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Lessons learned from COVID-19 pandemic situation towards building resilient cities (->SDG 11) – What can 3R and circular economy offer at local, national and regional levels?

(Background Paper for Webinar II)

Final Draft

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10th Regional 3R and Circular Economy Forum in Asia and the Pacific

Lessons learned from COVID-19 pandemic situation towards building resilient cities – What can 3R and circular economy offer at local, national and regional level?

(Background Paper and Synthesis for Webinar 2)

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Contents

Fo	Foreword								
Ac	know	ledg	jements	iv					
Ab	Abbreviations and Acronyms								
Ex	Executive Summary vi								
1.	Intr	oduc	ction	1					
	1.1.	Sus	tainable Development Goals	1					
	approach for sustainable development: transforming linear economy to circular	1							
	1.3.	Eco	-town: 3R and circular economy in practice	2					
2.	Eco	o-tow	n, 3R and circular economy towards achieving SDG 11	3					
2	2.1.	SDO	G11: Make cities and human settlements inclusive, safe, resilient and sustainable	; 3					
	2.2.	How	Eco-town, 3R and circular economy will help achieve the different targets of SDG-11	3					
	2.2.	1.	Resiliency and sustainability in infrastructure and utilities	3					
	2.2.	2.	Resource efficient and effective transportation	5					
	2.2.	3.	Sustainable land management	7					
	2.2.	4.	3R approach in urban waste management	8					
	2.2.	5.	Circular economy strategies in the protection of natural heritage	9					
	2.2.	6.	Participation by local organizations and citizens	9					
3.	Eco	o-tow	n, 3R and circular economy towards achieving SDG 12	10					
:	3.1.	SDO	G 12: Ensure sustainable consumption and production patterns	10					
(3.2.	How	Eco-town, 3R and circular economy will help achieve the different targets of SDG-12	10					
	3.2.	1.	Sustainable resource management	10					
	3.2.	2.	3R approach in managing food, industrial and electronic waste	10					
	3.2.	3.	Corporate synergy strategies for sustainability	13					
3.2.4. 3F sustainable		.4. taina	3R and circular economy for sustainable products and services: enabling ble procurement and consumer choice	13					
	3.2.	5.	Sustainable Consumer Lifestyle	14					
4.	Eco	o-tow	n, 3R and circular economy towards achieving SDG 14	15					
4	4.1.	SDC	G 14: Life below Water	15					
4	4.2.	How	Eco-town, 3R and circular economy will help achieve the different targets of SDG-14	15					
	4.2.	1.	3R for effective management of plastic use	15					
	4.2. mar	.2. nagei	Circular economy solutions in packaging value chains and supply chain ment	16					
	4.2.	3.	Sustainable fisheries and fishing practices	17					

	4.2.4	. Sustainable management of marine and coastal ecosystems through ecotourism	17							
	4.2.5	 Multi-stakeholder involvement and awareness raising 	18							
	4.2.6	Governance and international cooperation	19							
5. Ec in	5. How COVID-19 pandemic is interlinked with environmental degradation and what Eco-town, 3R and circular economy can offer in preventing future emergence of such infectious diseases									
	5.1.	COVID-19 and environmental degradation	20							
	5.1.1	. Waste generation: solid waste, toxic waste, hazardous waste	20							
	5.1.2	2. Water and sanitation, and life below water	20							
	5.1.3	B. Energy demand	21							
	5.1.4	. Consumption and production	21							
	5.1.5	Environmental emissions	22							
	5.2.	Eco-town, 3R, circular economy and the environment in time of COVID-19	23							
	5.2.1	. Resource efficiency	23							
	5.2.2	2. Sustainable growth: build back better through 3R and circular economy	24							
	5.2.3	8. Waste management	24							
5.3. Preventing future emergence of infectious diseases: What can 3R and circ economy contribute?										
	5.3.1	. City development and natural resource management	25							
	5.3.2	2. Climate change	26							
6.	Reco	ommendations for action	28							
	6.1.	Regional response	28							
	6.2.	National response	29							
	6.3.	Local response	31							
7.	The	Way Forward	33							
8.	Synthesis 36									
Ap	ppendix 40									
Re	eferences 50									

Foreword

In the eight months since the beginning of the COVID-19 pandemic, life or a semblance of normal routines have long gone. Everyday life now consisted of donning personal protective equipment, and extensive personal hygiene and sanitation practices. Shopping, education, medicine, banking, work, business, transportation and social services are continuously adapting to restrictions in place to control the transmission of the disease. E-commerce, distance learning, telemedicine, online banking, remote work, food deliveries, cycling, and mobile application-based processes have replaced the communal nature and physical channels that characterize these socioeconomic activities.

The limited capacity for socioeconomic activities negatively affected economies, and many countries now focus on economic recovery even as many parts of the world still experience a surge in COVID-19 cases and have yet to contain local transmission of the disease. From reactive and immediate containment responses, countries are now moving forward to build back the economy beginning with economic stimulus packages. A number of questions surface as to what form this recovery from a pandemic will take considering that the human-environment interactions contributed to the emergence of the disease. The prevailing linear economic model of take-make-consume-dispose may no longer be the default recovery path, making green recovery a sustainable and alternative option for building back economies.

The disruption in business as usual resulted in mounting changes, challenges and pressures not just in current ecosystems, but also in the design of future ecosystems. As the following discussions show, the pandemic hampered the progress in achieving sustainable development goals, and the urgency for transforming the way society creates and consumes products and services becomes crucial. The paper also presents how the Japan Eco-Town Program, with concepts rooted in 3R and circular economy, contributes to achieving a sound material cycle society, and how such concepts can support future growth that respects environmental boundaries and socioeconomic progress.

Acknowledgements

This background paper recognizes the multidisciplinary nature involved in framing issues and challenges of the current pandemic. While building on the decades of research of many senior experts in the field of eco-town, 3R, circular economy, environment, it acknowledges significant contributions from recent work by researchers and international organizations on COVID-19 in the references. This paper has also benefitted from several rounds of group discussions, research inputs and review from various graduate programs of the De La Salle University, Philippines. The graduate researchers (**Appendix F**) are professionals from various public and private sectors with specializations such as environmental engineering and management, industrial and systems engineering, computer engineering, social science, biology, chemistry and agriculture.

Abbreviations and Acronyms

- 3R Reduce, Reuse, and Recycle
- CE Circular economy
- COVID-19 Coronavirus disease 2019
 - EOL End-of-Life
 - EPR Extended Producer Responsibility
 - GHG Greenhouse gas
 - IRP International Resource Panel
 - kWh kilowatt-hour
 - km Kilometer
 - MoEJ Ministry of the Environment of Japan
 - OECD Organisation for Economic Co-operation and Development
 - PET Polyethylene terephthalate
 - PPE Personal protective equipment
 - PV Photovoltaic
 - SDG Sustainable Development Goals
 - SFM Sustainable Forest Management
 - SLM Sustainable Land Management
 - t/d Tons per day
 - UN United Nations
 - UNEP United Nations Environment Programme
- UNESCAP United Nations Economic and Social Commission for Asia and the Pacific
 - UNESCO United Nations Educational, Scientific and Cultural Organization

Executive Summary

The 2030 Agenda for Sustainable Development presents a blueprint for addressing global challenges to achieve an inclusive and sustainable future. With this comes the recognition of the need for sustainable growth models supported by responsible consumption and production patterns. The Japan Eco-Town Program sets such an example of resource efficiency and circularity by embodying 3R principles.

In relation to SDG 11 on resilient and sustainable cities, the eco-town program since 1997 exemplifies overall sustainability and resiliency in city and regional development with components on sustainable infrastructure and utilities, sustainable transportation, resource efficient production, and 3R principles in waste management. For SDG 12 on sustainable consumption and production, eco-town examples highlight sustainable resource management as it applies not only to resource extraction, and provision of products and services; but also in managing waste streams, and encouraging sustainability practices in households, and private public sectors. In terms of SDG 14 on life below water, eco-towns emphasize the significant contributions of 3R for effective management of plastic waste and circularity in the use of resources and materials. In addition, multi-stakeholder and international cooperation, and awareness on challenges on coastal management, as well as land-based human economic activities' impact on blue economy, are crucial in promoting sustainability in sectors that rely on marine ecosystems such as tourism and fisheries.

The emergence of the coronavirus disease (COVID-19) pandemic has challenged socioeconomic systems, public health and environment. On the environmental aspects, the disease has pressured waste management systems from increasing municipal and biomedical wastes. Preventing future emergence of infectious diseases will need better management of resources to lessen environmental degradation, and stronger emphasis on resource efficiency, circularity and 3R to provide products with less inputs and waste.

As authorities learn from and refine ongoing responses to the pandemic, the question remains on what economic recovery will look like following a pandemic that has roots on unsustainable consumption and production, and natural resource use. Regional cooperation and commitment to green recovery and natural resource management among others will be needed. On the national level, these responses can be translated to supporting measures related to SDGs like access to water and sanitation, and building resilient and sustainable infrastructure, and promoting public and private partnerships in sustainability initiatives. On the local level, responses can involve rethinking urban and rural development, redesigning business models and strengthening governance and social services. In all these responses, the essence of building back better needs to take on a sustainable approach, one that promotes green sectors, supports resiliency and climate goals, adopts circularity in growth, and creates localized responses tailored to the unique settings of communities and societies.

1. Introduction

1.1. Sustainable Development Goals

The Sustainable Development Goals (SDGs) are a set of 17 interconnected goals that aim to address global challenges and achieve a sustainable future where no one is left behind. The blueprint, that is the 2030 Agenda for Sustainable Development calls for peace and prosperity for people and the planet, tackles social inequalities and climate change while promoting economic growth, and environment and public health. Explicit in the 2030 Agenda is the inclusion of Goal 17 (strengthening partnerships for the Goals) which is the enabling mechanism to all the Goals.

In a report on the SDGs in 2019, UNESCAP (2019) calls for accelerated progress in the goals to achieve the 2030 Agenda. This call is more critical at this time when the COVID-19 pandemic has delayed the progress in many of the SDGs and exposed the urgent need to address global environmental threats that undermine the systems that enable the planet and its inhabitants to both survive and thrive (UNEP, 2020).

1.2. 3R approach for sustainable development: transforming linear economy to circular economy

Unsustainable production and consumption practices have led to the overexploitation of natural resources, disruption of ecosystems, and environmental health issues and diseases. Despite the urgent need to focus on the current COVID-19 pandemic, the long-term effects of the climate crisis and similar global threats of unsustainable development present a persisting threat to the future and of recovery. An estimated global temperature rise of at least 3.2 degrees may be experienced if additional commitments towards decarbonization are not put into practice, and the disruptions to the progress toward SDGs caused by COVID-19 will prove a burden moving forward.

Circular economy presents an alternative approach to the traditional linear economy model of take-make-consume-dispose, which presumes the availability of infinite and cheap resources to continuously create products with a finite lifespan with unlimited demand. Resources are finite, energy costs are increasing, and products end up in landfills where it pollutes the environment. The assumptions a linear extractive economy are predicated on is not exactly representative of the reality where humanity is consuming and disposing beyond planetary boundaries (Steffen, et al., 2015). Systems of production and consumption need to recognize limitations and transition to sustainable practices.

As circular economy aims to reduce waste, implementing its principles into existing economies would increase land productivity (Nikam, 2020) and resource efficiency. Designing products for its functionality following circular economy and reduce, reuse and recycle (3R) principles is essential especially in times of pandemic where more waste is being generated than usual. Applying the principles of a circular economy and 3R will support the transition to a sustainable material cycle society, eliminating waste and the

need for raw materials through continuous reuse and recycle of materials/ resources that are currently in the system. This entails partnerships and cooperation among governments, private sector, international organizations and the public. Policies can provide the impetus for the necessary shifts, private sector investment in technology and innovation, organizations the leadership in research and development, and public participation.

1.3. Eco-town: 3R and circular economy in practice

Japan's Eco-town Program exemplifies the benefits of 3R and circular economy at the local or municipal level where eco-efficiency, industrial symbiosis and urban symbiosis synergistically work towards closing the material cycle. Eco-town supports a sound material cycle society through gains in resource efficiency, material cycling and 3R approach. It provides opportunities for preventive environmental strategy and increasing economic efficiency while reducing risks to humans and the environment.

Van Berkel et al. (2009) highlighted that it was against the backdrop of economic stagnation and the lack of waste disposal facilities that prompted the national government of Japan to launch the Eco-Town Program in the late 90s. This initiative resulted in 26 Eco-Towns by 2006 specializing in the use and recycling of various urban and industrial waste streams within their geographical proximity. In an analysis of the implementation of the program, Van Berkel, et al. (2009) identified the success factors of the Eco-Town projects implemented in Japan:

- availability of investment subsidies,
- the coming into force of ambitious recycling legislation with quantified, product-specific targets,
- access to the significant technological resources of the private sector, and
- widespread recognition of the urgency to act on environmental issues.

Prior to COVID-19 and during this ongoing pandemic, many of the existing global threats to society have been amplified, and socioeconomic and environment systems are put under extreme pressure. Many economies are in a negative growth path and with increasing public health and environmental crises. These parallel scenarios along with the success factors identified may guide future responses to adapting and building back better through green measures.

2. Eco-town, 3R and circular economy towards achieving SDG 11

2.1. SDG11: Make cities and human settlements inclusive, safe, resilient and sustainable

Access to affordable housing and safe public transportation remain a challenge in cities' urban centers (United Nations, n.d.). To address these issues, SDG 11 focuses on sustainable cities and communities, and aims to tackle issues on safe, affordable, and sustainable housing and transportation, inclusivity and sustainability in urbanization, protecting cultural and natural heritage, sustainable waste management systems, deaths caused by natural disasters, public access to vulnerable people, and national and regional development planning (SDG Tracker, n.d.).

2.2. How Eco-town, 3R and circular economy will help achieve the different targets of SDG-11

To simultaneously achieve economic growth and solve the waste management problem, Japan started the Eco-Town program in 1997 based on the zero-emission concept, where industries and companies must actively implement strategies for waste reduction and management.

2.2.1. Resiliency and sustainability in infrastructure and utilities

By the end of 2007, Japan's Ministry of the Environment (MoEJ) and Ministry of Economy, Trade, and Industry had approved 26 Eco-towns with a total of 170 operational recycling projects including 61 subsidized ones (Ohnishi, et al., 2012). These eco-towns have specialized capabilities such as recycling urban waste streams in metropolitan areas (e.g., Osaka and Tokyo); waste handling and recycling at the regional level (e.g., Aichi and Hyogo); island-based waste management programs (Hokkaido and Naoshima); community-based recycling, environmentally conscious town planning and clusters of recycling businesses (e.g., Minamata and Toyoma); and new recycling businesses in industrial or port areas (Kamaishi and Okayama) (Van Berkel, et al., 2009).

Each Eco-town has a designated target zone and pre-defined responsibilities, collectively contributing to the targets of the country on improving resource productivity by about 40%, recycling by about 40%, and decrease in landfill by about 50%; eco-towns are divided into 5 groups of infrastructures (Van Berkel, et al., 2009):

a. Infrastructure for sorting, collection, recycling of containers and packaging and waste treatment for disposal

In line with existing laws in Japan that aim to preserve the environment and improve public health (MoEJ, 2007), infrastructures and facilities were put up to handle different waste streams. For example, Kitakyushu has recycling plants for polyethylene terephthalate (PET) bottles, fluorescent lights, and waste paper (Van Berkel, et al., 2009), and puts emphasis on "recycling" wastes rather than "treating" wastes in promoting waste reduction and recycling (M. Fujita, n.d.).

In 2005, a PET bottle recycling technology was able to recycle about 12,000 tons of bottles (MoEJ, 2007). A general recycling process starts with sorting and cleaning recyclable waste plastic materials that are then mixed with other materials and processed into new products like ammonia, reductants for blast furnaces, hydrocarbon oils for chemical plants and coke furnace gases for powering steel plant generators.

Wastes that are not recyclable undergo incineration to destroy disease-causing bacteria. In 2005, about 80% of domestic waste were incinerated (MoEJ, 2007). Due to social demands, a gasification and melting furnace was also introduced to reduce the generation of dioxins, and that further features a high-efficiency heat recovery system where the heat held in the waste is used to melt and solidify ash and effectively utilize molten slag (MoEJ, 2007). By the end of 2004, such furnaces are in operation in 54 facilities.

Final disposal refers to three types of disposal sites (controlled landfill site, inert controlled landfill site and controlled landfill site), which are differentiated according to the industrial waste it accommodates (MoEJ, 2007).

b. Technology and infrastructure for recycling of specific kinds of home appliances

Waste plastic from used home appliances are reused as components for new products through manual dismantling, meticulous separation of waste plastic and developing technologies to ensure the properties and service lives of recycled plastics meet product requirements. Japan laws indicate that home appliance producers should have a recycling rate of at least 60% for air conditioners, 55% for television sets, 50% for refrigerators and freezers, and 50% for washing machines (MoEJ, 2007). Akita, Hokkaido, Kurihara, Minamata and Naoshima all have facilities that process materials covering home appliances such as air conditioners and refrigerators (Van Berkel, et al., 2009).

c. Facilities for construction materials recycling

Construction activities generate mixed construction waste, such as waste plastic, wood, paper and metal. Recycling mixed construction waste requires making them into products with stable properties and qualities. Sorting technology for mixed construction waste involves using a sieve, removing oils, and washing gravels and sand. The remaining silt and clay are dehydrated, dried, and burned into recycled artificial aggregate. Among the Eco-towns, Chiba has the highest number of facilities for processing construction materials (Van Berkel, et al., 2009).

d. Food recycling facilities

As much as 78% of food waste from the food production industry and 24% from distribution and restaurants are recycled, producing fertilizer (through composting) or eco-feeds. Technology for producing eco-feeds from food waste involves collecting separated food residues suitable for making livestock feed and putting them through a heating and

drying process, fermentation, dehydration, or liquefaction (MoEJ, 2007). Eco-towns that can process food waste include Kamaishi, Omuta and Suzuka (Van Berkel, et al., 2009).

e. Facilities for automobile recycling

Management of vehicles at the end-of-life (EOL) phase involves collecting reusable or recyclable parts prior to crushing and shredding. The resulting shredding dust is treated through recycling technologies as a target reuse rate has been set (MoEJ, 2007). Examples of recycling processes for EOL vehicles include making suspension parts from melted aluminum; and waste tire reuse as a thermal energy source and material input in cement and steel plants, converting waste tires into resources at 60,000 tons annually (MoEJ, 2007). Some eco-town projects with facilities for recycling automobile parts are in Gifu, Hyogo, and Kitakyushu (Van Berkel, et al., 2009).

Other Asian countries share initiatives similar to Japan's eco-town. China has several public and private eco-industrial parks in major cities, low-carbon/ waste model city near Shanghai, residential & industrial renewable energy policy, sustainable city projects, and governmental integrated urban-rural city project; South Korea has eco-industrial park projects and high-density towns with vertical green space, sustainable technology centers, and a green building program; and India has a governmental pilot for six eco-city initiatives and community-based sustainable 'future city' (Joss, 2010).

2.2.2. Resource efficient and effective transportation

a. Transportation technologies

A key component for a developing city is transportation, and different companies try to develop alternative fuel sources for vehicles. For example, the use of beet sugar in ethanol production was developed by the Agricultural Utilization Research Institute (BioCycle, 2005). Another example is the creation of bus-taxis that operates on used cooking oil in Tottori Eco-town (BioCyle, 2005). Other transportation technologies are the Bus Rapid Transit system for sustainable public transport, hybrid and solar-powered cars for fuel efficiency, and smart transport systems for traffic problems.

b. Japan Smart Community

In Japan, the "smart community" aims to fully utilize information technology to cover the effective use of electricity and renewable energy resources, traffic system, and lifestyle. The Japanese model of the smart community can be described in four parts: New information network (the second internet), New energy system, New transportation system and New urban development (Gao, et al., 2016). The demonstration areas for the smart community were carried out in 2009. There were four unique large-scale demonstration projects for the smart community in Japan: Kyoto Keihanna District, Yokohama City, Kitakyushu City and Toyota City. The policies at the district level focused on pushing forward the renewable energy. For housing, the policies focus on developing

smart meters and electric vehicles. Other office and commercial buildings aimed at the Zero emission building (Gao, et al., 2016).

c. Hydrogen town project

The Kitakyushu Hydrogen Town project was launched in January 2011, in Yahata Higashisa district, Kitakyushu. The project marks as the world-first attempt to use a pipeline recycling the hydrogen generated in the iron manufacturing and operating the fuel cells as an energy supply to the district. The demonstration testing is processed jointly by Fukuoka Prefectural and city gas utilities. The 1.2 km pipeline connected with the hydrogen station and hydrogen fuel cells that installed in buildings in this district. These fuel cells generate electricity by combining hydrogen and oxygen (Gao, et al., 2016).

d. Smart Community Creation Project

Kitakyushu also started the Smart Community Creation Project. The government invested 16.3 billion yen from 2010 to 2014. It had four scenarios: smart life, smart office, smart mobility, and smart factories (Gao, et al., 2016). The project "optimized the demand and supply of regional electricity by utilizing IT that revolve around energy-saving stations. The energy- saving stations are the control centers responsible for operating the smart grid. The advice from the smart meters can help the customers to smooth out the energy fluctuation and improve the efficiency of energy use in the district" (Gao, et al., 2016). **Figure 2.1** shows the regional energy saving stations of Kitakyushu eco-town.

e. Solar Eco-City of Turpan Demonstration District in China

The Turpan project focuses on Building Integrated Photovoltaic (PV) construction considering integrated design of solar energy and building. The total energy consumption of the Turpan project in 2015 was 26.57 million kWh. Electricity provided by the big power grid and that generated by PV systems guarantee the energy consumption demand of the demonstration area and renewable energy contributes 24.15%, with total PV generation power of 10.18 million kWh and a self-occupied ratio of 63.02%. The rest of the power generated by the PV system is sold to local power grid corp. Annual electricity utilized by the system is double than PV generation power (Yang, et al., 2017). Furthermore, 99% of households already use solar water heaters in Rizhao, China (Izquierdo, et al., 2014).

f. Design of Transportation System by the UN Habitat

UN Habitat (2013) elaborated that the core of sustainable mobility is the prioritization of enhancing human access to equitable opportunities by improving city design and transport systems. The key to effective mobility is the speed and efficiency of travel. It is important that the public transportation system can perform at the best of its abilities and at the highest capacity. This comes with the idea of developing city design into a more compacted layout. A high-density populated area with an appropriate layout minimizes private vehicle use and shifts focus to other mobility options like walking, cycling, etc. (Ellen MacArthur Foundation, n.d.).

g. The Use of Other Available Energy Resources

The use of electric vehicles is highly ideal but along with it will be additional investments towards relevant infrastructures such as charging machines and stations for parking. There is also opportunity in using the concept of 3Rs for electric vehicle batteries. For lithium-ion batteries, which contain rare materials like cobalt, its lifespan can be increased through continuous repairs and eventually getting recycled (Lardier, 2020). On the other hand, the electric powertrain base for electric vehicles improves car efficiency and aids in minimizing or incurring even zero percent greenhouse gas emissions (Bouton, 2015).

2.2.3. Sustainable land management

According to the Food and Agricultural Organization of the United Nations, sustainable land management (SLM) is the use of land resources for the production of goods to meet changing human needs, while ensuring the long term productive potential of these resources and maintenance of environmental functions (Squires & Feng, 2018). One way to approach SLM is to apply it to land use types. Land use describes the type of activity being carried out on a unit of land, in urban, rural and conservation settings (IPCC, 2006).

Land based agriculture technologies can apply integrated soil fertility management, vegetation management, and water management to optimize nutrient use efficiency and improve crop productivity, to improve quality and quantity of crops, and to promote efficient use and protect water resources from pollution and over-exploitation respectively (Sanz, et al., 2017).

For forestry, sustainable forest management (SFM), reducing deforestation, afforestation/reforestation, and forest restoration were used in different countries. This is important to sustain natural resources that also help to reduce greenhouse gases and prevent soil erosions. SFM involves the proper management of all forests and forest ecosystems to sustainably increase their natural value. Reducing deforestation prevents the clearing of forests. Afforestation involves tree-planting on unnaturally forested areas while reforestation involves replanting trees to restore natural forests. Forest restoration supports the recovery or restoration of a degraded forest (Sanz, et al., 2017).

Grazing land is also needed to maintain animal production. Grazing pressure management assesses the maximum livestock population that a habitat or ecosystem can support on a sustainable basis, to ensure that resources such as vegetation, soil, and water, are not damaged, degraded, or depleted. On the other hand, animal waste management is the proper collection, handling, storage, and utilization of waste generated from animals (manure and urine), with the aim of recycling as much of the collected material as possible that can be used to improve soil fertility and productivity, and reduce nutrient losses (Sanz, et al., 2017).

Integrated systems include agroforestry, agro-pastoralism and fire, pest, and disease control. According to the United Nations Convention to Combat Desertification, agroforestry can improve productivity and soil structure, and provide socio-economic benefits through income generation opportunities and increased resilience to climate change (Sanz, et al., 2017). Agro-pastoralism is the integration of crop production and livestock production, and has the potential to improve productivity, reduce soil erosion, and improve nutrient and water use efficiency while fire, pest, and diseases control are measures that manage, prevent, or control fire, pests, and diseases, with the aim of reducing their negative effects on land, vegetation, and ecosystems, including biodiversity loss, outbreaks and climate change (Sanz, et al., 2017).

2.2.4. 3R approach in urban waste management

According to the UN (2018), urban population by 2030 will be 60% of the total world population and is expected to increase to 67% by 2050 (Brockerhoff & Nations, 1998). Cities contribute to 75% of the planet's carbon emissions despite occupying only 3% of total land mass. Transitioning to resilient and sustainable city models are imperative to achieve SDG 11, and other SDGs that parallel its targets. However, developing nations commonly exist without the proper infrastructure and framework to transition into a resilient and sustainable model (Allam & Jones, 2018).

Traditional waste management in developing countries follows a linear economy which demands a limitless space for the limitless waste generation. Land scarcity in the form acquiring new disposal sites was one of the primary concerns for Malaysia (Hezri, 2010). The country already had 77 open dumps, 49 controlled tipping landfills, and only 35 sanitary landfill sites (Idris, et al. 2004). Comparatively, the largest urban area in Vietnam, Ho Chi Minh generates about 7200 tons of municipal solid waste daily while Da Phuoc takes 3000 tons/day, and Cu Chi receives 3000-3200 tons/day (Visvanathan, et al., 2007). **Figure 2.2** shows the composition of municipal solid waste in some Asian countries.

One of key proposed strategies in attaining a sustainable and resilient city status is to achieve a "A Sound Material Cycle Society" or "3R Society". Congruent to this initiative, a society should also strive to be a "Low Carbon Society" and "A Society in Harmony with Nature" (Periathamby, 2016). However, not all Asian countries have seen significant improvement in 3R integration.

The wisdom behind Japan's 3R approach revolves around the "sense of regret for resources that turn into waste without reaching its full usefulness" (Tanaka, 1999). In 1995, 60% of the domestic waste in Japan was purely packaging. Thorough decisive governance and laws which put the responsibility of recycling mainly on the business enterprises were the foundations of Japan's recycle-centric society. In 2002, 19% of the 53 million tons of solid waste was recycled (Shekdar, 2009). During the G8 Sea Island

Summit in 2008, Japan launched its "New Action Plan towards a Global Zero Waste Society". The New Action Plan is composed of actions including support for the development of strategies and policy dialogues in line with the needs of each country, contribution to global warming countermeasures through environmentally sound waste management and 3Rs, and actions to establish a Sound Material-Cycle Society (3R society) at regional levels in Asia (MoEJ, 2008). Since then Japan has become one of the leading nations on Urban Waste Management through its Eco-Towns.

2.2.5. Circular economy strategies in the protection of natural heritage

A Natural Heritage is a natural landscape consisting of existing natural capital that geographically and territorially characterizes a city. Thailand's Dong Phayayen-Khao Yai Forest Complex, Malaysia's Gunung Mulu National Park, Vietnam's Ha Long Bay and the Philippines' Tubbataha Reefs Natural Park are some examples (UNESCO, 1972). The byproducts of urbanization such as pollution are specifically singled out to be major ascertained dangers for heritage sites (UNESCO, 2009). The establishment of such protected areas were calculated to be at a cost of \$45 billion. However, this same percentage of ecosystems proved \$440 billion as a gain for its services (TEEB, 2010). The circular economy principle is particularly relevant in attaining SDG 11 through the preservation and valorization of cultural and natural heritage sites (Amidžić, et al., 2019). It represents a new approach to nature protection that integrates economics and sustainable nature conservation. Maintaining a balance between natural capital and the growth of human-created capital is essential, and increasing social benefits is desirable only if it is sustainable and does not come at the expense of natural assets.

2.2.6. Participation by local organizations and citizens

An underrated pillar of building resilient cities is its people. Japan's Eco-towns actively recognizes the role of citizen participation. It expects its citizens to: (1) be involved in environmental town-building projects, (2) perform positive utilization of recycled goods and (3) foster cooperation for waste segregation (Fujita, 2006). Enhancing the public awareness through environmental education and dissemination of information is a key pillar in the process of sustainability (Visvanathan et al., 2007) (Amidžić, et al., 2019). This can be observed in the City Marine Park Model (**Figure 2.3**) which displays systematic landscaping choices for cities at a coastal area that centers its innovations on the "human interest", and promotes more sustainable lifestyle choices that influence the overall goal of a sustainable and resilient city (Pittman, et al., 2019).

3. Eco-town, 3R and circular economy towards achieving SDG 12

3.1. SDG 12: Ensure sustainable consumption and production patterns

Decoupling economic growth from environmental impacts is key to developing sustainably, establishing sustainable consumption and production patterns, and transitioning towards a greener and more socially inclusive global economy (UNEP, 2020). Food waste, water pollution and energy consumption continue to increase and pressure the environment and natural resources. By 2030, energy use in Organisation for Economic Co-operation and Development (OECD) member countries would have increased by 30% with households consuming 29% of global energy and contributing 21% to carbon emissions (UN, 2020).

The main objective of SDG 12 is to "Ensure sustainable consumption and production patterns". It deals with the efficient use of natural resources, food production and supply related losses, chemical and waste management, and sustainable corporate practices and public procurement (Gasper, Shah, & Tankha, 2019).

- 3.2. How Eco-town, 3R and circular economy will help achieve the different targets of SDG-12
 - 3.2.1. Sustainable resource management

Circular economy is about the preservation of materials and products, which bring economic, social, and environmental benefit through systems designed to minimize waste generation and its negative (Velenturf, et al., 2019). **Figure 3.1** shows how, under the circular economy principle, industrial materials are kept within the system through natural means, minimizing their negative environmental impacts. However, possible leakages as a result of improper waste management pose a threat to complete recyclability (Velenturf, et al., 2019).

A successful shift to circular economy involves reducing the dependence of economic growth and activity on the unsustainable extraction of resources (UKWIN, n.d.) and would need action at every stage of the value chain: from raw material extraction, product design, production, distribution, consumption, up to waste management and recycling (luga, 2016) with the design stage being the most critical to sustainability (CHEManager, 2019). Although the practice of sustainability itself may hinder economic growth, resource efficiency will lessen production costs across industries and increase product value through extended life cycle of materials (Ewijk, S, 2018). In line with this, Material flow analysis can be used to reduce waste management system complexity, manage secondary flows, model the interrelation of the national economy with waste management (Ministry of the Environment, 2014), and increase transparency and communication between stakeholder decision making (Allesch & Brunner, 2015).

3.2.2. 3R approach in managing food, industrial and electronic waste *Food Waste*

Majority of food waste management problems come from inefficient technologies, climate conditions, and mismanagement of forecasting demand (Ruetgers & Lazell, 2017). A circular economy mindset would address the generation of food surplus, prevent landfill disposal (KPMG, 2020), and promote resource efficiency and food security. The agri-food value chain must work towards keeping food fresh for longer periods of time and converting waste into energy and other products (KPMG, 2020). Governments can help influence these transitions through policies, incentives, support, and training (KPMG, 2020). For example, governments and businesses can collaborate with rural producers to implement regenerative farming practices such as using organic fertilizers from urban by-products and improving crop and animal diversity (Ellen MacArthur Foundation, n.d.).

For Asian countries, food waste management policies and regulations are defined by four major factors: increasing awareness of the food waste management problem, commitment to national and international development goals, socio-cultural and economic constraints, and recognition of the potency to recover energy and nutrients from food (Joshi & Visvanathan, 2019). In Japan, the Food Waste Recycling Law sets recycling targets at 95% for food manufacturers, 70% for wholesalers, 55% for retailers, and 50% for restaurants by March 2020 with large volume generators of food waste (exceeding 100 tonnes annually) required to submit food waste-related data every year (Takata, et al., 2012). Efforts also include the implementation of pilot projects to review expiration date and its labelling methods (Parry, et al., 2015), installation of biogas plants for methane fermentation systems, usage of recycling-oriented resource management of organic waste, collection of waste for compost production, and producing feedstuff from recyclable food waste (Gasper, et al., 2019). In Hong Kong, they pledged to reduce their food waste from 3600 tons per day (t/d) in 2014 to 2160 t/d by 2022 through promoting food waste separation, recycling, and treatment (HKEB, 2014). In Thailand, they aim for a 50% national food waste reduction by 2026 through food waste segregation and the implementation of the National 3Rs Strategy and the 3Rs Act (Ong, et al., 2018). In India, their Municipal Solid Wastes Rule categorizes waste into three different streams: biodegradable, non-biodegradable and hazardous (Ong, et al., 2018). Malaysia has enforced the Solid Waste and Public Cleansing Management Act which penalizes illegal dumping of wastes and mandates the separation of solid waste at source (Ministry of Housing, 2015) while Korea has banned the landfilling food waste since 2005.

Information drives for food waste awareness are also important. Hong Kong has campaigns such as 'Food Wise Hong Kong Campaign' that disseminates best practices to reduce food waste at source and the 'Green Lunch Charter' that encourages schools to reduce food waste and use disposable lunch boxes (Joshi & Visvanathan, 2019). In Singapore, the National Environmental Agency and Agri-Food and Veterinary Authority conducts educational programs on meal planning, food storage, and curbing impulse buying of food products (Ng, et al., 2017). Similarly, Thailand also collaborated with the Food and Agriculture Organization on a national campaign called "The National Save Food" to raise awareness on food waste (FAO, 2015).

E-Waste

E-waste policies Asia can be categorized in terms of legislation, inventories, management, and treatment and range from Basic, Intermediate to Advanced (Pariatamby & Victor, 2013). In Japan, the Promotion of Effective Utilization of Resources law urges manufacturers to practice recycling and waste reduction. For consumers, the Recycling of Specified Kinds of Home Appliances law imposes taxes on new computer purchases and recycling costs for recycling older ones (Balde, et al., 2017). The Act B recycling company collects four types of used electronic household appliances and separation of reusable parts are done (Gasper, et al., 2019). In other Asian countries such as Indonesia, Malaysia, the Philippines, Singapore, Thailand, and Vietnam, they allow the transportation of e-waste to utilize the proper disposal technologies and recovery facilities (Jain, 2017). In some cases, there would be recycling fees which can be refunded based on the value of extracted resources. On the other hand, Singapore and China regulate the movement of e-waste to monitor the disposal of hazardous materials (NVP, 2020) and standardize recycling processes (Zhang, et al., 2012).

Korea, Singapore, and China also have extended producer responsibility (EPR) systems which require producers to recycle discarded products and report the relevant data to the government (Chung & Murakami-Suzuki, 2008). India has also implemented EPR in 2011 (Patil & Ramakrishna, 2020). In line with community engagement, Singapore has a National Voluntary Partnership Program where the volunteers are spreading awareness and collecting e-waste for recycling (Patil & Ramakrishna, 2020). In India, the E-Waste Harit Recyclers Welfare Association gives its members help and legal status in adopting environmental-friendly e-waste management.

However, global e-waste recycling rate is still only at 20% even though 66% of the world's population come under e-waste legislation as most countries have a limited e-waste management scope and fall short on strong law enforcement (WEF, 2019).

Industrial Waste

Hazardous materials are, unfortunately, commonly found in all kinds of materials, making recycling materials more challenging (CHEManager, 2019). Decreasing the hazardous content in materials through innovation and design would increase recycling rates and reduce the need for virgin raw materials. From a chemical point of view, product composition transparency and the elimination of hazardous materials must be implemented for the promotion of circular economy (CHEManager, 2019). Recycling can only be sustainable if there is assurance in the safety of the materials (SSNC, n.d.).

Some factors to consider in managing hazardous waste are the land space for disposal and the conformity to environmental standards of waste management facilities (Tanaka, M. & Ueda, T., 1991). In the Kawasaki Eco-Town Plan, the majority of wastes can be

treated within the city itself since they recycle wastes from existing manufacturing infrastructures (GECF, 2005). There are also projects that utilize mining and refinery related infrastructures to recycle the waste being discharged by certain industries such as forestry, construction, and agriculture (Fujita, T, n.d.).

3.2.3. Corporate synergy strategies for sustainability

Numerous corporations in Japan have already initiated strategies for sustainability. Modeco and Patagonia upcycle waders into bags (Skinner, 2019); Asahi Breweries purify biogas from wastewater treatment for power generation (Japan for sustainability, 2018); Ajinomoto reduces food resource consumption through resource-efficiency technology (Ajinomoto Group, 2018); and Saraya uses Rapid Freezer technology to reduce spoilage in deliveries (Saraya, 2019). In China, construction companies have been leading in circular economy implementation. Broad Group contractor increased efficiency six to ten times and decreased cost by 40% through modular design, while another company WinSun decreased material usage by 30-60% through 3D printing (Ellen MacArthur Foundation, 2018). In terms of energy efficiency, the largest standalone building with its own PV system in Shanghai has more than 20,000 solar panels and annually produces 6.3 million kWh of electricity.

Some companies in Asia have urban water supply initiatives such as the N-Park Condominium in Malaysia where the water-saving project saved 8 million liters of water over a six-month period and Vietnam's Ang Giang Stock Plant Protection Company consolidated small plots of land into larger areas, supported coordinated production, and enabled cost sharing of water infrastructure (United Nations ESCAP, 2015). For plastic waste management, the Philippines' GreenAntz collects and uses used sachets to make construction bricks; Cambodia's Rehash Trash provides training on upcycling plastic waste into products; and SC Johnson has a pilot project in Indonesia to collect and recycle plastic in eight local communities using blockchain technology (Akenji, et al., 2019).

3.2.4. 3R and circular economy for sustainable products and services: enabling sustainable procurement and consumer choice

It is important to note that the meaning of "sustainable" may differ globally and depends on the goods and services available in a particular location. For example, wooden furniture may be sustainable in Canada, Malaysia, or Brazil but not to the desert areas of the Middle East (UNEP, 2012). There is also a difference in Green procurement and Sustainable procurement. Green procurement only refers to the environment, while the latter refers to the environmental, social, and economic sustainability of goods and services (UNEP, 2012). Therefore, criteria for sustainability would involve resource efficiency levels, product recyclability, and reparability based on potential and the hazardous chemical content (UNEP, n.d.), while environmental labeling is based on environmental considerations (Migliore, Talamo, & Paganin, 2020). Eco-labeling encourages consumers to follow proper sustainability practices. In Japan, Ecomark has 50 categories that provide a certification criteria based on life cycle analysis (JEA, n.d.), while China now has 85 categories (CERTRIP, n.d.). On the other hand, Korea's Ecolabel certifies services such as cleaning and maintenance that use proper eco-labeled products (UNEP, 2012). Singapore, Indonesia, and Thailand also have Green Labeling practices (AIT, 2016).

3.2.5. Sustainable Consumer Lifestyle

A "sustainable lifestyle" is a cluster of habits and behaviors, which aims to minimize resource extraction and waste generation, while supporting equality for all involving five different areas: buildings and housing, mobility, food and nutrition, consumption, and leisure (UNEP, 2016). Discovering alternative ways to acquire needs is one of the keys to sustainable consumption. Beyond looking for sustainable alternatives, it can also pertain to not shopping at all. Designing and implementing effective policies can lead to wider and faster implications towards sustainability compared to changing individual actions (UNEP, 2012).

Some countries have active efforts towards the promotion of sustainable lifestyles. Japan's Fifth Environmental Basic Plan promotes the idea that sustainability can solve other social issues and create an improved society (Gilby, et al., 2019). In Singapore, the Tianjin Eco-City aims to be a model for sustainable development through practicality, replicability, and scalability (Gilby, et al., 2019). The Philippines' online platform MUNI Meetups promote insightful and action-oriented learning and networking events on sustainable living (Gilby, et al., 2019). In China, the "Notes on Reducing Loan Risk by Enforcing Environmental Protection Policies and Regulations" policy promotes a green credit policy to all enterprises implementing environmentally friendly practices (IGES, 2008). Thailand has given attention to its energy sector with a waste-to-fertilizer and energy program (IGES, 2010). Likewise, several local government units in India give incentives to institutions and households that use solar energy (Das, et al., 2017). In Vietnam and Malaysia, governments more walkable areas are being developed to lessen the need for automobiles (ADB, n.d.). However, despite these efforts, Asian countries still face the challenges of limited access to sustainable products and services, lack of transparency and credibility of product performance, lack of information on low-impact use, and limited disposal facilities and take-back schemes.

4. Eco-town, 3R and circular economy towards achieving SDG 14

4.1. SDG 14: Life below Water

The proper management of oceans is a key feature of a sustainable future (UN, 2020), but has increasingly been exploited from overfishing (UNDP, 2020). Despite providing food, livelihood and ecosystem services, oceans deteriorate due to pollution from land-based sources and ocean acidification brought about by climate change. The enhancement of conservation and sustainability practices of ocean-based resources through international policies can help mitigate the challenges oceans continue to face (UNDP, 2020). Designated marine protected areas must be effectively and sustainably managed, and appropriate regulations implemented to reduce the overexploitation of resources, marine pollution and ocean acidification. SDG14 aims to:

- prevent and significantly reduce marine pollution of all kinds, from land-based activities
- sustainably manage and protect marine and coastal ecosystems
- minimize and address the impacts of ocean acidification
- effectively regulate harvesting and end overfishing, illegal, unreported, and unregulated fishing and destructive fishing practices and implement science-based management plans
- conserve at least 10% of coastal and marine areas; prohibit forms of fisheries subsidies which contribute to overcapacity and overfishing
- increase the economic benefits to Small Island Developing States and least developed countries
- increase scientific knowledge, develop research capacity, and transfer marine technology
- provide access for small-scale artisanal fishers to marine resources and markets
- enhance the conservation and sustainable use of oceans and their resources by implementing international law (UN, 2020).
- 4.2. How Eco-town, 3R and circular economy will help achieve the different targets of SDG-14

4.2.1. 3R for effective management of plastic use

Marine litter presents a significant threat to marine life. In 2015, plastic consumption ranged from 0.13% to 0.75% of material consumption in the Asia Pacific Region where plastic consumption increases as per capita income increase (**Figure 4.1**), and projected to be at 40 million tons by 2030 (Jain, 2019). Marine plastic litter is recognized as a resource inefficiency problem that can be sufficiently addressed by circular economy through reduction at source (UNIDO, 2019), increasing the demand for recycled plastics, designing for recyclability, keeping plastic out of the environment, and closing the loop through chemical recycling (Ledsham, 2018).

3R-related efforts focused on waste management in Asia and the Pacific region have been shown to increase recycling rates between 2000 and 2015, and advance

greenhouse gas (GHG) mitigation efforts in Japan, China and Singapore through landfill diversion and waste treatment approaches (Jain, 2019). Prevention is still the most favorable option for enhancing plastic waste management followed by reusing and recycling before final disposal (**Figure 4.2**). Policies and regulations in consumption and production of plastic in the region include measures such as bans, fines, import and export controls, and market-based instruments like EPR, improving recycling rates, and imposition of taxes and levees.

4.2.2. Circular economy solutions in packaging value chains and supply chain management

The increasing demand for plastic packaging materials like beverage bottles, snack bags, plastic bags, and Styrofoam, largely short-term and single-use designed for immediate disposal after use, have resulted in large plastic waste generation for treatment and disposal (Geyer, Jambeck, & Law, 2017). In South Korea, for instance, plastic production by industry accounts for about 36 to 46.5% of materials used, and plastic waste in beaches is as much as 82% of the total waste (Jang, Lee, Know, Lim, & Jeong, 2020).

Management of municipal waste in South Korea starts with source separation at households, followed by curbside collection of specific wastes or at collection centers, and finally incineration or disposal at landfills (**Figure 4.3**). Some municipalities further recover material resources from waste before treatment by energy recovery followed by incineration without heat recovery and power generation (Korea MOE, 2019). Subsequently, material flow analysis of all plastic streams is conducted. Much of the waste from plastic generation are short-term or single-use plastics that can leak to the oceans (KOEM, 2019). South Korea has also introduced an extended producer responsibility system for packaging waste where funding and mandatory recycling targets are established (**Figure 4.4**).

A circular economy approach to addressing plastic waste include the use of alternative non-fossil fuel feedstock for plastic production, the reuse of plastic waste, the redesign of plastic products and manufacturing processes to enhance longevity, reusability and waste prevention, and the promotion of sustainable business models (Barra, Leonard, Whaley, & Bierbaum, 2018). Designing plastics by considering both their service lifetime, and efficient end-of-life recyclability are key to promoting true circularity (Hahladakis, lacovidou, & Gerassimidou, 2020). Reusable packaging and items for waste minimization as well as design for recycling must be promoted, together with the assessment for 'biodegradable' packaging (Renaud, Stretz, Lateheru, & Kerbachi, 2018). These must be addressed by the main consumers of plastic packaging. Ideally, they must form collaborations with plastic producers and converters which are the companies that manufacture plastic products (UNIDO, 2020). Moreover, there must be a transversal view towards the global value chains of plastics in which the recycling and reuse of plastics is highlighted. For example, as plastic is a highly relevant issue for the fast moving consumer goods industry, core practices should include changes to packaging through

innovation and collaborations with their respective supply chains, and the education of consumers through packaging labels and in-store initiatives (Paletta, Leal Filho, Balogun, Foschi, & Bonoli, 2019).

4.2.3. Sustainable fisheries and fishing practices

One of the most prevalent issues regarding marine plastic pollution pertains to ghost nets. Ghost nets are fishing nets which have been discarded or lost in the ocean and live on for years as ocean waste. Each year, about 13,000 fishing nets contribute to plastic pollution in the ocean and pose a threat to marine life; hence, researchers have been exploring the use of biodegradable materials as an alternative (The Explorer, 2020). Reusable, recyclable and repairable material and design options for fishing nets will also allow for environmentally conscious circular designs. Aside from the material use and disposal of fishing nets, current production models in the fishing industry tend to favor cost efficiency, leading to the overfishing of in-demand species and disruption in ecological balance. Developers need to look into the entire lifecycle from sustainable production, biodegradability of fishing materials in the marine environment and safe disposal at end-of-life (Feary, et al., 2020).

Legislation within the industry are vital to promote regenerative fishing practices and resilient aquaculture (Burch, Rigaud, Binet, & Barthélemy, 2019); and enhance circular design in fishing gear, standardize production of fishing gear for quality, recyclability and composition, support the research and development of sustainable alternatives (Feary, et al., 2020), and devise collection, disposal, and recycling schemes facilitate proper management of the waste generated by the fisheries industry (Ruiz-Salmón, et al., 2020). Collection and recycling activities offer opportunities for new business models in the management of old fishing nets by turning them into raw materials (Burch, Rigaud, Binet, & Barthélemy, 2019). Proper management can also lead to an increase of sustainable catches, lower energy utilization, enhanced food security (UN, 2014).

4.2.4. Sustainable management of marine and coastal ecosystems through ecotourism

The conservation and sustainable use of biodiversity enables the establishment of a blue economy, broader sustainable development, and poverty eradication especially for developing countries where economies are more reliant on environment and natural resources, and where marine and coastal ecosystems are prone to degradation. An ecosystem approach towards designating appropriate marine protected areas can play a significant role towards the restoration of biodiversity, renewal of resources, and management of resource extraction (UN, 2014). One way to establish this is through ecotourism, defined as the responsible travel to natural areas that conserves the environment, sustains the well-being of the local people, and involves interpretation and education (TIES, 2015).

Ecotourism needs to be able to establish preventive measures on waste generation and marine litter associated with regular tourism activities. These measures should include improvements in the waste management system in tourist areas, biodegradability requirements for recreational fishing gear and accessories, environmental education programs specifically targeting tourists, economic measures such as deposit refund schemes for bottles and fines for littering, and regulatory measures such as smoking and plastic use bans on beaches (Watkins, et al., 2015). Within these measures, it is also important to include the benefits provided by coral reefs and making long-term investments for their preservation which are usually excluded (IUCN, 2018).

Ecotourism can be also a self-financing endeavor where tourism and environmental fees fund the protection and management of protected areas, maintain the sites, and support waste management infrastructure. The sustainability of tourism can also be guided and measured by established standards and indicators such as those of the Global Sustainable Tourism Council criteria and indicators program and Global Reporting Initiative for sustainable organizations.

4.2.5. Multi-stakeholder involvement and awareness raising

Effective marine litter prevention relies on the successful interaction between stakeholders. Initiatives towards marine litter prevention often comes from industries which work closely with marine ecosystems. However, those who have direct benefits from reduced littering, such as tourism stakeholders, can be important allies. To do this, public authorities should encourage such collaborations at the local and national levels (Renaud, Stretz, Lateheru, & Kerbachi, 2018). Public-private partnerships and support from multilateral development banks should also be given attention as developing effective waste management systems would require having a substantial amount of investment (Barra, Leonard, Whaley, & Bierbaum, 2018). Such action plans can be seen in "The Plastics Pact" which is a network of local and regional initiatives from different countries and continents that joins multiple key stakeholders to implement solutions towards a circular economy for plastic (Ellen MacArthur Foundation, 2020). This can also be seen in the development of Japan's eco-towns wherein initiatives by local governments include the promotion of collaboration among private companies, collaboration with local universities, and call for cooperation and involvement of residents in collecting recyclable waste materials (Fujita, 2011).

It was also determined that the most important predictors of the waste separation behavior are intention, perceived behavioral control, habits, social norms, and personal norms (Ofstad, Tobolova, Nayum, & Klöckner, 2017). To have a better effect on the awareness raising it is vital that the educator must influence the stakeholder to change their behavior when it comes to marine pollution.

Circular economy solutions for plastics also need the collaboration of businesses and consumers to increase awareness towards shifting from non-essential plastic use,

encourage recycling, and increase the value of plastic products (Barra, Leonard, Whaley, & Bierbaum, 2018). Several diverse and unique actions have already been implemented in several countries which target consumers, fisheries, school students and others to raise awareness on the significance of having urgent and effective action plans towards preventing and reducing plastic litter discharge to the oceans. Some examples of this are Japan's "Plastics Smart" campaign and "Marine Litter Act" (MOEJ, 2019).

4.2.6. Governance and international cooperation

To achieve marine litter reduction and prevention, action plans at a national and especially local level where waste and plastic leakage into waterways and the ocean arise are needed. Because of this, global governance initiatives should expand in scope and depth and integrate the recommendations for national and local policies. The transnational value chains of plastics should also be considered (Renaud, Stretz, Lateheru, & Kerbachi, 2018).

In line with this, circular economy solutions for plastics should include the adoption of fiscal and regulatory measures to support sustainable production and deal with the negative effects of plastic use (Barra, Leonard, Whaley, & Bierbaum, 2018). As an example, in the development of Japan's eco-towns, local governments include the provision of information and policy to facilitate starting and operating waste recycling businesses, securing funds for eco-town programs, prioritizing recycled products and recyclers, and encouraging incentives of recyclers (Fujita, 2011). Government policies can also instruments such as the taxation of marine pollution and the creation of Marine Protected Areas (OECD, 2017). Additionally, each country should construct stricter laws which have a clear mandate that a government agency knows their jurisdiction to environment protection. As an example, in Depok Indonesia they strictly enforce the new system and regulation when it comes to go to court. With the stricter regulation and enforcement, the people in Depok Indonesia change their behavior when it comes to waste segregation (Miquelis & Subramaniam, 2017).

The government support to the private sector is also vital for the reduction of marine plastic pollution. The government can create laws which penalize those who will violate and incentives such as tax incentives, subsidies, other mechanisms to those who will abide or increase their involvement in the reduction of marine plastic pollution (Garcia, Fang, & Lin, 2019). Therefore, the four aspects to be considered in creating a global, holistic, and integrated approach towards global sustainability are the harmonization of international laws, coherence across national policies coordination of international organizations and science-policy interaction (Ferraro & Failler, 2020).

5. How COVID-19 pandemic is interlinked with environmental degradation and what Eco-town, 3R and circular economy can offer in preventing future emergence of such infectious diseases

5.1. COVID-19 and environmental degradation

The emergence of the coronavirus disease (COVID-19) pandemic has been met with various responses from mandating PPEs to imposing partial or full lockdowns. Regardless of the public health outcomes of these containment measures, the social, economic and environmental impacts of have become apparent eight months on to this global health crisis. The following subsections focus on the environmental impacts of COVID-19.

5.1.1. Waste generation: solid waste, toxic waste, hazardous waste

Lockdowns increased the demand for online shopping, and home deliveries of food and other necessities, leading to significant growth in organic and inorganic wastes generated from households (Zambrano-Monserrate, Ruano, & Sanchez-Alcalde, 2020). Online food purchases increased by 92.5% and for other products like masks by 44.5% in South Korea (Cho, 2020). Demand for online shopping has also increased in Vietnam (57%), India (55%), China (50%), Italy (31%), and Germany (12%) which resulted in the proliferation of single-use plastic as packaging (Sharma, et al., 2020).

In addition, hazardous biomedical wastes have become even more prevalent following global demand for PPEs such as face masks and gloves (Kulkarni & Anantharama, 2020), overwhelming existing medical transport and disposal infrastructure around hospitals (ADB, 2020). The Asian Development Bank (2020) projected that more than 150 tons of additional medical waste will be generated per day in some cities in Southeast Asia (**Table 5.1**).

Further compounding the challenge of managing waste during COVID-19, a rollback in sustainable practices and policies on reducing plastic packaging has been observed for fear of COVID-19 transmission, such as the temporary suspension of curbside recycling collection programs in select areas in the **US** (Kulkarni & Anantharama, 2020); waived plastic bag charge for online deliveries in the United Kingdom and delayed implementation of packaging deposit return schemes in Scotland (Peszko, 2020); and ban in bringing and using reusable wares like reusable bags and cups in retail establishments, and stalled legislations in reducing plastic packaging (McCormick, 2020).

5.1.2. Water and sanitation, and life below water

Foremost among the recommended containment measures is handwashing, which has caused a rise in domestic water consumption and wastewater generation (Quintuña, 2020). The scarcity of water supply presents a challenge among the 2.2 billion people that lack access to clean and safe potable water and the 4.2 billion people that lack access to adequate sanitation, and could displace 700 million people by 2030 (United Nations, 2020). Where water is available, frequent handwashing, bathing, cleaning and

disinfection of surfaces produces significant amounts of wastewater to be treated. In addition, the excessive use of disinfectants such as sodium hypochlorite also has harmful effects to wastewater treatment systems (Quintuña, 2020).

The pandemic has caused most of the world to live with restrictions to mobility, hence, major industrial sources of marine pollution such as industrial wastewater disposal, crude oil, and heavy metals have decreased. Tourism activities which involve the use of marine and coastal environments such as boating have also been suspended. Because of this, an improvement in surface water quality in terms of suspended particulate matter is expected (Yunus, Masago, & Hijioka, 2020). The reduction of human activity due to the imposition of lockdown and quarantine restrictions also gives way for the marine environment to recover from overfishing (UN, 2020).

5.1.3. Energy demand

The lockdowns resulted in a sharp decline in the demand for oil, and subsequently to its price, effectively decreasing the motivation for clean energy transitions that have been underway. Without government intervention, lower oil prices and cheaper energy leads consumers to use energy less efficiently and reduces the appeal of buying or investing in personal clean energy products such as fuel-efficient cars and energy-saving appliances (Birol, 2020). In addition, the decline in incentives for renewable energy development may cause a serious reduction in renewable energy investments, and a further delay in the achievement of global climate goals. In addition, some workers in the sector have been dismissed or suffered from the outbreak (Eroğlu, 2020).

The pandemic also disrupted supply chains, and caused delays in construction of renewable energy projects, procurement of equipment, production of solar panels (Vaka, Walvekar, Rasheed, & Khalid, 2020) as well as problems with customer acquisition. For the renewable energy sector, this meant difficulties in tax stock markets as well as the risk of not receiving any government incentives by the end of the year. Although the renewable energy sector has remained resilient in the first half of 2020, it is expected to slightly decelerate in the latter half with a 13% projected reduction in additional capacity versus previous year (IEA, 2020).

5.1.4. Consumption and production

The lockdowns and mitigating measures impacted household consumption of food, packaging materials and energy among others. The volume of waste and recyclables generated from residential areas have increased owing to the rise in home deliveries and demand for PPEs such as face masks and gloves (Kulkarni & Anantharama, 2020). Single-use plastics have become once again the default material of choice in many establishments (food-delivery services and e-commerce) as a COVID-19 precaution.

Food producers also suffered especially during the initial stages of the lockdowns. The limited mobility prevented many food producers, especially farmers, from accessing their

respective markets (ILO, 2020). This, together with the closing of local markets, schools, restaurants, hotels, and other institutions, which usually purchase large food quantities, resulted in a surplus of food supply and generated a significant amount of food waste (Kulkarni & Anantharama, 2020).

Several shifts can be noted in energy consumption. As overall electricity demand decreased in Italy (11%), Australia (6.7%) and India (26%), there has been a significant decrease in commercial and industrial load demand while a substantial increase is observed in residential load demand (**Figure 5.1**) (Elavarasan, et al., 2020). Similarly, in China, energy consumption for cooking has increased by 40%, entertainment by 300%, heating and cooling by 60% and lighting by 40% versus pre-lockdown and are expected to continue with the pandemic (Cheshmehzangi, 2020). On the other hand, energy demand for private transportation increased due to private car use (up by 40%) for fear of transmission, whereas use of public transport declined (80%) in the early stages of the lockdown and continues to decline (Cheshmehzangi, 2020).

5.1.5. Environmental emissions

While some shifts in consumer behavior that contributed to environmental improvements are likely to persist such as teleconferencing and distance education (Eroğlu, 2020), environmental emissions will likely skyrocket again when the pandemic ends as countries begin economic recovery (Zambrano-Monserrate, Ruano, & Sanchez-Alcalde, 2020).

- a. A significant decrease in NO₂ and PM2.5 concentrations has been observed in cities that have strictly implemented lockdowns (Zambrano-Monserrate, Ruano, & Sanchez-Alcalde, 2020). Carbon dioxide emissions from transportation were reduced by as much as two million tons per day in 18 countries in the Asia and Pacific region early in the year (Figure 5.2) (ADB, 2020).
- b. With the lack of tourism activities, noticeable improvements in beaches and bodies of water near cities or residential areas were noted such as the unprecedented water transparency in the city canals of Venice, Italy (Braga, Scarpa, Brando, Manfè, & Zaggia, 2020). The nature and extent of these improvements, however, depend on the level of urbanization (regional and distribution within the watershed), climate (predominant wind direction and precipitation), and physical characteristics of the watershed (Hallema, Robinne, & McNulty, 2020).

In contrast, increased usage of PPEs and plastic, and lack of adequate waste management can worsen existing challenges on flooding and marine litter. Improper waste disposal and waste leakages contribute to huge amounts of plastics, microplastics and microfibers in wastewater and water systems (UNEP, 2020).

Similar to the impacts on energy demand, the lockdowns decreased the commercial and industrial water consumption and lessened wastewater generation (Nghiem, Morgan, Donner, & Short, 2020), but domestic water consumption and wastewater generation increased due to intensive hygienic and disinfection measures. Furthermore, the increase in the usage of disinfectants to reduce the risks of COVID-19 contamination contains a high level of contaminants which can cause damage to river, stream and marine environment if improperly handled (UNEP, 2020).

c. The limited use of public and private transportation as well as commercial activities have resulted in a significant decrease in noise in most cities (Zambrano-Monserrate, Ruano, & Sanchez-Alcalde, 2020), which can have positive effects to human and environmental health. Moreover, the reduction in noise can aid seismologists in detecting micro-tremors and smaller earthquakes (Koelemeijer & Hicks, 2020), and improve the assessment of the distribution, frequency, and severity of seismic hazards (NRC, 2006).

5.2. Eco-town, 3R, circular economy and the environment in time of COVID-19

The COVID-19 pandemic has illustrated the increasing environmental pressure brought about by the containment measures in place, and highlighted the need for better practices not only in response to COVID-19, but also on established and existing systems. The United Nations Environment Programme (UNEP) identified four vital SDGs for COVID-19 recovery, namely, Climate Action (13), Life on Land (15), Life Below Water (14), and Responsible Consumption and Production (12); and that progress made in almost every other SDG will be compromised if the necessary actions in these critical SDGs for recovery are not prioritized (UNEP, 2020). The following subsections present resource efficiency, 3R and circular economy, and waste management as approaches and tools that can support better environmental performance.

5.2.1. Resource efficiency

One month into the lockdowns in tropical countries, illegal forest clearing has nearly doubled to that of 2019 (4732 km²), where a total of 9583 km² of deforestation alerts were detected, threatening forest ecosystems and human settlements (Brancalion, et al., 2020). The Feedback Loop in **Figure 5.3** has been conceptualized linking deforestation and COVID-19, and explains how zoonotic diseases, public health, economy, agriculture, and forests may all be reciprocally linked in complex positive and negative feedback loops with overarching consequences. Deforestation and unsustainable practices in farming, urbanization and utilization of ecosystems must shift towards sustainable ones to prevent future pandemic outbreaks. Natural resources, energy and materials need to be used efficiently and circularity promoted to prevent environmental degradation.

Similarly, the decline and degradation of natural marine, coastal and freshwater ecosystems, increasing ocean warming, acidification and pollution calls for a more

judicious use of natural resources. Also, as waste often ends up as marine litter and with the pandemic causing a surge in medical waste and single-use plastic, sustainable blue economy solutions in COVID-19 recovery plans need to be incorporated.

5.2.2. Sustainable growth: build back better through 3R and circular economy The COVID-19 has affected SDG responses by causing disruptions in supply chains and shifting the focus of authorities towards fighting the virus and economic recoveries. For example, construction on India's solar projects has stopped due to supply chain problems while China has relaxed fossil fuel restrictions to boost their economy (Regan, 2020). While these short-term measures may have halted the sustainability transitions happening around the world, long-term recovery plans can still bear the opportunity for sustainable growth through investments in circularity and 3R, which will create new prospects for economic recovery and sustainable resource use.

One of the challenges highlighted by the pandemic is the insufficient means of managing the waste created from the use of PPE and plastic packaging. If the global population adheres to a standard usage of one disposable face mask per day, the pandemic could easily result in a monthly global consumption and waste of 129 billion face masks and 65 billion gloves (Adyel, 2020). It is also estimated that globally, the plastic packaging market will grow from USD 909 billion in 2019 to USD 1,013 billion by 2021 (Business Wire, 2020). The Ellen MacArthur Foundation (2020) proposes opportunities for environmental and economic recovery that takes into consideration the waste problem during this time, namely, innovative reuse business models for plastic packaging, and infrastructure for plastic collection, sorting and recycling. In addition, investment in recycling infrastructure could address environmental problems and create more job opportunities.

5.2.3. Waste management

The COVID-19 pandemic has highlighted the vulnerabilities of current waste management systems and infrastructures to fluctuations in waste generation resulting to more wastes disposed in landfills, accumulation of hazardous wastes and improper waste disposal (Sinha, Michelsen, Akcura, & Njie, 2020). This situation opens countries with insufficient solid waste management systems up to potential rampant dumping, open burning and incineration that in turn could affect air quality and pose health risks (Sarkodie & Owusu, 2020). The ongoing pandemic also increases the risk of disease transmission among people (Kulkarni & Anantharama, 2020) in particular where informal workers are involved in solid waste management, impacting their health and livelihood.

Furthermore, the physical distancing and lockdowns have significantly affected the recycling market and programs resulting in a decrease in the demand for recycled plastics (Sarkodie & Owusu, 2020). Likewise, the limitation on cross-border movements affected the transport of recyclable waste materials to intended overseas recycling centers.

Because of this scenario, most of the plastic waste and recyclables have been put into disposal due to inadequate local waste treatment facilities.

5.3. Preventing future emergence of infectious diseases: What can 3R and circular economy contribute?

Most economies are still on a linear growth path that is heavily reliant on the extraction of natural resources, which makes them vulnerable to biodiversity loss and environmental degradation. Pandemics will continue to arise in the future without measures that address the unsustainable path of development (WEF & EcoWatch, 2020). Integrating the principles of 3R and circular economy into city development, natural resource management and climate change mitigation can help prevent future emergence of infectious diseases.

5.3.1. City development and natural resource management

The COVID-19 pandemic has highlighted biodiversity decline and the unique interconnectedness of humans and nature (Heiliman, 2020); and the need for effective waste management systems, better ecosystem and natural resource management, and access to clean water and sanitation. Recent pandemics experienced by humans were a direct consequence of city development, which created a climate and biodiversity crises (Settele, Diaz, Brondizio, & Daszak, 2020).

- a. Sustainable urban development requires city transformation wherein there is no need for the consumption of additional non-urbanized areas (Mangialardo & Micelli, 2020), decreasing land conversion and natural resource consumption. Disease transmission from various wildlife species to humans has been found to be caused or facilitated by the degradation of natural habitats (Jeffries, 2020), disruptions in land ecosystems such as illegal logging, mining and road building (Vidal, 2020), and exploitation of wildlife through hunting and trade (Johnson, et al., 2020). Even efforts towards the expansion of livestock production, especially in developing countries, increase the risk of pathogen spillover by increasing by expanding the wildlife–livestock–human interface (Di Marco, et al., 2020).
- b. As circular economy aims to reduce waste, implementing its principles into existing economies would increase land productivity (Nikam, 2020) and resource efficiency. Thus, it would help support the conservation of natural habitats, reduce the need for land transformation, and, as a result, help prevent the spread of infectious diseases. Extended urbanization and the increase of informal public areas also contribute to making communities more vulnerable to infectious diseases (Pinheiro & Luís, 2020) as they increase the rate of land transformation as well as the need for resource extraction. Important risk factors identified in previous influenza outbreaks include land-use diversity, high poultry density population, diversity in flock sizes of poultry, and high Compound Topography Index, which points to the need for a proper description of rural-urban transition

and peri-urban classification for better analysis of infectious diseases in the future (Saksena, et al., 2017).

- c. Waste management systems need to consider incorporating 3R principles and include the informal sector in waste management system planning to improve overall recycling rates and lessen the waste inflow into final disposal sites especially in developing countries (Ferronato & Torretta, 2019). The accumulation of solid waste in urban areas also acts as a risk factor for zoonotic and vector-borne diseases. As garbage accumulates over time, it creates food reservoirs, and burrowing and breeding sites for these animals (Krystosik, et al., 2020), increasing the risk of those involved in informal waste sectors from contracting such diseases from scavenging activities (Ferronato & Torretta, 2019).
- d. The pandemic has highlighted the need to create multi-stakeholder partnerships, and investment in wastewater treatment facilities and sanitation. Sustainable wastewater management includes the collection, transportation, treatment, and safe disposal of wastewater as well as creating alternative and low-cost treatment systems. Future guidelines should also look into the reuse of wastewater, especially greywater, to decrease the strains on drinking water reserves and leave sufficient quantities of clean water for other uses, especially personal hygiene (UNEP, 2020). Inadequate wastewater management systems pose a threat to public health. The spread of wastewater-related diseases is usually associated with the lack of infrastructure for wastewater treatment and management, and the use of untreated water to meet water supply shortages (WHO Regional Office for Europe, 2018).

5.3.2. Climate change

Fighting climate change as a root cause of disease transmission can simultaneously mitigate the threats of biodiversity loss as well as future pandemics (Boukerche & Mohammed-Roberts, 2020). Climate change can be linked to the recent re-emergence and resurgence of some diseases, especially the ones which are vector-borne, because rising temperature and changes in rainfall patterns have created ideal living and breeding conditions for vectors and pathogens to survive in environments which were previously inhospitable to them (Curseu, Popa, Sirbu, & Stoian, 2009). For example, countries which were previously too cool for diseases associated with tropical and subtropical regions are now susceptible to such diseases (Boukerche & Mohammed-Roberts, 2020). Warmer temperatures have previously been linked to the changes in the range of malarial mosquitoes and the spread of malaria and the Zika virus (UNECA, 2020). Aside from this, rising temperatures have affected migration patterns and wildlife settlements causing animals to have unusual contact with other animals and create opportunities for pathogens to have new hosts (Harvard School of Public Health, 2020).

This COVID-19 pandemic has resulted in reduction in air pollution, especially in advanced economies, due to the imposed lockdowns that limited economic activities. However, this also revealed that economic activities are still very much linked or coupled with environmental impacts such as air pollution. As economies begin to forge a path of economic recovery, it provides the best opportunity to consider incorporating principles of circularity to these plans to untangle connections between socioeconomic wellbeing and environmental degradation. These principles of circular economy can be used as a tool for climate change mitigation, crafting a more resilient economy, and facilitating a socially just and inclusive society (Mohammed, et al., 2021). Moreover, tackling issues regarding air pollution and climate change together creates the opportunity to gain health, economic and environmental benefits of having more efficient transportation, energy systems, low-carbon economies, and more sustainable food systems (WHO Regional Office for Europe, 2018). A paradigm for developing sustainability needs to be embraced globally to facilitate significant climate actions.

6. Recommendations for action

As COVID-19 quickly spread in many countries, measures implemented started with immediate, reactionary containment measures to respond to the outbreak. Most of these measures are still in place eight months since the pandemic ensued, and the environmental impacts the use of PPEs and mobility restrictions have become apparent from increasing generation of waste to disruption in renewable energy supply chain (see Section 5.1). The following subsections provide suggestions on COVID-19 response and post-COVID-19 actions at the regional, national and local levels that take into consideration circular economy and 3R principles. Examples of existing measures are referenced when available.

6.1. Regional response

Regional cooperation promotes an enabling environment to operationalize 3R and circular economy tools in addressing the common threat of COVID-19 and preventing future emergence of infectious diseases. Cooperation may take the form of information sharing, benchmarking success cases and removing barriers.

- a. Strengthening regional supply chains and easing regional barriers to trade of essential goods will prevent delays in pandemic response. A similar approach is the "green corridor" being implemented by the Eurasian Economic Commission where essential commodities are fast-tracked by simplifying customs procedures and also implementing trade digitalization (Kalanina, 2020). The closing of national borders to all transportation hampered the delivery of goods like PPEs and medical equipment, and disrupted global supply chains in many sectors. By promoting stronger trade and cooperation, countries and respective sectors can pool together the strengths and capabilities for the benefit of the region.
- b. Fostering regional commitment to a green recovery. This commitment can take many forms in the Asia Pacific region including technical cooperation between countries, public-private partnerships, research and development, and regional funding mechanisms on green industries and green skills enhancement. Many countries in the OECD have developed support measures that would help green economic recovery packages such as the European Coronavirus Recovery Fund where 30% of one trillion euros are allocated for green projects (OECD, 2020). This calls for engaging in an inclusive reform policy at a regional level that would involve a more comprehensive growth model to strengthen value chains between countries.
- c. Coordinating regional action on environment and natural resource management. With the current pandemic, awareness has increased on the potential future emergence of infectious diseases. Asia has been cited as a critical region for the emergence of new coronaviruses due to the rampant deforestation (Afelt, Frutos,

& Devaux, 2018). Southeast Asian countries has seen a reduction of forest cover of 80 million hectares from 2005 to 2015, and this biodiversity decline can give rise to dormant viruses, which may be a source of new and emerging infectious diseases (Lim, 2020). Stronger cooperation and measures on natural resource management and resource efficiency are needed at the regional level, and interpreted at the national level for local implementation.

6.2. National response

Foremost among national responses are health and economic objectives to address the ongoing pandemic. The following suggestions offer elements of circularity and principles of 3R in existing national measures and proposals.

- a. Adaptability of infrastructure and response for sustainability. The global shortage of face masks has been worsened by export imposed by many countries (Park, et al., 2020). In response, several companies have re-configured their production lines to produce PPEs and medical equipment such as Ford Motor Co. and General Motors Corp. that shifted their operations to manufacturing ventilators, face shields and other medical supplies (Camillo, 2020). Garment manufacturers in China fulfilled PPE demand from several countries, and Malaysia has exported 65% of rubber gloves for medical use (Mezzadri & Ruwanpura, 2020). Some groups in the Philippines created reusable and recyclable masks out of non-woven polypropylene for use in low-risk areas, and Temasek Foundation in Singapore offered free hand sanitizer refills to 1.5 million households instead of throwing away empty alcohol and shampoo containers (Fernandez, 2020).
- b. Ensuring access to water and sanitation for all. Proper hygiene and disinfection, through access to water and sanitation, have been paramount to the fight against COVID-19. The need for clean water increased due to COVID-19, making it more difficult for some communities to acquire their water supply (ILO, 2020). Affordable access to water, sanitation and hygiene services is essential for combatting pandemics, and can help mitigate the economic costs of future pandemics (Cooper, 2020). Policy responses that address water security are needed, especially as the progress in meeting SDG 6 (availability and sustainable management of water and sanitation) was slowed down due to the effect of the pandemic on water utilities (Butler, Pilotto, Hong, & Mutambatsere, 2020).
- c. Prioritizing and investing in green sectors in national economic recovery packages. Several countries have already begun to develop economic packages or strategies to recover from the impacts of COVID-19 and several of these have approaches including a green, climate, or sustainability focus (Mehta, Crowley, Iyer, Andrich, & Subramaniam, 2020). Examples of existing packages in the Asia Pacific region (Table 6.1) including those initiated and developed pre-COVID-19 and are highly relevant to build upon for a post-COVID-19 green recovery.

Examples of green sectors and infrastructures with multiple benefits include wastewater treatment, water recycling, and waste management and recycling. Rainwater and floodwater harvesting, and reusing treated wastewater has the potential to reduce the water demand (UNEP, 2020). Waste management systems based on 3R also helps lessen waste sent to landfills or incinerators, and reduce greenhouse gas emissions that contribute to climate change (EPA, 2020).

- d. Embracing sustainability with projects, initiatives with national policies. There is an urgent need for sustainable economic recovery plans that divest from polluting industries (UNECA, 2020), and address issues related to climate change, resource depletion, and continued socio-economic inequalities (Dixon, 2020). The post-COVID-19 world must work towards sustainability, which is based on reducing environmental emissions and protecting the environment. Investing on clean energy projects as part of recovery plans, for instance, can create economic gains and green jobs in addition to longer-term rewards for air quality, energy security and energy costs (C40 Cities Climate Leadership Group, 2020). The UN Secretary-General has also proposed six climate-positive actions for governments to take as they move towards economic recovery (United Nations, 2020):
 - Green transition through investments which accelerate the decarbonization of all aspects of the economy
 - Green jobs and sustainable and inclusive growth
 - Green economy through making all societies and people more resilient
 - Invest in sustainable solutions, eliminating fossil fuel subsidies, and polluters paying for their pollution
 - Confront all climate risks
 - Global cooperation
- e. *Planning for resilience of systems and infrastructures*. Strategies and action plans in line with waste management for post-COVID recoveries should incorporate resiliency and preparedness for future crises (Vanapalli, et al., 2020). The interconnectivity of environmental issues and infectious disease emergence is not given enough attention and is not always considered in sustainable development plans (Di Marco, et al., 2020). Moreover, current economic response plans mostly focus on post-outbreak response, which does not eliminate the associated risk factors (Ricciardi, 2020). Without integrating the mitigation of diseases into sustainability plans, the ability to achieve SDG targets will be compromised (Di Marco, et al., 2020).
- f. *Facilitating and supporting private sector-led actions*. Many companies are also working towards aligning their COVID-19 recovery plans with their commitment to net-zero emissions to build resilience to the negative impacts of climate change, and secure business operations and jobs (WBCSD, 2020). According to the

Wellbeing Economy Alliance (2020), COVID-19 recovery plans should: prioritize long-term human wellbeing and ecological stability in all decision-making; protect all existing environmental targets and policies; develop new green infrastructure and provisioning; guarantee needs satisfaction and livelihoods for everyone; fair distribution of resources and opportunities; and implement circular economy principles to minimize resource use and waste (Büchs, et al., 2020).

Some producers of protective and medical equipment are using machines developed by Precious Plastic, an open-source hardware plastic recycling initiative, to turn recycled plastic into face shields and masks (Hew, 2020). In the Philippines, Coca-Cola is partnering with the government to invest in the country's first recycling facility, scheduled to open in late 2020. Through financial and infrastructure investment, plans in the development of the facility continued amidst the pandemic with the aim of systematically addressing waste in the country.

g. Using sustainability metrics in choosing and implementing solutions to the pandemic. During the pandemic, digital transformation is having a record pace. In the long term, the COVID-19 pandemic is changing the infrastructure landscape and increases the pressure to accelerate upgrades to smart-city technologies such as artificial intelligence, sensor technologies, machine learning and Internet of Things. While these technologies are also expected to support climate goals, training a particular AI model is reported to consume high amounts of energy (Figure 6.1) (Klemeš, Fan, & Jiang, 2020). Emission is found to be as much as the carbon emission of five cars in their lifetimes which is driven by the additional tuning steps that require tweaking of neural network design to improve the model's efficiency (Hao, 2019). Careful consideration and assessment need to be done to find the balance and appropriate use of technology in promoting public health and safety alongside environmental and economic goals.

6.3. Local response

National responses and direction can be translated into local responses that would better fit local capabilities and resources, and geographical characteristics.

a. Rethinking rural and urban development with respect to ecosystem boundaries. The pandemic highlighted the need for more open spaces, better design of public spaces and green infrastructures. Reuse of old buildings, which extends the useful life of these buildings, supports the key concepts of sustainability by decreasing the need for material, transport and energy consumption and pollution (Ijla & Broström, 2015). Land conversion for urban development needs to be planned with respect to land use and surrounding ecosystem. With the increasing habitat degradation, diseases passed from animals to humans such as COVID-19 will continue to emerge as degraded habitats facilitate more animal-human interaction. In addition, biodiversity loss puts communities at a

greater risk in terms of climate change impacts. People who have been displaced by environmental disasters have to not only deal with monetary loss and property destruction, but also increase their susceptibility to illnesses and dependence on ecosystem services (COHAB Initiative Secretariat, 2010).

- b. *Responsive governance and social services*. As consumers increasingly adapt to the lockdowns imposed, some behaviors may persist even after the pandemic. Work from home arrangements and online education can become a mainstay, and will require excellent telecommunications and digital infrastructure. Waste management measures need to be able to adapt to the shifts that have happened in waste generation. Also, as waste often ends up as marine litter and with the pandemic causing a surge in medical waste and single-use plastic, sustainable blue economy solutions in COVID-19 recovery plans need to be incorporated.
- c. Redesigning business models. Lockdown measures have accelerated new and emerging sectors that support sustainability and responsible consumption such as locally sourced production. The United Nations is currently working with partners to incentivize circularity in order to shift to more sustainable and resilient economies and societies (UNEP, 2020). New considerations, challenges need to be taken into consideration by businesses to adapt to the changing business and economic landscape. For global travel, tourism and hospitality, a sustainable business model will aim to reduce carbon footprint and incorporate 3Rs.

7. The Way Forward

The foregoing sections clarified the involvement of unsustainable consumption and production patterns, climate change, environmental degradation and biodiversity decline in the ongoing pandemic, and that after the COVID-19 pandemic, there is still a high risk of another epidemic to emerge (Grandcolas & Justine, 2020). Increasing environmental stress from natural resource extraction, land use and degradation, waste disposal, and land and resource scarcity are some of the important drivers for adopting circular economy principles and stimulating the efficient use of natural resources (Breure, Lijzen, & Maring, 2018).

As countries start a path to recovery, linear economic growth models are called into question as these are the underlying principles of present economic systems that are coupled to environmental degradation. The overall development and recovery slogan of "building back better" needs to find an interpretation and actualization that considers circularity, sustainability and inclusivity. Developing future-proof sustainable development and recovery will only be possible if responses, plans and policies are given the attention they need (UNEP, 2020).

a. Essence of building back better. The economic recovery packages being rolled out by nations will need to incorporate green elements of resource efficiency as these are likely to result in economic growth, develop new green sectors, and support city resilience and crisis prevention (UNEP & IRP, 2020). With resource efficiency and sustainable consumption and production policies in place, the International Resource Panel model shows that by 2060, there will be global gross domestic product growth by 8% especially among middle- to low-income countries, global resource use can slow down by 25% and global greenhouse gas emissions can be cut by 90% (IRP, 2019).

UNEP and the International Resource Panel also provides examples of sectors to which these green stimulus packages can be directed (UNEP & IRP, 2020):

- Circular economy transitions will require regulatory supporting mechanisms, streamlining of value retention programs, closing-the-loop, and technology transfer and local skills enhancement among others.
- Resource efficiency and resiliency of cities will necessitate urban infrastructures that embody resource efficiency, circular urban metabolism, innovation for resource efficiency, and careful urban planning for long-term flow of strategic resources.
- Resource-smart food systems will be supported through investing in productivity, regenerative farming practices, food waste recycling; changing diets towards less meat and animal products; and having adequate legal frameworks for land tenure.

These green recovery packages will involve long-term effort, changes and rethinking of how people need to live, work, eat, move and consume. In the short-term, how can Sustainable (green) Public Procurement support a green stimulus expenditure in the rebuilding of resilient society during the partial economic recovery during the pandemic?

b. New meanings for resiliency. In addition to existing plans for smart cities, sustainable cities and city resiliency, resiliency will take on a new meaning post pandemic. Cities and municipalities have become aware of the linkages between land habitat degradation, climate change, unsustainable consumption and production, and the spread of diseases; and of the consequences pandemics or disease outbreaks can have on socioeconomic wellbeing. This will have implications on everyday life like how urban spaces and settlements are designed, how businesses operate, and travel and leisure activities are carried out.

With these changes, how can micro, small and medium enterprises adapt and participate in a more inclusive green recovery?

c. Climate goals. Government initiatives need to invest on climate friendly and naturebased activities for economic regrowth, employment opportunities and increase resilience to threats – supporting sustainable infrastructures and rebuilding for sustainable cities in preparation for the post-COVID-19 world (UNEP, 2020). Climate goals and objectives need to be the emphasis in any recovery plan. As much of the progress in achieving SDGs has been delayed, more effort needs to be exerted in aligning nation plans in moving forward to align with the 2030 Agenda along with the Paris Agreement.

Climate change has been shown to be a major factor in many disease transmission. While there has been progress in the development of renewable and clean energy in the last decade, how will energy and energy efficiency, and resource management be accelerated and mainstreamed in rebuilding societies?

d. Localized actions and global impacts. One of the universal impacts of the pandemic was unemployment. As travel, tourism and hospitality and many other sectors virtually had to halt operations, unemployment began to rise. This impacted especially the vulnerable sectors of society. While these sectors are currently on hold, investment and support for new local business models on marine plastics and green tourism infrastructure can prepare for reopening of borders and encourage growth of green jobs in the sector, as well as community-based environment programs. This can be in line with the objectives of the Global Tourism Plastics Initiative that supports UNEP's Clean Seas' global campaign (UNEP, 2020). In what other ways can sustainable blue economy solutions be

incorporated in the COVID-19 recovery plan considering the surge in marine litter from single use plastic?

e. Raw materials in waste. While unfortunate, plastic packaging has been one to become mainstreamed again during the pandemic from increased demand for food deliveries and logistics, and will likely have long-term impacts like clogging waterways and marine litter considering improper waste disposal in many areas. Prior to the pandemic, different sectors and companies have already started to develop ways to utilize plastic debris from the ocean and recycle them into new products (Magnier, Mugge, & Schoormans, 2019). For example, Norwegian companies have developed solutions and technology such as using offshore technology to collect plastic waste, converting plastic waste into recycled carbon fuels, and exchanging plastic waste for tokens at recycling centers (The Explorer, 2020). This example can be adapted to local capacities, and be supported with technical skills training.

With fears of secondary transmission if reusable materials are used, would a resumption of plastic ban be feasible during the pandemic? What would a balanced approach in land-based economic activity that has little impact on oceans look like?

8. Synthesis

The Webinar 2 invited speakers to deliver main messages and panelists to interact on five issues. The presentations and discussions in the Webinar are reflected and synthesized in the ff. paragraphs.

The COVID-19 pandemic and its side effects provide waste and resource management systems the basis to consider a circular economy approach. Immediate and intermediate changes on how people consume in response to the fear of disease transmission resulted to increases in consumption of consumer electronics, deliveries of food and other essentials and PPEs among other things. Wastes that are not avoided end up requiring additional steps such as reuse or recycling as applicable, or treatment prior to landfilling. Preventative steps put forward in a circular economy model makes for better economic proposition that moves away from costly recycling and pollution treatment.

In response to the current pandemic, countries at the national and local levels imposed various measures, such as mobility restrictions and use of PPEs, to contain the transmission of the disease. These necessary measures allowed for some socioeconomic activities to continue, but with added challenges to the environment primarily in the tons of waste generated from single-use plastic and packaging materials, PPEs and hazardous wastes, as well as electronic wastes from the increased digital consumption. The intermediate changes to everyday life during the pandemic can have lasting impacts.

While the pandemic presented as a new disruption and threat in the form of the novel coronavirus, the consequences and challenges that the world deals with now closely resemble existing problems on waste management, resource management, inequality and sustainability. Present waste management systems struggle with the magnitude and mix of waste streams generated at this time. Raw material extraction still comprise a majority of the inputs to the world economy, with consumption being the backbone of economic growth. Unemployment, poverty, lack of access to basic needs aggravate the circumstances of the poor population. With the interruptions in supply chains, progress in implementing sustainable programs and projects suffer delays. These challenges, albeit amplified at the current pandemic, represent some of the ongoing and pressing problems that have yet to find adequate solutions in the current economic models.

Planning for economic recovery from the effects of the pandemic will need careful and thorough examination of the impacts the changes in consumption preference, challenges to waste management systems and the threat of future pandemics have to societies in addition to existing factors. As the next paragraphs will illustrate, the pandemic brings with it a renewed urgency and opportunity to turn development path to circularity, one that fosters closed loop industrial systems supporting new products, new services, and new ways of doing things that embed circularity at its core. Some examples, methods and approaches already exists in both developed and developing nations. There is opportunity for better growth models, where human and environmental wellbeing take priority.

Building back better represents both a challenge and opportunity for resilient and sustainable growth models to shape future development. Circular economy continues to capture different perspectives in the interpretation and implementation of circularity, and complexities in systems. This openness in the interpretation of the 3Rs (reduce, reuse and recycle) to suit the needs of particular settings allows for flexibility in execution of circular economy and consideration of local scenarios. In its current evolution, CE 3.0 recognizes the need to maximize value retention and shift to 10R (plus other interpretations of reuse) with differing timeframes for implementation by various groups like business sector, government, research institutions and nongovernmental organizations. At this time, a number of initiatives already started to incorporate CE to reduce impacts of pandemic response and other related activities.

Circular economy opens new business opportunities that address the vulnerabilities exposed during this pandemic. Business models incorporating inclusive and local supply chains, minimizes resource extraction and increases resource efficiency would support seamless economic activity, and help alleviate environmental stresses brought about by the pandemic. Prior to the pandemic, green and sustainable products increasingly permeate consumer preferences. Existing examples of products addressing the disposable or throwaway culture include Ecoware's sustainable food packaging and Saathi Pads' sanitary napkins made from banana fibers. Offering consumers alternatives and solutions to disposable items such as food packaging and surgical masks will greatly reduce waste generation and raw material consumption. Moreover, adapting business models can also be a setting where rethinking of production and consumption can happen by treating products as a service.

Aside from the fragility of supply chains, dangers to frontline workers present a crucial challenge in addressing COVID-19 disruptions. Circular economy promotes better protection for workers. Actions and protective measures where hazards to workers remain high need to be in place, particularly for workers in the waste sector. Significant potential for green jobs creation exists in Asia Pacific countries if investments and measures are coursed through sectors that aim to improve energy use, waste management, resource independency and environmental degradation. National actions on policy coordination, and local programs and plans on technical capacity building and awareness enable local workers to have the necessary skills for green sectors.

As livelihoods became vulnerable from limited socioeconomic activities, the poor felt the most impact in having less capacity and resources to cope with unemployment and housing needs. The pandemic highlights the urgency to build resilient, safe, healthy and inclusive cities in response to the effects of the pandemic, and more importantly to promote harmony in man-nature relationship, preventing further habitat and environmental degradation. Resiliency need to incorporate better land use management,

accessible and equitable urban spaces, green infrastructure, adaptive buildings, and circular economy geared towards community and shared economy.

The current public health crisis also stressed the improvements needed for sustainable response to the urgent needs and changes brought about by the pandemic. While immediate pandemic response may have foregone environmental aspects due to time constraints, subsequent measures and long-term plans in moving forward need to address the shortfalls, such as the increased material consumption and waste generation, that challenge waste management systems in many countries. Adopting a circular economy approach necessitate redesigning socioeconomic systems for decarbonization and decentralization of society. In Japan, for example, future efforts on waste management recognize the need to improve public health, and disaster and climate change response, creating new value for the community.

The past nine months has shown the accelerated progress science, technology and cooperation can achieve to address the pandemic as a public health crisis. Beyond this accelerated achievement, the threat of diseases and future pandemics remain, and with roots on resource use and environmental degradation. Future resiliency needs to integrate elements of sustainability, circularity and equity into long-term plans in addition to adaptability of systems to threats like pandemics, climate change and disasters. These perspectives can provide economic stimulus packages the direction for economic recovery that builds new business models, supports sustainable infrastructures, bridges the inequality gap, prioritizes human and environmental protection, and fosters inclusivity among others. Many international organizations and research institutions provided evidence and data on the potential benefits of investing in circular economy, green sectors, resource efficiency and sustainable food systems to societies. Moreover, existing examples of 3R, CE programs and green sectors can be replicable and adaptable to local needs and situations.

Redesigning socioeconomic systems for circularity requires multi-stakeholder actions and participation. Greater coordination need to be in place for recycling, resource management, waste management circular economy from national priorities to local initiatives, and to broader cooperation in regional landscape. Having enabling policies and frameworks can facilitate the transition from business as usual to a circular economy model. Mechanisms of engaging stakeholders need to be strengthened to increase public and private awareness and participation while governments take the lead and facilitating role in this change through regulatory and market mechanisms. In a climate where economic recovery appears of utmost urgency, the foregoing discussions offer a parallel urgency for economic recovery in harmony with circularity. Building back better means stepping away from the "take-make-consume-dispose" economic model. Rebuilding economies require adopting resource circularity perspective, sustainable business models, public participatory approaches, localized actions, and wider cooperation.

Collectively, localized interpretations of green recovery can have global impacts for sustainable and resilient growth.

Appendix

Appendix A



Figure 2.1. The Regional Energy-Saving Station (Gao, Fan, Ushifusa, Gu, & Ren, 2016)



Adhikari, & Ananth, 2007)



Figure 2.3. City Marine Park Model (Pittman, et al., 2019)

Appendix B



Figure 3.1. Production-Consumption System Diagram (Velenturg, A. et. al, 2019)

Appendix C



Figure 4.1. Plastic consumption per capita versus income per capita (Jain, 2019)



Figure 4.2. 3Rs approach to achieve circularity (Jain, 2019)



Figure 4.3. Source separations and recycling of plastic waste from households in South Korea (Jang, Lee, Know, Lim, & Jeong, 2020)



Figure 4.4. The recycling system for packaging waste by EPR in South Korea (Jang, Lee, Know, Lim, & Jeong, 2020)

Appendix D



Figure 5.1. Pre-COVID and During-COVID percentage electricity demand by major sectors (Elavarasan, et al., 2020)



Note: Asian Development Bank members considered: Armenia; Australia; Azerbaijan; Bangladesh; Cambodia; Hong Kong, China; India; Indonesia; Iran; Japan; Kazakhstan; the Kyrgyz Republic; Malaysia; Mongolia; Myanmar; Nepal; New Zealand; Pakistan; People's Republic of China; the Philippines; the Republic of Korea; the Russian Federation; Singapore; Sri Lanka; Taipei, China; Tajikistan; Thailand; Turkmenistan; Uzbekistan; and Viet Nam.

Figure 5.2. Transport-related carbon dioxide emissions reduction in selected countries (ADB, 2020)



Figure 5.3. Feedback loops between tropical deforestation and the COVID-19 (Brancalion, et al., 2020)

City	Population (World Population Review)	Additional Medical Waste	Total Possible Production Over 60 Days
Manila	14 million	280 t/d	16,800 tons
Jakarta	10.6 million	212 t/d	12,750 tons
Kuala Lumpur	7.7 million	154 t/d	9,240 tons
Bangkok	10.5 million	210 t/d	12,600 tons
Ha Noi	8 million	160 t/d	9,600 tons

Table 5.1. Additional medical waste generated in response to COVID-19 (ADB, 2020)

Appendix E

Country	Recovery Initiative	Focus	Allocation
South Korea	New Green Deal (Kim, 2020)	 Large-scale investments in renewable energy Introduction of a carbon tax Phaseout of domestic and overseas coal financing by public institutions Creation of a Regional Energy Transition Centre to support workers' transition to green jobs 	US\$138 billion
New Zealand	Focus on Environment and Jobs	 Create 11,000 environment jobs Jobs restoring wetlands, regenerating planting, nature-based tourism jobs, and enhancing biodiversity on public and private lands 	US\$ 1.1 billion
The Philippines	Green Program and "Build, Build, Build" Program	 Investments in urban areas through scaling up projects Maintained infrastructure as one of the priorities for economic recovery, which can be a major impetus to creating projects, investment opportunities, and green jobs 	US\$ 160 billion
Indonesia	Action Plan to Reduce Plastic Pollution	 Road map for reducing plastic leakage in coastal waters by 70% by 2025 and near zero by 2040 through a circular economy approach Investment to green small and medium-sized enterprises Sustainable infrastructure for recycling New technologies for packaging and recycling Waste disposal facilities 	US\$ 5.1 billion
Thailand	Public-Private Investment Projects (Reuters, 2020)	 92-project plans include 18 high-priority infrastructure projects 	US\$ 33 billion
Fiji	World Bank's Sustainability Checklist and Climate Vulnerability Assessment (Fargher & Hallegatte, 2020)	- Prioritization of investments based on identified interventions that performed well along the checklist categories: Short-term growth; Long- term growth; Resilience; and Decarbonization	US\$ 1.7 billion

Table 6.1. Areas of focus of recovery initiatives in selected countries in the Asia Pacific region



Figure 6.1. Comparison of CO₂ emissions of various human activities to AI model training (Klemeš, Fan, & Jiang, 2020)

Appendix F

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