Chapter 3

Evolutionary Acts and Global Economic Transition: Progress of the Circular Economy in ASEAN

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Chapter 3

Evolutionary Acts and Global Economic Transition: Progress of the Circular Economy in ASEAN

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1. Introduction

The Association of Southeast Asian Nations (ASEAN) region has a huge market of US$3.6 trillion with a population of 622 million. Industry and service sectors play key roles in the gross domestic product (GDP) of its member nations.

Figure 1 illustrates the importance of the industrial sector in the GDP of ASEAN nations. Currently, 30%–50% of national GDP is linked to the industrial sector and is expected to grow further. The ASEAN model for economic growth, characterised by accelerated industrialisation through free trade and foreign direct investment (FDI) with a regional production network, has been successful. As projected by Nielsen (2015), 55% of the population (400 million) will be elevated to the middle-class level[1] by 2020 compared to the 28% (190 million) in 2012. This implies that more resources and energy will be needed to meet the increasing production capacity and consumer demand in lieu of the rising purchasing power of the people in ASEAN.

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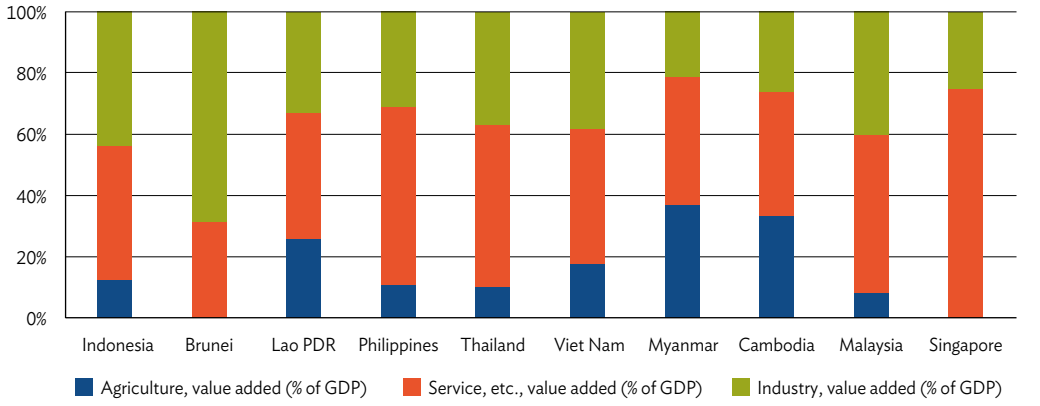
1 Middle-class level is defined as people having a daily disposable income of US$16–US$100.

Figure 1. ASEAN GDP by Sector



ASEAN = Association of Southeast Asian Nations, GDP = gross domestic product, Lao PDR = Lao People's Democratic Republic.
Source: ASEAN, 2015.

ASEAN is a diverse region comprising 10 countries, each at different stages of development. The linear approach of growth – 'take-make-use-dispose' – has been the trend for most countries in ASEAN. Singapore, ranked second in the Global Competitiveness Index (GCI)[2], has moved up from linear approach to the circular economy. As reported by the National Environment Agency of Singapore, only 2% of Singapore's waste is finally disposed in landfills while 60% is recycled and 38% is incinerated to produce renewable energy. Indonesia, which has the highest GDP in ASEAN, disposes 69% of its waste in landfills (Jong, 2015). As resources become scarcer and more expensive in future, there is an urgent need to transition to a circular economy in ASEAN.

[2] The World Economic Forum annually publishes the Global Competitiveness Index (GCI), which ranks the competitiveness of around 140 economies. GCI rank is based on both static and dynamic components (termed as 'pillar' in GCI) which include institutional capacity, infrastructure, microeconomic environment, health and primary education, higher education and training, goods market efficiency, labour market efficiency, financial market development, technological readiness, market size, business sophistication, and innovation.

The current efforts to attain sustainable economy in ASEAN countries, which focus on optimised use of resources, are limited to the 3Rs – reuse, reduce, and recycle. The circular economy, however, is not limited to the 3Rs. Developed countries like Germany and Japan have already recognised this concept where used resources are moved in a closed loop. The circular economy focuses on increasing material efficiency and resource productivity. It implies producing more GDP with minimum use of resources, particularly virgin resources. The circular economy thus requires recognising waste as resources. Unlike the 3Rs, the circular economy also extends to a conceptual business model, which helps synchronise the materials and resources flow in the supply chain to minimise or eradicate the need for resource consumption. One such business model, initiated by Philips, successfully broke the paradigm of owning a product to utilise its value and moved to a new paradigm where people can only own the value of the product. This sort of business hugely focuses on increasing the lifespan of the products. Although the 3Rs are part of the circular economy, the opportunities and potentials of the circular economy are far beyond the 3Rs.

Moving one step ahead of the circular economy is the Industrial Revolution 4.0 (Industry 4.0), which has emerged in the last few years to revolutionise the efficiencies of industries. Industry 4.0 targets minimising the use of labour and optimising the use of resources through the use of technologies. Through robots, big data management systems, cyber-physical systems (CPS), and the like, Industry 4.0 can achieve its goal of reducing dependence on unskilled and semi-skilled labour force. Industry 4.0 is an alternative way for industries to maximise their profit while increasing the efficient use of resources. However, under the ASEAN context, which thrives on the unskilled and semi-skilled labour force, the way forward with Industry 4.0 is still not clear. The ASEAN region further lacks the technological competitiveness to absorb Industry 4.0 and is still struggling to gain more control on its supply chain.

2. Economic Resilience and Evolution in the ASEAN Region

Apart from establishing regional stability, ASEAN was formed to primarily boost the economy of its member states through integration. One key milestone of ASEAN was the adoption of the ASEAN Economic Community (AEC) Blueprint in 2007, followed by the formal establishment of the AEC on 31 December 2015. AEC Blueprint 2015 is built on the following pillars: single market and production base, competitive economic region, equitable economic development, and integration into global economy. These interlinked pillars are mainly focused on elimination of trade tariff; free flow of goods,

services, investments, skilled labour, and capital; establishment of common framework, standards, and cooperation across several areas; improvement of transport connectivity amongst ASEAN countries; development of a coherent external economic relationship; and enhancing sharing in the global supply network (ASEAN, 2015a).

The mid-term review of the AEC Blueprint by the Economic Research Institute for ASEAN and East Asia in 2012 highlighted the key achievements of the AEC Blueprint 2015 in areas like free trade, single window, free flow of investments, and the like. The Common Effective Preferential Tariff, the implementing mechanism of the vision for the ASEAN Free Trade Area, is significantly reduced in the ASEAN region. The number of items with zero tariff rose from 40% in 2000 to 99.11% in 2012 for six ASEAN nations. Considerable progress was also achieved in the implementation of the ASEAN Single Window policy. This is the heart of AEC 2015, which is aimed at facilitating the trade. The policy aims to speed up the process of cargo clearance from customs. Only five nations currently have the National Single Window policy (Indonesia, Thailand, the Philippines, Malaysia, and Singapore), although only Singapore executes an effective Single Window approach. Viet Nam is on the way to implementing the ASEAN Single Window policy while Cambodia, the Lao People's Democratic Republic (PDR), and Myanmar are still behind. The implementation of AEC 2015 also resulted in the improvement of the free flow of investment within the ASEAN region. However, AEC 2015 failed at establishing and implementing trade standards, mutual recognition agreements, and movement of professional service providers.

The economy of the ASEAN region almost doubled from US$1.33 trillion in 2007 to US$2.57 trillion in 2014 and its per capita GDP increased by 76% at the same time. These quantify the success of AEC 2015. The ASEAN economy grew to be the third largest in Asia and the seventh largest in the world in 2014 (ASEAN, 2015b). The ASEAN region also gathered 11% of the total foreign direct investment inflow in 2014, making it one of the potential markets for global investment. The foreign direct investment was only 5% back in 2007 when the AEC Blueprint was just initiated (ASEAN, 2015b).

At the end of the AEC Blueprint 2015, the AEC decided to move forward with the AEC Blueprint 2025 for networking and building a competitive, innovative, highly integrated, and contestable ASEAN (ASEAN, 2015c). The AEC Blueprint 2025 is based on the following pillars: highly integrated and cohesive economy; competitive, innovative, and dynamic ASEAN; enhanced connectivity and sectoral cooperation; resilient, inclusive, people-oriented, and people-centred ASEAN; and global ASEAN. ASEAN's growth is predicted to grow at 5.2% over 2015–2020 (OECD, 2016) and to be the fourth largest in the world by 2050 (Vinayak, Thompson, and Tonby, 2014).

However, these gains are not equitably divided amongst ASEAN member nations (Table 1). Indonesia, with an enormous GDP of about US$872 billion, accounts for nearly 35% of the total ASEAN economy. Similarly, Indonesia, Thailand, the Philippines, Malaysia, Singapore, and Viet Nam occupy 95% of ASEAN's economic wealth, while Myanmar, Cambodia, and Lao PDR are moving at a tremendous rate. ASEAN nations are at different stages of economic growth and the variance can be seen in their GDP and per capita GDP. Similarly, the level of industrial contribution to GDP also differs. Brunei Darussalam, Indonesia, Thailand, and Malaysia are more inclined towards the industries whereas Singapore and the Philippines are more inclined towards the service economy. Cambodia, Lao PDR, Myanmar, and Viet Nam (CLMV) are still struggling to escalate their production. Domestic material consumption, which refers to the raw material extracted in a nation and all the physical imports after deducting the physical exports, is a suitable indicator for resource consumption. The domestic material consumption for Singapore and Malaysia is also seen to be significantly higher than the other ASEAN nations. Among the CLMV nations, Viet Nam has a higher domestic material consumption with 8.5 tonnes/capita, while Myanmar consumes the least resources.

Table 1. Economic Status of ASEAN Member Countries and their Resource Consumption

Country	GDP Growth Rate (%)*	GDP (in US$ Billion) Per Annum*	Per Capita GDP at Current Price (US$)**	Industrial Contribution to GDP (%) (2013)*	DMC (tonne)***	Per capita DMC (tonne/capita)***
Indonesia	5.0	872	3,467	42.6	1,822,839	7.5
Thailand	0.9	373	5,678	36.9	577,912	8.6
Malaysia	6.0	313	10,420	39.8	448,861	15.9
Philippines	6.1	299	2,707	31.3	374,549	4.0
Singapore	2.9	293	55,182	25.1	161,737	31.8
Viet Nam	6.0	198	1,909	33.2	755,956	8.5
Myanmar	8.5	65	916	21.3	208,498	4.0
Cambodia	7.1	17	1,047	25.6	83,073	5.8
Lao PDR	7.5	12	1,505	33.2	NA	NA
Brunei Darussalam	-2.3	11	39,679	68.24	3,128	7.9

DMC = domestic material consumption, Lao PDR = Lao People's Democratic Republic, NA = not available.
Sources: *Work Development Indicators, 2014; ** ASEAN Economic Community Chart Book 2014; *** Dittrich, 2014.

ASEAN accounts for 7% of global exports and is the fourth largest exporting region in the world after the European Union (EU), United States, and China. The manufacturing capabilities of this region are also diverse and different member countries specialise in different sectors. Table 2 shows the manufacturing capabilities of this region are also diverse.

Table 2. Globally Recognised Major Industries of ASEAN Member Countries

Country	Recognised Sector
Viet Nam	textile and apparel, leather, shoes
Singapore	electronics, service industry
Malaysia	electronics, palm oil
Thailand	vehicle and automotive-parts exporters
Indonesia	palm oil, coal, cocoa, tin
Philippines	agricultural products, business process outsourcing
Brunei Darussalam	natural gas, oil

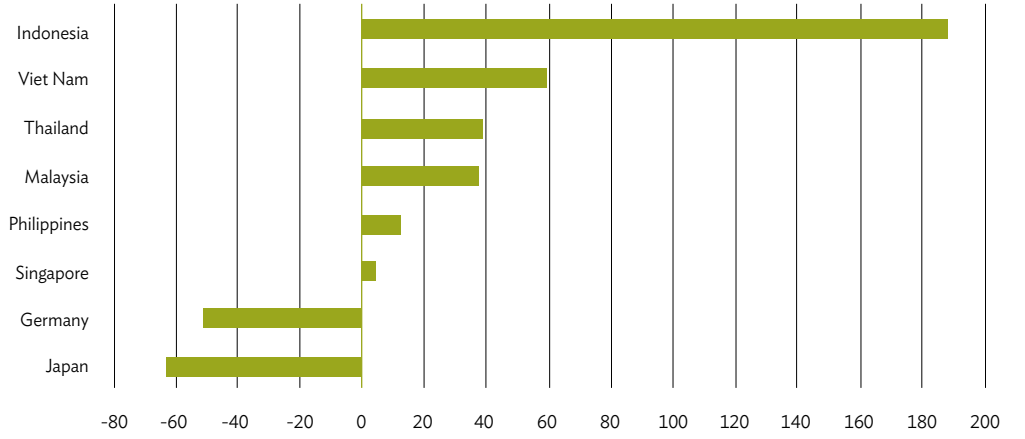
DMC = domestic material consumption, Lao PDR = Lao People's Democratic Republic, NA = not available.
Sources: *Work Development Indicators, 2014; ** ASEAN Economic Community Chart Book 2014; *** Dittrich, 2014.

3. Linear Economy and its Limits to Growth

Though ASEAN member nations have achieved rapid economic growth, this was attained at a significant environmental cost. As can be seen in Figure 2, total cumulative CO_2 emissions in Singapore, the Philippines, Malaysia, Thailand, Viet Nam, and Indonesia increased between 2007–2011, while CO_2 emissions decreased in Germany and Japan during the same time interval. The increase in CO_2 emissions can be attributed to the increase in industrial activities and resource consumption. It also signifies the trend in linear economy, which focuses on the 'take-make-use-dispose' principle. The ASEAN economy is based on the principle of linear economy where the resources flow from 'cradle to grave'. 'Cradle to grave' flow implies that the resources flow from extraction of minerals to the landfill after production and consumption of the materials.

However, if this linear economy continues, two earths will be needed to meet human consumption needs by 2030 as estimated by the United Nations. Resources have been abundantly exploited to raise the GDP of nations. About 65 billion tonnes of raw materials entered the economy and resource demands are expected to soar to 82 billion tonnes by 2020 (Ellen MacArthur Foundation, 2012). Therefore, the linear economy model is not sustainable, and ASEAN must transition to a model like that of Japan and Germany.

Figure 2. Change in CO_2 Emissions Per Annum in Million Tonnes, 2007–2011



CO_2 = carbon dioxide.
Source: World Development Indicators, 2016.

Figure 2 demonstrates the difference in annual CO_2 emissions between 2007 and 2011. Japan and Germany, which have moved forward with stringent laws and market-based policies, have managed to develop new technologies and business models, and enhanced resource use efficiency with considerable reduction in the annual CO_2 emissions. However, for the ASEAN6 region (Indonesia, Thailand, Malaysia, Viet Nam, the Philippines, and Singapore), which accounts for over 95% of ASEAN's wealth, Figure 2 shows that the economic growth and resource consumption are coupled, as the increase in GDP is also followed by an increase in annual CO_2 emissions. Indonesia increased its CO_2 emissions by 188.4 million tonnes (MT) in 2011 compared to its annual CO_2 emissions in 2007. Indonesia emits the highest amount of CO_2 in the ASEAN region. Similarly, Viet Nam, Thailand, Malaysia, the Philippines, and Singapore increased their annual CO_2 emissions by 59.3MT, 38.3MT, 37.6MT, 12.3MT, and 4.2MT, respectively, compared to the 2007 emissions. However, in the same year, Japan and Germany reduced their annual CO_2 emissions by 63MT and 51MT, respectively, compared to their CO_2 emission levels in 2007.

CO_2 emissions are related to resource consumption. Resource extraction, processing, production, use, and disposal are all linked to energy consumption, which leads to the emission of CO_2 as well as other greenhouse gases. CO_2 has been widely used to quantify resource use efficiency, which advocates minimum use of energy and resources or, alternatively, minimise CO_2 emissions to do the same activity (e.g. extraction, production, use, disposal, and the like). Linear economy disregards this cost and is focused on the economic gain.

3.1 Constraints to Linear Economy

The linear economy has undoubtedly assisted the ASEAN economy to grow. However, it has limits and sustainable growth is not possible with this economic development model as there is an end to resources use. Some aspects of linear economy that trigger the need for the circular economy for ASEAN are as follows:

3.1.1 Inefficient resource consumption along the supply chain

Linear economy excessively produces waste, which ultimately end up in landfills. Wastes are created throughout its supply chain – from mineral extraction, production, transportation, packaging, etc. However, sometimes, the supply chains are much more complex like in the case of the food supply chain where the wastes are produced from each component of the supply chain. The constrained approach of linear economy simply deals with the 'take-make-use-dispose' approach, which might not be resource efficient.

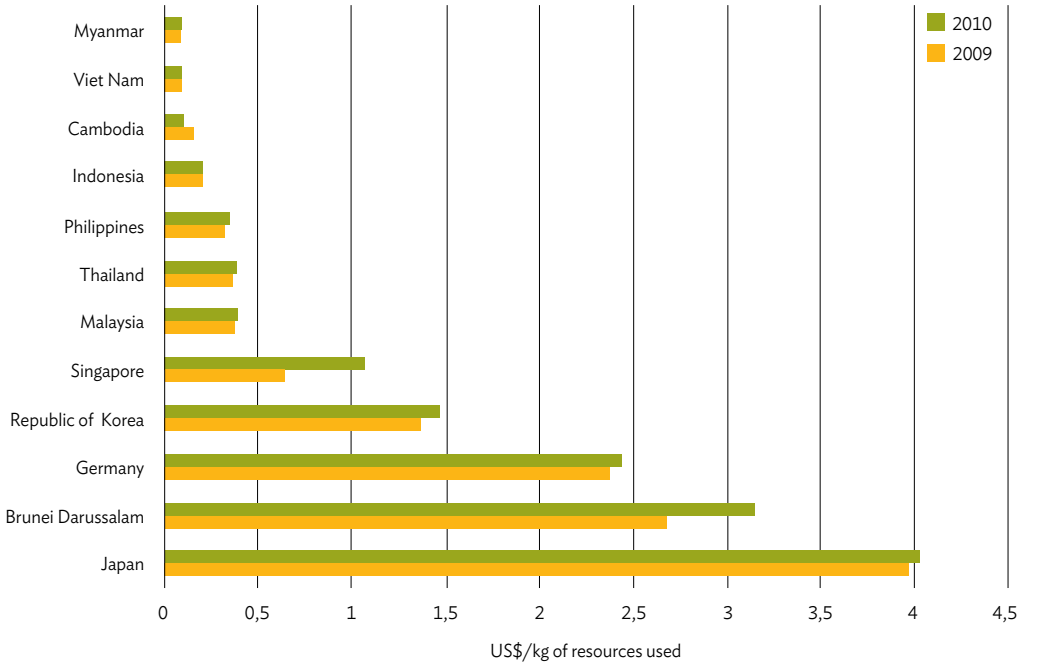
The Food and Agricultural Organization of the United Nations estimated a massive food loss of 1.3 billion tonnes, which accounts for one-third of the current food production (FAO, 2011). The Food and Agricultural Organization further estimated that 42% of fruits and vegetables and up to 30% of grains produced in Asia and the Pacific region are lost between production and the market. Food waste created by consumers is only a small fraction of this supply chain. These losses occur due to the following reasons in the supply chain: lack of technological advancements in harvesting techniques, pests during handling and storage, lack of efficient processing plants, and lack of logistics and data on customer demands.

Waste generation in the supply chain is inevitable in the conventional linear approach. This calls for an alternative that uses the principles of the circular economy to reduce waste generation and to improve efficiency throughout the supply chain.

3.1.2 Low resource productivity

ASEAN Member States have low resource productivity. Resource productivity indicates the effectiveness of the resources used for generation of wealth. Higher resource productivity not only signifies higher per capita income or GDP of a nation but also depicts minimal environmental impact.

Figure 3. Resource Productivity of ASEAN Countries



ASEAN = Association of Southeast Asian Nations, kg = kilogram.

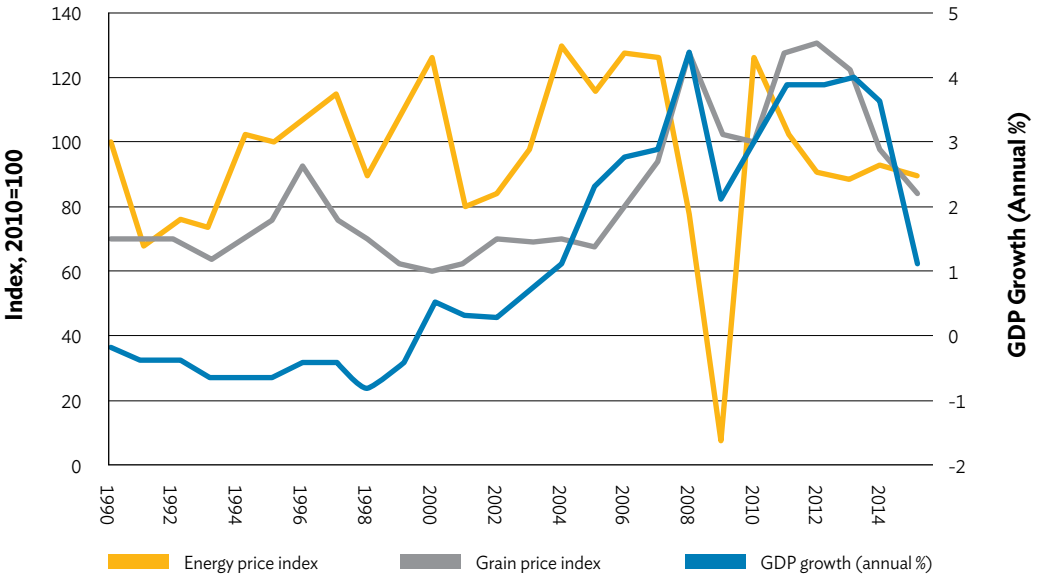
Sources: Wirtschafts Universität Wien, 2014; Global Material Flows Database.

Figure 3 illustrates the low resource productivity of the ASEAN region, except Singapore and Brunei Darussalam. Japan and Germany have stringent rules, regulations, and policies as well as a vibrant private sector and strong research and development (R&D) system to support the circular economy, resulting in higher resource productivity.

3.1.3 Vulnerability due to mounting commodity price

The linear approach to growth demands the use of virgin raw materials. This dependence on virgin resources makes the company vulnerable to price hikes. The circular economy aims at decoupling the economy from excessive resources consumption. Thus, it is necessary for the ASEAN region to explore ways to reuse and recycle the used materials.

Figure 4. Comparative Analysis of Commodity Price and GDP Growth
World Development Indicators (1990-2014)



GDP = gross domestic product.

Source: Based on UN Comtrade data.

The figure above shows the comparison between the GDP growth rate and the price of two commodities (energy and grain). Energy price index and grain price index refer to the basket of these commodities or all its sub-categories. As seen in the graph, the GDP growth rate seems to have a direct relationship with the fluctuating price of commodities. A stronger relationship can be seen in 2009 where the fall in the global GDP was marked by the decline in the energy and grain price indices. Similarly, when the global economy collapsed in 2015, energy and grain price indices also crashed.

4. Evolution of the Circular Economy

With depleting resources and increasing rate of carbon emission becoming global problems, an economically viable solution that promotes conservation and optimal use of environmental resources is an essential agenda for any nation. The major sector to be considered for such advancement is the industrial sector, which depends largely on the use of natural resources and economic growth. This sector consumes significant amount of natural resources and produces by-products that have no further use in the production process but are to be disposed as waste. A current linear model, which is

based on the generation of more wealth by consuming more resources, is questionable from the point of view of competitiveness and sustainability.

With innovative technologies and smart business models, one of the prominent solutions to resource scarcity is to circulate these wastes in a closed loop in the form of material symbiosis between companies and production processes (Andersen, 2007). This principle of loop closing with the aid of new technologies, production models, and green entrepreneurship is termed as 'circular economy', and was first introduced in German and Swedish environmental policies (Yuan, Bi, and Moriguichi, 2006).

4.1. Evolution from Linear Economy to Circular Economy

Figure 5 presents the stages of global industrial development. During the early industrial development stages, environmental problems were addressed by considering all pollution issues that could be solved through the dilution approach. Regulatory and associated policy instruments were progressively developed later, aimed at controlling and enabling the manufacturing sector to deal with environmental impacts downstream, with emphasis on end-of-pipe waste treatment.

In the 1980s, cleaner production was the next response to pollution management, which moved beyond the traditional concept of pollution dilution and treatment. The changes intended to decrease waste production, minimise the resources used, and increase the efficiency of the production processes. Cleaner production looked at the waste and pollution created by the industries from the modular approach and emphasised the improvement of each module.

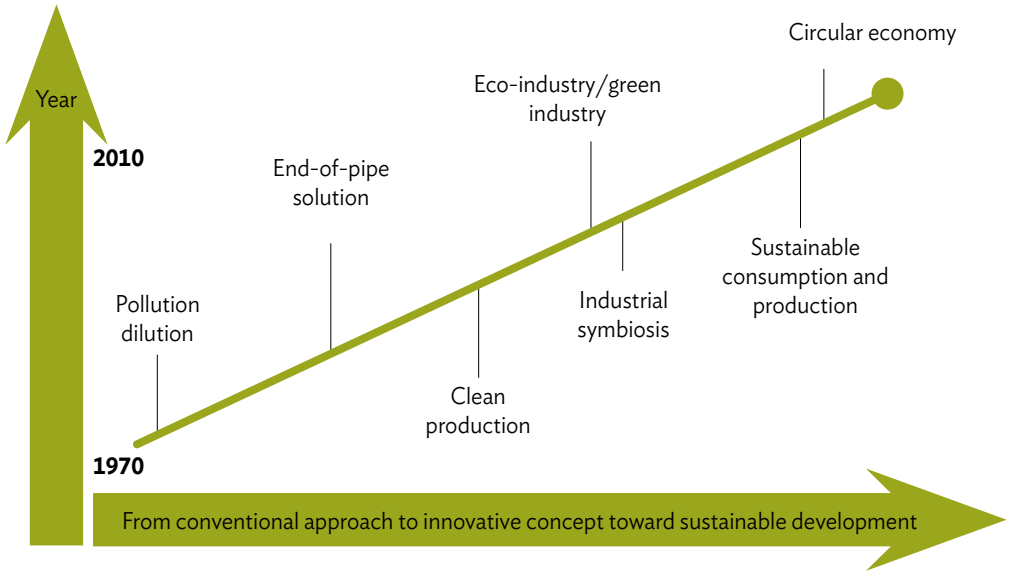
However, these approaches did not have a holistic view, lacked integrated policy support, and often failed to penetrate the supply chain and emerging production networks. The investments made in pollution control and infrastructure focused either on the eradication of pollution or on the improvement of resource and energy efficiencies. These solutions did not aim at eradicating the need for virgin natural resources and were based on the linear model of resource consumption. Thus, with the rising population and needs, consumption and pollution invariably increased.

Sustainable consumption and production (SCP), as defined by the Oslo Symposium in 1994, is about 'the use of services and related products, which respond to basic needs and bring a better quality of life while minimising the use of natural resources and toxic materials as well as the emission of wastes and pollutants over the life cycle of the service or product so as not to jeopardise the needs of further generations'. SCP was indeed the

first attempt to manage waste in the supply chain. It focused on consuming the goods and reducing the creation of wastes in a sustainable way.

In the 2000s, the circular economy became the next step towards transforming the vicious into a virtuous cycle. The circular economy calls for an innovative supply chain and business model that eliminates waste by designing products in such a way that resources can be used in a cyclical way rather than being disposed in landfills. Furthermore, the circular economy concept integrates all upstream and downstream processes/flows throughout the economic value chain (facilitate materials in cyclical flow).

Figure 5. Development of Environmental and Resource Management Approach by Industrial Sector



Source: Authors.

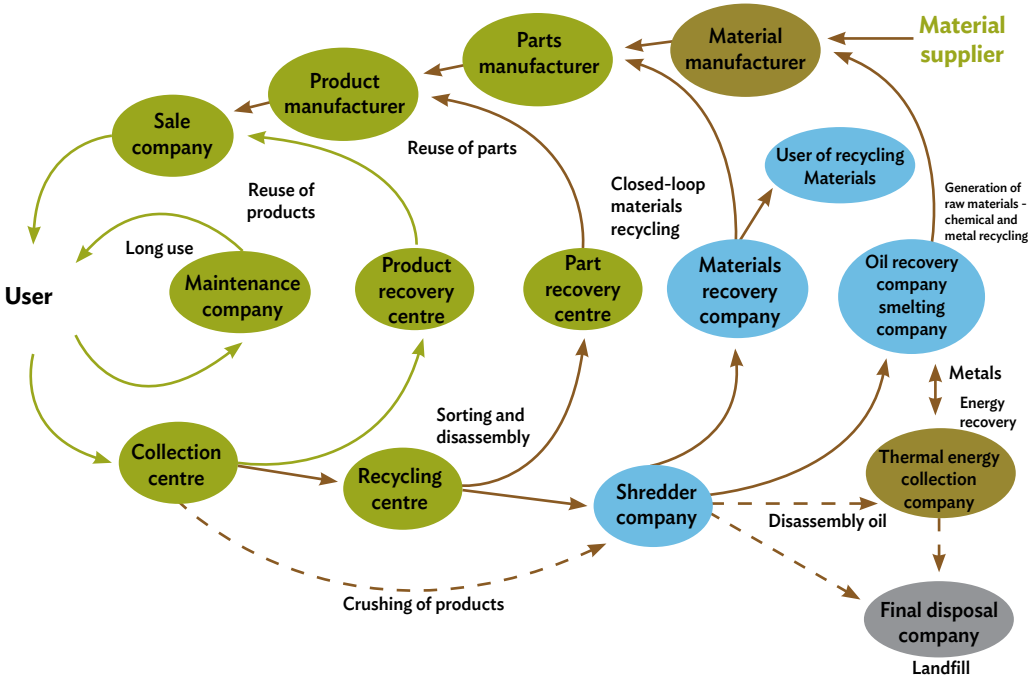
The circular economy is based on a win-win philosophy where both economy and environment can be sustained in a healthy way (Geng and Doberstein, 2008). It focuses on the following objectives: economic (accelerate growth), social (job creation and employment), and environmental (reduce pollution and greenhouse gas [GHG] emissions). It puts emphasis on the most efficient use of resources and recycling as well as environmental protection (UNEP, 2014). The circular economy is described in terms of an industrial system that replaces the 'end-of-life' concept by restoration and regeneration through intention. By redesigning products, services, or processes, it aims to transform wastes or discarded materials into productive and reusable products through closed-loop systems (Sempels and Hoffmann, 2013; Ellen MacArthur Foundation, 2013).

4.2 Contents of the Circular Economy

Several definitions of the circular economy have been proposed in the literature. The Ellen MacArthur Foundation (2013) highlighted that the circular economy is a restorative system which aims at careful management of material flows. It looks to eradicate waste through careful designs and minimise the use of resources by considering everything (including waste) in the economy as a valuable resource. The concept advocates the need for functional service, selling the use of the product rather than the product, effective take-back arrangements for products which have reached their 'end-of-life', and the proliferation of product and business models which generate durable products, and facilitate disassembly and refurbishment.

A practical example of the circular economy can be illustrated by Ricoh's Comet Circle (see Figure 6). The system of material flow puts priority on the inner loop based on designing for long use, reuse/repair; design for easy sorting; and disassembly. The next priority is given to recycling.

Figure 6. Example of the Circular Economy (Ricoh's Comet Circle)



Source: Ricoh Group.

The cradle-to-cradle philosophy, based on the circular economy principle, classifies all materials used in production processes around two kinds of metabolism: the biological and the technical. The biological nutrient is a material or a product initially designed to reintegrate the natural cycle, and the technical nutrient is a non-biodegradable material that can be recovered and reintroduced into a closed-loop production cycle, without loss of quality. Further, 'waste does not exist when the biological and technical components (or materials) of a product are designed by intention to fit within a biological or technical materials cycle, designed for disassembly and repurposing' (Ellen MacArthur Foundation, 2013).

4.3 Need for the Circular Economy

The World Economic Forum estimates that only 20% of the total global materials, valued at US$3.2 trillion, are recovered, while 80% is lost to the 'take-make-use-dispose' model. The concept of the circular economy is recognised as an alternative approach to transform the linear system into a more sustainable approach based on circular cycles (called the closed loop). The circular economy concept is gaining more attention recently as it will potentially help reduce resource extraction and waste streams, minimise environmental impacts, and support organisations to move towards sustainable development.

One of the key advantages of the circular economy is that it focuses on reducing dependency on the resource market, which reduces a country's or company's vulnerability to costs. Unlike in the past century, resource prices are soaring, and this trend will continue for the next 20 years (Dobbs et al., 2011). Thus, a more resilient economy that is not centred on energy and use of virgin materials is essential. The circular economy, which evolves around the same concept, focuses on the usage of materials through reuse, refurbishment, remanufacturing, and recycling. Apart from reducing vulnerability from macroeconomic shock, the circular economy also reduces pressure on the environment and minimises the environmental cost. Economically, it also creates jobs as a new sector has evolved.

The carpet giant Interface successfully runs a programme called Network Philippines, which buys discarded fishing nets from local communities and recycles it into fresh carpet tiles. Apart from reducing its dependence on virgin resources, social and environmental benefits are embedded in this business model. Nylon, which is made from petrochemicals, is used for production of fishing net. For decades, nylon was considered unrecyclable until the groundbreaking discovery by Econyl Corporation in 2011. Econyl's

regenerative system is capable of recycling fishing nets into nylon yarn (raw material for carpet manufacturers).

In the Philippines, discarded nylon fishing nets continue to injure and even kill marine life. These globally discarded fish nets cumulate around 10% of the total marine wastes (Macfadyen, Huntington, and Cappell, 2009). Interface explored the opportunity of utilising these discarded nets as raw material through the formation of Network Philippines, which is the association of Interface, Aquafil, and the Zoological Society of London (see Figure 7).

Figure 7. Network Philippines

SPFTC = Southern Partners and Fairtrade Center Inc., ZSL = Zoological Society of London.
Source: Authors.

Under this business model, the seller gets paid for the nets which initially threatened marine life. The collected nets are exported to Aquafil which applies its technology to convert it into a raw material (nylon yarn) for the Interface manufacturing process. This kind of business model and technological innovation not only helps companies meet the sustainability need but also motivates the community to participate in the circular economy.

The circular economy has been considered an important tool to attain the resource efficiency agenda established under the Europe 2020 Strategy for smart, sustainable, and inclusive growth. The circular economy has also been recognised as China's national regulatory policy priority, and the Chinese government has introduced numerous regulations to support and build its implementation. Under the circular economy package, Europe has targeted to achieve 70% recycling by 2030 and put a ban on sending recyclable materials to landfills by 2025 (EU Commission, 2014). Asian countries like Japan, the Republic of Korea, and Taiwan have also introduced the circular economy in their policies and have demanded that manufacturers recycle 75% of their annual production. The practice of circular economy has also been seen at the industrial level in Asia.

The industrial and business sectors have a very significant influence on the transformation of the linear system to a more sustainable model of development, particularly in the way companies design how their products are manufactured, the decision on what materials are used, and the structure of their operational business practices, from procurement until the end of product's lifetime. The industrial sector has become increasingly proactive in contributing to sustainable development due to multilateral environmental agreements, international trade agreements, and national environmental regulations and pressures. Companies now need to be more careful and proactive in environmental regulations; the circular economy not only solves environmental issues but also makes business profitable.

4.4 Value Drivers of the Circular Economy

Value drivers are the entities that give the product or service of companies more competitive advantage. They add value that is recognisable and appealing to the consumers. This can be capitalised as they differentiate the product or service from the competitor's product. The circular economy value drivers are marketable as the consumers are progressively moving towards 'green consumerism', which demands the inclusion of social and environmental costs in the product or products. The circular economy value drivers, which focus on prolonging the usage of a product, recirculating the resources, and increasing the regenerative capacity through effective product design, are easily capitalised in the form of Ecolabels, certifications, and the like, which are clear and lucid to the consumers. The ability to upgrade and use the product for

longer time also adds value to the product and these value drivers are mostly observed in the electronics market where consumers regularly upgrade, for instance, their mobile phones. Some of the value drivers of the circular economy that the consumers can benefit from or can be advertised from the perspective of green consumerism are as shown in Table 3.

Table 3. Value Drivers of the Circular Economy and Associated Consumer Benefits

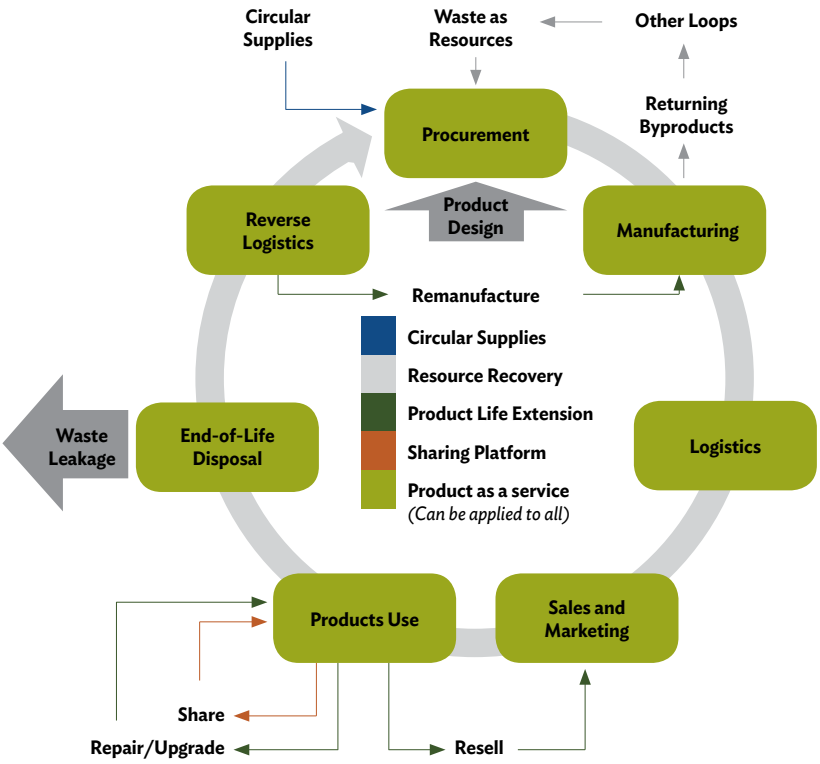
Value Drivers	Method
Extending the length of use cycle of an asset	• designing to last long • designing for easy recyclability • designing for easy repair and upgrade • including clear guidance for maintenance
Increasing the utilisation of an asset or resource	• increasing the sharing of assets • increasing resource productivity • limiting the negative externalities
Looping or cascading an asset through additional use cycles	• reusing of the material • recycling of used material for use as raw materials • refurbishment of the assets
Regenerating natural capital	• returning the biological nutrient back to land • avoiding topsoil erosion • regenerating the nutrients of soil • maintaining marine ecosystem

Source: Authors.

4.5 Circular Economy Business Models

Companies in ASEAN are becoming increasingly aware of the merits of the circular economy for their businesses and the collateral benefits it can bring. The circular economy not only provides companies the opportunity to be greener but it also generates revenue for the companies' sustainable growth. The business model adopted by the companies can be divided into five categories (as illustrated in Figure 8).

Figure 8. Circular Economy Business Model



Source: Modified from Accenture, 2015.

4.5.1 Circular input model

Under this business model, limited resources are replaced by fully renewable, recyclable, and biodegradable resources in the supply chain. It aims to decrease a company's dependence on valuable resources and vulnerability to the rising prices of scarce resources by using recycled materials.

Greenpac, a Singapore-based company that designs and manufactures packaging systems, has adopted the circular input model where packaging materials are designed for recyclability. Their 'revolutionary systems concept packaging' solution uses oriented strand boards and water-based glue to do away with the use of nails, which can sometimes destroy the product. It is the world's first nail-free wooden packaging design that is 100% reusable and recyclable. The new design also saves 60% of the material and therefore reduces the weight of packaging, saves transport costs, and reduces carbon emission (Greenpac Environmental Packaging, 2008).

Under the circular input model, resources are moved along the loop. One example is the use of tyre waste for the manufacturing of shoe outsoles. The tyre and footwear industries are the largest users of raw rubber. Recycling the used rubber from tyres into footwear can reduce the resource consumption and increase resource efficiency. Omni United, a Singapore-based tyre manufacturing industry, and Timberland, a footwear company in the United States (US), explored this link and have partnered to manufacture tyres that can be easily recycled at the end-of-life into crumb rubber to be used by Timberland for making shoe outsoles (Ecobusiness, 2014).

4.5.2 Resource recovery

This business model targets to improve technology and capabilities to efficiently eliminate material loss in the supply chain. It targets to recover and reuse resources for the next cycle through recycling, industrial symbiosis, and cradle-to-cradle design.

Wongpanit is a waste management company that has pioneered the resource recovery principle in Thailand. Wongpanit is spread throughout the nation and has more than 900 branches spread all over the country. The company is continuously growing as waste generation is inevitable. The largest waste recycling plant of Wongpanit is located in Ayutthaya (the ancient capital of Thailand) and it recycles 100 tonnes of wastes a day. The recycled materials mostly include metal, paper, glass, plastic, waste tyres, hazardous waste, food residues, electronic waste, expanded polystyrene foam, and many more. Wongpanit has managed to increase the public interest in waste management by buying waste from the user. It has also collaborated with the government to promote separation of waste materials at the source. Moreover, the company offers capacity-building training programmes as well as provides job opportunities to disadvantaged people.

PT Enviro Pallets, a US company based in Bali, Indonesia, came up with an innovative business model where the plastic wastes from the island are processed to produce shipping pallets. The company buys plastic waste from the local waste collectors at a minimum of US$0.09 per kilogram, creating jobs for many and improving the environment (Richardson, 2015).

4.5.3 Product life extension

This business model deals with designing a product that can be repaired, upgraded, remanufactured, and remarketed with ease. Under this business model, a product is designed to have a prolonged lifetime to avoid ending up too early in the waste stream.

The product life extension business model has already been initiated by multinational companies like Philips and Optus. The Dutch electric equipment giant, Royal Philips, has a new healthcare imaging system refurbishment facility in the Netherlands that refurbishes x-ray, magnetic resonance imaging, nuclear medicine, and ultrasound systems; and extends their product lives. Similarly, Optus, the Australian telecommunications provider, through its sustainable asset-disposal initiative, sold its entire set of outdated inventories to users who will be using them for their own business or to sustainable recyclers. This kind of business model increases the product life and decreases the need for landfills. It is economically rewarding as well (Accenture, 2015).

4.5.4 Sharing platforms

This business model is centred around sharing the products and assets amongst companies to minimise the need for owning a product. Through this model, the productivity of a resource can be enhanced and the resource consumption can be decreased.

With the launch of sharing platforms like Airbnb (home sharing) and Uber (car sharing), the sharing business model is gaining momentum. It is also gaining popularity in the ASEAN region. Tripid, a ride-sharing service based in the Philippines, connects drivers and passengers headed the same way. This platform helps create a community of drivers and passengers who opt to share rides with others while also allowing users to act as drivers for others looking for a ride. The sharing platform has spread to the food sector. Malaysia-based Plate Culture allows homes to host a meal in their own kitchen. The menu and prices can be easily uploaded on the site where home meal lovers can find such a place to eat their meal. Similarly, sharing platforms like Waste Is Not Waste in Singapore enables business and companies to sell their waste to the right buyers. In addition to selling the product, the platform also provides companies the option to trade their wastes.

4.5.5 Produce as a service

This business model is a paradigm shift from the conventional thinking of owning a product. Under this business model, customers pay for the performance of the product. This model is attractive for companies that wish to reduce their operational costs by outsourcing more eligible businesses for services.

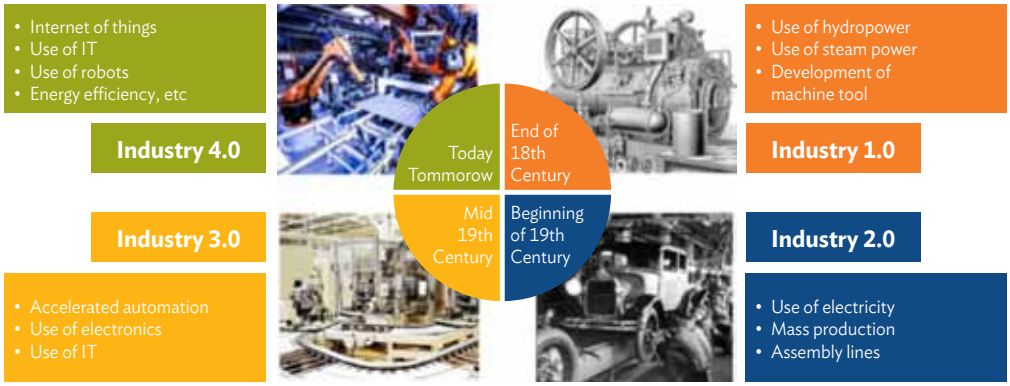
Sunlabob is a solar enterprise based in Lao PDR which has initiated this business model to light rural areas in the country. Sunlabob created a solar lamp renting business where people can rent a solar lamp on a daily or weekly basis. This lighting as a service business model is affordable for the villagers who cannot buy the expensive solar panels and lights but have enough money to borrow the service rather than buy the product. It also ensures better maintenance and efficiency of the equipment as the service providers are obliged to maintain the quality of their service. This kind of business model is resource efficient as it reduces the resource consumption and increases the reliability of the service. The lighting of the famous Dragon Bridge in Da Nang, Viet Nam, runs under the same business model where Philips sells the light rather than the bulbs. Philips is responsible for lighting this landmark and charges for the service, which gives it liberty to sustainably manage its resources for better performance. This type of business model can motivate as well as offer economic benefits to the business/firm/company to prolong its product life cycle by proper maintenance and refurbishment, thus increasing the resource efficiency.

5. Digitising the Circular Economy: Industry 4.0

Figure 9 presents the evolution of Industry 4.0. ASEAN manufacturing can be strongly associated with Industry 1.0, which is based on the use of hydropower, system power, and machine tool. Industry 2.0 is associated with mass production based on the division of labour using renewable energy. Industry 2.0 was followed by Industrial 3.0, wherein electronics, information and communications technology (ICT), and robots played a key role in the atomisation of the production line.

Moving one step ahead of the circular economy is Industry 4.0, which focuses on the use of intelligent assets (robots, internet of things, ICT, and others). Through effective use of intelligent assets, Industry 4.0 aims to make the production line of the industrial system 'cyber efficient'. Industry 4.0 refers to the digital transformation of the design, manufacturing, operation, and service of the manufacturing systems and products.

Figure 9. Evolution of Industry 4.0



IT = information technology.

Source: Authors.

5.1 Characteristics of Industry 4.0

Industry 4.0 relies on the use of ICT in the supply chain. It not only focuses on making the production more efficient but also tries to make the system efficient outside the company boundary. Industry 4.0 focuses on the vertical networking of the production system, logistics, marketing, and services. It targets the customer's needs and is capable of customised production at a lower cost, with improved resource efficiency than the conventional system. It also accounts for the end-of-life of the goods and works on life cycle approach. It further targets the use of intelligent assets that can significantly cut production, transportation, and distribution costs.

The comparative advantages on different mechanism, technology, and uses in Industry 4.0 is shown in Table 4.

Table 4. Mechanism, Technology, Uses, and Comparative Advantages of Industry 4.0

Mechanism	Technology	Use	Advantages
CPS	ICT, sensors, intelligent robots, and 3D printing	Monitor and control production	Minimise the creation of waste and the production cost. The production process is more resource efficient as it is automated.
Network communications	Wireless and internet technology	Synchronise machines, products, and people	Production process can be changed at short notice. There is more control over the machines and the process is more efficient.
Remote monitoring	Robots and skilled labour	Remote monitoring of problems	As the production process can be remotely monitored and the problem can be remotely solved, there is less usage of unskilled and semi-skilled workforce.
Big data management	Simulation and modelling	Prediction of consumer behaviour	Better forecast of demand can potentially reduce the inventory and the probability of wastage of the manufactured good.
Energy efficiency and decentralisation	Use of renewable energy and recycled resources	Staying resilient to the vulnerabilities	Reduces the need for virgin resources. As the environmental costs are indirectly reduced due to the principle of energy and resource efficiency, Industry 4.0 can add green value to the products.

3D = three-dimensional, CPS = cyber-physical systems, ICT = information and communications technology.
Source: Authors.

5.2 Positioning of ASEAN Members in Preparedness for the Circular Economy and Industry 4.0

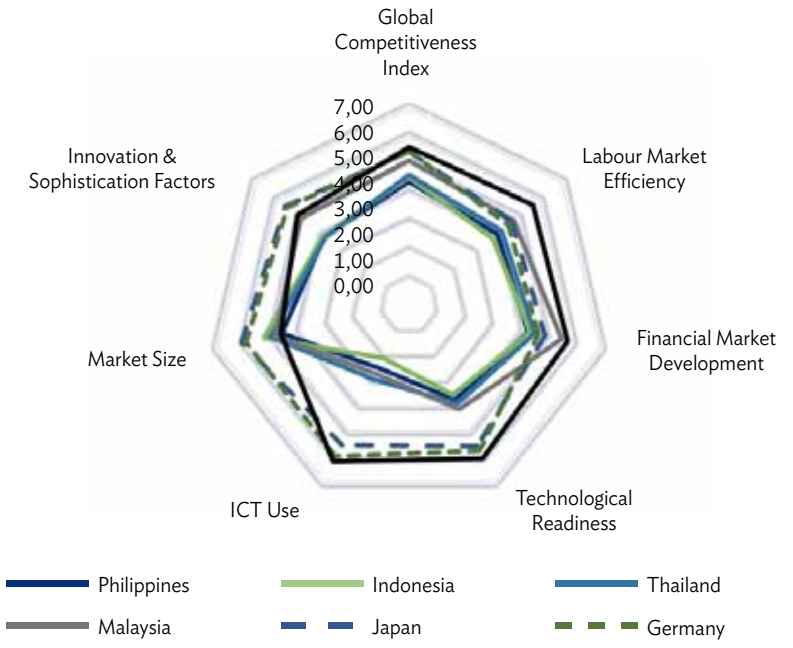
The Global Competitiveness Index (GCI) was used to clarify ASEAN's position in the context of its performance, capabilities, and preparedness. The Global Competitiveness Report 2014–2015, which analyses the GCIs of countries, analyses and ranks 140 countries according to their competitiveness. It measures institutions, policies, and factors that can lead to economic growth and is based on theoretical and empirical research. GCI consists of 110 variables organised into 12 pillars. These pillars measure the following sub-indices: basic requirements, efficiency enhancers, and innovation and sophistication. These sub-indices, pillars, and variables use a scale from 1 to 7, where 1 means least competitive and 7 means highly competitive. Two-thirds of the scaling

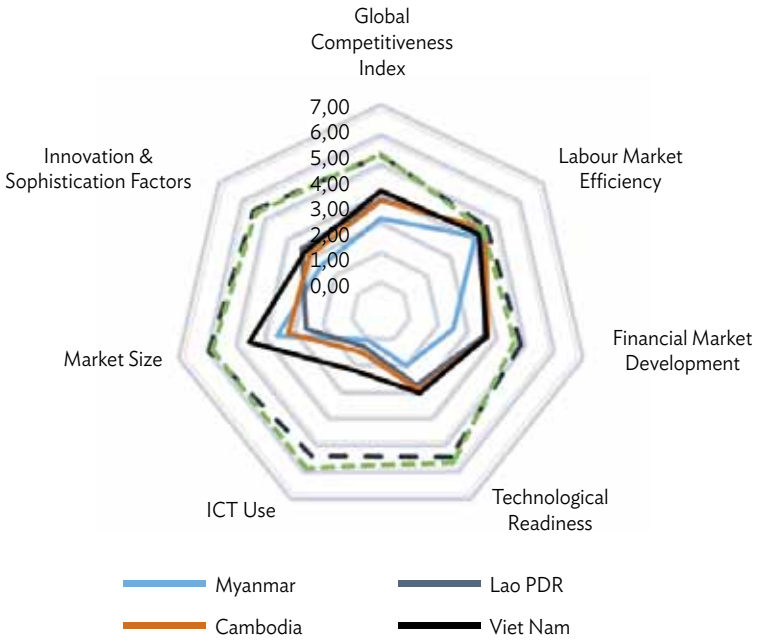
of the variables of the GCI is done through executive opinion surveys while one-third comes from publicly available reliable sources or databases.

However, for purposes of analysing ASEAN in terms of its capability to absorb the circular economy and Industry 4.0, the GCI scale has four pillars of the sub-index efficiency enhancer (labour market efficiency, financial market development, technological readiness, and market size); one sub-index of innovation and sophistication factors; and one variable of efficiency enhancer, i.e. ICT use, which falls under the technological readiness pillar that has been used in Figure 10. Japan and Germany, which have been reported to be flourishing with the circular economy and Industry 4.0, have also been analysed for benchmarking ASEAN.

CLMV countries are marginally behind Japan and Germany as seen in Figure 10. In the ASEAN6, Singapore is as competitive as Japan and Germany, but has constraints in terms of market size. Other ASEAN6 nations are more or less at the same scale and need a lot of improvement in their technology, labour efficiency, and innovation to compete with the developed economies. ICT use in the ASEAN region (except for Singapore) needs a huge improvement and needs to be supported well by policies.

Figure 10. ASEAN Position in the Global Context (Above ASEAN6 and Below CLMV)





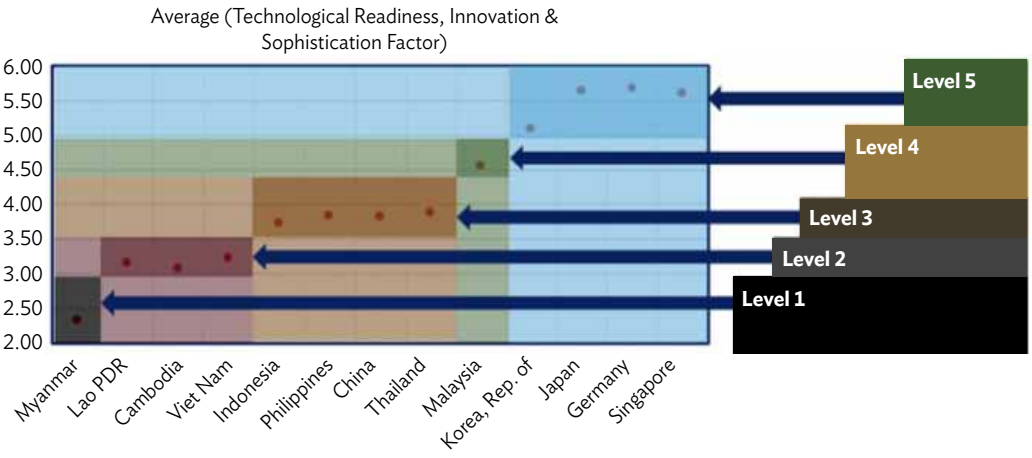
CLMV = Cambodia, Lao PDR, Myanmar, and Viet Nam, ICT = information and communications technology, Lao PDR = Lao People's Democratic Republic.

Source: Authors.

Narrowing down our analysis to Industry 4.0, which is more related to innovations and technology, Figure 11 ranks ASEAN's potential for Industry 4.0 in terms of its average technological readiness, and innovation and sophistication factors. The GCI for technological readiness measures the flexibility and potential of the nation to capitalise on the technologies to enhance the productivity of industries. This pillar gives special emphasis to the use of ICT to improve the performance and efficiency of the industrial system (Schwab and Sala-i-Martin, 2015). Similarly, the innovation and sophistication factors measure the business network of the country, the companies' operations and strategies, and the capacity to innovate. The innovative and sophistication factor signifies the research and development capacity, strategy, and policies of the economy that thrive on innovating new products and services to stay competitive in the market.

In Figure 11, Myanmar almost has no potential for Industry 4.0. Cambodia, Lao PDR, and Viet Nam also have the least potential. Singapore is highly competitive with other developed economies like Japan and Germany, and has the potential for Industry 4.0. Malaysia tends to have medium potential while Indonesia, the Philippines, and Thailand have low potential for Industry 4.0.

Figure 11. ASEAN Potential for Industry 4.0



ASEAN = Association of Southeast Asian Nations, Lao PDR = Lao People's Democratic Republic.

Source: Authors.

ASEAN countries need to progress swiftly to catch up with developed nations in terms of technology and innovation. The research and development sector should be strengthened with suitable policies and strategies.

5.3 Impact on ASEAN Economy

One of the competitive advantages of the ASEAN region lies in the existence of cheap labour force, which includes semi-skilled and unskilled workforce. Advanced nations, whose technologies need cheap labour, usually find the ASEAN region profitable for production of their goods. However, with the evolution of technology, Industry 4.0 is targeting to increase the labour productivity through massive exploitation of technology. It aims to eradicate the need for semi-skilled and unskilled workforce, which is otherwise the selling point of ASEAN countries. CLMV will be the most affected ASEAN countries as they tend to attract more multinationals and their economies are trending towards the industrial evolution.

As shown in Table 2, ASEAN nations excel in different sectors, most of which are labour intensive. Multinational companies that have the technology but need cheap labour can flourish in the politically stable ASEAN region, which is open to foreign direct investment. The footwear industry in Viet Nam plays a crucial role in its economy. Viet Nam exported footwear worth of US$12 billion in 2015 (Asia Pacific Leather Fair (APLF), 2016), which represented a significant portion of its total exports. Around

US$2 billion worth of goods reached the EU market in the same year. However, these industries exist in the ASEAN region because of cheap labour. Now, with the emerging possibility of mechanised production, the ASEAN market is in danger of losing its competitive advantage to the intelligent assets that do away with the need for labour.

Adidas, a German shoe manufacturing industry, manufactures its goods in Viet Nam using cheap labour. Adidas shut down its production in Germany 20 years ago due to high labour costs. However, with the evolution of robots and advancement in production technology, Germany is set to start a new shoe manufacturing factory back home since a robot-based production unit will produce shoes more quickly. Germany is further planning to set up more shoe factories in the US and Britain or France in the future. Resource efficiency, no doubt, can be better achieved with Industry 4.0 but at the cost of loss of jobs, which a developing economy like most economies in ASEAN is vulnerable to.

Germany is a pioneer of Industry 4.0 and has several policies that drive the revolution of Industry 4.0. Some of the strategies, policies, and projects for the evolution of Industry 4.0 are as shown in Table 5.

Table 5. German Policy Drivers of Industry 4.0

High-Tech Strategy 2020	Aimed at establishing Germany as the lead provider of scientific and technological solutions to issues in climate/energy, health/nutrition, mobility, security, and communication
Lead Market for CPS 2020	Under the national Industry 4.0 project, Germany targets to be the lead provider of CPS by 2020
Agenda CPS	Aimed at promoting R&D to shape technological revolution and to be the lead market and provider, in competition with other industrial and technological players
ICT 2020: Research for Innovations – IT Systems for INDUSTRIE 4.0	Fund research on ICT in complex systems (e.g. embedded systems), new business processes, and production methods as well as the internet of things and services.
Autonomics for INDUSTRIE 4.0	Contribute to the implementation of goals set out in the High-Tech Strategy 2020
RES-COM	Target automatised conservation of resources through application of highly interconnected and integrated sensor-actuator systems

CPS = cyber-physical systems, ICT = information and communications technology, R&D = research and development.

Source: Authors.

The EU further plans to increase its manufacturing from 15.4% to 20% by 2020. Under this scenario, the future of economies relying on labour-intensive production like the ASEAN region is unpredictable. The ASEAN region thus needs to promote micro, small, and medium enterprises (MSMEs) to move towards Industry 4.0 and to stay competitive with the large companies that have higher potential for Industry 4.0. The circular economy, which presents the innovative business model, and which has the potential for creating jobs based on resource circulation in the loop, could trade-off with the jobs lost due to Industry 4.0. However, detailed research and analysis, and a farsighted vision are needed for ASEAN.

6. Policies Supporting the Circular Economy in the ASEAN Region

6.1. ASEAN Policy: AEC Blueprint 2025

After the conclusion of the AEC Blueprint 2015, remarkable success was seen in economic growth in ASEAN. However, this growth did not consider environmental sustainability and the developments were achieved at the cost of resources and energy use. Linear approach to growth was observed and the principles of the circular economy were not adopted.

AEC Blueprint 2025 attempts to address the need for resource efficient technology, energy efficiency, and sustainability. The clauses that will impact both the circular economy and Industry 4.0 in the ASEAN region are as shown in Table 6.

Table 6. Strategic Measures Adopted in the AEC Blueprint 2025

Clause Number	Strategic Measures	CE	IE
B4: Productivity-driven growth, Innovation, Research & Development, and Technology Commercialisation	Strengthen the competitiveness of the MSME sector through the application of science and technology	•	•
	Support the development of highly mobile, intelligent, and creative human resources that thrive on knowledge creation and application	•	•
	Focus support on the development of research and technology parks; joint corporate, government and/or university research laboratories; research and development centres; and similar science and technology institutions and centres	•	•
	Share information sharing and promote networking to stimulate ideas and creativity at business-level	•	

Clause Number	Strategic Measures	CE	IE
B.8: Sustainable Economic Development	Foster policies supportive of renewable energy and set collective targets accordingly	•	
	Develop a framework to utilise low-carbon technologies with international support	•	
	Promote the use of biofuels for transportation: Free trade in biofuels within the region, and investment in research and development on third-generation biofuels	•	
	Promote good agriculture practices to minimise the negative effects on natural resources such as soil, forest, and water; and reduce GHG	•	
C.2: Information and Communications Technology	Innovation: Support ICT innovations and entrepreneurship as well as new technological developments such as smart city, and big data and analytics		•
	Human capital development: Strengthen the professional development of the ICT workforce in the region		•
	New media and content industry: Encourage the growth and use of e-services and new media in the region		•
C.4: Energy	Increase the component of renewable energy to a mutually agreed percentage by 2020	•	
	Reduce energy intensity in ASEAN by 20% as a medium-term target in 2020 and 30% as a long-term target in 2025, based on 2005 level	•	
C.5: Food, Agriculture, and Forestry	Enable sustainable production and equitable distribution	•	
	Increase resilience to climate change, natural disasters, and other shocks	•	
	Improve productivity, technology, and product quality to ensure product safety, quality, and compliance with global market standards	•	•
	Promote sustainable forest management	•	
	Develop and promote ASEAN as an organic food production base, including striving to achieve international standards	•	
C.8: Minerals	Promote environmentally and socially sustainable mineral development	•	
D.1: Strengthening the role of MSMEs	Promote productivity, technology, and innovation through measures to enhance MSME productivity by understanding key trends in productivity	•	•
	Build industry clusters through industrial linkages and promote technology	•	
	Build capabilities to foster industry clustering	•	
	Promote innovation as a key competitive advantage through technology use and application to business and business-academia linkages		•

ASEAN = Association of Southeast Asian Nations, AEC = ASEAN Economic Community, CE = circular economy, GHG = greenhouse gas, IE = Industry 4.0, MSME = micro, small, and medium-sized enterprises.

Source: Authors.

Table 6 presents the strategies (which can be linked to the circular economy and Industry 4.0) that ASEAN member countries will be adopting to ensure a sustainable economy until 2025, as published in the AEC Blueprint 2025. These strategies are aligned with the circular economy and Industry 4.0 and focus on technological advancement in MSMEs through science and technology and R&D, development of highly skilled human resources, increase in R&D, increase in the usage of renewable energy, low-carbon technology and biofuels, reduction in GHG emission through good agricultural practices, innovation in ICT, management of big data, elevation of e-service industries, improvement in resource productivity, development of ASEAN as the hub for organic farming, sustainable and environment-friendly mineral extraction, development of industrial clusters, and promotion of innovation for economic growth.

One of the highlights of AEC 2025 is the focus on the supporting role that ASEAN claims to provide for the technological advancement of MSMEs. The use of ICT, big data analysis, e-services, and advanced technology could push MSMEs closer to Industry 4.0. The development of industrial clusters and fostering of human resources and skills in this sector can also help ASEAN move towards the circular economy. Although these strategies fall under the periphery of the circular economy and Industry 4.0, the AEC Blueprint 2025 has not recognised the circular economy or Industry 4.0 as a whole.

6.2. National Policy

National policy and strategies play a crucial role in promoting the circular economy and Industry 4.0. However, ASEAN countries presently lack clear policies and strategies for the advancement of the circular economy and Industry 4.0. Some of the policies that ensure 3Rs and resource circulation in ASEAN are presented in Table 7. These policies could be the guiding principles for the development of individual national policies on the circular economy and Industry 4.0.

Table 7. Policy Development on the 3Rs and Resource Circulation in Asia

Country	3Rs and Resource Circulation Policy Development
Malaysia	**The 2007 Solid Waste and Public Cleaning Management Act (2007):** The responsibility for solid waste management was transferred from local governments to the central government. The 3R principles were introduced. Privatisation of waste management is encouraged.
	The Five-year Plan 2011–2015 calls for increasing the rate of resources recovery from household wastes, from 15% to 25% by 2015.
	The Eleventh Malaysia Plan 2016–2020 highlights the importance of pursuing 'Green Growth' for sustainability and resilience.
	The National SCP Blueprint 2016 to 2030 provides pathways for SCP to cover the circular economy.
	The Global Cleantech Innovation Programme of the Malaysian Industry-Government Group for High Technology, in collaboration with the United Nations Industrial Development Organization, is an annual competition and accelerator-based programme that aims to identify, fund, and nurture Malaysian start-ups in clean technologies.
Philippines	**The Ecological Solid Waste Management Act (2001)** introduced the 3R principle. All municipalities are required to achieve 25% diversion of solid waste (recycling and reduction) by 2006. Recycling rate in 2010 was 33%.
	The National Solid Waste Management Commission coordinates, at the national level, the ministries and other related parties in improving solid waste management (inaugurated in 2001).
	The National Framework Plan for the Informal Waste Sector in Solid Waste Management (2009) was established to support the formulation of a 3R national strategy. It is an action plan for improving the conditions of the informal sector engaged in solid waste management.
	The Philippine Developmental Plan 2011–2016 increased the waste diversion rate from 33% in 2010 to 50% in 2016.
Thailand	**The take-back programme for used products** started for containers and packaging, used lead-acid batteries, mobile phones, and batteries, in cooperation with the manufacturers and retailers. The take-back of fluorescent lamps is also in place, in cooperation with the Japan External Trade Organization.
	The initiation of a recycling-oriented society has been implemented in more than 200 communities through the 3Rs. In some communities, a 30%–50% or more reduction in waste generation was achieved.
	The Industries Waste Exchange Program registered over 450 firms by 2005.
	The National Economic and Social Development Plan 2017–2021 has policies like zero-waste society, green industry cluster, sustainable agriculture, promoting reusing and recycling, supporting factory owners to move forward with the green supply chain/green value chain.

Country	3Rs and Resource Circulation Policy Development
Lao PDR	**The 8th 5-year National Socio-Economic Development Plan 2016–2020 (waiting for approval from the National Assembly)** includes: • green and clean city development; and • green and sustainable urban development through waste reduction and integrated waste water refreshment system.
	Vision 2030, 10-Year Strategy 2016–2025, and 5-Year Work Plan of Natural Resources and Environment Sector provide for the: • participation in green growth to achieve sustainable development; • support of green productivity, and reduction of natural resources consumption in the industrial and tourism sectors, and households; and • reduction of impacts on environment from development and investment activities (e.g. reduction of CO_2 emission from transportation sector, and the like).
Viet Nam	**3R-related laws and policies:** Under the 2005 Law on Environmental Protection, 14 decisions were taken in relation to 3R and solid waste management. Decree No. 57 on integrated solid waste management in 2007; and Decision No. 1440 on planning/construction of solid waste management facilities in three central economic regions until 2020 in 2008.
	The 3R National Strategy (approved by the prime minister) targets 30% recycling of collected waste; 30% separation-at-source rate for households, and 70% for firms for 2020.
	The National Strategy on Cleaner Production in Industry Toward 2020.
	National Programmes on Sustainable Consumption and Production (NPSCP) for the period 2011–2020, with Vision 2030.
Cambodia	**The Green Growth Roadmap**, endorsed in 2009, outlines a framework for environmentally sustainable and socially inclusive development and growth in Cambodia. The master plan is currently being developed.
Singapore	**The 3R Guidebook for Hotels**, prepared by the National Environment Agency and the Singapore Hotel Association, offers a step-by-step and practical guide on planning and implementing 3R programmes.
	The 3R Guidebook for Shopping Malls, prepared by the National Environment Agency, offers guidelines to help shopping malls improve their current waste management practices, and identify opportunities for 3R. These guidelines focus on minimising the need for disposal of waste by shopping malls.
	The Sustainable Singapore Blueprint 2015 has strategies for smart city, 3R, energy, and water-efficient household appliances. It has clearly mentioned the need to use 3R on resources due to limited landfill spaces.
Indonesia	**The Waste Management Law No. 18/ 2008** focuses on waste reduction, recycling, reuse, and treatment as resources, extended producer responsibility, etc. The country has a weak policy for 3R and resource circulation.
Myanmar	Relevant rules and regulations are yet to be framed (UNCRD, 2013).
Brunei Darussalam	Recycling in Brunei Darussalam is still in the infancy stage and the country faces many challenges (UNCRD, 2013). It lacks proper institutional policies for 3R. The hazardous oil and gas industrial materials are mostly exported to the United Kingdom and Germany.

3R = reuse, reduce, and recycle, Lao PDR = Lao People's Democratic Republic, SCP = sustainable consumption and production

Source: Adapted from Hotta.

7. Conclusion

While companies are key to fostering the shift to a circular economy, governments also play an important role. To successfully tackle a systemic reshaping of the production and consumption model that has dominated the past two centuries, a tight alignment of supply, demand, and policy is required. This means that governments must use their powers to shape market conditions at the national and even at the global level to create the right conditions for change. This also means adopting the circular economy in their own substantial organisations and supply chains through areas like public procurement.

The ASEAN industrial sector believes that it is only through greater government intervention at global, national, and local levels that they can sustainably move from sporadic, incremental advances to collective and transformative impacts. They also want clear policies and regulations that can provide long-term investment stability to accelerate the pace of change and greater investment. They are calling for active intervention by governments and policymakers, in collaboration with business, to align public policy with sustainability at global, national, and local levels.

The governments of ASEAN member countries, irrespective of their developmental stage and industrial structure, have a role in not only providing supporting measures for the circular economy but also in improving the acquisition and application of knowledge on the circular economy. The AEC and the ASEAN Socio-Cultural Community can play vital role in knowledge networking through various measures such as raising awareness on the benefits of the circular economy, exchanging knowledge and networking, providing support and appropriate incentive schemes for collaboration across the ministries, fostering network supporters, and bringing together actors. Regional knowledge institutes like the Economic Research Institute for ASEAN and East Asia and the Asian Institute of Technology can act as facilitators and moderators of networking and knowledge exchange.

To accelerate the concept of the circular economy within ASEAN countries, policymakers must design and implement policies that are conducive to innovation and drive dynamic growth. Some governments are taking preliminary steps to that end. For instance, the Singapore Packaging Agreement, a joint initiative between the government, the private sector, and non-governmental organisations to reduce packaging waste from consumer products and the supply chain, has saved US$20 million over five years on locally consumed products. To promote the circular economy concept, greater focus should be oriented towards manufacturing sectors where competitiveness can be easily seen. In CLMV, national governments should prioritise capacity-building activities that are linked to increasing the technical competence of the labour force, especially in the

service sector. The respective governments can also play an active role in the strategic clustering of industries in certain regions. Innovative eco-industrial clusters, which have been viewed as engines of regional growth, are networks of independent firms, local universities, and community actors. The governments can create favourable conditions for innovative clustering and linking them to value-adding production chains. By introducing incentives at the local level in the form of social community funds, providing strategic information on circular economy targets, and sponsoring industry–community–university partnership, the governments can help operationalise the circular economy at the local level.

The EU has been the world's leader in regulatory innovation to promote sustainable growth. The European Resource Efficiency Platform provides policy recommendations and actions to help member states move to a circular economy and, in the process, reduce the total material requirements of its economy by 17%–24%, thus boosting the GDP and creating between 1.4 and 2.8 million jobs (European Commission, 2014). In the US, for example, the circular economy is supported by the 'bio-preferred' public procurement programme, which aims to increase the development, purchase, and use of bio-based products, through the procurement preference of federal agencies and their contractors, and voluntary product certification and labelling for consumers. These are valuable examples that ASEAN leaders could consider either on a regional or country basis.

Governments in general still need to make greater and more rapid progress in creating a policy environment that nurtures circular business models. Policies like shifting taxation from labour to resources, setting specific recycling targets for industries, making companies responsible for products throughout their life cycle, implementing tax premiums for the use of regenerated resources, and creating an international standard definition of wastes, and the like are needed to make circular thinking the de facto way of doing business in the future. Governments can serve as catalysts for circular economy innovation and as role models in adopting circular business models, reducing their own reliance on natural resources in the materials they purchase.

During the next decade and beyond, industrial production will be increasingly disaggregated and codified through the internet of things. Since the internet and communication technologies can overcome constraints of time and distance, the creation of virtual organisations, networks of lead firms, and independent institutions is warranted to facilitate the sharing of information and good practices for integration into the circular economy. Through intensive communications and interactions, a virtual organisation at ASEAN level can increase the ability to transfer strategic know-how and competence within and across networks, supporting the circular economy.

In this era of global competition, regional economic integration, and local environmental considerations, the determinants of success of economies depend upon the harnessing of the full potentials of national innovation systems. To improve innovative capacity and competitiveness, ASEAN should focus its industrial, environmental, and research policies on the importance of the strategic integration of circular economy and Industry 4.0. The current knowledge networking in ASEAN often takes place spontaneously in the market, without significant government support. Thus, there is a need for shift towards direct support through public–private partnerships to achieve the targets of circular economy.

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