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TACKLING THE WASTE CRISIS IN SINGAPORE AND ASIA-PACIFIC: A ROLE FOR BUSINESS IN ADVANCING THE CIRCULAR ECONOMY

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6 Key takeaways on Asian Pacific Business and the Shift to the Circular Economy

1 Waste generation in Asia Pacific is expected to outpace national management strategies and capacities in the next few decades.

The region will be producing **close to 2.5 million tonnes** of waste on a daily basis by 2035.

2 Global trends are shifting the operating environment for business, disrupting linear production systems.

Business will need to step up and **respond through technology and business model innovation** to remain relevant.

3 Singapore's National Environment Agency is encouraging businesses to adopt circular economy approaches.

The Zero Waste Master-Plan calls on businesses to adopt a zero-waste mindset, with a focus on closing the loop on **3 priority waste streams**: food waste, packaging waste and e-waste.

4 First-movers in Asia Pacific are experimenting with circular concepts as part of business improvement.

New business models are reshaping markets and enabling the transition to a circular economy, which presents **a US$4.5 trillion opportunity** for the global economy.

5 Pioneering businesses currently face systemic barriers related to regulation, access to finance and immature markets.

Regulatory mechanisms - such as extant biosecurity laws which **prevent imported organic material from being recycled or reused** - have not been adapted to enable the adoption of closed-loop models.

6 As critical agents of change, businesses and their actions will need to be systemic.

They will need to deliver transformational outcomes at scale in response to a fast-changing landscape.

Executive Summary

On 1 April 2019, Temasek organised a discussion by Chief Executive Officer of Singapore National Environment Agency (NEA), Mr Tan Meng Dui, as part of the Ecosperity Conversations series.

The session discussed the long-term waste management outlook for Singapore, supportive policies and grants in place for businesses to incorporate circular approaches, pilot projects that the government is spearheading to reduce waste nationwide, and the importance of public campaigns to educate consumers. A 3P approach towards a zero waste nation was advocated.

Drawing on insights from Mr Tan's presentation, this summary report considers the issues raised within the context of Singapore, and extends the discussion to the broader waste challenges, as well as impact and opportunities for businesses in the wider Asia Pacific region. Businesses in Singapore and the region clearly have an important role in addressing the challenge. This report pays specific attention to how businesses may fulfil this by systemically embedding circular economy approaches into their own organisations and critically, into the ecosystems they exist within.

1. The waste challenge in Asia Pacific: urgent, systemic and complex

In the past decade, Singapore has experienced an increase in the amount of waste generated that will pose significant challenges to current management strategies and capacities. Between 1970 and 2017, the amount of solid waste that Singapore disposed of increased seven-fold.[1] In a country confronted by land scarcity, there is concern that its designated landfill, Semakau Landfill, will reach full capacity by 2035[2] if the amount of waste continues to grow at the same rate.

The nation's challenge of excess waste is not unique; East Asia and the Pacific alone generate close to a quarter of total global waste.[3] Of the eight million tonnes of plastic that find its way into the oceans annually for example, almost 90% comes from at least five countries in Asia.[4] The rate of waste generation in the region is set to accelerate within the decade; by 2025, the region is expected to produce approximately 2.5 million tonnes daily.[5] As middle class populations continue to grow, the waste challenge will exacerbate unless critical changes are made in our policies, production methods and consumption behaviours.

Waste-related data remains incomplete for many countries in Asia. Nonetheless, e-waste,[6] food waste[7] and plastics[8] have been identified as high-volume, fast-growing waste streams in the region. The hazardous nature of e-waste and micro-plastics is aggravated in regions that do not have adequate systems to ensure safe take-back and recycling

E-waste in Southeast Asia has jumped 63% within five years from 2012 to 2017.

South Asia, Southeast Asia and industrialised Asia (China, Japan, South Korea) combined make up over 50% of global **food waste**.

The greatest **plastics** polluters are said to be the Asian economies.

[1] National Environment Agency, "Waste Management Overview". Available at: https://www.nea.gov.sg/our-services/waste-management/overview

[2] Ministry of the Environment and Water Resources, "Managing our Waste: Landfill". Available at: https://www.mewr.gov.sg/topic/landfill

[3] The World Bank (2018), "Global Waste to Grow by 70 Percent by 2050 Unless Urgent Action is taken: World Bank Report". Available at: https://www.worldbank.org/en/news/press-release/2018/09/20/global-waste-to-grow-by-70-percent-by-2050-unless-urgent-action-is-taken-world-bank-report

[4] World Economic Forum (2018), "90% of plastic polluting our oceans comes from just 10 rivers". Available at: https://www.weforum.org/agenda/2018/06/90-of-plastic-polluting-our-oceans-comes-from-just-10-rivers/

[5] The United Nations Economic and Social Commission for Asia and the Pacific (2015), *Valuing Waste, Transforming Cities,* Chapter 1. Available at: https://www.unescap.org/resources/valuing-waste-transforming-cities

[6] United Nations University (2017). "E-Waste in East and South-East Asia Jumps 63% in Five Years". Available at: https://unu.edu/media-relations/releases/e-waste-in-east-and-south-east-asia-jumps-63-percent-in-five-years.html

[7] Food navigator-asia.com (2018). "Is technology the answer to solving Asia's food waste crisis?". Available at: https://www.foodnavigator-asia.com/Article/2018/09/19/Is-technology-the-answer-to-solving-Asia-s-food-waste-crisis

[8] IOC Sub-Commission for WESTPAC (2017). "WESTPAC Takes Steps to Combat Marine Microplastics Pollution in Asia and the Pacific". Available at: http://iocwestpac.org/news/845.html

processes. In particular, plastics and packaging waste tend to end up in municipal drainage systems, where a lack of collection receptacles results in water pollution. For these key waste streams, standard landfilling approaches are proving insufficient because of their inability to effectively capture waste and their unsuitability for long-term waste management.

The waste crisis in Asia Pacific leads to systemic effects such as a warming climate,[9] air and water pollution, and biodiversity loss,[10] extending to risks to health and well-being both in the short and long term. Vulnerable populations in Asia often bear the brunt of poorly-managed waste. In localities where open dumping is the most common waste management approach, research points to adverse health impacts on surrounding populations.[11] Where open dumping is illegal and infrastructural capacities are exceeded, illegal shipment of waste to developing countries in Asia occurs. When China instituted a plastic waste import ban in 2018, Thailand, Malaysia and Vietnam experienced a surge in recyclable plastics[12] from nations seeking to externalise their responsibilities for waste management, leading to illegal 'recycling' facilities involved in unlawful dumping and burying, as well as open-burning.[13]

Governments as well as businesses and other stakeholders in the region have begun enhancing their waste management approaches in response to the waste crisis. A complex web of interconnecting factors has, however, entrenched mindsets, behaviours and ways of conducting business which pose a barrier to change on a transformative scale. An everyday illustration of this phenomenon is the increased presence of disposable cutlery in Singapore's food establishments. This is driven in part by the convergences of a thriving convenience economy, and the labour intensity of traditional dishwashing options which had been undercut by recent

[9] According to a recent report, 'Plastic & Climate: The Hidden Costs of a Plastic Planet' (2019), the production and incineration of plastic in 2019 alone has added an estimate 850 million metric tonnes of greenhouse gases into the atmosphere. Accessed at: https://www.ciel.org/plasticandclimate/; With regard to food waste, the U.N. Food and Agriculture Organization estimates that 30 percent of food is wasted globally across the supply chain and this contributes 8% of total global greenhouse gas emissions. See http://www.fao.org/save-food/resources/keyfindings/en/

[10] The United Nations Economic and Social Commission for Asia and the Pacific (2015), *Valuing Waste, Transforming Cities,* Chapter 1. Available at: https://www.unescap.org/resources/valuing-waste-transforming-cities

[11] Vrijheid, M. (2000). Health effects of residence near hazardous waste landfill sites: a review of epidemiologic literature. *Environ Health Perspect.*, 2000 Mar (108), 101-112. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1637771/

[12] Eco-Business (2018), "Thailand to ban plastic waste imports by 2021". Available at: https://www.eco-business.com/news/thailand-to-ban-plastic-waste-imports-by-2021/

[13] MalayMail (2019), "139 illegal plastic recycling plants ordered shut, says minister". Available at: https://www.malaymail.com/news/malaysia/2019/02/25/139-illegal-plastic-recycling-plants-ordered-shut-says-minister/1726677

government quotas on foreign labour.[14] These factors reinforce each other in a way that has economically, socially and culturally entrenched single-use plastic waste into the current system.

Transformation of Asia Pacific's current waste management practices will need a paradigm shift in our systems of production and consumption. In recent years, the concept of the circular economy [15] has been defined as a model that aims to keep resources in use for as long as possible, helping societies become more resource-efficient.

What is the Circular Economy?

The Circular Economy is a regenerative economic system that aims to move society away from linear 'take-make-waste' models. In a circular economy, the value of products and materials is maintained for as long as possible, waste and resource use are minimised, and resources are kept within the economy when the product has reached the end of its life, to be used again and again to create further value.

Circular Economy Package: Q&A,
The European Commission

Public policy interventions are critical to introduce and embed circular economy concepts. Businesses, however are an equally central actor in defining the alternative pathways for production and consumption that will enable us to break away from linear models. We are now seeing clear signals that businesses will need to act accordingly. Those that do make efforts to pre-emptively transform themselves will be well-positioned to shape a new economy, and a different future.

[14] AsiaOne (2013), "Hawkers may soon outsource dishwashing". Available at: https://www.asiaone.com/singapore/hawkers-may-soon-outsource-dishwashing
[15] The European Commission (2015). *Circular Economy Package: Questions & Answers*. Available at: http://europa.eu/rapid/press-release_MEMO-15-6204_en.htm

2. Global trends are signalling a destabilisation of 'business-as-usual' models of linear consumption and production

Globally, our production systems have reached impressive levels of efficiency, but society is beginning to see that such a system which accepts waste and excess production as inevitable will require a fundamental reconceptualisation. A culmination of factors at the global level are pointing to a rapidly changing environment for business when it comes to their standard sources of value creation. Production, in particular, is gradually coming under attack. While landscape pressures – such as climate change, an increasing scarcity of resources and population increase – have been building steadily over decades and are known to businesses as indirect, growing threats, more immediate signals are now indicating that the model of linear consumption and production will likely be disrupted.

Businesses should consider the impact of the following interrelated societal trends:

Signals of a new operating environment

- A turn against single-use plastic
- A shift in consumption patterns away from ownership
- Increased attention from governments to inadequate recycling and take-back infrastructure
- Regulatory tools for waste reduction and recycling
- Disruption from new sharing, circular and digital business models

A turn against single-use plastic. Influenced by changing values and the visibility of successful alternatives to wasteful business and practices, global consumer sentiment against single-use plastic is altering consumer relationships with business. The easy replicability of the anti-plastics movements has been facilitating their spread across the Asia Pacific, and consumers are increasingly switching to more sustainable products and services.[16] In a recent survey conducted in Singapore, 80% of respondents expressed their readiness to move away from plastic straws and spend money on alternatives.[17]

[16] The Guardian (2018), "The plastic backlash: What's behind our sudden rage – and will it make a difference?". Available at: https://www.theguardian.com/environment/2018/nov/13/the-plastic-backlash-whats-behind-our-sudden-rage-and-will-it-make-a-difference

[17] Eco-Business (2018), "80% of Singapore consumers ready to ditch plastic straws". Available at: https://www.eco-business.com/news/80-of-singapore-consumers-ready-to-ditch-plastic-straws/

A shift in consumption patterns and ownership toward dematerialization.[18] The movement against single-use plastics has not just evolved against other categories of waste, but also against wastefulness in general.[19] In particular, younger generations prefer spending on experiences over material possessions, leading to the rise of an experience economy.[20] Savvy use of digital media is helping to entrench these new behaviours to the point of becoming new status indicators for cultural emulation. These trends are already prompting some changes in business strategies such as a shift away from product offerings to services.

Increased attention on recycling and take-back infrastructure at national and regional levels. Governments in a number of Asia-Pacific countries are identifying the surge in waste as a strategic national concern. Attention is being paid to how extant waste policies, practices and infrastructure are no longer fit-for-purpose: landfills are filling sooner than expected[21] and municipal solid waste agencies are compelled to rely much more heavily on recycling strategies instead.[22] For example, Indonesia introduced the 3R concept (reduce, reuse and recycle) through the country's first solid waste management law in 2008.[23] The Singapore government is also spearheading a more circular economy through its inaugural Zero Waste Masterplan, to be released in the second half of 2019. Given this shift in governmental agendas, attention has turned to businesses to play their part in reducing waste and introducing closed-loop recycling solutions.

Regulatory tools are being used to support governmental agendas of waste reduction and increased recycling. Governments in Asia Pacific are designing regulatory mechanisms to compel, incentivise and support businesses to participate effectively in achieving waste reduction and management goals. Such regulations have evolved from a focus on responsible, hazard-free recycling, to more sophisticated regulation designed to enable circular solutions.

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18 Dematerialisation refers to the process of lessening our economic reliance on physical resources. See The Guardian (2013), "Dematerialising the future: what role can technology and consumers play?". Available at: https://www.theguardian.com/sustainable-business/dematerialising-future-technology-consumers

19 Forbes (2018), "What a Waste: Online Retail's Big Packaging Problem". Available at: https://www.forbes.com/sites/jonbird1/2018/07/29/what-a-waste-online-retails-big-packaging-problem/

20 Forbes (2019), "NOwnership, No Problem: An Updated Look at Why Millennials Value Experiences Over Owning Things". Available at: https://www.forbes.com/sites/blakemorgan/2019/01/02/nownership-no-problem-an-updated-look-at-why-millennials-value-experiences-over-owning-things/#7971a465522f

21 Global Citizen (2018), "The US is Rapidly Running out of Landfill Space". Available at: https://www.globalcitizen.org/en/content/us-landfills-are-filling-up/

22 There have been innovations in recycling and recovery technology and infrastructure previously but up to now, few efforts have been made to mainstream these solutions, putting the region at risk of waste generation outpacing national management strategies.

23 The Jakarta Post (2015), "Indonesia in state of waste emergency". Available at: https://www.thejakartapost.com/news/2015/10/09/indonesia-state-waste-emergency.html

In China, the Circular Economy Promotion Law[24] encompasses a comprehensive set of policy measures aimed at different stages of resource lifecycles, extending beyond recycling policies to initiate change with resource-oriented, production-oriented and use-oriented policies.[25] Some governments have implemented mandatory waste audits that encourage businesses to fully understand the waste they are generating within their supply-chains. Extended Producer Responsibility (EPR) policy reinforces the responsibility of businesses to treat and dispose of post-consumer waste. India's E-waste Management Rules of 2016 incorporate such an EPR.[26] Single-use plastics bans have been gaining popularity globally and Malaysia will be the first country in Southeast Asia to ban single-use plastic (by 2030) as part of its zero-waste plan.[27]

Disruption to linear economic models by new sharing, circular and digital business models. These models inherently challenge the current system in which consumption is based on ownership, setting a foundation for circular solutions. The arrival of companies such as Grab and Airbnb has promoted the sharing of underutilised resources through rental and platform models. 'Uberisation' has been coined as a term, reflecting how quickly sharing models have leapfrogged across a variety of industries, threatening the long-term viability of companies which manufacture and retail tangible products. Rental business models are also growing. The global online clothing rental market for example, is expecting a compound annual growth rate of 10% to 2023.[28] Whilst the concept of circularity has been around for decades, its increasingly widespread adoption can be credited to disruptive digital technologies that allow societies to share goods to an extent never before possible.[29] As these models scale, incumbents are being forced to reconfigure their core business models and their supply chain relationships accordingly.

Considered together, these trends indicate that the operating environment for business is about to experience a profound shift with regard to waste management approaches. The task now for

[24] The Standing Committee of the National People's Congress, PRC (2008). *Circular Economy Promotion Law of the People's Republic of China* (Order No. 16 of the President of the People's Republic of China).

[25] Zhu, J., Fan, C., Shi, H., & Shi, L. (2019). Efforts for a circular economy in China: A comprehensive review of policies. *Journal of Industrial Ecology*, *23*(1), 110-118. Available at: https://onlinelibrary.wiley.com/doi/full/10.1111/jiec.12754

[26] Ministry of Environment, Forest and Climate Change (2016). *E-waste Management Rules.* Available at: http://cpcb.nic.in/displaypdf.php?id=UHJvamVjdHMvRS1XYXN0ZS9FLVdhc3RlTV9SdWxlc18yMDE2LnBkZg==

[27] Eco-Business (2018), "Malaysia to ban single-use plastic". Available at: https://www.eco-business.com/news/malaysia-to-ban-single-use-plastic/

[28] Reuters (2018), "The Global Online Clothing Rental Market is expected to showcase a Significant CAGR of 10% during the forecast period 2015 – 2023". Available at: https://www.reuters.com/brandfeatures/venture-capital/article?id=44966

[29] Eco-Business (2015), "The rise of the circular economy in Asia". Available at: https://www.eco-business.com/news/rise-circular-economy-asia/

businesses is to find new drivers of future value that will help them operate within planetary boundaries and 'future-proof' business value in the face of changing operating environments.

3. The role of business in delivering Singapore's vision for a Zero Waste Nation

Stakeholders in Singapore – government agencies, businesses, consumers and civil interest groups – have collectively experienced all the trends highlighted above. To chart the adoption of a circular economy approach to sustainable waste and resource management, Singapore's Ministry of the Environment and Water Resources (MEWR) will release its inaugural Zero Waste Masterplan in the second half of 2019.

MEWR's Zero Waste Masterplan: The 3R Approach and related policies

The 3R approach to waste management (Reduce, Reuse, Recycle) provides a framework that outlines the broad activities needed to transform the current waste management system into one that accounts for the entire life cycle of resources. It encourages business and consumer stakeholders to consider interventions that:

- extract maximum value from any single resource;
- recover and regenerate materials at the end-of-life stage; and
- close the loop of product life cycles through increased reuse and recycling.

Fig. 1: The 3R Approach to Waste Management

Source: NEA. "Toward a Zero Waste Nation", Presentation, *The Ecosperity Conversations* (2019)

In Singapore, three of the top five waste streams (food waste, paper and plastic) currently experience low recycling rates and contribute to approximately 67.4% of total waste disposal rates in 2017. E-waste also experiences low recycling rates and could cause environmental impacts and public health risk if not properly disposed of. The 3R approach is thus targeted at closing the loop for food waste, packaging waste and e-waste as key waste streams. Food waste has increased by 24,000 tonnes from 2015 to 2017,[30] and plastic waste per capita has increased by 20% in the last 15 years.[31] Singapore is also the second largest generator of e-waste in the region with 60,000 tonnes generated annually, some of which ends up with scrap traders who lack the skills to recycle them safely.[32]

Closing the loop on these waste streams requires a collective effort undertaken by consumers, industry and government. This will involve a complex interplay of consumer behaviour and business practice supported by necessary infrastructure at every stage of a resource's cycle.

[30] Business Insider Singapore (2019), "85% of Singapore residents eat out every week – and rice and noodles are the most commonly wasted food items while doing so, NEA says". Available at: https://www.businessinsider.sg/85-of-singapore-residents-eat-out-every-week-and-rice-and-noodles-are-the-most-commonly-wasted-food-items-while-doing-so-nea-says/

[31] The Business Times, Consumer (2018), "Plastics still pose a problem for Singapore". Available at: https://www.businesstimes.com.sg/consumer/plastics-still-pose-a-problem-for-singapore

[32] The Straits Times (2018), "Singapore's mountain of e-waste". Available at: https://www.straitstimes.com/singapore/environment/singapores-mountain-of-e-waste

i) Consumers and Households

With regard to consumers, the government plans to conduct public campaigns to educate and raise awareness. Based on a survey in 2018, just 7% of households were able to correctly distinguish all surveyed items in terms of their recyclability[33]. Consumer behaviour can also be key to prevention and reduction of food waste at source. Efforts include:

- Guidebooks and ambassadors to encourage behaviour such as ordering smaller portions when eating out to prevent food waste.[34]
- Promoting the donation of excess food and providing collection points for excess household food items in conjunction with logistical service providers.[35]
- The National Recycling Programme is planning to supplement increased access to blue recycling bins by introducing recycling chutes alongside general waste chutes in all new Housing Board developments.[36]

ii) Infrastructural pilots

The state has invested in a set of infrastructural pilots to accelerate the zero waste and circular aims. The pilots form elements of a waste management system that is able to reduce waste going to the landfill. They focus on processes and facilities that extract resource value from unavoidable municipal solid waste and sludge.

- **A Mechanical & Biological Treatment (MBT) facility**
  The MBT facility will recover recyclables through a mechanical sorting process from unsorted domestic and trade waste. Remaining waste is converted into Solid Recovered Fuel through a biological treatment process. The facility is expected to commence operations in 2020.
- **A Waste-to-Energy Research Facility**
  Using high-temperature slagging gasification technology, the facility aims to treat 11.5

[33] National Environment Agency. “Towards a Zero Waste Nation”. Presentation, *The Ecosperity Conversations*, 1 Apr 2019.
[34] Ibid
[35] Ibid
[36] Ibid

tonnes of municipal waste daily.[37] Downcycling incombustible waste into inert slag allows its potential re-use as secondary material for construction purposes, such as road sub-base.[38] Operations are expected to commence in late 2019.

- **Co-digestion of food waste and used-water sludge**

  Through co-digestion at the Ulu Pandan Water Reclamation Plant, food waste can be centrally processed together with used water sludge and synergies can be reaped for both food waste and water management.[39] By co-digesting used water sludge with food waste, more biogas can be produced compared to the separate digestion of the two inputs. The approach will be implemented in the future Tuas Nexus, an integrated development comprising a water reclamation plant and an integrated waste management facility.

- **Side-loader collection of recyclables**

  To improve the productivity of collection and recycling processes which are often still reliant on manual handling, a driver-operated mechanised collection arm has been implemented on trucks to collect recyclables from blue bins. Manpower to manipulate bins will thus no longer be needed. The technology was trialled in 2018 and will be implemented in new Public Waste Collector contracts.[40]

iii) Business and Industry

Large waste generators are expected to act by:

a) identifying opportunities to lower the amount of waste they dispose;
b) developing waste reduction plans, setting reduction targets and monitoring actual performance; and
c) publicising initiatives and achievements, and demonstrating leadership in waste efforts so that others can learn from them.

To this end, a combination of policy and regulatory measures are being adopted as part of the Zero Waste Masterplan to elicit specific business responses, as documented in Table 1 below.

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[37] National Environment Agency. "Towards a Zero Waste Nation". Presentation, *The Ecosperity Conversations*, 1 Apr 2019.
[38] Ibid
[39] Today (2017), "PUB's co-digestion plant now processing 3 tonnes of food waste daily". Available at: https://www.todayonline.com/singapore/pubs-co-digestion-plant-now-processing-3-tonnes-food-waste-daily
[40] National Environment Agency. "Towards a Zero Waste Nation". Presentation, *The Ecosperity Conversations*, 1 Apr 2019.

TABLE 1: Policy and regulatory measures introduced by the Singapore government as part of the Zero Waste Masterplan

Aims	Policy and regulatory mechanisms	Intended business response
To ensure businesses fully understand their waste streams and impact on national waste management, especially for packaging waste	**Mandatory Packaging Reporting** of packaging data and plans to reduce waste will be introduced in 2020, applicable to companies with an annual turnover of more than $10 million (i.e. 10% of all companies in Singapore).	Through accurate data, businesses would identify their waste footprint and diagnose where to concentrate their innovation and change efforts to enhance their waste reduction plans. To obtain more value out of the reporting process and to better position themselves for upcoming legislation, businesses should consider extending data collection and analysis to waste streams other than packaging.
	Mandatory Waste Reporting will be extended from large commercial premises such as malls and hotels to include large factories, warehouses and convention centres above a certain gross floor area from 2020.	
To ensure businesses recognise their responsibility over waste streams across the entire life cycle of their products, and activate their value chains in response	**An e-waste management system based on the Extended Producer Responsibility (EPR) framework** will be implemented in 2021. Producers of covered electrical and electronic equipment will be responsible for collecting and treating their e-waste. • Retailers will need to provide free 1-for-1 take-back upon delivery of a product. • Retail stores with (Electrical and Electronic Equipment) EEE sales above 300m^2 will also be required to have in-store e-waste collection points for small consumer e-waste. • All producers of non-consumer EEE will need to provide free take-back services of their end-of-life products to their clients upon request.	Businesses would look within supply/value chains for collaboration opportunities: • The EPR would encourage producers to assess their downstream value chain relationships for opportunities to partner recycling and logistics service providers for safe take-back. • Consumer EEE retailers and large food waste generators would be encouraged to assess their upstream value chain relationships for opportunities to partner producers that on circular solutions.
	The **EPR for packaging waste** including plastic is currently being explored, to come into effect in 2025, with similar aims as above.	
	Mandatory segregation of food waste for treatment will be implemented from 2021. Developers of new premises where large amounts of food waste will be generated must allocate space for on-site food waste treatment in their building plans.	

Aims	Policy and regulatory mechanisms	Intended business response
To scale innovations that are already in place and ensure businesses kickstart necessary conversations on funding and investment	**Large consumer EEE producers will be required to collectively fund an appointed Producer Responsibility Organisation (PRO**), to meet set obligations for the collection and proper treatment of e-waste.	Large consumer EEE producers could work with the appointed PRO to gain access to a steady stream of feedstock for closed loop or downcycling models. Businesses would plan for and mobilise funding and investment (internal or external) to either explore potential opportunities or execute pilots. Businesses would also partner financial institutions to identify and solidify value propositions.
	Grants made available to public and corporates for ideas on better recycling. These include the 3R Fund, Towards Zero Waste Grant, Call for Ideas Fund and Partnership Fund.	

Governing agencies in Singapore have developed comprehensive capacities for integrated waste management, but "doing better" would require looking upstream to minimise resources used and wasted, and increasing recycling practices at the level of the individual citizen.[41] Mindset shift is crucial to this transformation and demands exposure to potential value-creating scenarios relating to the use of waste. Businesses are well-placed to facilitate that change within themselves and their value networks, as they can influence many important societal relationships.

[41] National Environment Agency. "Towards a Zero Waste Nation". Presentation, *The Ecosperity Conversations*, 1 Apr 2019.

4. Business responses to the challenge of waste: roles, actions taken, challenges and enablers

The Masterplan has indicated that business will be important drivers in the national response to waste. To understand how they best respond, it is useful to consider: what role they can play to enable a zero waste, circular ecosystem; what they have been doing so far to reduce waste; what common challenges 'first-movers' have experienced; and to date, what has enabled businesses to ensure that their efforts will galvanise entire societies in transitioning towards a circular economy.[42]

A. The role of business in addressing the waste challenge

There are four main ways in which businesses can contribute to – and accelerate the formation of – a zero waste ecosystem in Singapore and Asia Pacific:

i) By spearheading innovative technologies and practices

Businesses should focus their innovation efforts on reducing waste at source, improving waste segregation, and maximising energy recovery from waste.

It is not only established businesses or disruptive start-ups that can drive these innovations. Smaller businesses can also adopt waste management innovations by forming strategic relationships with bigger players in their supply chains, or partnering with other small businesses to pool resources and capabilities.

ii) By influencing consumer recycling and waste reduction behaviour

B2C companies, with their direct relationships to consumers, are well-positioned to shape consumption and recycling behaviour through the design of products and services. Designs that integrate take-back services for example, can influence consumer behaviour to meet circular

[42] Forum for the Future has partnered ambitious businesses in Asia Pacific in their conception and implementation of circular business solutions. The following analysis is a product of this engagement as well as an understanding of how global businesses have responded to sustainability-related challenges.

goals. Where a business activates its storytelling capabilities towards this end, it can further drive home messaging and precipitate changes in cultural understanding.

iii) By strengthening the infrastructure development of municipal waste management

Having directly experienced the current limitations of recycling and waste infrastructure ecosystems, businesses are well placed to inform improvements to this system. This can be done through policy dialogue or by prototyping new practices that are connected to local waste management infrastructure. In this way, businesses can serve to catalyse the closed-loop infrastructure that will enable circular businesses. Waste management service providers, industrial engineering businesses and third-party logistics service providers (3PL) can demonstrate thought leadership on gaps in waste management infrastructure. They may also apply newer technologies in the form of Artificial Intelligence (AI), drones and machine learning to waste and landfill management for greater efficiencies.[43]

iv) By investing and unlocking financial flows

Many closed loop and recycling technologies are in early commercial proof-of-concept stages and require investment to refine their models. Large businesses or alliances of smaller businesses are best positioned to fulfil that investment gap and explore localised or regionalised solutions for these technologies. An example of this is Circulate Capital, an initiative that convenes these actors to direct institutional investment toward scaling integrated waste management and recycling companies in Southeast Asia.[44] Financial institutions can lay down the structures necessary for business model shifts, guiding future asset allocation and investment decisions on an industry level.

[43] McKinsey & Co, Sustainability Blog (2019), "How AI can unlock a $127B opportunity by reducing food waste". Available at: https://www.mckinsey.com/business-functions/sustainability/our-insights/sustainability-blog/how-ai-can-unlock-a-127b-opportunity-by-reducing-food-waste

[44] AsiaOne (2018), "Circulate Capital Announces US$90 Million in Expected Funding to Combat Ocean Plastic". Available at: https://www.asiaone.com/business/circulate-capital-announces-us90-million-in-expected-funding-to-combat-ocean-plastic

B. Business activities to address the waste challenge

Businesses in the region have started to engage with circularity in various forms. Their forays into this area have mainly been through experimenting with waste minimisation at the design stage and improving resource recovery. A few have begun scaling circular approaches into full business models. The following examples illustrate some common approaches being taken:

i) Experimenting with waste minimisation at the design stage

Designing out waste. Waste minimisation in the supply chain tends to be limited to the stage of manufacturing, where process innovation and *kaizen*[45] activities are employed to ensure efficient production. Circular approaches encourage a full appraisal of a product's entire lifespan, ensuring from the outset that less material will be needed throughout a production chain, or that the materials used can be recycled or reused. For example, Nestle Singapore has found that simple design changes to their Milo drink powder packages, where the height of the packaging was shortened, managed to avert the annual use of approximately 30 tonnes of plastic laminate.[46]

Designing against obsolescence. When considering a product's entire lifecycle at the design phase, circular design has spotlighted opportunities to capture market segments by designing for longevity of use. Products can attain maximum utility when durable materials are chosen or when circular design aspects such as modularity are incorporated. IKEA for example, has been especially catering to the realities of smaller housing options in Hong Kong and Singapore by offering modular sofas which can be customised to different home sizes and quickly packed and dispatched by suppliers.[47] To reduce the volume of untouched food that is discarded at the end of each flight due to food safety risks, Singapore inflight caterer SATS has innovated to preserve the shelf life of ready-to-serve meals through technological processes such as pasteurisation and

[45] A methodology for continuous improvement that is often applied to manufacturing. Its aims are to increase productivity by reducing waste and eliminating unnecessary human activity within the production process. (Source: *Lean Production, accessed 2019*)

[46] Eco-Business (2019), "Ready to report: How Singapore firms are preparing for new packaging mandate". Available at: https://www.eco-business.com/news/ready-to-report-how-singapore-firms-are-preparing-for-new-packaging-mandate/

[47] Gaia Discovery (2017), "Singapore – Far from a Circular Economy?". Available at: https://www.gaiadiscovery.com/planet/singapore-circular-economy

sterilisation.[48] Meals can be stored without refrigeration for up to 24 months when they are not consumed on flights to avoid pre-consumer food waste.

ii) Improving resource recovery

Improving the ability to collect and segregate waste. In many Asian Pacific countries, reverse logistics are not at sufficient scale to provide a seamless supply of recycled raw material. Businesses have sought to better collect and segregate waste by adapting existing technologies. Lab-tested technological innovation for identifying and segregating organic waste at scale has been boosted by integrated machine learning functions that are able to automate the segregation process, moving us away from manpower-intensive models. Other businesses are establishing new relationships with innovative logistics service providers to fill market gaps. For example, RESQ in Singapore provides an app-based subscription service connecting Small and Medium Enterprises (SMEs) with certified e-waste recyclers. It allows recyclers to aggregate e-waste collections from a wide pool of SMEs, making recycling more accessible through logistics and business model development.[49] This innovation corrects the market gap by responding to the fact that even though SMEs collectively generate a lot of e-waste, there is often not enough volume produced by one company to justify corporate deals with recyclers.

***Improving the capacity of recycling technologies to maximise material recovery*.** Large Asia Pacific manufacturers are being requested by their brands and retailers to play a role in the transition to a circular economy. To close the loop, some are building partnerships with technical institutions and waste management service providers to experiment with potential solutions at scale. WRAP, a UK based charity that works with businesses and communities to accelerate the move to a resource-efficient economy, has been instrumental in conducting research about the main barriers of plastics recycling, such as removing dyes from plastic waste to be able to return them to almost-virgin plastic material.[50] In the apparel industry, The Hong Kong Research Institute

[48] The Straits Times (2019), "Longer shelf life for in-flight meals: SATS' ready-to-eat meals that cab be kept up to 24 months". Available at: https://www.straitstimes.com/singapore/transport/ready-to-eat-meals-that-can-be-kept-for-6-to-24-months-part-of-25m-investment-by

[49] Eco-Business (2019), "Could this app ease Singapore's e-waste problem?". Available at: https://www.eco-business.com/news/could-this-app-ease-singapores-e-waste-problem/

[50] WRAP (2010). *Improving the recyclability of mixed plastics: Removable colour systems* (Project code: MDP024-005). Available at: http://www.wrap.org.uk/sites/files/wrap/Removable%20colour%20systems%20final%20report.pdf

of Textiles and Apparel has pioneered a hydrothermal method for recycling cotton and polyester textile blends, enabling waste textile that was once un-recyclable to be turned into new fibre.[51]

iii) Scaling circular approaches into business models

Some businesses in the region have taken bold steps to ensure that the circular paradigm is integrated into their core business. They have gone beyond merely incorporating circular approaches in their processes, to deriving full business value from circular models.

In Asia, the Product-as-a-Service (PaaS) model has been one of the more prominent business models taken up by both B2B and B2C businesses, as the suppliers, service providers and customers of value networks have developed supporting capabilities such as on-demand logistics/delivery. High smartphone penetration rates in the region[52] simplify and facilitate the complex logistics of circulating and tracking products between consumers and a network of service providers to be simplified and facilitated through an app. Most businesses with circular ambitions recognise that fully embracing new circular business models will require an initial period of renegotiating existing commercial relationships, or seeking new relationships and partnerships. They have begun investing in building these supporting eco-systems ahead of channeling resources to pilot full business models.

Singapore-based pioneers of Product-as-a-Service models include Revolv, which has met the challenge of increased uptake of single-use plastics and disposables perpetuated by the food delivery industry. It has built a digital platform that enables consumers to rent instead of purchase containers for their food takeaways.[53] Launched in Hong Kong, Bali and Singapore, metal and rice husk containers are outfitted with tracking technology and consumers have designated centralised drop-off points to return containers for cleaning and recirculation. Its subscription fee-based leasing provides restaurants and hawkers comfortable and cost-friendly alternatives to disposables that will enable them to continue partaking in the convenience economy without generating a major waste footprint.

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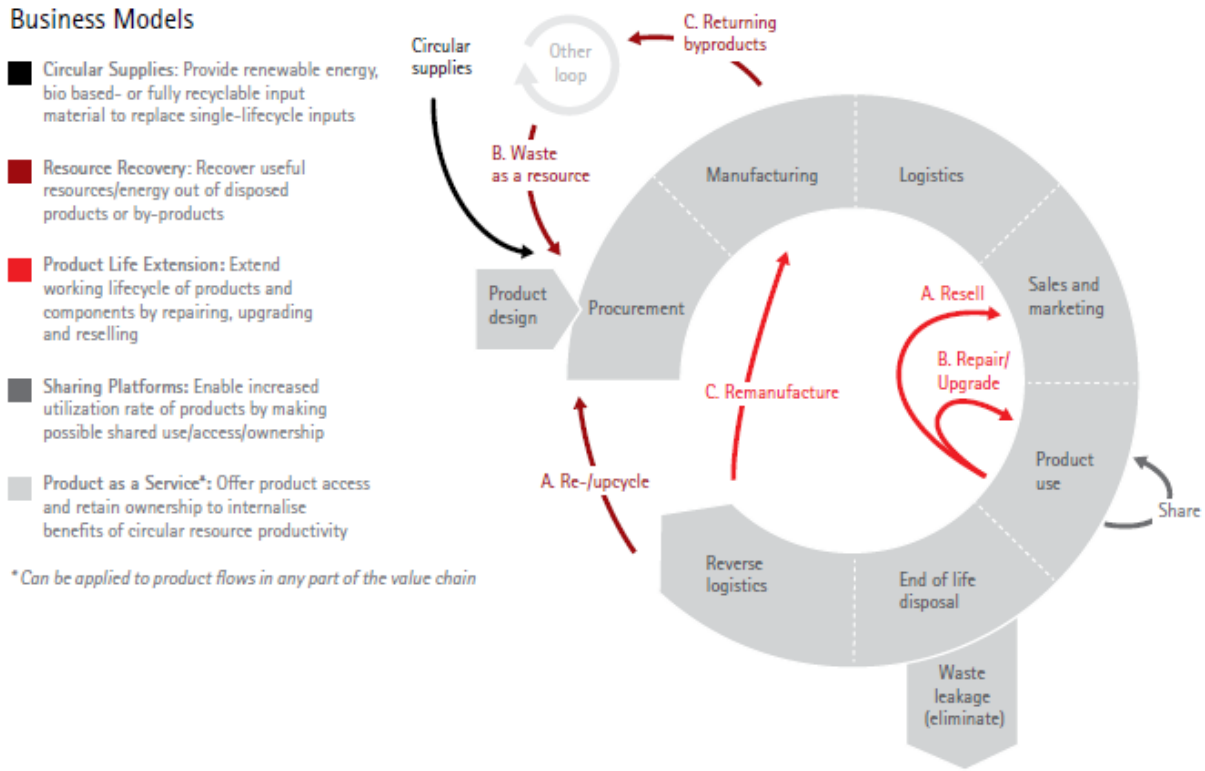
[51] Fashion United (2018), "H&M Foundation and HKRITA to open textile recycling facilities in Hong Kong". Available at: https://fashionunited.uk/news/business/h-m-foundation-and-hkrita-to-open-textile-recycling-facilities-in-hong-kong/2018090538672

[52] Zenith Media (2017), "Smartphone penetration to reach 66% in 2018". Available at: https://www.zenithmedia.com/smartphone-penetration-reach-66-2018/

[53] Eco-Business (2019), "Singapore, this new service gets rid of single-use plastic from takeaways". Available at: https://www.eco-business.com/news/singapore-this-new-service-gets-rid-of-single-use-plastic-from-takeaways/

In a 2015 study by Accenture of over 120 case studies of companies that were able to generate resource productivity improvements through innovations on circularity, five underlying business models were observed being adopted in Europe and North America. These are captured in *Figure 2*. In Asia Pacific, businesses are starting to track towards these models, but the unique realities of doing business in the region mean that different businesses have had varying entry points to the circular economy. Firstly, many businesses here are still demonstrating a lower risk appetite to embrace a full business model shift, particularly given that they are operating in an environment where circular models have yet to be mainstreamed. A cautious approach to experimentation is also the result of currently weak market signals. Secondly, businesses in the region are often upstream or mid-supply chain players for whom these circular models may not yet have resonance since they speak more to brands and downstream entities. It is thus emerging that Asian businesses are adapting within their contexts to find routes to scale.

Fig. 2: The five circular business models



Source: Accenture Strategy, *Circular Advantage: Innovative Business Models and Technologies to Create Value in a World without Limits to Growth,* (2015)[54]

[54] Accessed at: https://www.accenture.com/t20150523T053139__w__/us-en/_acnmedia/Accenture/Conversion-Assets/DotCom/Documents/Global/PDF/Strategy_6/Accenture-Circular-Advantage-Innovative-Business-Models-Technologies-Value-Growth.pdf

C. Challenges to implementing zero waste/circular initiatives

The activities described in the previous section have been taken by first-movers in Asia Pacific who have contributed to building functional markets in the region in order to achieve a circular economy. Apart from the internal organisational changes that these pioneers have experienced, many have also faced regulatory, market, and finance challenges in their initial efforts.

i) Regulatory challenges

Businesses have been exploring the opportunity to create regional closed loop infrastructure by sending waste material back to their suppliers and manufacturers to integrate into new production. However, they have come up against current regulatory regimes that tend to classify 'take back' materials as waste. Moreover, it is common practice that foreign materials categorised as waste by domestic health and biosecurity authorities face the prospects of mandatory incineration or landfilling, preventing practical reuse and down-cycling even if materials are viable and non-hazardous. Airlines have encountered these regulatory barriers in certain regions (such as Australia and New Zealand) when identifying opportunities to achieve zero cabin waste through the recycling of sealed, unopened dry goods. Regulations related to the movement of waste have been instituted based on assumptions of linear systems of production and consumption. The Basel Convention for example, limits transboundary movement of hazardous waste from developed to developing countries to prevent dumping practices,[55] and was amended in May 2019 to include plastic waste.[56] While such regulation still plays an important role, there is a need for regulators to find ways to ensure that it is adjusted in ways that retain their core intentions while supporting circular transitions.

ii) Market challenges

Negative public perception of secondary or used materials has posed a barrier to acceptance of rental and sharing concepts, especially when Asian consumers have grown accustomed to easy

[55] Basel Convention (accessed Apr 2019), *Convention Overview*. Available at: http://www.basel.int/TheConvention/Overview/tabid/1271/Default.aspx

[56] Synergies among the Basel, Rotterdam and Stockholm conventions (2019), "Governments agree landmark decisions to protect people and planet from hazardous chemicals and waste, including plastic waste". Available at: http://www.brsmeas.org/?tabid=8005

access of brand new consumer goods through digital channels.[57] While there is growing acceptance of the sharing of goods, brands and retailers have yet to surface these desires in meaningful ways with their marketing strategies. Deep cultural aversion to goods or materials that have previously been used by others still exist[58] and present as one of the more profound market challenges in the region to the wider uptake of circular goods.

iii) Financial challenges

The transition to a circular economy involves considerable costs linked to the need for industrial renewal, asset investments, R&D, subsiding new business models and technology uptake. In general the Asia Pacific region is still lagging on sustainable investing.[59] As some businesses experiment with product-service offerings, a common challenge expressed is the difficulty in obtaining capital to fund their transitions from banks and shareholders in Asia that are yet to align circular business model lending with their ESG investment strategies. In Product-as-a-Service models, contracts with customers and their creditworthiness take on more importance as part of doing business, but for banks and those who have approached them to finance this transition, established procedures for assessing creditworthiness is not proportionate to the small size of the loans. It is crucial then, for banks and financial institutions to engage with SMEs and transitioning corporates at early stages of circular business model innovation to bridge the knowledge gap on risks that are unique to these models.

Markets may take shape and develop functionality on their own in the transition to a circular economy, but the risks of not leading on their development are the high opportunity costs, and costs of a slow transition. It is imperative then, that businesses search and develop the most efficient and impactful approaches to this.

[57] The Business Times (2016), "The Future of Commerce has Arrived: Understanding the New Asian Consumer". Available at: https://www.businesstimes.com.sg/hub/accenture/the-future-of-commerce-has-arrived-understanding-the-new-asian-consumer

[58] Forbes (2016), "As Sharing Economy Starts to Trump Superstition, Asian Startups Make Their Move". Available at: https://www.forbes.com/sites/ralphjennings/2016/05/26/revulsion-to-used-goods-tests-sharing-economy-apps-in-asia/#29876bb455d9

[59] Eco-Business (2019), "Asia lags West on sustainable investing – but is the most bullish about the future". Available at: https://www.eco-business.com/news/asia-lags-west-on-sustainable-investing-but-is-the-most-bullish-about-the-future/

D. System-change approaches to transitioning from a linear to a circular economy

A system-change approach to tackling complex sustainability challenges aims to deliver transformational – rather than incremental – changes that help us to effectively break away from status quo. It encourages us to recognise the web of interrelations that create complex problems and to account for the fact that any interventions by actors to solve these problems rarely occur in isolation. We therefore need to pay attention to any individual actor's role and position within the system and identify how their practices and behaviours *affect* the whole system and therefore their potential to *effect* change in the whole system. Importantly, a system-change approach foregrounds the need to collaborate across different sector, cultural and personal perspectives so that the relevant actors can collectively understand the problem and seek solutions.[60]

To accelerate the impact of investment, business model and business practice transitions, businesses may apply these systems approaches:

i) *Setting action roadmaps to determine a business' position of influence and agency in the system*

When used well, business roadmaps can serve to identify and set ambitions for action based on an actor's position in within their system. Efforts to create them can be undertaken individually or as part of a consortium of businesses. When systemic tools and approaches are applied, they can be used to enhance the impact of waste reduction plans by helping the business better understand which actors and processes they are interconnected with. This gives the opportunity to identify precise opportunity areas for action commensurate with a business' specific agency and set targets accordingly. For example, the targets could reflect certain power dynamics within their own value or supply chains that contribute to excess waste production. In the context of food waste, a large proportion of this can occur in the supply chain because producers over-produce to counter retailers' demands for a particular quality and cosmetic standard.

When deciding what data to collect and analyse, it is important to ensure alignment with the goals and targets set by the business. Information flows enable businesses to identify what their

[60] Forum for the Future (2016), Systems thinking: Unlocking the Sustainable Development Goals [Blog post]. Available at: https://www.forumforthefuture.org/blog/systems-thinking-unlocking-the-sustainable-development-goals

footprint is and where they can intervene to create positive feedback loops and minimise negative ones.

Some companies choose to turn their goals into public commitments as a means of being held accountable by other actors in the system. Sealed Air, a packaging company, has committed to a plastics reduction pledge, designing their packaging to be 100% recyclable or reusable by 2025. It has described a three-pronged strategy to achieving this target that gives an indication of its core capabilities: accelerating uptake of recycled materials, expanding reuse models for packaging and taking on leadership with global value chain partners to ensure execution.[61]

ii) ***Empowering the supply chain to support circular goals***

Supply chain management and supply chain relations are regarded, from a systemic perspective, as instrumental in implementing circular economy principles related to waste minimisation and closed loop production. Supply chain management can help control material flows and interface between upstream and downstream players; they are critical to getting more actors on board to support transitions.

Within supply chains, brands and retailers which are transitioning towards circularity have yet to make substantive efforts to change their supplier relationships, adversely affecting the ability to transition successfully. Suppliers who are under pressure to prioritise manufacturing costs find it difficult to invest in building circular systems within their own businesses in situations where their customers do not recognise waste management as a shared responsibility.

Looking across the supply chain can present wider, more systemic opportunities to retailers who are seeking to drive innovation in circularity. Telecommunications company KPN recognised that to enable circular and zero waste operations and supply chains by their stipulated target of 2025, it was imperative that most of its supply chain could effectively collaborate. In 2017, it introduced a Circular Manifesto to accelerate circular innovation, asking its major suppliers such as Huawei

[61] Supply Chain Asia (2018), “Sealed Air announces 2025 sustainability and plastics pledge”. Available at: http://supplychainasia.org/sealed-air-announces-2025-sustainability-plastics-pledge/

and ZTE to work together with them on projects to design longer lasting hardware that could be easily disassembled into their constituent parts.[62]

iii) *Building focused collaborative efforts across value chains and industries to deliver system-wide interventions*

Transitioning to a circular economy is a systemic undertaking which cannot do without the transformation of whole sectors and their value chains. It also requires building new forms of commercial relationships between previously unconnected industries, as waste from one becomes feedstock for another. Businesses need to begin connecting in different ways to activate joint resources. Collaborative efforts that lead to joint action are crucial to this level of ambition as they have the potential to include diverse perspective and ensure multiple stakeholders working in alignment. Sectors engaging in circular economy transformation often see open innovation models of collaboration emerge due to the need to challenge existing assumptions and act on opportunity in new ways.

The Circular Leap Asia programme is an example of a collaboration to create pioneering innovations and practices in manufacturing and has begun with the textile material streams, bringing together established players with emerging enterprises and outsider ideas to stimulate innovative responses that manufacturers and partnering brands can then pilot.[63]

iv) *Focusing on financial innovation to unlock business action*

If one of the ambitions of a circular economy is to mainstream circular business models, businesses must be assured that capital can be made available for new experimentation and new ventures. Financial innovation, as a lever for change, can be best utilised when created and dispatched in collaboration, and used to target critical need within the system. When it was identified that there was a need to harness major investment into infrastructure and related innovation to allow whole industries to advance their zero waste and circular ambitions, businesses have turned to pre-competitive collaboration to summon capital and collectively

[62] Platform for Accelerating the Circular Economy (2019), *Circular Value Creation: Lessons from the Capital Equipment Coalition*. Available at: https://www.circle-economy.com/wp-content/uploads/2019/01/Circular_value_creation_2019_v7_WEB.pdf
[63] Forum for the Future (2018), Circular Leap Asia. Available at: https://www.forumforthefuture.org/circular-leap-asia

manage it. P&G, PepsiCo, Unilever and several of the world's leading consumer packaged goods and chemical companies have pledged USD90 million to working with the non-profit Ocean Conservancy and investment management firm Circulate Capital to address critical waste and recycling infrastructure development that governments are not seen to be effecting quickly enough.[64]

5. Conclusion

Excess waste is a defining issue of our era. We live in a world where more than 90% of the raw materials used go to waste rather than being valued and cycled back into our economy, with significant consequences for the health of both people and planet.[65] The urgency to move concertedly away from a linear 'take-make-waste' economy towards a circular one grows daily. That this imperative is increasingly being recognised by governments and citizens alike is a signal to businesses that a radical transformation of their business models will be a necessity in the not-too-distant future.

For businesses in Asia Pacific, the market for circular solutions may still be nascent. Yet, those that approach circularity and its concepts as a tool for business renewal will ready themselves for a future marketplace where a confluence of public policy interventions and consumer demand will have mainstreamed such practices. New commercial relationships and new ways of engaging with consumers are already on the horizon; it is up to businesses as agents of change to consider what it would take to enable this transformation, and ultimately, to act on it. By taking a systemic approach towards introducing circular business models, businesses have the opportunity to rapidly remove systemic barriers to progress and accelerating the uptake of new models. In doing so, it can play a critical role in the development of a circular economy which will help the region avert an impending crisis and set it on a steady path towards achieving a sustainable future.

[64] AsiaOne (2018), "Circulate Capital Announces US$90 Million in Expected Funding to Combat Ocean Plastic". Available at: https://www.asiaone.com/business/circulate-capital-announces-us90-million-in-expected-funding-to-combat-ocean-plastic

[65] Circle Economy (2018). *The Circularity Gap Report: An analysis of the circular state of the global economy*. Available at: https://docs.wixstatic.com/ugd/ad6e59_733a71635ad946bc9902dbdc52217018.pdf