$30,000
Globalisation and openness	Interest in global standards is minimal.	Attempts to accept global	Institutional transition is active. Trying to keep global standards.	Most global standards are relatively common.	Regarded to be a globally leading country.
Performance of Multi-national corporations (MNCs)	Few domestic MNCs and only a few foreign MNCs exist.	Few domestic MNCs. Many foreign MNCs invest in the domestic market	Start to produce successful MNCs. They begin to open foreign factories and subsidiaries.	Some MNCs are globally competitive. Most MNCs have many sub-activities that operate overseas.	Have many globally leading MNCs.

Assessment Criteria	Readiness Level				
	Level 0	Level 1	Level 2	Level 3	Level 4
Consumer awareness	Most people do not have knowledge about Industry 4.0 (I4) and the circular economy (CE).	People only in the leading class understand about I4 and the CE.	Most people have heard about I4 and the CE but are not interested significantly	Many people recognise the importance of I4 and the CE, but hardly buy the related products or services.	Most consumers want to buy products or services related with I4 or the CE
Country-level Factor 3: Industry and Technology					
ICT infrastructure (smartphone penetration rate)	Smartphone penetration rate (SPR) < 50%	50% < SPR	70% < SPR	80% < SPR	90% < SPR
R&D effort (R&D amount/GDP)	Under global top 70	Global top 70	Global top 50	Global top 30	Global top 10
Support for start-ups and entrepreneurs	No stress on or interest in start-ups.	It is heard that start-ups are necessary for the economy, but the policies are not very strong.	Government stresses the importance of start-ups, but there are not many successful start-ups.	Start-ups are active in many areas. Support programmes from the government are found.	Many start-ups were globally successful. Start-ups function in a critical role in the economy.
Strength of manufacturing industry	There is no ability to develop own manufacturing industries. Most industries depend on foreign firms.	Many foreign MNCs invested in the domestic markets. Domestic firms also exist, but the capability is weak.	Most manufacturing firms are dominant in the domestic markets, but not competitive in world markets.	Domestic manufacturing firms are trying to produce and sell in foreign markets. The global capability is still insufficient.	Several manufacturing industries are competitive in the world market.
Corporate-level Factor 1: Leadership					
Managerial entrenchment (agency problems)	Governance reform is strongly required by stakeholders.	Agreed that governance reform is necessary. Protests against the management are seen.	Regarded as a critical problem to decrease corporate competitiveness.	Agency problems or entrenchment exist but are not considered to be serious problems.	Agency problems of management are negligible.
Global leadership	Little experience in foreign environments.	Most of past career was made in domestic environments.	Familiar to foreign market, but lacks om global competence, including English.	Have some limitations as a global leader. Can lead foreign subsidiary with the help of local people.	Managers have global talent and vison. Can work with any foreign employees.
CEO innovativeness	Dislike risk-taking situations. Avoid any projects with high uncertainty.	Tend to be risk-averse. Pursue stable management style.	Requires risk-taking behaviour from employees.	Has experience of innovative performance during their past career.	CEO has led the introduction of new products or business models.

Assessment Criteria	Readiness Level				
	Level 0	Level 1	Level 2	Level 3	Level 4
Corporate-level Factor 1: Leadership					
Corporate vision	Vision is not presented or is neither clear nor realistic.	Many employees have strong concerns or complain about t hevision.	Current vision looks somewhat ambiguous. Is not understood or supported by employees.	Clear vision is offered, but needs to persuade employees.	Clear and feasible vision is offered. Have most employees motivated by the vision.
Corporate-level Factor 2: Business Environment					
Industry condition	Industry is in declining stage. Exiting from the industry should be considered.	Few technological innovations. Industry is mature.	Marginal innovations are happening.	Technology change is critical. Start-ups and M&A are active for the development of new technologies.	Innovations in products and business models are frequent.
Competition and rivalry	Monopoly by an inefficient firm.	Monopoly by an efficient firm.	There are many players in the market, but competitive is not fierce.	Several firms compete. They are sensitive to others' strategies and performances.	Competitive pressure is strong. Competition amongst many firms is fair. Competition occurs globally.
Stakeholder pressure	No interest from stakeholders.	I4 and the CE are stressed in society. Individual firms are not pressed to adopt them.	Pressure is strong, but the corporate response is superficial. Only for advertising effect.	Pressures from stakeholders are strong. Management is trying to follow.	Strong pressure from diverse stakeholders for I4 and the CE. Right response is made and also monitored.
Consumer expectation	Little knowledge about I4 and CE, or the necessity of them in society is small.	Heard about I4 and the CE, but do not understand them in detail.	Understand the importance of I4 and the CE. Not interested in the effective responses of firms.	Understood that I4 and the CE should be reflected in corporate management process.	Eager to purchase products satisfying I4 and the CE.

Assessment Criteria	Readiness Level				
	Level 0	Level 1	Level 2	Level 3	Level 4
Corporate-level Factor 3: Resources					
Corporate culture and creativity	Technology level is very low. Independent management without the help of foreign firms is hard.	Survive only in domestic or regional market. Traditional management system is dominant.	Transition from traditional culture to creative culture is discussed.	Is successful in catching up with the products and technology of leading firms and compete well against global leaders. Is changing to creative culture.	Introduced innovations in products, production, or other management processes. A leader in the global market.
R&D input	R&D/sales < 5%	R&D/sales > 5%	R&D/sales >10%	R&D/sales >15%	R&D/sales > 20%
Experts	There are no experts in I4 or the CE.	The ability of experts lags behind that of the experts in the leading firms.	Experts understand the top-level technologies, but they can only introduce and imitate them.	The ability of the experts is in the top level in the world, but they have not produced many innovations in the world market.	Experts in I4 and the CE are at the top level compared with any experts in the world. They lead innovations in the world market.
Financial availability	Is in significant difficulty in financial availability.	Has high level of debt and cannot invest in long-term innovation, such as I4 and the CE.	Only limited amount of funds can be invested in innovative projects.	Recognised as a sound firm in its financial availability.	Financial availability is not concern a at all for the development of I4 and the CE.