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Consumer Plastic and Plastic Resource Ecosystem in Singapore

A Position Paper by the Singapore Environment Council

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- Consumers Association of Singapore (CASE)
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- NTUC Income
- Singapore Manufacturing Federation
- Singapore Packaging Agreement
- South West Community Development Council (SWCDC)
- Tzu Chi Singapore

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FOREWORD

Dear Friends, Sponsors and Partners,

On behalf of the Singapore Environment Council (SEC), I would like to express my sincere gratitude for your continued support provided throughout the course of producing the SEC position paper on 'Consumer Plastic & Plastic Resource Ecosystem in Singapore'.

I like to specially thank Deloitte & Touche Enterprise Risk Services Pte Ltd for their unwavering commitment in the past six months. I would also like to acknowledge all respondents and our partners, Coca-Cola Singapore, NTUC Income, Singapore Manufacturing Federation, CASE, Mahota Singapore, Singapore Packaging Agreement, NWCDC, SWCDC, CSCDC, and Tzu Chi Singapore, who have participated in the study. We greatly value the contributions of our partners in our efforts to help shape the future of plastics in Singapore.

I would also like to express our sincere gratitude to the Ministry of the Environment and Water Resources and National Environment Agency for their invaluable contributions to the report.

Our plastic ecosystem is mostly linear, which means that plastic goes from producers to consumers, to the waste bin. This places a strain on our waste management systems as well as uses up an enormous amount of natural resources.

Plastics are not going away. They are an essential part of modern living and contribute many good things, such as ensuring food hygiene, efficient packaging and proper storage. Singapore's increasing consumption of plastics is widely discussed in the media, especially our use of plastic bags, disposable plastic items and PET bottles.

Our study focuses on three segments of the plastic ecosystem, upstream producers' responsibilities including packaging, consumer lifestyles including recycling behaviour, and downstream processes including waste management. The study also reveals the extent of consumer plastic use as well as the way plastic bags, plastic disposables and PET bottles are reused, recycled or discarded.

The study found that people in Singapore use about 1.76 billion plastic items each year. This figure includes 820 million plastic bags from supermarkets, 467 million PET bottles, and 473 million plastic disposable items like takeaway containers. One factor which exacerbates the issue is our low recycling rate, at 6 per cent in 2017.

According to the research, the reason for the low recycling rate includes a lack of public awareness of what can be recycled, as well as the entire landscape of recycling in Singapore. As a result, the majority of plastic products are disposed of as general waste rather than recycled through a circular value chain.

I encourage you to read the report and welcome any feedback you have. I am sure that together we can establish a new direction in the way Singapore uses and manage its plastic waste.

Taking the study results forward, SEC plans to roll out a two-phased strategy. In its first phase, SEC's campaign calls on every individual in Singapore to reduce plastic waste by using one less plastic item per day. Additionally, we will focus on recycling through educating consumers on why, what and how to recycle plastics. In the second phase, SEC will facilitate industry stakeholder engagement among the 3P sectors to create a closed-loop ecosystem for plastic recycling that will give purpose to plastic afterlife for a circular economy.

We look forward to working with businesses, schools, communities and government agencies to drive towards a zero-waste nation. The work of SEC is an ongoing one and we are grateful for the contributions of our partners, with whom we are working together to foster lasting environmental values among people in Singapore.

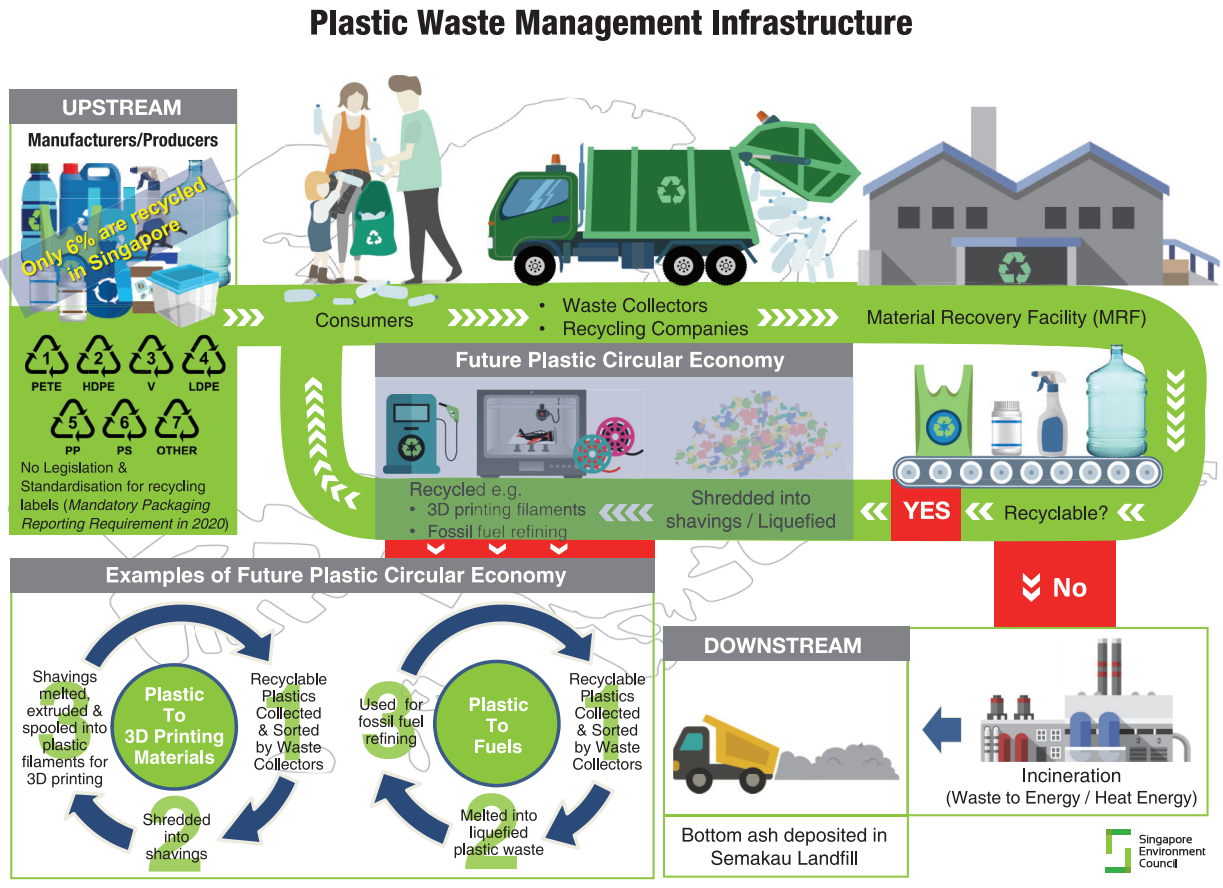
Every little change can make a big impact.

Jen Teo
Executive Director
Singapore Environment Council

EXECUTIVE SUMMARY

Singapore's increasing consumption of plastics has gained vast media attention, especially concerning plastic bags, disposables, and polyethylene terephthalate (PET) bottle use. This has been supplemented by added concern on the low recycling rates in Singapore.

A recent study conducted by SEC looked at the plastic ecosystem and plastic lifecycle in Singapore. Based on the study, the estimated number of plastic bags taken from supermarkets per year alone is 820 million. The study suggested that 2 to 4 plastic bags are taken from supermarkets per person per trip in Singapore.



Source: https://www.freepik.com/ & https://www.vecteezy.com/

Figure 1: Plastic Resource Ecosystem in Singapore

The study was the first to determine the plastic disposables and PET bottle usage in Singapore. Based on the study, the estimated number of polypropylene (PP) items (plastic disposables) used per year is at least 473 million and the estimated number of PET bottles used per year is at least 467 million. This suggests that a person in Singapore uses at least 1 to 3 PP items per week and at least 1 to 3 PET bottles per week.

The study was supported by a literature review of past studies relating to plastic use, after-use and disposal in Singapore and other countries; quantitative research through online surveys; and qualitative research through deep-dive interviews with selected stakeholders. Data on consumer consumption patterns, plastic use behaviour, and disposal was collected using an online survey of 1,003 respondents based in Singapore.

Key findings of the study showed the diverging views of introducing a financial penalty for the use of plastic bags. The results revealed that 25.92% ranked the introduction of financial penalties on plastic bags as their preferred recommendation. However, a higher proportion (28.32%) of respondents ranked the introduction of financial penalties on plastic bags as their least preferred option. Other key findings of the study showed that Singapore's low recycling rates could be attributed, in part, to low awareness of the type of plastics that can be recycled. The study suggested that close to 70% of the survey respondents are not fully aware on what can be recycled in Singapore, and 45% of the survey respondents find it most useful to obtain information regarding the types of plastics that can be recycled in Singapore. The study found that recycling rates might be enhanced by strengthening downstream recycling efforts and supporting markets within Singapore that demand recycled plastic.

The study also reiterated the results of SEC's 2013 Plastic Bag study, when evaluating the after-use patterns of plastic bags. A high percentage of respondents (67%) indicated that bagging and disposing of general waste in a plastic bag is the most likely after-use pattern.

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[1] Estimated figure based on survey findings and this is linearly scaled using Singapore's population aged 20 and above (mid-year estimate 2017 which is obtained from Department of Statistics Singapore), which is the closest available demographic profiles of the survey respondents

[2] Estimated figure based on survey findings and this is linearly scaled using Singapore's population aged 20 and above (mid-year estimate 2017 which is obtained from Department of Statistics Singapore), which is the closest available demographic profiles of the survey respondents

[3] Estimated figure based on survey findings and this is linearly scaled using Singapore's population aged 20 and above (mid-year estimate 2017 which is obtained from Department of Statistics Singapore), which is the closest available demographic profiles of the survey respondents

A NATION OF PLASTIC

SINGAPORE'S PLASTIC CONSUMPTION

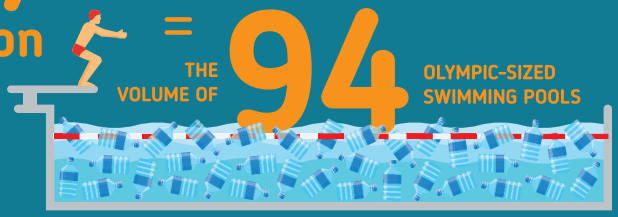
Singapore Environment Council

PET PLASTICS

LINED END TO END, PET BOTTLES COLLECTED IN A DAY FROM SINGAPORE WOULD STRETCH FOR 300KM, OR

THE LENGTH OF SINGAPORE

467 million PET BOTTLES ARE USED IN SINGAPORE EACH YEAR



= THE VOLUME OF **94** OLYMPIC-SIZED SWIMMING POOLS

1-3 PET BOTTLES USED PER PERSON / WEEK

PLASTIC BAGS

2-4 PLASTIC BAGS TAKEN FROM SUPERMARKETS PER PERSON / TRIP

820 million SUPERMARKET PLASTIC BAGS ARE USED IN SINGAPORE EACH YEAR =

473 million PP PLASTICS ARE USED IN SINGAPORE EACH YEAR =

THE LAND MASS OF SENTOSA ISLANDS

POLYPROPYLENE (PP) PLASTICS

1-3 PP PLASTIC DISPOSABLES USED PER PERSON / WEEK

DON'T WASTE REDUCE LAH

IN SUNNY SINGAPORE, ONLY 6% OF PLASTIC WASTE GETS RECYCLED. IT'S TIME WE RETHINK OUR RELATIONSHIP WITH PLASTIC BY REDUCING, REUSING, AND RECYCLING IT.

Based on the literature review on best practices globally alongside feedback provided by diverse group of stakeholders through surveys and interviews, the study provides the following recommendations to help improve Singapore's plastic ecosystem:

1. **Raising awareness through effective campaigns that focus on recyclables and eliminating single-use plastics**
   Campaigns can focus on types of recyclable plastics, method of recycling and preparation steps required for recyclables being recycled. Similarly, campaigns on awareness on types of single-use plastics and its non-recyclability can be implemented nation-wide.

2. **Standardisation of Recycling Bins in Singapore**
   It is suggested to have necessary augmentations to the bin design, colour and location, which trigger intuitive recycling behaviour, especially for commercial areas.

3. **Downstream Recycling Efforts in Singapore**
   Downstream recycling efforts can supplement upstream recycling efforts to make the recycling system in Singapore more robust. Recyclable material sorting can be practiced at the waste-to-energy facilities downstream to divert general waste and recyclable materials and achieve 100% recycling in Singapore. This would require upgrading the current waste-to-energy plants in Singapore to introduce an Integrated Waste Management System, which includes recycling on-site. Countries in the middle-east have already implemented such integrated waste management system that treats mixed domestic solid waste.

4. **Innovation to Reduce Plastic Packaging Waste**
   Public sector organisations and NGOs could partner with major packaging waste industries, such as food and beverage and consumer goods, to reduce plastic packaging of their products.

5. **Building a Market for Recycled Plastic through Innovation**
   To support the upstream and downstream recycling efforts, government and public sector organisations could step-in to support existing markets in Singapore that are manufacturing recycled plastic pellets. Recycled plastic can be used to support the major manufacturing segments in Singapore, particularly the biomedical manufacturing, electronics and general manufacturing industries, to achieve a closed loop circular economy in Singapore.

For example, several start-up companies around the world are devising machines to produce plastic filaments to be used for 3D printing machines. Singapore's plastic waste stream could be directed towards recycling plastics to feed the biomedical companies for 3D printing of devices such as prosthetics. Similarly, recycled plastics can be used for manufacturing flat-panel displays and ink and toner cartridges for the electronics manufacturing segment in Singapore. Artificial intelligence systems can be designed to support the waste management sector in Singapore. Research has also led to the use of pyrolysis technology to convert plastics to oil and fuel. Singapore could leverage on driving the use of such innovation to feed the chemical manufacturing segment (petrochemical and petroleum segments) in Singapore. The supply of rPET (recycled PET) to general manufacturing industries in Singapore could further aid the recycled plastics market.

6. **Replace Single-Use Plastic Bags/Rolls with Alternatives**
   Public sector organisations and NGOs could partner with major privately owned supermarkets in Singapore to replace plastic bag rolls for vegetables and fruits with effective alternatives, such as reusable bags made from super light, durable nylon or reusable organic cotton muslin bags. The same initiative could be taken for bakeries across Singapore where consumers are encouraged to bring their own reusable containers when purchasing bread from bakeries instead of using the small non-reusable plastic bags provided.

7. **Legislation and Policy Measures**
   A formal legislation might be required to increase the recycling rate from 6%. To do so, a multi-prong approach could be required. We note that mandatory reporting of packaging data and packaging waste reduction plans will be implemented in 2020. In addition, a policy with a focus on step-wise reduction of single-use plastics, such as the small plastic bags obtained at bakeries, plastic packaging of vegetables and fruits at supermarkets, and plastic bag rolls to collect and weigh the fruits and vegetables. Mandating compulsory recycling at commercial facilities may also improve the recycling rates in Singapore.

   To transition the plastic lifecycle in Singapore from a linear to a circular economy requires a coordinated effort. A more robust, innovative and disruptive system for managing plastic waste in Singapore is needed with an emphasis on the 2M – Mitigation and Management, including mitigating the use of those single-use plastics that are generally not re-used by consumers, and better management of domestic plastic waste generated.

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1. INTRODUCTION

1.1. Background

In 2013, Singapore Environmental Council (SEC) conducted an industry-leading study aimed at evaluating patterns of plastic bag use in Singapore. The position paper titled 'Identifying and Mitigating the Wastage and Inefficient use of Plastic Bags in Singapore' (Singapore Environment Council, 2013) presented the findings from the study alongside targeted recommendations for at policy makers, retailers, educators, and members of the public. Since the release of the position paper, several efforts have been carried out to reduce dependency on plastic bag use and increase awareness of the impact of plastic waste on the environment.

Despite the efforts, plastic waste has again risen to the forefront of the environmental agenda in Singapore. To provide a deeper analysis of the plastic ecosystem, this position paper seeks to explore a wider scope of the plastic ecosystem in Singapore

1.2. Objective of Position Paper

The objectives of this study are:

- Understand the factors influencing the domestic plastic consumption and waste production in Singapore
- Assess the plastic consumption pattern of consumers, shopping behaviour of consumers, and the factors that influence plastic consumption
- Assess the after-use pattern of plastic
- Understand the reasons for the stagnation of plastic waste recycling rates between 6% and 13% since 2003, in Singapore (National Environment Agency, 2018)

1.3. Outline

This report has been developed by a literature review (detailed in Section 2), as well as a collection of quantitative and qualitative data through surveys and stakeholder interviews respectively, detailed in Section 3. The scope of the report includes understanding consumption and after-use patterns of consumers for the following type of plastics:

- LDPE (Low Density Polyethylene) - particularly focusing on bags obtained from supermarkets
- PET (Polyethylene Terephthalate) plastics - particularly focusing on bottles
- PP (Polypropylene) plastics - particularly focusing on disposable food containers
- HDPE (High-density polyethylene) plastics – particularly focusing on common household bottles

Quantitative research through online surveys was conducted to understand the factors that influence plastic consumption and after-use pattern of consumers. The research was also to understand the reasons for the stagnation of plastic recycling among consumers and provide recommendations to improve initiatives on plastic recycling. A survey sample size of 1,003 respondents based in Singapore has been considered for this study.

Qualitative research through an in-depth interview with 10 key stakeholders was conducted to gain insights on the plastic consumption and waste scene in Singapore, and to understand the challenges and opportunities to improve initiatives on plastics recycling in Singapore. Interviews were conducted from November 2017 to May 2018.

2. LITERATURE REVIEW

2.1. Global Studies Literature Review

Plastic production has surged over the past 50 years, from 15 million tonnes in 1964 to 311 million tonnes in 2014, and is expected to double again over the next 20 years (World Economic Forum, 2016). Annual plastic production has grown at a rate of about 8.60 (PlasticsEurope, 2016) from 1950 to 2016. It is estimated that the manufacturing of plastics consumes the same amount of fossil fuel as the entire aviation industry (Tan E. , 2018). Out of the estimated 335 million tonnes of plastic produced in 2016 (PlasticsEurope, 2017), only 9% of the plastics are recycled (Parker, 2017), with a vast majority (79%) accumulating in landfills or sloughing off in the natural environment as litter. There are more than 30 types of materials that come under the family of plastics, which are made into thousands of different types of products depending on use (PlasticsEurope, 2017). The packaging industry, in particular, has been found to be highly dependent on plastic.

The main cause for the increase in plastic production is plastic packaging. Between 2000 and 2015, the share of plastic packaging as a share of global packaging volume increased from 17% to 25% (World Economic Forum, 2016). Plastic packaging includes but is not limited to PET bottles such as water and soft drinks, HDPE bottles such as shampoo, milk and detergent bottles, LDPE plastic bags such as rubbish bags, and PP plastics such as disposable food containers. The packaging volumes by 2050 are expected to quadruple to 318 million tonnes annually which is more than the entire plastic industry today (World Economic Forum, 2016). Global plastic bottle consumption alone is staggering. An article (Laville & Taylor, 2017) in the Guardian stated that the annual consumption of plastic bottles is set to top half a trillion by 2021, with a million plastic bottles being bought around the world every minute.

A range of countries, as diverse as Hong Kong, Portugal, Australia and China have implemented regulation to curb the use of plastic. Notable research has been conducted to evaluate the effectiveness of different initiatives to impact the use, re-use, and disposal of plastic, with the majority of research focusing on plastic bags. More than 40 countries across the globe have plastic bag bans or taxes in place, including countries across Europe, North America, Asia and Africa (Tan E. , 2018). A study (Legislative Council Panel on Environmental Affairs, 2007) conducted in Hong Kong compared the various legislative measures adopted in different countries to reduce plastic bags consumption and the results achieved. The results revealed that consumer penalties introduced at the retail level were the most effective. Such results are clearly illustrated in Ireland, where plastic bag usage dropped by more than 90% after the introduction of consumer levies.

However, some studies have criticised the introduction of consumer levies on plastic bags. For instance, a study (Martinho, Balaia, & Pires, 2017) conducted on the effect of plastic bag tax in Portugal, revealed a 74% reduction in plastic bag consumption and a 61% increase in reusable plastic bags after tax implementation. The study found that as the tax implementation increased, the demand for plastic bin bags increased by 12%. An Australian-based study has also criticised the consumer levies approach for failing to recognise how plastic bags are typically re-used or re-purposed. The study found that 9 out of 10 households in Australia line their general waste bins with either plastic bags, or specific bin liners (WALGA, 2016). Similar results were obtained in 2013 from Singapore (Singapore Environment Council, 2013).

Similar studies evaluating plastic bag use and storage behaviours have also been conducted in China. One study (Zhu, 2011) found that 71.80% of consumers reported accepting a plastic bag from a retailer if it is free regardless of whether they required a bag, while 23.90% would only use plastic shopping bag if the purchased quantity necessitated it. In places like San Francisco, the ban on plastic bags in 2005 was met with objection from the trade and instead the City Government signed a voluntary agreement with major supermarkets to reduce 10 million plastic bags, which was not met within the target year (Legislative Council Panel on Environmental Affairs, 2007).

Studies have also attempted to find out what consumers do with plastic bags after use. The SEC 2013 Position Paper (Singapore Environment Council, 2013) revealed that more than 40% of respondents stored plastic bags, whereas only 8.5% recycled the bags. Similarly, a study (WRAP, 2014) conducted in Hong Kong revealed that the plastic bags are frequently stored out of habit. The research found that consumers typically reuse the bags as bin liners, while others stored the bags to be reused at a later point. The study found that despite consumer intentions to bring their own plastic bags whilst shopping, many forgot to bring them or required their use due to unplanned shopping trips.

Significant research has been conducted into consumer use, reuse and disposal patterns. A study (Sharp, Hoj, & Wheeler, 2010) conducted in Australia found that consumer behaviours were more influenced by financial penalties, i.e., through a plastic bag levy, rather than financial incentives, i.e., discount. It follows that information and awareness is not enough to influence consumer behaviour. Conversely, a study in Canada found that financial incentives and penalties introduced to curb plastic use only effective at enhancing existing behaviours but ineffective in stimulating behavioural change. For instance, consumers who were already practising it but did not have any impact on those who were not.

Factors influencing recycling habits such as time constraints, communication, and social influence have also been studied to understand consumer behaviour. Whilst convenience and cost of recycling were found to be the primary determinant of consumer behaviour, time commitment was also found to be a significant factor (Shakil

Ahmed, Ahmed Bazmi, Waheed Bhutto, Shahzadi, & Bukhari, 2014). A Singapore-based study (Ho, Liao, & Rosenthal, 2014) found that for adult Singaporeans, attitude, media dependency, traditional media attention, and interpersonal communication were positively associated with purchasing ecologically safer consumer products and environmental civic engagement. In a Hong Kong based study (Wan, Shen, & Choi, 2017), the key findings showed that subjective norm, the perception of social pressure from important others, plays a crucial role in motivating one to recycle and is likely to motivate one who possesses limited knowledge on recycling benefits to practise recycling. These studies highlight the importance of understanding the specific cultural factors that may motivate and influence consumer behaviour.

Consumer awareness of the environmental benefits of recycling does not always correspond to recycling behaviours. A study (Kolbe, 2015) found that even though the knowledge of the environmental benefits of recycling was high among German students, their participation in recycling behaviour is low. However, a Singapore-based study (Ministry of Environment and Water Resources, 2013) found that consumers commonly reported that they wanted to know more about recycling, including how to recycle, the location of recycling bins, and the benefits of recycling. The same study also reported that consumers expressed a desire for improved accessibility of recycling infrastructure in Singapore. The Singapore government has sought to enhance the recycling infrastructure by introducing recycling chutes in all new public housing projects (National Environment Agency, 2017).

The global recycling industry has undergone notable disruption in recent years. While the global plastic production has skyrocketed, the annual volume of globally traded waste plastic was less than 5% weight of the new plastics production in 2012 (Velis, 2014). China has long been the primary importer of used plastics, with recent estimates suggesting that the country receives 56% (by weight) of the global imports of waste plastics (Velis, 2014). However, in 2017, China notified the World Trade Organisation (WTO) that it would stop the import of used plastic and paper to reduce the imports of contaminated materials into the country.

Despite this, the industry demand for recycled plastics looks promising. With the Chinese import ban, the prices for recycled plastics have risen as compared to virgin plastics. This has stimulated industry demand for recycled plastics (Chasan, 2017). According to a recent study, the recycled plastic market is to reach USD 30 billion by 2025 (Persistence Market Research , 2017), with demand for recycled HDPE and PET plastics holding the largest market share. Prominent food and beverage, and consumer and retailer companies are also contributing to this demand, as they seek to pioneer new technologies and better integrate recycled plastics into their products.

Extended Producer Responsibility (EPR), a policy approach that shifts the cost of managing post-use products, either partially or fully, from local governments to the producers of those products is growing. EPR is practised by many countries as a way of streamlining and managing the plastic waste collection process. Some EPR laws require

producers to physically manage their products at end-of-life as well (SAIC, 2012). EPR is implemented by countries like Germany to reduce the plastic consumption and increase the overall recycling rate. The success of these policies is debatable. A study (SAIC, 2012) compared U.S. states with and without EPR laws and found that EPR can achieve high recycling rate at a reasonable cost. The study found that consumers do not mind paying the extra cost, as they would end up paying for it as hidden cost either of the product or as part of the EPR utility bill.

2.2. Good Recycling Practices in Some Countries

Several countries have taken comprehensive measures to manage their plastic waste, through recycling. Leading practice across Europe typically combines government regulation with innovative private sector recycling services. The European Union (EU) has established a waste recycling target of 50% by 2020, however, Germany has set an ambitious target of achieving almost complete (100%) waste recycling by 2020. Germany was leading the recycling race in the world in 2016 with a domestic recycling rate of 65%. Germany's success has been linked, in part, to successful coordination between government regulation, and collaboration with the private sector. A recent paper (Hartmann & Žmak, 2017) highlighted the success of "Green Dot" and the dual system of packaging recycling in Germany.

The "Green Dot" system, introduced in Germany, is an industry-funded system of waste collection, which is operated by Duales System Deutschland GmbH ("DSD", English for German Dual System). The system liberates retailers and firms from individual take-back and recovery obligations under the German Packaging Ordinance. Companies that participate in the system, pay for disposal of the plastic items they manufacture, beforehand and are eligible to have a "Green Dot" logo on their plastic packaging. Under this system, private households are given a yellow bag in which they can put every packaging. These are collected by DSD-operated waste collection vehicles, which will sort and recycle the wastes accordingly. Germany has also introduced the largest plastic bottle deposit system (Hartmann & Žmak, 2017) which was introduced in 2006. Under this system, every shop with more than 200m^2 shop area is obliged to take back every drink packages sold of the same material. The recycling-rate of PET bottles with the deposit in Germany was 97.20% in 2017 (Hartmann & Žmak, 2017). Germany presents a unique case, as efforts to address recycling rates have been sustained for many years. It may not be possible to replicate these efforts exactly for smaller recycling markets such as Singapore.

Austria has also been successful in managing plastic waste by achieving high recycling rates. The ARA (Altstoff Recycling Austria AG), set up in 1993, is used to collect and recycle packaging waste from households. The ARA System was established to handle the management of the packaging waste resulting from packaging production and retail

industry operations. ARA system runs a nation-wide collection and recovery system for packaging from households and businesses. There are two household collection schemes implemented across Austria, depending on the region. ARA system sorts recyclables from non-recyclables. The non-recyclable materials are then used for energy recovery (Plastic ZERO, 2012).

In the Asia-Pacific context, Taiwan's 4-in-1 recycling programme is often cited as leading best practice. The system involves coordinated recycling efforts between consumers, recycling industries, local authorities, and recycling fund. Consumers are mandated to deposit their segregated waste at local collection points. Recycling industries buy the waste material in order to recover commodities and generate revenue. Local authorities organise municipal collection teams to collect waste from collection sites. The recycling fund is the most important aspect of the system. Manufacturers and importers of new regulated recyclable waste are required to pay a fee to the Environmental Protection Administration Taiwan (EPAT) that contribute to the recycling fund. This is distributed to trust funds and special income funds that are used to subsidise private collectors and recycling enterprises (EPA Website, 2012).

A commonality between many leading practices has been the integration of EPR, including collaboration and coordination of recycling efforts between governments, consumers, producers and the recycling industry. The EPR approach encourages a shared responsibility and accountability for plastic waste recycling between all parties.

2.3. Plastic Waste Landscape in Singapore

Singapore has been in the forefront in implementing various initiatives to manage the waste generated within the country. This includes building waste-to-energy plants, with the objective of reducing the volume of solid waste generated in the country. The government has also invested heavily in waste management infrastructure over recent years. Despite these efforts, the amount of waste generated has also substantially increased. The amount of waste sent for disposal rose from 1,260 tonnes per day in 1970 to 8,443 tonnes per day in 2017 (National Environment Agency, 2018), with plastic waste contributing a significant amount to this volume.

In 2017, close to 815,200 tonnes of plastic waste has been generated (National Environment Agency, 2018). This number is likely to have risen. A study in 2016 showed the increasing consumption of bottled water in Singapore (SGD 134 million industry), which has also led to the increasing use of PET and disposable plastic as most of the bottled water come in plastic packaging (Lim, 2016).

Singapore's supermarket chains were in talks in 2017 to introduce a voluntary charge on plastic bags, which was scheduled to commence in 2018. However, the decision was not taken as the supermarket chains were also concerned about the impact of the levy

on low-income households and the long-term effectiveness of the levy (Ng, 2017). In 2018, Dr Amy Khor, the Senior Minister of State for the Environment and Water Resources announced that the ministry would not be implementing a mandatory plastic bag levy (Boh & Tan, 2018) One of the reasons was due to plastic bags being used for the responsible and hygienic bagging of waste in Singapore. A more sustainable approach, as mentioned by the Senior Minister of State, was to tackle the excessive consumption of plastic disposables in Singapore. Recently, NEA announced that it will be implementing mandatory packaging reporting requirements in 2020. Businesses that place packaging (including plastic bags) on the consumer market will be required to report annually on the types and amounts of packaging materials they are placing on the market and their packaging waste reduction plans. This aims to bring greater awareness to companies on the potential for waste reduction within their business operations, and spur them to take action to reduce the amount of packaging used and packaging waste disposed of. Moving forward NEA is studying the feasibility of having an Extended Producer Responsibility (EPR) Framework to manage plastic and packaging waste.

Efforts to curb the use of plastic should be informed by how consumers are using plastic, and determining the type of plastic that can be reduced or recycled versus the type of plastic that should be eliminated completely. For instance, consumers typically use a supermarket plastic bag for 30 minutes, whilst a plastic straw is used for five minutes. Other types of short-lived plastics include plastic stirrers, which have a lifespan of 10 seconds. Single-use plastics provide a few extra minutes of convenience but are disposed of after use. Most plastic straws, lids, cups, and stirrers fall into this category. Single-use plastic packaging is also a growing concern in Singapore. In Singapore, packaging makes upa third of domestic waste (Tan E. , 2018). Unlike countries such as South Korea, Taiwan, and Hong Kong that have EPR or related legislation for packaging waste, Singapore does not hold businesses accountable for the plastics they introduce to the market.

It is estimated that 95% of plastics, having a value of USD 120 billion (SGD157 billion), is discarded after their first use. Plastics hold a high economic value and effective recycling ensures we do not lose its value (Tan E. , 2018). However, in Singapore, the recycling rate of plastics dropped from 11% in 2013 to 6% in 2017, (National Environment Agency, 2018). Despite the rapid expansion in plastic consumption in Singapore, recycling rates are stagnant, fluctuating between 6% and 13% in the last 15 years. A significant proportion of Singapore's recycled plastics are exported to China. For instance, in 2011 Singapore contributed 7.60% of ASEAN's plastic export to China (Velis, 2014).

However, China's announcement that it intended to ban some imports of waste and recycling will likely disrupt Singapore's plastic waste exports. It is still unclear as to what extent Singapore's plastic waste exports to China will be affected. Nonetheless, there

has also been constant efforts urging the government and supermarkets in Singapore to take action over plastic waste and plastic bags respectively.

Several groups in Singapore have implemented various programs to bring awareness to the people regarding the environmental effects of plastic use, in order for people to reduce their dependency on plastics and to encourage recycling. These programmes have been implemented as early as 2001 where NEA introduced the National Recycling Programme where Public Waste Collectors (PWCs) licenced by NEA are required to provide recycling bins and recycling collection services. The myENV mobile application introduced by the NEA has detailed information on the recycling bins and collection services. Various organisations in Singapore have also contributed to plastic waste reduction, re-use, and recycling efforts by running campaigns to educate consumers on the type of plastics to recycle. Some groups have also held waste collection drives to collect plastics for recycling. These efforts have, to some extent, brought awareness of people towards the environmental implications of plastic use.

Various initiatives have been trailed in Singapore in recent years in an effort to promote plastic recycling and re-use rates. From late 2017 to early 2018, Reverse Vending Machines have been installed in a few supermarkets around Singapore, that lets consumers exchange bottles and cans for vouchers. The initiative is a result of a collaboration between a food and beverage company and a supermarket chain in Singapore. Though the machine costs between SGD 10,000 and SGD 100,000, the pilot test with these machines revealed that 50,000 bottles were collected within three months (Charles, 2018). Similarly, in 2018, Singapore's first zero-waste grocery store was opened. The store sells goods without any packaging and encourages customers to re-use containers (Hicks, 2018).

Many government initiatives have been undertaken for recycling as well. One such is NEA's 3R fund that particularly focusses on increasing the recycling rate in Singapore by co-funding up to 80% of the qualifying cost of the recycling technology, which is subject to a cap of SGD 1 million per project. The fund aims to help organisations - including companies, non-profit organisations, town council, schools, institutions and managing bodies - overcome the start-up cost for recycling facilities, and offset part of the technological cost in order to increase recycling in Singapore (National Environment Agency, 2018). Environment Technology Research Programme (ETRP) is another SGD 21 million funding programme by NEA. It aims to enhance the technological competencies and support companies and researchers in waste management research. They focus on projects in waste management, such as those related to energy recovery, materials recovery and special waste treatment (Green Future Solutions, 2015).

However, the lack of market demand for such recyclable products poses the real problem. In order to make the system profitable, there needs to be a market for recycled goods within Singapore. Therefore, in spite of such funding provided by the government in Singapore, there is a lack of investment in recycling technologies by waste management companies. The effect of these problems are not just felt in

Singapore, but also can be seen in the global recycling market (Davis, 2015). These constraints highlight the some of the constraints with implementing a market-driven model where the market size and profit opportunities are more limited.

Singapore's plastic recycling ecosystem is closely interlinked with the global recycling ecosystem, particularly due to its current dependence on plastic exports to China. To better understand Singapore's plastic lifecycle, it is necessary to gain a deep understanding of the factors that influence plastic use, after-use, and disposal.

2.4. Conclusion on Literature Review

The literature review highlighted the scale and growth of plastic consumption, globally and in Singapore. These trends have had the result of increasing plastic waste in Singapore.

The literature review explored the different initiatives designed to curb plastic consumption, and encourage more responsible after-use and disposal of plastic waste. The majority of initiatives designed to curb plastic waste have focused on plastic bags. Levy and bans have proved effective in some countries but resulted in increased plastic consumption in others. In Singapore, a levy placed on plastic bags has been met with significant rejection from the consumers and the government, as studies have shown that consumers are regularly re-using plastic bags to line garbage bins and dispose of general waste. Placing a ban on plastic bags would also raise objections in Singapore for the same reason. Rather, Singapore can have a greater impact by focusing on reducing the consumption of plastics that are typically not re-used by consumers for other purposes. Single-use plastics (such as PET bottles, Styrofoam containers, and non-reusable plastic bags) are of great concern in Singapore, due to their high consumption rates, low re-use rates, and the inability of the plastics to be recycled.

The literature further shows that there are various factors influencing recycling habits – such as time, awareness and cost. Access to recycling bins and convenience has been highlighted in some studies as some eminent factors that influence recycling in Singapore. Behavioural habit is considered to be another factor. However, various organisations in Singapore have implemented various campaigns and initiatives, and yet plastic recycling rates are low and stagnating. This shows that there are deeper factors affecting recycling which need to be explored.

One such factor can be attributed to the demand for recycled products created by the recycled plastics market. Since Singapore is not a manufacturing hub of plastics, the recycling industry in Singapore is relatively underdeveloped, with the majority of sorted recyclables being exported for recycling. Without an established market, the demand for recycled plastic is low, thus limiting the demand. This can be considered a barrier to Singapore developing a circular economy. As such, there is an opportunity for industries within Singapore that rely on plastic waste to create a demand for recycled products.

EPR was also identified as an effective method for supporting the transition from a linear to a circular plastic waste economy. In Singapore, there is currently no mandate on recycling or take-back. As such, a comprehensive review of existing and potential government and industry initiatives and incentives is required to evaluate what action could be taken to support increase re-use and recycling. From the literature review, it can be concluded that the involvement of all stakeholders in the plastic ecosystem is essential to create a circular and robust recycling model in Singapore.

3. RESEARCH AND FINDINGS

3.1. Design and Methodology

The empirical research was conducted using online surveys and in-person interviews. The online survey comprises open and closed questionnaire questions. The online survey was conducted to understand the demographic profiling of participants, their plastic use, after-use, and disposal behaviour. The online survey also sought to evaluate the level of knowledge survey respondents had in relation plastic recycling, and gather recommendations on how the plastic consumption and recycling practices in Singapore can be improved.

The survey went through numerous iterations and was piloted on a test population prior to roll out. The test population were asked to complete a Pilot Test Feedback Form to guide further survey enhancements. The final survey comprises 17 questions, with the estimated completion time of 15 minutes. The survey questions can be found in Appendix A.

Based on Singapore total population of 5.6 million[4], a 95% confidence level with 3% margin of error would require a sample size of about 1,000. The survey was rolled-out using Qualtrics, an online survey tool to target 1,000 respondent based in Singapore with a demographic profile listed in Table 1. An online survey was selected as a survey approach for practical reason as Singapore is incredibly digitally included[5] and there is no established theory relating digital inclusion to recycling behaviour in Singapore. The online survey was live for six months, from December 2017 to May 2018.

[4] Singapore total population is 5,612,300 (mid-year estimate 2017 which is obtained from Department of Statistics Singapore)

[5] There is 82% penetration in terms of internet users in Singapore, according to the report "Digital in 2017" by Hootsuite and We Are Social.

3.2. Demographic Profile of Survey Respondents

A total of 1,003 completed surveys were obtained and analysed for this report.

Table 1: Demographic Profile of the Survey Respondents

Category	Count
Gender	
Male	371
Female	632
Age	
15-25	291
26-40	371
41-60	275
Above 60	66
Number of people in household	
2-3	345
4-5	470
More than 5	130
I live alone	58
Highest education	
Primary/ secondary school	77
ITE (Institute of Technical Education)/ Diploma/ A levels	264
Degree	414
Post-graduate	228
Others	20
Occupational Status	
Employed	638
Unemployed	45
Student	232
Housewife/homemaker	44
Others	44
Type of housing	
Condominium/Apartment	319
HDB	553
Landed Property	120
Others	11

3.3. Findings from Surveys

The online survey was structured around five primary themes:

1. Plastic Usage Habits of respondents for:
    - LDPE or low-density polyethylene (especially plastic bags)
    - PP or polypropylene (especially disposables)
    - PET or polyethylene terephthalate (especially bottles)
2. Post use (after-use) pattern of respondents for:
    - LDPE (especially plastic bags)
    - PP (especially disposables)
    - PET (especially bottles)
    - HDPE or high-density polyethylene (especially common household bottles)
3. Reasons for the stagnation of recycling rates in Singapore
4. Recommendation to reduce plastic consumption and improve recycling rates in Singapore

3.3.1. Plastic Usage Habits of Respondents

3.3.1.1. Plastic Bags From Supermarkets

Respondents were asked to indicate their plastic bag usage per shopping trip to the supermarket. More than 68% of the respondents indicated that they take between 1 to 5 plastic bags per shopping trip at the supermarket. Conversely, 15.15% of the respondents indicated they bring their own bags for shopping, while 13.56% of respondents indicated they take 6 or more bags per shopping trip. Only 2.99% of the respondents indicated that the question is not applicable to their shopping patterns, as they do not shop at the supermarket.

Respondents were also asked to indicate whether they request for separate bags to hold their wet and dry items at the supermarket. The results reveal that 53.54% of respondents do not request separate bags, however, 36.39% of respondents do request separate bags. 10.07% of the respondents indicated that the question is not applicable.

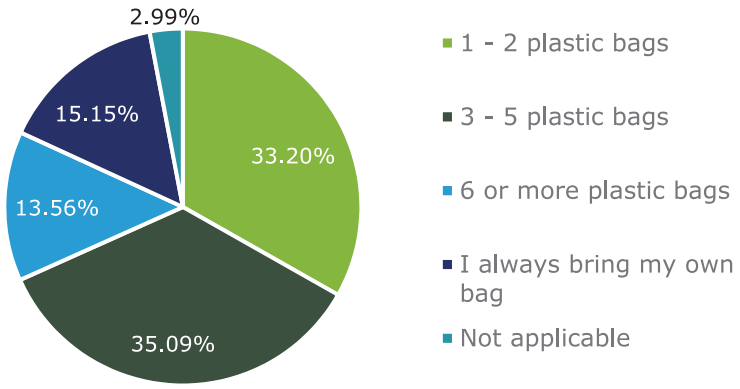

Figure 2: How many plastic bags do you take from the supermarket per shopping trip?

Based on the results, it is estimated that consumers in Singapore take 820 million[6] plastic bags from supermarkets each year. The study suggests that 2 to 4 plastic bags are taken from supermarkets per person per trip in Singapore.

Plastic Bag Use by Gender

The study found that respondents who were women indicated to be twice as likely to bring a reusable bag as respondents who were men (18% versus 10%).

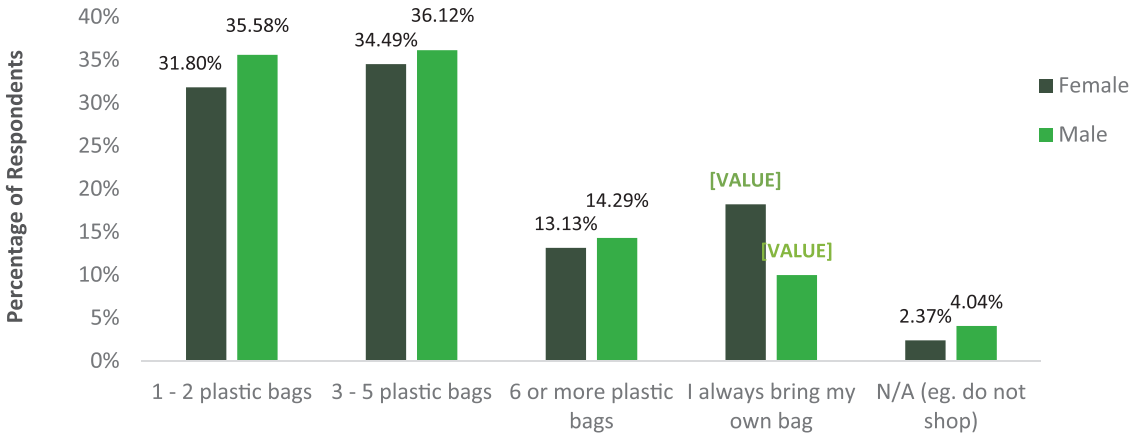

Figure 3: Plastic Bag use by Gender

[6] Estimated figure based on survey findings and this is linearly scaled using Singapore's population aged 20 and above (mid-year estimate 2017 which is obtained from Department of Statistics Singapore), which is the closest available demographic profiles of the survey respondents

Plastic Bag Use by Age Group

The study found that most respondents who were above 60 years of age used 6 or more plastic bags per shopping trip as compared to respondents from other age groups. Similarly, the least number of respondents who were above 60 years of age bring their own bags to the supermarket as compared to other age groups.

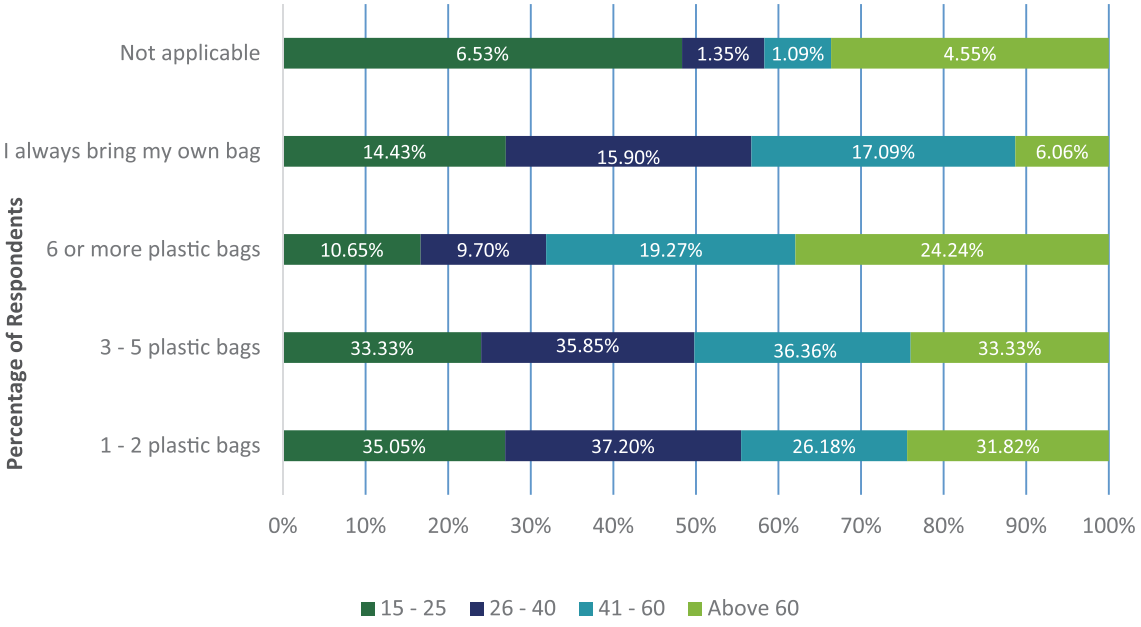

Figure 4: Plastic Bag use by Age

3.3.1.2. PET Bottle Usage

Respondents were asked to indicate the number of PET bottles they used per week. The results reveal that 57.93% respondents use 0 to 1 PET bottles per week, whereas 2.99% of respondents indicated they use more than 7 PET bottles per week.

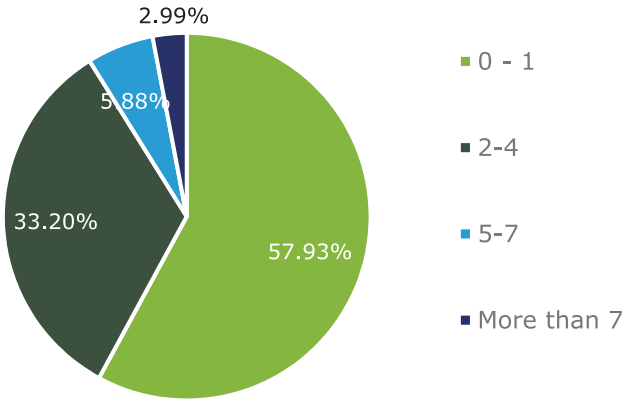

Figure 5: How many PET bottles do you use per week?

Based on the results, it is estimated that consumers in Singapore use 467 million[7] PET bottles each year, with 1 to 3 PET bottles used per person per week.

3.3.1.3. PP Plastic Usage

Similar results were obtained when respondents were asked to indicate the number of PP items they purchased per week. The results reveal that 58.82% of respondents purchase 0 to 1 PP items per week, whereas 6.68% indicated they purchase 5 to 7 PP plastic items per week. Only 3.49% indicated to use more than 7 PP Plastic items per week.

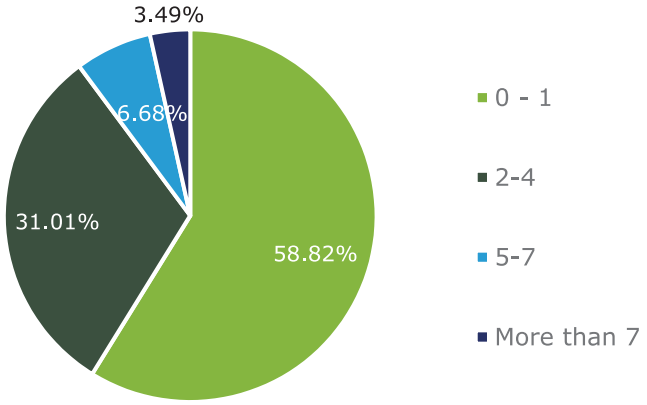

Figure 6: How many PP items do you purchase per week?

Based on the results, it is estimated that consumers in Singapore purchase 473 million[8] PP items (disposables) each year, with 1 to 3 plastic disposable item used per person per week.

3.3.2. Plastic After-Use Habits Of Respondents

Review of literature shows that there are various trends of after-use habits of plastic by people all around the world. In Singapore, various plastics are seen to be after-used differently. With plastic bags, the common after-use pattern is to use it to bag and dispose of general waste. With PET bottles, most people have indicated to recycle PET bottles as the most common after-use pattern. For PP Items, it is re-used and for HDPE bottles, most people have indicated that the most likely after-use pattern is disposal in the garbage bin.

[7] Estimated figure based on survey findings and this is linearly scaled using Singapore's population aged 20 and above (mid-year estimate 2017 which is obtained from Department of Statistics Singapore), which is the closest available demographic profiles of the survey respondents

[8] Estimated figure based on survey findings and this is linearly scaled using Singapore's population aged 20 and above (mid-year estimate 2017 which is obtained from Department of Statistics Singapore), which is the closest available demographic profiles of the survey respondents

3.3.2.1. Plastic Bag After-Use Patterns

Respondents were asked to rank which action they were likely to take immediately after bringing home plastic bags from the supermarket. The survey provided five options, with one being the most likely action, and five being the least likely action. The following action options were presented to respondents:

- Use them to bag and dispose of general waste
- Store them
- Reuse plastic bag
- Dispose of in the garbage bin
- Recycle

The majority of respondents, 67%, ranked 'use them to bag and dispose of general waste' as rank their most likely option. Majority of respondents ranked 'store them' as their second most likely option (44.37%). The least likely action recorded by respondents (51.84%) was 'dispose them in garbage bins'.

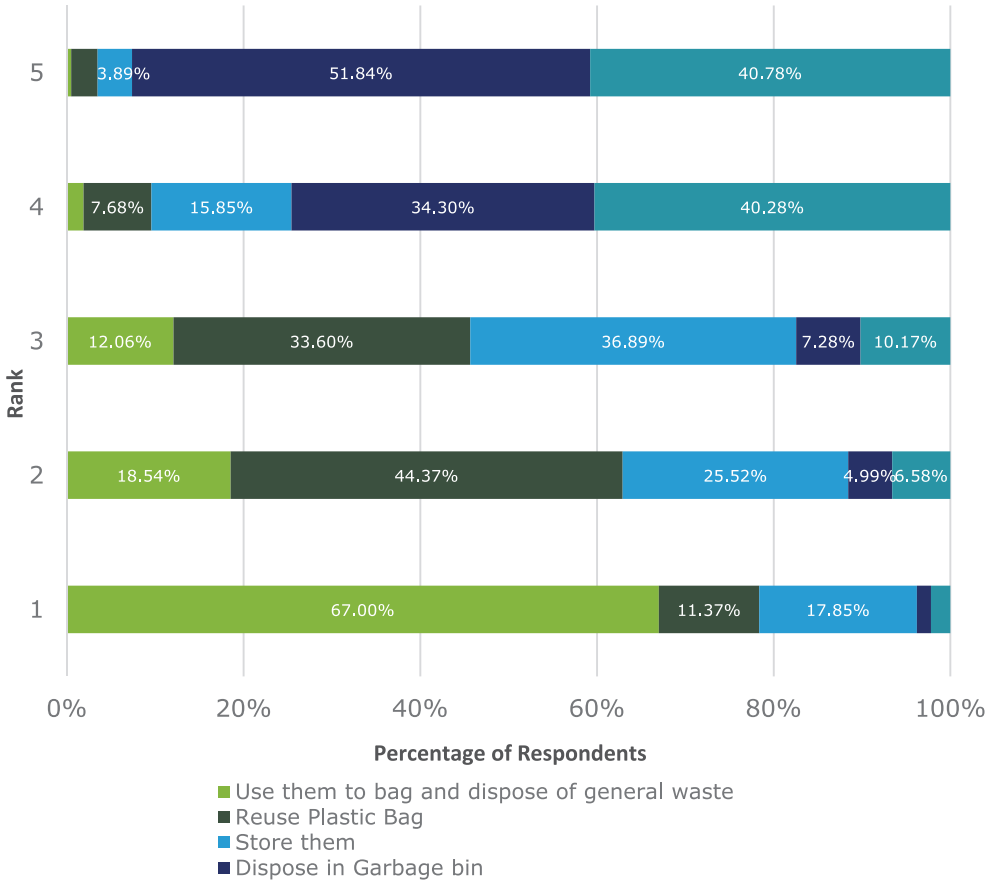

Figure 7: Most likely action (rank 1) to least likely action (rank 5) taken by respondents immediately after bringing plastic bags home from the supermarket

Respondents indicated a variety of reasons for storing and reusing plastic bags. Examples include:

Plastic bags are stored and/or reused for –

- Storing food
- Storing clothes
- Future disposal of general waste
- Carrying wet items
- Carrying dirty laundry
- Grocery shopping, or in supermarkets
- Picking dog faeces
- Gift wrapping
- Storing vegetables
- Storing miscellaneous items

3.3.2.2. PET Bottle After-Use Pattern

Respondents were asked to rank which action they were likely to take after using a PET bottle. The survey provided three options, with one being the most likely action, and three being the least likely option. The following action options were presented to respondents:

- Recycle
- Reuse
- Dispose in garbage bin

Respondents (37.09%) indicated that the most likely action would be to 'recycle the PET bottles' after use. This was followed by 'reuse' (ranked '2' by 36.29% of the respondents). The least likely option indicated is 'disposing PET bottles' in the garbage bin (ranked '3' by 42.07% of the respondents).

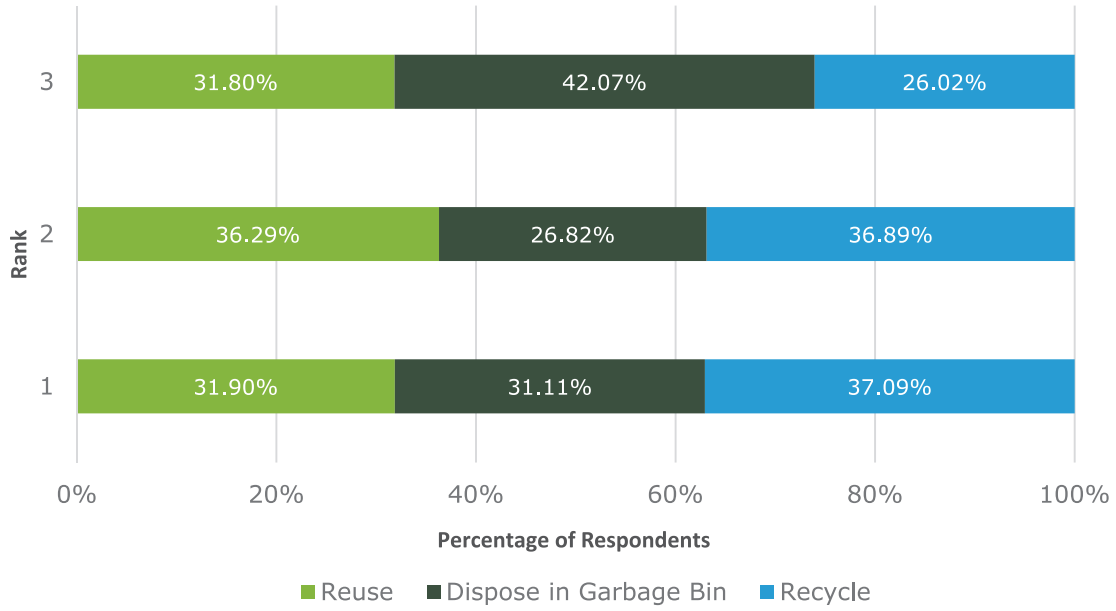

Figure 8: Most likely action (rank 1) to least likely action (rank 3) taken by respondents after using PET bottles

Respondents indicated that they reuse PET bottles for the following:

- To store water
- To store other liquids
- For art and handicrafts
- For gardening
- Storing soap

Others indicated not reusing PET bottles.

3.3.2.3. PP Items After-Use Pattern

Respondents were asked to rank which action they were likely to take after using PP items. The survey provided three options, with one being the most likely action, and three being the least likely option. The following action options were presented to the respondents:

- Recycle
- Reuse
- Dispose in garbage bin

The majority of respondents (52.84%) ranked 'reuse' the PP item as their most likely option. Majority of respondents ranked 'recycle' as the second most likely option (42.07%). The least likely option recorded by the majority of respondents (47.96%) was 'dispose in the garbage bin'.

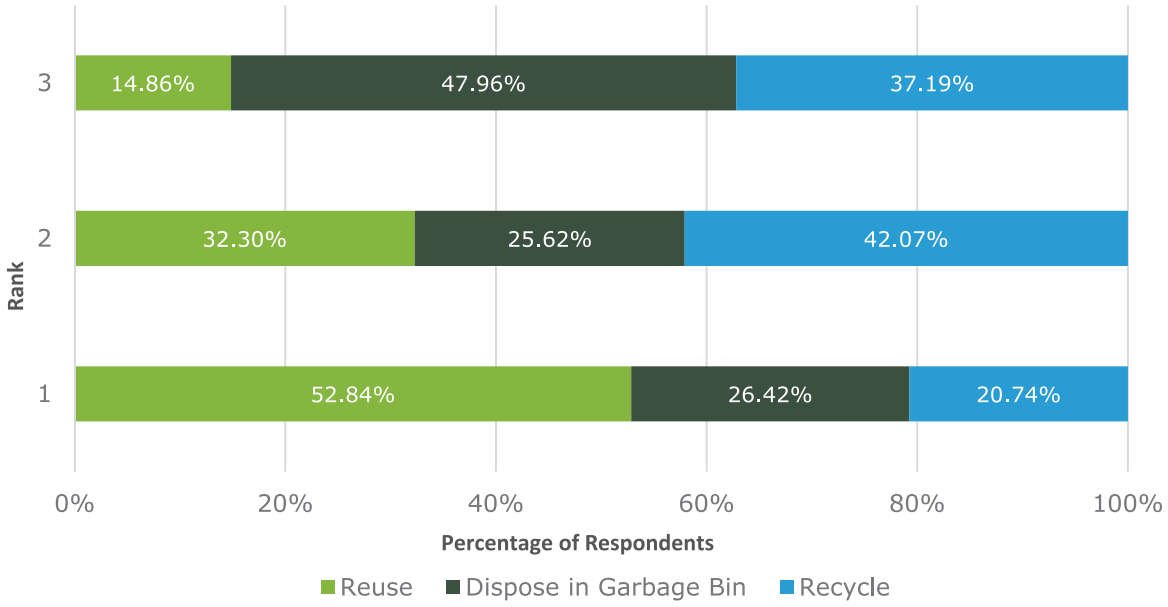

Figure 9: Most likely action (rank 1) to least likely action (rank 3) taken by respondents after using PP Items.

3.3.2.4. HDPE Plastics After-Use Pattern

Respondents were asked to rank which action they were likely to take after using HDPE plastic items, particularly those such as shampoo and detergent bottles. The survey provided three options, with one being the most likely action, and three being the least likely option. The following options were presented to the respondents:

- Recycle
- Reuse
- Dispose in garbage bin

The majority of respondents (44.67%) ranked 'dispose in garbage bin' as their most likely option. Majority of respondents ranked 'recycle' as the second most likely option (37.29%). The least likely option recorded by most respondents (46.96%) was 'Reuse'.

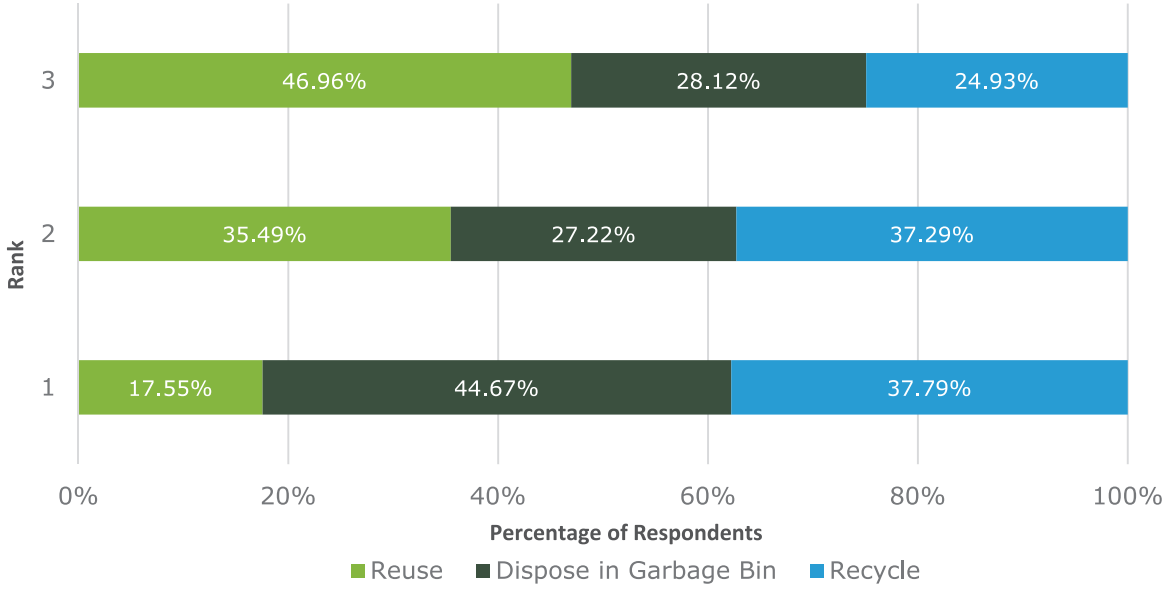

Figure 10: Most likely action (rank 1) to least likely action (rank 3) taken by respondents after using HDPE plastic items

Respondents were asked to indicate the various ways in which they would reuse HDPE bottles. Out of 319 respondents, 67.39% stated that they use HDPE bottles to store other liquids such as detergents, shampoos and glass cleaners. Of these respondents, 44.18% stated that they refill HDPE bottles with refillable packs. While 12.85% of respondents indicated that they would not reuse the HDPE bottle. The most commonly cited reason was the risk of toxicity of materials inside the bottle.

3.3.3. Understanding Reasons For Stagnation Of Recycling Rates In Singapore

This study aims to identify the reason(s) for the low recycling rate in Singapore. The recycling rates for plastics have been from 6% to 13% in the past 15 years (National Environment Agency, 2018). There are many possible reasons for the low and stagnating rates of recycling. Reasons identified in the literature review primarily pertain to low rates of awareness on the type of plastics that can be recycled. The literature review also highlighted that infrastructure-based difficulties in recycling may also contribute to low-rates of recycling. For instance, consumers may not be familiar with the recycling location or may be deterred if recycling location is not in close proximity.

3.3.3.1. Awareness On Types of Plastics That Can Be Recycled In Singapore

Respondents were assessed on their knowledge on the types of plastics that can be recycled in Singapore. From a list of options, they were asked to select the types of plastics that could be recycled in Singapore. The options provided to the survey participants are listed below. Respondents could choose more than one option.

- Plastic bags
- Take-away containers (non-polystyrene)
- Styrofoam containers
- Bottled drinking water
- Detergent bottles

The Singapore National Environment Agency (NEA), a public organisation responsible for improving and sustaining a clean and green environment in Singapore, has published a list of the items that can and cannot be placed in the blue recycling bin, including a breakdown of plastic items (National Environment Agency, 2017). The online survey provided an example of common consumer plastic products and asked participants to indicate whether they could be recycled.

The results show that only 29.21% of respondents were fully aware of the type of plastics that can be recycled (i.e. they answered all question correctly), whereas the remaining respondents only partially answered the question correctly.

Table 2: Please select the types of plastics that can be recycled in Singapore

Answers	Number of Respondents	Percentage (%)
Answered all questions correctly (5/5)	293	29.21
Selected all options including 'Styrofoam containers' (4/5)	130	12.96
Selected 3 out of 4 correct options (3/5)	314	31.31
Selected 2 out of 4 correct options (2/5)	177	17.65
Selected 1 out of 4 correct options (1/5)	86	8.57
Answered all questions incorrectly (0)	3	0.30

3.3.3.2. Location Of Recycling Bin

Respondents were asked whether they were aware of the location of their closest recycling bin. The majority of respondents (78.86%) indicated that they were aware of the location of the nearest recycling bin. However, 21.14% of respondents indicated that they were not aware of the location of their nearest recycling bin.

Of the 21.14% of respondents who were not aware of the location of their nearest recycling bin, 43.40% have indicated living in Condominiums/Apartments, followed by 41.04% living in HDBs (41.04%), and 14.62% living in landed properties. Based on the survey response, more than 50% of the respondents who indicated that they were not aware of the location of their nearest recycling bin live in private housing.

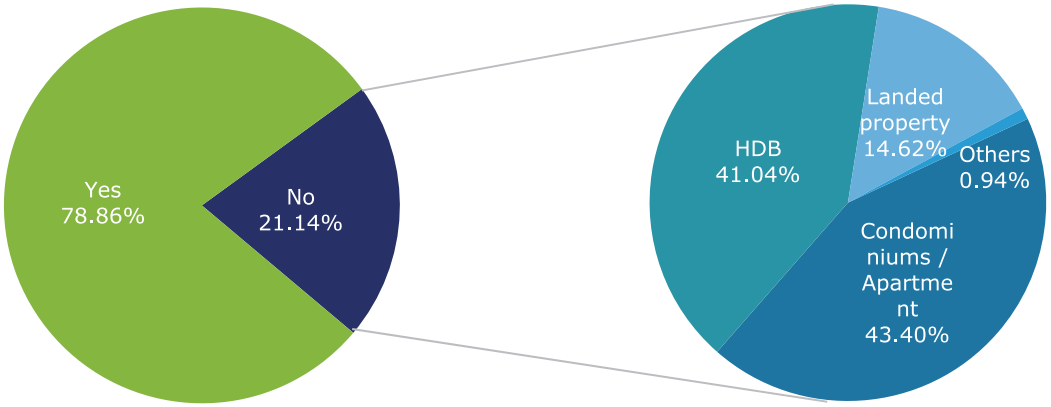

Figure 11: Are you aware of where the nearest recycle bin is located?

3.3.3.3. Most Likely Reason Why Respondents Would Not Like To Recycle

To understand some of the factors that may contribute to low recycling rates in Singapore, respondents were asked to indicate the most likely reason for why they would not recycle plastics. Five options were provided to respondents, including the option of 'Others' where respondents were required to manually fill in the reason for not recycling plastics. The following options were presented to respondents, and they were asked to select only one option:

- Inconvenient to bring recyclables to the recycling bin
- Inconvenient to separate recyclables from normal waste
- Too few items to recycle
- Will re-use it for other purposes instead of recycling
- Others

The majority of respondents (35.59%) selected the option, 'Will re-use it for other purposes instead of recycling'. This was followed by 'Others' (21.64%). Under this option, respondents indicated a broad number of reasons. The reasons were coded to support data collection. The coded data were then grouped based on the recurrence of responses, to come up with repeating data categories. Data categories are as follow:

- Cannot find recycling bins/no recycling bins located nearby
- Do not know what to recycle
- I recycle/reuse
- Inconvenient to wash and dry recyclables/inconvenient to clean the recyclables as it is contaminated
- Do not believe that plastics get recycled in Singapore

The results reveal that the majority of respondents who had selected the option 'Others', found it inconvenient to wash and dry recyclables, or to clean recyclables before disposal as it was contaminated with oil, food, etc. Second highest responses in this category were indicated by respondents (16.99% in both cases) on not knowing what to recycle and not knowing the location of the recycling bin.

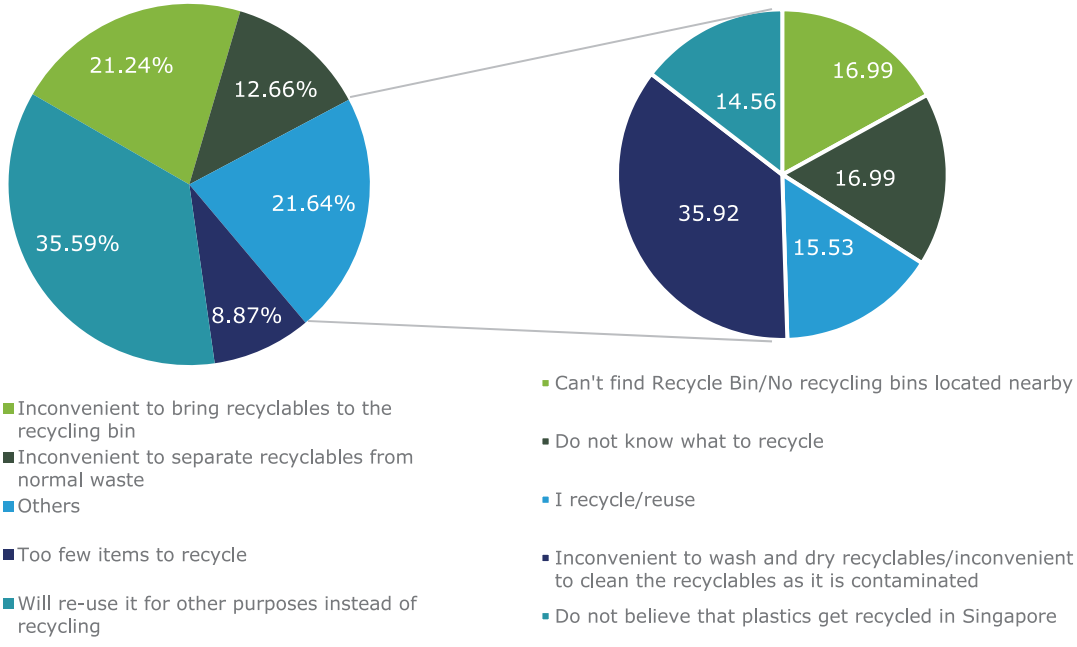

Figure 12: Please select the most likely reason why you would not recycle plastics

3.3.4. Recommendations

The online survey sought to elicit recommendations from respondents on the actions and initiatives that could be introduced to reduce plastic usage and encourage increased rates of recycling. Respondents have indicated that they would like to see plastic being managed in an effective way through the charging of plastic items, and retailers providing incentives for bringing own bags/containers. Similarly, people have also indicated that they would like to know the type of plastics that can be recycled in Singapore and the location of the recycling bins. Overall, most respondents have indicated that the most effective way of improving the recycling rate would be to provide incentives for recycling.

3.3.4.1. Recommendations To Reduce Unnecessary Plastic Usage

Respondents were asked to rank which recommendations they felt would be effective in reducing plastic usage in Singapore. Respondents were asked to rank six recommendations, with one being the most effective recommendation and six being the least effective recommendation. The following recommendations were listed:

- Reminders from cashiers on the need for plastic bag/disposal container
- More efficient bagging or packaging of items
- Have more campaigns and activities to increase awareness on the importance of plastic waste reduction
- Retailers to provide an incentive (e.g. product discounts, shopping vouchers, membership points) when I bring my own bag/container
- Implement a charge on plastic items (plastic bags, takeaway containers, cutlery etc.)
- Others

The results show that majority of the respondents recommend retailers to provide incentives such as product discounts, shopping vouchers and membership points, when consumers bring their own bag/container, suggesting that these actions will have the greatest impact on reducing plastic use in Singapore.

The results also show that a significant proportion of respondents felt that the introduction of a financial penalty (25.92%) on the use of plastic bags, takeaway containers, cutlery etc.) would be the most effective method (ranked 1 out of 6) to reduce unnecessary plastic usage. However, 28.32% of respondents indicated that the introduction of financial penalties would be the least effective method (ranked 5 out of 6). The results reveal diverging views on how best to tackle plastic consumption through the introduction of financial penalty for taking plastic bags.

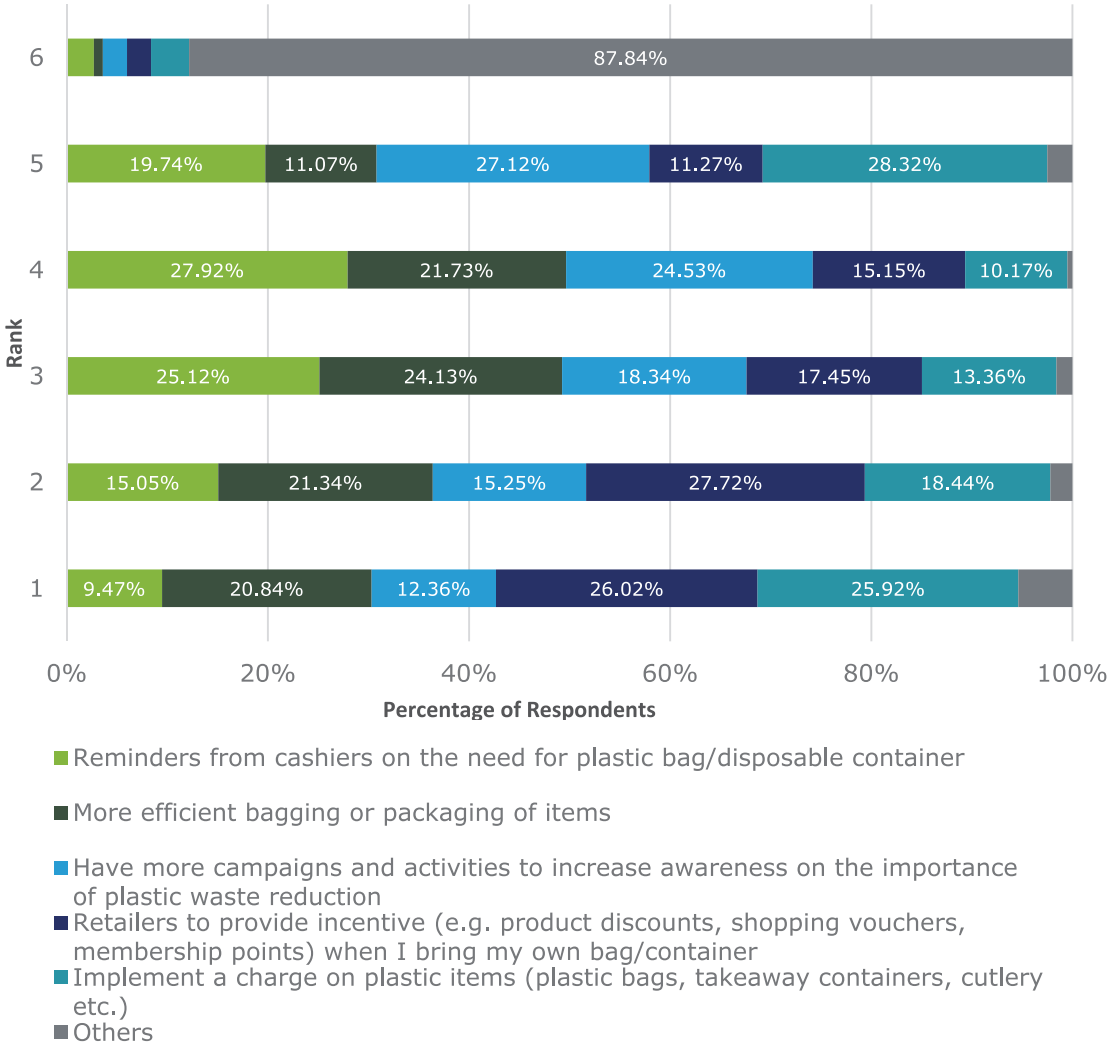

Figure 13: Most effective action (rank 1) to least effective action (rank 6) recommended by respondents to reduce unnecessary plastic usage

Respondents were given the option to select 'Others' and invited to insert their own recommendations to reduce unnecessary plastic usage. 87.84% of the respondents have ranked the 'Others' option as 6 and 169 respondents indicated additional remarks to reduce unnecessary plastic use (in addition to available options). The recommendations inserted by respondents were coded and categorised into three main recommendation themes.

Table 3: Recommendations provided by respondents to reduce the unnecessary plastic use

Others	
Recommendation	**Results**
Recommendation 1: Reduce plastic packaging	Stated by 11.24% of respondents
Recommendation 2: Limit the availability of plastic and convenience of plastic or provide environmentally friendly alternatives	Stated by 46.15% of respondents
Recommendation 3: Promote awareness and education about plastics and its use	Stated by 16.56% of respondents use
Recommendation 4: Improve the convenience of recycling facilities	Stated by 26.03% of respondents

Recommendation 1: Reduce Plastic Packaging

Respondents recommended that manufacturers should reduce the amount of plastic packaging on their products. Example responses categorised under this recommendation include:

Respondent 1:

"Encourage manufacturer to reduce packaging"

Respondent 2:

"Work with large companies to not individually wrap items that are then packaged again in plastic"

Respondent 3:

"Reduce use of plastic as a packaging material"

Respondent 4:

"Related to "more efficient bagging or packaging" - unfortunately, we must often buy fruit and some veggies in plastic-wrapped Styrofoam! This is terrible, but in some markets, there is no "unpackaged" fruit such as mangos or tomatoes"

Recommendation 2: Limit the availability of plastic and convenience of plastic or provide environmentally friendly alternatives

Respondents recommended that greater controls could be introduced to limit the availability of plastics, particularly single-use plastics. Respondents did not indicate whether the limits should be imposed by the government or by businesses or institutions. Example responses categorised under this recommendation include:

Respondent 1:

> "Ban the use of disposable PP containers or bottles."

Respondent 2:

> "(1) initially implement a nationwide supermarket "NO PLASTICS DAY" with all stakeholders involved, including enough pre-enforcement publicity campaign. (2) The next stage is for all supermarkets to enforce charging of items (plastic bags, takeaway containers, cutlery, etc.)"

Respondent 3:

> "Ban plastic straws and ban food plastic containers unless justified and necessary. Also, all retailers should be obliged by law to use biodegradable plastic bags. Ban plastic cutlery."

Respondent 4:

> "Do away with selling water in plastic bottles, have more water fountains"

Respondent 5:

> "Supermarkets can take back used plastic bags from last purchase"

Recommendation 3: Promote awareness and education about plastics and its use

Respondents recommended that there is a need for greater education and awareness on the use of plastics in Singapore.

Respondent 1:

> "More awareness about different types of plastics and how certain types may pose or are causing health and environment issues, and then how we can help"

Respondent 2:

> "Awareness at all ages, for example, screenings of the Blue Planet and then showing the daily habits of people in Singapore, e.g. Lau Pa Sat, a supposed tourist attraction for the clean and green "Garden city", uses ONLY disposals, Old Chang Kee uses ONE single-use plastic bag per item, daily habits of "da-bao-ing" tea and coffee. If awareness is raised on the need to cut down on these habits or bring their own containers (thermos flasks for drinks, food containers such as those used in the past to take away, a lot of plastic wastage can be reduced. "

Respondent 3:

> "Develop awareness in schools at all levels, also at all residents' n companies' activities. "

Recommendation 4: Improve the convenience of recycling facilities

Respondents recommended that there is a need to increase the number of recycling bins/location and provide incentives to make recycling more convenient.

Respondent 1:

> "Invest in recycling bins (one for each - plastic bottles, paper, wet waste in every condo/HDB. Fine those residents who do not separate the waste!!"

Respondent 2:

> "We really need more recycling bins in Singapore."

3.3.4.2. Recommendations On What Respondents Would Like To Find Out Regarding Plastic Waste Recycling

Respondents were asked to indicate what additional information they would like to access with regard to plastic waste recycling. They were presented with five options and asked to rank the options with one being most useful to five being least useful. The additional option of 'Others' was provided to encourage respondents to include additional information. The five options included:

- Types of plastics to be recycled
- Recycling campaigns/efforts in Singapore
- Benefits of recycling
- Location of recycling bin
- Others

The majority of respondents (45.16%) indicated that the most useful information they would like to find out was information regarding the types of plastics that can be recycled in Singapore. This was followed by the request for more information regarding the location of the recycling bin (29.01%) as the second most useful information.

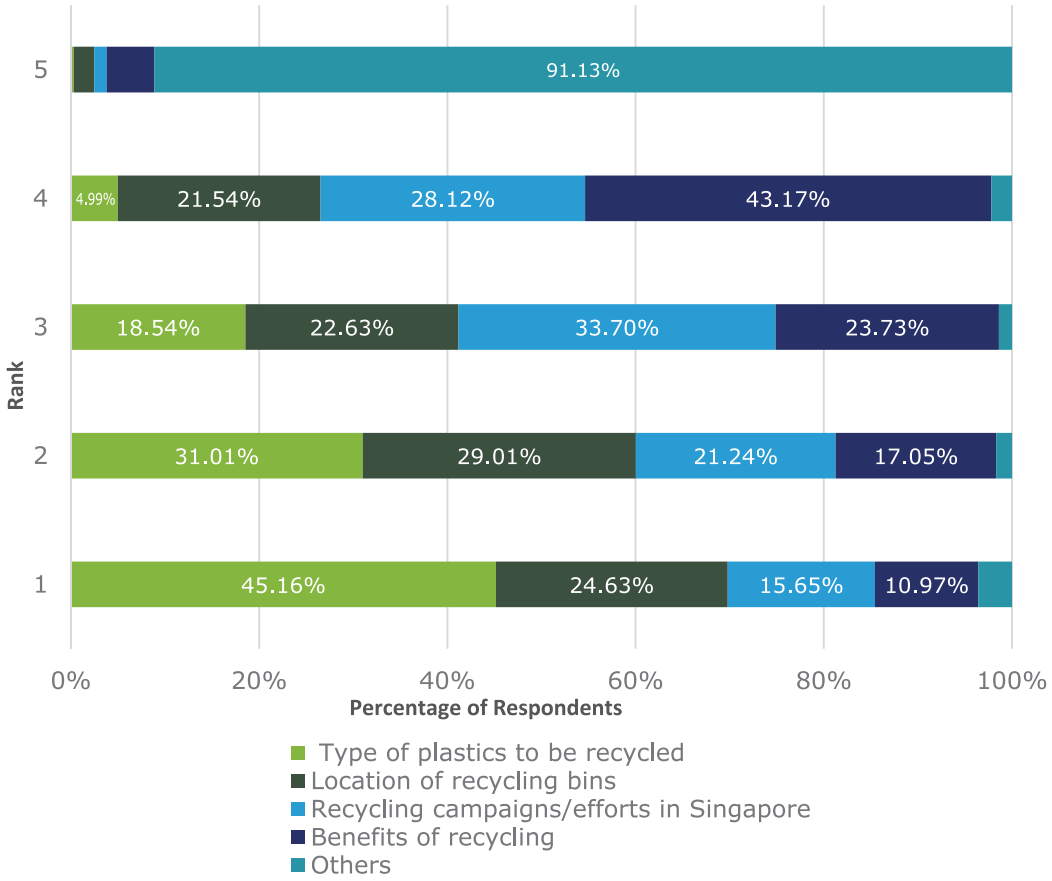

Figure 14: Most useful information (rank 1) to least useful information (rank 5) recommended by respondents regarding what they would like to find out about plastic waste recycling

A significant proportion of respondents (91.13%) ranked the 'Others' option as rank 5. Under this option, 94 respondents provided a range of additional suggestions on what they would like to find out regarding plastic waste recycling. These suggestions were coded and categorised into three main themes as given below.

Table 4: Suggestions provided by respondents on what they would like to find out regarding plastic waste recycling

Others	
Recommendation	**Results**
Recommendation 1: Provide more information on the recycled plastic lifecycle	Stated by 48.93% of respondents
Suggestion 2: Provide more information on how and what to recycle	Stated by 30.85% of the respondents
Suggestion 3: Provide more information on the environmental benefits of recycling	Stated by 20.21% of respondents

Suggestion 1: Provide more information on the recycled plastic lifecycle

The majority of respondents that selected 'Others' indicated that they would like more information on the lifecycle of plastic waste after it is disposed of in the recycling bin in Singapore. Example responses include:

Respondent 1:

"Where our plastics, papers, metals, and other materials go to when we recycle them? Does it create an even bigger carbon footprint or does it actually alleviate and help us reduce total wastage in the system?"

Respondent 2:

"Ultimate fate of the recycled plastic; gap in knowledge as people will find it difficult to link what is thrown in the recycling bin and the final recycled goods; Some illustrations will be beneficial"

Respondent 3:

"What happens to the recycled products? Are we really contributing?"

Suggestion 2: Provide more information on how and what to recycle

Respondents also indicated that they would like more information related to what types of materials can be recycled, and how they should be disposed of. Examples responses include:

Respondent 1:

> "General education about how to recycle, e.g. do you need to clean the plastic bottles before putting into the recycling bin? Do you need to put different plastic types into separate bags? What happens if you see rubbish in the recycling bins? Why are paper, glass and other recyclables placed in the same big bin as plastics? What can the general public do to help make the job of the recycling centres easier? What happens when rainwater enters the recycling bins? What happens when cats/dogs/birds/rats or other pests defecate/dirty in the bins?"

Respondent 2:

> "Be clear of which plastics can be recycled and have a separate bin for plastic waste"

Respondent 3:

> "What one needs to do before putting plastics into the recycling bin (e.g., washing it)?"

Suggestion 3: Provide more information on the environmental benefits of recycling

Respondents also indicated that they wanted more information relating to the environmental impact of plastic waste and the environmental benefits of recycling. A small percentage of respondents also responded that they would like recycling bins to be more easily accessible, and highlighted the need for increased consistency around the country to prevent confusion. Example suggestions included:

Respondent 1:

> "(We would like to know about) Campaigns on TV, Radio, and Online. I have not seen or heard anything on plastic recycling on these media. Schools, by Town Councils"

Respondent 2:

> "[We would like] to have a clear/transparent plastic to show the types of item /trash to be placed inside each bin instead of covered bin. Alternatively, have a standard colour code for all bins (Green bin - paper, Yellow bin - plastic, Red bin -food waste, Brown - other trash that is oily, etc.)"

3.3.4.3. Recommendations To Encourage Plastic Waste Recycling

Respondents were asked to indicate which recommendations they felt would be most effective in encouraging plastic waste recycling in Singapore. They were presented with six options and asked to rank the options, with one being the most effective recommendation, and six being the least effective recommendation. Respondents were also given the option of selecting 'Others' and submitting additional recommendations on what they thought could encourage plastic waste recycling in Singapore. The six options included:

- Provide incentives for recycling
- Weekly or monthly training/drives on recycling in housing complex
- Create awareness on the types of plastics that can be recycled and the method of recycling
- Place more recycling bins around my area/make recycling bins more accessible
- More media coverage on plastic waste recycling
- Others

The majority of respondents (38.58%) indicated that the provision of incentives for recycling is the most effective way to encourage plastic waste recycling. Respondents were asked to write what kind of incentive would be most effective to encourage recycling, according to them. Respondents suggested a broad range of incentive mechanisms, including monetary systems, point systems, cash discounts, rebates, coupons, vouchers, and discounts. Example recommendations included:

Respondent 1:

> "Businesses that form part of the plastic consumption should be obligated to handle and receive returns of plastic by customers in a reverse cycle so that those who generate the most plastic have the most responsibility to return plastic to its generating source. E.g. Customers who buy products with plastic packaging returns plastic to the supermarkets which in turn return to wholesalers, wholesalers return to plastic selling companies. Plastic selling companies receive some level of subsidy for recycling the plastic."

Respondent 2:

> "Discount when taking away food in own container or coffee in own cup"

Respondent 3:

> "HPB rewards or EZlink rewards - tag to any of the daily existing rewards platform"

In addition to recommending incentives, respondents also recommended the use of awareness raising efforts, as the second most effective recommendation (rank 2). Majority 26.82% of respondents recommended that recycling rates could be improved by placing more recycling bins around the country and making recycling more accessible. This was closely followed by 26.42% of respondents who recommended that more could be done to raise awareness on the types of plastics to be recycled and the method of recycling (rank 2).

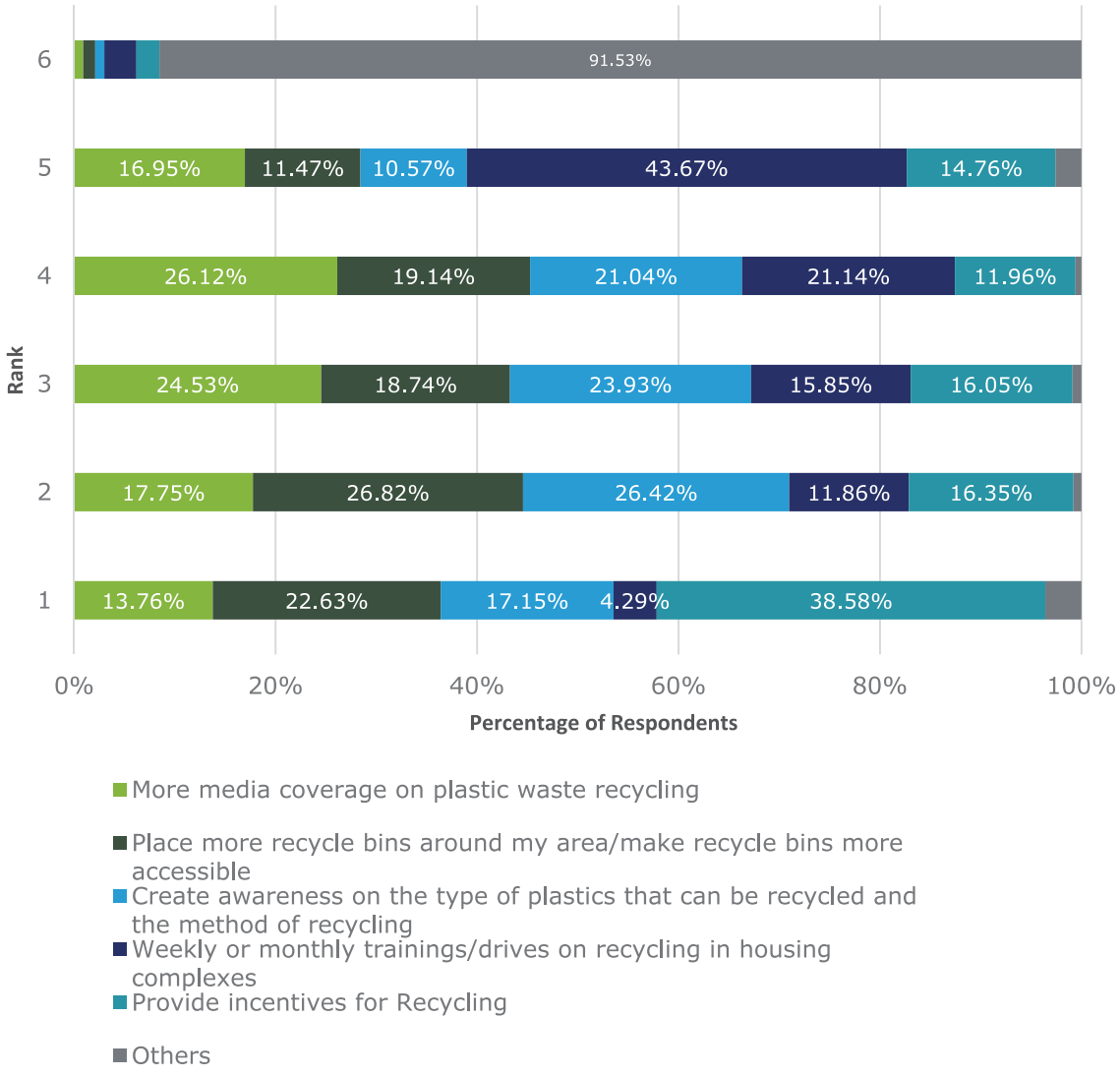

Figure 15: Most effective recommendation (rank 1) to least effective recommendation (rank 6) provided by respondents to encourage plastic waste recycling

The vast majority (91.53%) of the respondents ranked the option 'Others' as rank 6. Respondents that selected the 'Others' option, provided additional recommendations on encouraging plastic recycling. Example of recommendations provided by respondents include:

Respondent 1:

"Label all Plastics properly by recycling 1, 2, 3, 4, 5, and 6"

Respondent 2:

"Recycling practices should be extended to companies' sustainability efforts"

Respondent 3:

"Maintenance of recycling bins - most recycling bins are run down and broken"

Respondent 4:

"Reduce the use of plastic in the first place including tackling the issues previously mentioned. At the same time increase capabilities of recycling plastic and increasing the cost of single-use plastic to deter wastage"

Respondent 5:

"Provide easy access to separated bins e.g. Recycling bin/chute for plastic, paper and cans and a bin/chute for general waste"

Respondent 6:

"[Information about what consumers should] do before putting the recyclable items into the recycle bin e.g. bottles should be rinsed at least once from pretending foul smell, display how recycling can lead to lesser catastrophe in the world, best is just make the charges of the plastic containers and bottles more expensive"

3.3.5. Other Thoughts On Plastic Usage, Waste And Recycling In Singapore

Respondents were also asked to comment on their thoughts regarding plastic usage, waste and recycling in Singapore. A large proportion (64%) of the respondents have responded to the question expressing their thoughts on what should and shouldn't be done to reduce plastic usage and increase plastic recycling.

Some of the respondents have expressed their personal experience regarding plastic use or recycling. Some are given below:

Respondent 1:

"Coming from a different country, recycling here is very confusing. I'm not sure it exists (at my condo they seem like normal trash cans and I don't really see a recycling truck or something). It's also a normal way of life. We learned about how and why to do it in elementary school, and we came home and trained our parents, and now we get in trouble if we put things in the wrong bin. It needs to be a way of life, especially here where we don't have much space, not recycling should be heavily discouraged."

Respondent 2:

> “Singapore has to step up as an environmental leader in Asia. Lead by being the best example of caring about the environment. Make strict laws on recycling. If there can be a fine for littering, there should certainly be a fine on not recycling.”

Respondent 3:

> “The recycling bins found around my HDB block is always overflowing with waste of all sorts. It confuses me to see that one bin is meant for all types of recyclables (paper, aluminium, and plastics). As a result, most people don't treat the bins as a recycling bin and simply dump whatever. I hesitate the recycle because I feel like my recyclables will be contaminated and then dumped.”

Respondent 4:

> “A lot of people do not know what types of plastic can be recycled, or that those contaminated with food cannot be recycled. It is important to create awareness on recycling. Also to increase the numbers of recycling bins so that people can be constantly reminded to recycle instead of disposing of the plastics.”

3.4. Findings from Interviews

A total of 10 stakeholders were interviewed from November 2017 to May 2018, including 6 from the academia (3 research experts and 3 school teachers), 4 were from the industry (2 from waste management business, 1 from consumer goods manufacturing company and 1 from recycling industry). Karung Guni men, or Singapore's traditional rag-and-bone men who collect recyclables and other waste items from residences around Singapore, were also interviewed.

The main objective to interview key stakeholders was to better understand the plastic scene in Singapore and the efforts taken by countries in other parts of the world. Questions were targeted to understand the plastic consumption situation in Singapore, plastic recycling practices and advancements in Singapore and the world, challenges faced by the businesses and consumers and the future of plastic consumption and waste in Singapore.

3.4.1. Industry

Industry stakeholders were interviewed with the objective of a better understanding of the plastic waste ecosystem; plastic recycling trends and the challenges and opportunities associated with plastic recycling. The interviews were structured using a combination of open questions to promote discussion and analysis. A summary of the discussion is outlined below:

Plastic waste ecosystem

The interviews revealed insightful findings pertaining to the unique nature of Singapore's plastic ecosystem. Interviewees explained that while Singapore produces a large amount of raw plastics, raw materials/polymers/resins, many of these plastics are exported to manufacturers outside of the country. Singapore then imports plastic packaging and consumable packaging back into the country. This finding indicates that Singapore does not have the full packaging ecosystem located within its borders.

Plastic waste recycling

The interviews indicated that the majority of recycled plastic waste comes from storage, distribution, retailer and catering businesses, with a more limited proportion coming from residents.

Waste is organised and managed through multiple methods. There is a residential municipal waste collection and business-to-business contractors manage this waste collection. The waste collected by municipal collectors is sorted by public waste collection contractors and aggregated. Other contractors and larger aggregators sort commercial materials. Interviewees explained that there is a limited recycling of the

sorted plastic waste in Singapore due to limited manufacturing demand for recycled plastic. Therefore, these aggregated materials are traded on the global market and are recycled at manufacturing locations such as Malaysia, and formerly China (before the green fence).

At the municipal level, informal waste collectors, known as – 'Karang guni' – operate a door-to-door collection service of certain items such as newspapers, televisions, radios and computers. Low trade value is typically usually not collected. The Karang guni collector pays the residents during collection and sells the items to a recycler.

Plastic recycling challenges and opportunities

One interviewee highlighted potential challenges and opportunities associated with consumers and more broadly with the waste management industry.

The interviewees indicated that current rates of consumer consumption present a challenge to plastic recycling. In particular, the interviewee highlighted Singapore's dependence and over-use of plastics by consumers. They attributed this trend to convenience, cheap supply of plastics, resistance to change, and resistance to taking personal responsibility. Opportunities and suggested recommendations to curb the use of plastics included the introduction of financial levy's, such as a charge per bag at checkout in supermarkets, as well as financial incentives, such as the provision of discounts to people who drink coffee in reusable cups. The interview recognised that the introduction of financial penalties would likely result in resistance in the short term, but it offers and effective longer term solution to transition consumer behaviours.

From an industry perspective, challenges predominantly pertained to the separation and contamination of recycled plastics. The convenience of the waste chute system in many residential apartments means more plastic goes in the waste stream than in the recycling stream, and then to incineration. Of the plastic that is being disposed of in the recycling bins, there is a high risk of contamination due to the tendency of normal waste being thrown into the recycling bins.

Associated with this is the challenges faced by the waste collectors. Limited availability of waste collection workers has placed capacity constraints on Singapore's waste collection system. Few Singaporeans entering the industry, with limitations on the quota on foreign workers employed. Lack of manpower could be overcome by full automation technology. However, as the current rate of recycling is so low at present, there is insufficient incentive to justify the provision of source-segregated transport. Due to the low volumes of recyclables collected, the waste management businesses also do not want to invest in automation technology for sorting waste.

There is a lack of local demand for recycled plastic for manufacturing was identified as a primary constraint in the waste management business interviews and interview with the Karung Guni man (rag and bone man). For instance, the Karung Guni man stated that

plastics are not profitable relative to other materials such as e-waste. This is due in part due to the difficulty of storing plastics. Plastics occupy a lot of volume despite being lightweight. The Karung Guni man indicated that even at the peak of plastic price, 1 tonne of plastic waste only fetches SGD1.50, which is insignificant considering the logistical issue in transporting the waste volume over a long distance. High storage costs are further exacerbated by high transport costs. Collecting and transporting plastics does not provide enough revenue to recoup the costs.

The interviewees further underscored the potential impact of China's green fence policy where certain categories of plastic waste are prohibited from import into the country. The interview explained that the price per tonne for general waste is low and the disposal by chute is convenient. The long-term challenge will occur when the Semakau landfill is filled up, resulting to find a new landfill site that does not restrict port operations. Such a scenario will lead to increase in prices for disposal, and may consequentially create more lucrative opportunities for the plastic recycling industry.

The interviewees further emphasised that strategic regional development of manufacturing demand for recycled plastic would be viable to mitigate the above challenges. This can be achieved through bottle-to-bottle recycling, at food and beverage manufacturing, in neighbouring countries, and in automotive and other sectors. Recycled plastic demand development will improve value placed upon plastic, and will subsequently drive this demand through the entire value chain. The interview highlighted that source segregation is only effective for commodities that have a sustainable price or demand. Source segregation will not work any better than co-mingling if cost recovery for multiple collections cannot be sustained.

The interview concluded by stating that the future of plastic recycling in Singapore will not change unless the demand for sorted plastic recyclables is increased. This can predominantly be achieved by an aggregate and trade approach. Waste management businesses in Singapore would definitely need support once NEA builds the Integrated Waste Management Facility at Tuas South. Waste management businesses receive low to no returns during sorting of recyclable waste. The only returns received is while exporting the sorted materials for recycling. Support is also needed to reduce the landfill volume and reinvest of the cost saved from incineration to develop the recycled products market. At the same time, the policy support for regional integration with manufacturing in neighbouring countries is required.

3.4.2. Experts/Academics

Academics were interviewed with an objective of a better understanding of plastic consumption trends; consumer motivations and recommended actions to promote increased plastic recycling. The interviews were structured using a combination of open questions to promote discussion and analysis. A summary of the discussion is outlined below:

Plastic consumption trends

Plastic consumption pattern has faced insignificant change over the years. Although awareness is high, particularly on the ill effects of plastic use, consumption patterns remain unchanged. The interviewee explained that as a developed country, Singapore is lagging behind its peers. Plastic is still indiscriminately used with almost no motivation to bring reusable bags. The low price of plastics is aggravating this issue. Due to a change in lifestyle, Singaporeans frequently dine outside and unconsciously consume more plastic (in terms of plastic cups, straws, plates, etc.). Singaporeans spend most of their day at work rather than home, as such commercial entities are generating more waste relative to residential properties. Hence, efforts on controlling plastic consumption and increasing plastic recycling should be focused on commercial entities rather than on private residences.

They explained that the 'convenience factor' has a big role to play in this. Singaporeans are buying convenience as they have the buying power. Plastic is readily available in Singapore. People will not bother to bring reusable bags with them while buying groceries after work. There was a time when food was wrapped in paper, now it is packaged in plastic. Most of the people use the plastic bags to dispose/bag rubbish at home. Therefore, they find it necessary to accept plastic bags from the supermarket. The convenience of throwing rubbish down the chutes in private apartments and HDBs also underscores this convenience factor. The interviews with teachers further emphasised this view. One interview revealed that accessibility and location of recycling bins played a major role in the effectiveness of the school recycling system. Recycling bins and general waste bins should be located in close proximity to one another.

Another factor that is influencing plastic consumption is food safety. Food packaged in plastic prevents contaminations. However, consumers continue to request supermarket cashiers to separate wet and dry food, despite individual packaging to prevent these leakages. This behaviour indicates that consumers will likely resist or contend efforts to ban plastics.

The interviewee explained that recycling and waste disposal habits are often governed by human behaviour. It is important to understand human behaviour to bring a change in their habits. Based on Behavioural Science there are two systems that govern decision making: System 1 and System 2. System 1 is intuitive, based on reflex. System 2 makes one ponder and think, and take action accordingly. For recycling, people only use System 1 type of thinking, which results in all types of trash in the recycling bin. People do have a general desire to recycle, but since the system does not communicate what is recyclable and what item should go into what bin, it results in a lot of trash. Hence, people are forced to use System 2 thinking while they face System 1 problem. If you want people to behave in a certain way, we have to look at how the message is being communicated. This starts when recycling bins in the country are standardised.

Plastic recycling challenges and opportunities

The academic interviewee explained that co-mingled recyclable waste in Singapore has a high contamination rate; with 40% of the recyclables within the bin do not end up being recycled. Therefore, people's confidence in the recycling system is no longer there. All the factors affecting the outcome must be properly controlled, only then the system will work successfully, in addition to having a will and determination to make it work. This includes looking at bin location, bin cleanliness, the frequency of renewal and training the collection staff and most importantly the most economic and logistics arrangement of collection and recycling materials.

There are new recycling chutes built in the HDBs. However, these new recycling chutes may not increase the general recycling rate. As such, chutes are recently introduced in some of the HDBs; such features would take time to be implemented across the nation. In addition, co-mingled recycling chutes will not help in increasing recycling rates due to contamination. In those HDB complexes where this has been implemented, the recycling chutes are placed before the general waste chute. Due to the convenience factor, people are seen to dispose of all their waste in the recycling chute (since people have to walk ahead to dispose of general waste). Recycling infrastructure in Singapore can be improved by making logistics more viable and introducing some laws to address market failure. Subsidies should be introduced to help the waste management companies. The government should look at the total lifecycle costing of the waste management.

In Japan, there are various types of waste materials to be segregated, and yet people there are habituated to segregate their waste effortlessly. The challenge in Singapore primarily pertains to the education and awareness of adults and children. While people would ask the children to be educated, it has not been proven that children can influence the adults. This view was strongly conveyed by the interviews with teachers. Interviewees suggested that children are only moderately aware of the process of how waste is disposed of in Singapore. Most schools are taking efforts to educate students on the negative impact of plastics on the environment by organising talks for the students, conducting outreach programmes and having lessons with recycling messages as part of the curriculum. In spite of this, teachers say that there is a lack of awareness among students on the types of plastics that can be recycled in Singapore and how to recycle them.

Whilst schools can play a key role in promoting awareness with children, time and resources will need to be invested. One teacher indicated that there are too many programmes going on in school and it is difficult for teachers and students to dive deeper into one particular subject in school.

This should be studied and tested to develop proven intervention tactics. The interviewee further explained that the government or retailers could consider incentives to encourage people to practice recycling, can also be beneficial. Incentives need not

only be financial. 'Feel good' feeling can be considered as an incentive, as the crowding effect can influence the majority to practice recycling.

Singapore also faces various challenges in sorting and cleaning of plastics. Without cleaning, other countries will not accept the used plastics. As water is a scarce resource and is costly, it is rare that used plastics are cleaned with water prior to export. Technology is available but return on investment ("ROI") is not attractive. The common lease period of 15 years is too short to justify investing in such technology. The land cost to build waste management facilities is prohibitively high as well. Since waste management companies do not invest in technology, they would have to rely on foreign workers. Unlike other high profile industries that Singapore is well known for, the waste management industry is not considered glamorous and hence not many people would likely to join such an industry. Therefore, the Singapore government may need to subsidise the technology in the future. If not, the waste management companies will not survive financially in the near future.

4. ANALYSIS OF FINDINGS

4.1. High Plastic Use in Singapore

Single-use plastics are those forms of plastics that are used only once before disposal or recycling. Survey findings show that the population of Singapore is heavily dependent on single-use plastics, with increasing consumption patterns for plastic bags, and high consumption of PET bottles and PP items.

1. **Plastic Bags:**
   With the majority of the population going to the supermarket 3 to 5 times in a week and requesting between 1 and 5 plastic bags per shopping trip, the annual plastic bag consumption has risen drastically. The previous study conducted by SEC in 2013 revealed that most people use plastic bags to bag and dispose of general waste in Singapore. This has not changed and results still show that 67% of people are most likely use plastic bags to bag and dispose of general waste. As such initiatives to ban or tax plastic bags in Singapore are unlikely to be well-received by people owing to their dependency on this behaviour. Convenience has also played a key role for people to readily accept plastic bags. Convenience and habit play a key role in plastic consumption in Singapore. However, not all types of plastic bags can be used to line the garbage bin and reduction efforts should start by focusing on such plastics (single-use plastic bags). These include smaller bags given by bakeries, or plastic rolls placed at supermarkets to bag vegetables and fruits which are often disposed of with no apparent after-use.

2. **PET Bottles:**
   Survey results show that the annual PET consumption in Singapore is high, with 467 million[9] bottles being used per year. The results further show that 37.09% of respondents are most likely to recycle PET bottles, and 36.89% have indicated that they are most likely to re-use the bottle. However, consumption is still high as bottled drinking water is a SGD134 million industry in Singapore with most of the water available in PET plastic packaging. PET bottles are recyclable in Singapore, and there is a need to cut-back consumption at the source and increase the recycling capacity of PET bottles in Singapore.

[9] Estimated figure based on survey findings and this is linearly scaled using Singapore's population aged 20 and above (mid-year estimate 2017 which is obtained from Department of Statistics Singapore), which is the closest available demographic profiles of the survey respondents

3. **PP Plastics**

   From the survey results, estimation shows that the number of PP items consumed per year is 473 million[10], which is significantly high. Take-away containers significantly contribute to the high consumption of PP plastics. Targeted efforts are needed to encourage environmentally friendly packaging alternative or bring your own containers, and make it difficult to obtain plastic take-away containers.

4. **Styrofoam**

   Styrofoam containers present a clear example of the single-use plastics since they cannot be recycled or easily re-used. Styrofoam containers are used in Singapore as take-away containers for food. Findings show that 20.13% of the respondents in the survey think that Styrofoam can be recycled in Singapore. Just like PP plastic take-away containers, alternatives for Styrofoam is much needed to reduce the consumption of this single-use plastic.

   Single-use plastics are cheap and convenient to obtain, but use a lot of resources for manufacturing and have detrimental impacts on the environment. Significant effort need to be taken to reduce the use of these plastics, as well as increase the recycling capacity for those plastics that can be recycled.

4.2. Lack of Awareness among Consumers

1. **Lack of Awareness on what to Recycle**

   One of the most prominent findings from the survey results was that most respondents are not fully aware of what types of plastics can be recycled in Singapore – which is about 70% of the sample population. Findings from an interview with one of the academic experts revealed that recycling behaviour is automatic and intuitive. The expert has mentioned that people do desire to recycle, but since the system does not communicate what is recyclable and what item should go into what bin, recycling bins are contaminated with mixed waste. This fails the recycling process. Moreover, recycling bins in all public spaces are of different designs and colours, which make recycling confusing and difficult.

   As recommended by 45.16% of the respondents, the most useful information they would like to know regarding plastic waste recycling is an awareness of the types of plastics that can be recycled by them. Similarly, there is a need to make recycling an automatic yet an effective process by standardising the recycling bins throughout the country.

[10] Estimated figure based on survey findings and this is linearly scaled using Singapore's population aged 20 and above (mid-year estimate 2017 which is obtained from Department of Statistics Singapore), which is the closest available demographic profiles of the survey respondents

2. **Lack of Awareness on how and where to Recycle**

Regarding the most likely reason why respondents would not like to recycle, 21.64% of the respondents, have chosen the option 'Others' and have indicated various reasons on why they would not recycle plastics. In this category, the highest percentage of respondents (35.92%) have commented that they find it inconvenient to wash and dry recyclables. Many others within this category who have indicated that they are not able to remove the food and oil contaminants from the plastics prior to recycling and hence do not recycle plastics. For those plastics that can be recycled, the NEA list of recyclables states to empty and rinse when necessary. Cleaning plastic containers to perfection is not compulsory. People need to be informed of this to encourage more recycling.

Survey findings also showed that 21.24% of the respondents find it inconvenient to take recyclables to the recycling bin. This shows that recycling bins are not prominently placed around these areas. Recycling is also not as convenient as throwing rubbish into the chute. Recycling chutes in new HDBs are making it more convenient to recycle, but if respondents aren't aware of what and how to recycle, this would lead to contamination of the recycling bins. These results emphasise the need to develop recycling solutions that are convenient for the consumer, and educating consumers on how to recycle effectively to avoid contamination.

3. **Lack of Awareness on Process of waste management in Singapore**

Out of 206 respondents who have given several options on why the most likely reason why they would not recycle plastics, 30 respondents have indicated that they do not recycle because they think their recyclables end up with general waste. Respondents have also indicated on wanted to know about the waste flow process in Singapore and what happens to recyclables after they have been placed in the recycling bin. This shows residents have not been made aware of the entire landscape of recycling in Singapore, which includes what they must recycle, how they must recycle, where to find the bins and what happens to their recyclables thereafter.

4.3. Recycling Efforts are Concentrated Upstream

The surveys and interview findings show that, with the introduction of the National Recycling Programme in 2001, all efforts to increase the recycling rate is concentrated at the consumer level or upstream. Findings from an interview with a prominent waste management company in Singapore showed that the infrastructure for recycling can improve to make logistics more viable for transport of segregated recyclables. Studies (Keppel Seghers, 2012) also show that countries around the world are investing in infrastructure to improve their recycling rates downstream i.e. at the waste collection and incineration level. For Singapore to regain its status as a leader in waste management, the government may need to explore additional infrastructure investment. There is a need for smart and disruptive infrastructure and process in Singapore to facilitate waste recovery upstream. Recycling efforts both upstream and downstream will lead to effective waste management and significant material recovery.

4.4. Limited Market for Recycled Products

The NEA website and other PWC websites have stated that domestic and industrial recyclables in Singapore are taken to material sorting facilities where they are sorted mechanically, baled and sent to local recyclers or exported for recycling. Furthermore, 7.60% of the total plastic export from ASEAN to China is from Singapore. Singapore is also known to send plastic waste to other countries in South-East Asia. The actual recycling of plastic takes place in these countries, which will be used to manufacture new products. As Singapore is not a manufacturing hub of plastics, there is no market within Singapore to recycle plastics. However, an industry that uses recycled plastics can be identified and a market for recycled plastics can be built within Singapore to cater to this industry. This would support the principle of circular economy in Singapore with plastic waste, as well as boost the economy of the country.

5. RECOMMENDATIONS

5.1. Efforts to Raise Awareness through Effective Campaigns

The targeted nationwide campaign could be implemented to increase consumer awareness of the environmental impacts of plastic waste and increase consumer knowledge on the type of plastics that can be recycled as well as the steps necessary to prepare the plastics for recycling in Singapore.

1. Campaigns for Awareness on Recyclables

Campaigns ideas such as "Know Your Recyclables" would bring more awareness to people regarding the type of plastics that can be recycled and the steps necessary to prepare plastics to be recycled (such as cleaning it before it is deposited into the recycling bins) to reduce contamination.

i. In public spaces, such as MRT stations, trains, elevators, bus stops and buses, advertisements in the form of posters can be displayed in an attractive manner via framing the posters with plastic bottles. The content of the posters would discuss the types of plastics that can and cannot be recycled and alongside, instructions on how to pre-treat plastic recyclables.

ii. Promote mobile applications such as myENV mobile application developed by NEA and other such channels by incentivising downloaders of the app with a rewards system. The myENV mobile application contains the necessary information regarding why, what and how to recycle. Improvements to the application can include a more interactive user-friendly interface and the inclusion of games to entice the younger generation to adopt the use of this application. The completion of games in the application as well as carrying out recycling actions will reward points to the user to be used in the rewards scheme.

iii. Organise talks for schools, universities and community centres inviting PWCs and Material Sorting Facility owners to educate and raise awareness on the types of items that can be recycled, what happens to recyclables and method of recycling.

iv. Leverage on digital signage to show short video clips on trains, bus stops and in shopping malls on the types of waste (including plastics) that can and cannot be recycled as well as the steps required to prepare waste for recycling. The visual demonstration would capture more attention from commuters than a static poster or written text containing the same information. The video could also show what happens to recyclables after consumers deposit their recyclables into the recycling bin. This serves to educate people and clear misconceptions on the outcome of recyclables.

2. Efforts to Reduce Single-Use Plastics

Campaigns that focus on single-use plastics, explaining why we must reduce our dependence on them, what the alternatives are, and where to find them, may be effective topics. Campaigns conducted in partnership with industries that sell or use eco-friendly alternatives will also be necessary to raise awareness on where to obtain alternatives to single-use plastic.

i. Campaigns could include posters on what are single-use plastics and why we must stop using them. These should be placed in public places, especially in hawker centres and food stalls near commercial complexes. Taglines such as, "It is just one plastic straw, said 5.6 million Singaporeans" can be used to promote awareness on the scale of the Singapore's plastic waste footprint or the harmful effects of straws and the non-recyclability of them.

ii. SEC and the government could work with hawker centres and start-up organisations to promote alternate forms of eco-friendly packaging to provide to the hawker centres and to encourage consumers to bring their own reusable containers. Several start-ups have developed sustainable packaging containers. Consumers can be given a choice to take away food in plastic containers or alternate packaging material (with or without the difference in price for both types of packaging). Sustainable packaging option would help reduce the plastic use of consumers, at the same time boost sustainable start-up companies in Singapore.

iii. As the majority, 38.58% of the respondents have indicated that providing incentives for recycling would be the most effective way to encourage plastic waste recycling, campaigns could also focus on working alongside major hawker centres and food stalls around Singapore to device a system to provide incentives to consumers if they bring their own containers. Food coupons, rebates, vouchers, for instance, can be used to incentivise consumers to motivate them to bring their own containers. Posters on bringing own containers.

iv. The campaign could encourage company employees to store their own containers in office pantries and use them to take-away food, instead of using Styrofoam and plastic cutlery. Similarly, companies can provide steel/glass containers and cutlery to their employees to be used during food take-away. Partnering with companies can promote this initiative, and for companies, this can be a part of their Corporate Social Responsibility (CSR) strategy.

v. Introducing water fountains in public areas can incentivise people to bring their own bottles to re-fill water instead of buying PET packaged drinking water bottles.

5.2. Standardisation of Recycling Bins in Singapore

As highlighted by a prominent academic during the interviews, recycling behaviour is intuitive. The interviewer also highlighted the need to standardise Singapore's recycling bin system to support this behaviour. Another academic has highlighted the need to promote recycling and waste management in public and commercial entities. This goes to show that there is a need to concentrate recycling efforts in public and commercial entities by standardising recycling bins and its design throughout Singapore, which clearly explains what can and cannot be recycled.

a. Nationwide initiative for increasing the awareness and encouragement of recycling. This may include diverting the attention of the public from throwing waste into general trash cans, towards the recycling bins. This could include placing creative signs on general trash cans pointing out the items that should not be thrown inside. The sign can also direct the public to the nearest recycling bin.
b. Prominent academic interviewed mentioned that design plays a key role in regulating recycling behaviour. The recycling bins should be designed in a way that should promote recycling in a fast, automatic and frequent manner, instead of a slow, logical and calculating manner. The bins should facilitate information absorption automatically. The main aspect of the bin design is to make recycling an automatic process that does not require people to read and comprehend their actions. Design of the bin should facilitate the public to be informed on their recycling decisions prior to disposal into the bin. The design should also prevent unwanted disposal of recyclables into the bin. The following should be emphasised during design:

Standardisation of:

- Bin colour
- Bin shape
- Labels/information

Consideration to be given to:

- Bin location
- Bin cleanliness
- Innovative design of bins that prevents disposal of unwanted recyclables
- Frequency of waste removal
- Training of janitorial staff
- Logistic arrangement of collection of recyclables

5.3. Concerted Effort for Plastic Reduction and Recycling in Singapore

Review of literature from case studies of good recycling practices around the world has one aspect in common – which is the concerted effort taken by all stakeholders involved in recycling, to bring about a collective change to the system. Similarly, in Singapore, recycling efforts should not be cornered to one end of the ecosystem. Instead, recycling should be addressed collectively by all stakeholders in the system.

1. **Dedicated Recyclable Collectors**
   To improve the efforts of recycling in Singapore, specialised companies that primarily deal with recycling should be given the opportunity to operate in Singapore. Specialised recycling companies possess the necessary recycling technology and capabilities to handle recycling in Singapore. This opportunity exploitation for specialised companies to venture into Singapore could be done by separating the contracts for collection of general waste and recyclables. Furthermore, this could also potentially be a good investment opportunity for the government to not only improve the recycling rates in Singapore but also establish an economy for recycled materials.

2. **Downstream Recycling Efforts in Singapore**
   The public-private partnership of the waste-to-energy facilities in Singapore should account to include material sorting facilities to divert recycling waste from general waste for incineration. Downstream recycling efforts can supplement upstream recycling efforts to make the recycling system in Singapore more robust. Keppel Seghers owns and operates two waste-to-energy plants in Singapore. The company operates a Domestic Solid Waste Management Centre (DSWMC) in Qatar which is an integrated waste management system that treats mixed domestic solid waste. The DSWMC comprises state-of-the-art waste sorting and recycling facilities, a composting plant, and waste-to-energy incineration plants (Keppel Seghers, 2012). This model can be replicated for Singapore – with only the addition of composting and waste sorting and recycling facility. Similarly, NEA owns two of the waste-to-energy plants. Through these facilities, NEA can replicate the same model to recover recyclables within the facility of incineration.

3. **Innovation to Reduce Plastic Packaging Waste**
   Public sector organisations and NGOs could also partner with major packaging waste industries, such as food and beverage and consumer goods, to reduce plastic packaging of their products. These industries can account for this as their CSR activity, and at the same time, increase their brand reputation and have a positive impact on the environment.

4. Building a Market for Recycled Plastic through Innovation

Upstream and downstream recycling efforts would not be effective unless there is a market built to collect and use the sorted recyclables. Government and public sector organisations could step-in to support existing markets in Singapore that are using specific types of plastics for manufacturing recycled plastic pellets. Buy-back centres for recyclables should be given government aid to support the principle of circular economy. At the same time, labour constraints for these sectors should also be eased to facilitate capacity growth in these industries.

By establishing a market for recycled plastic, Singapore will be able to address the emerging limitations presented by China's green fence policy and advance its position as Asia's innovation hub, by developing innovative methods to reintroduce recycled plastic into the economy to aid growth and build a circular economy. For instance, the use of recycled plastic can support the current manufacturing segments in Singapore.

Medical Manufacturing - Use of Shredded Plastic for 3D Printing

The use of recycled plastics is finding its way into various industries, such as 3D printing. 3D printing allows the manufacturing of three dimensional objects from a digital file. Just like an inkjet printer needs ink cartridges to be able to print, 3D printers need plastic filament. According to Wohlers Report 2016 (McCue, 2016), the 3D printing industry grew to USD 5.16 billion in 2015 and was projected to grow to USD 16.2 billion in 2018 (Chang, 2014).

Economic Development Board (EDB) of Singapore posted an article in January 2018, on how 3D printing is transforming biomedicine in Singapore (Economic Development Board, Singapore, 2018). Based on the article, Singapore is leading the world in biomedicine, and 3D printing is the new technology that is making this possible.

Several start-up companies around the world are devising machines to produce plastic filaments to be used for 3D printing machines. Singapore's plastic waste stream should be directed towards recycling for biomedicine companies – for 3D printing for prosthetics (Charleston, 2017), and other medical devices. This would not only create a demand for recycled plastics within Singapore, but also reduce virgin plastics used for the 3D printing process in Singapore, at the same time contribute to the development of the biomedicine industry within Singapore, and a circular economy.

Electronics Manufacturing with Recycled Plastic

Singapore plays a leading role in the electronics industry. According to the Economic Development Board in Singapore many gadgets such as disc drives, printer heads and batteries are created in Singapore (Economic Development Board, 2018). More and more electronics manufacturers are using recycled content in the plastics used in electronics (Powell, 2017). Singapore can position itself as the innovation lead to provide recycled plastics in electronic components such as commercial flat-panel displays and ink and toner cartridges. There is also a lot of research work being undertaken in Singapore to push the boundaries of Artificial Intelligence (AI) and autonomous vehicles (AVs). The use of AI can be implemented to automate waste recycling in Singapore which would cut costs of labour intensive waste collection and sorting, and help achieve recycling at a reduced cost.

Chemicals – Plastic to Fuel

American Chemistry Council in 2011 published a paper on the use of pyrolysis technology to convert plastics to oil and fuel. Such technology includes conversion of plastics to gas, which is then converted to liquid, followed by acid removal process and finally, the separation or refining (American Chemistry Council, 2011). Over the years, similar technologies have been developed and perfected and are available for wide-scale adoption. The use of such technology provides the opportunity to overcome shortage of landfill space in Singapore, increase the recovery of plastics, aid Singapore's petrochemical segments for economic growth and provide a circular economic model for plastics.

5. **Replace Single-Use Plastic Bags/Rolls with Alternatives and Limit Plastic Bag Usage**

Not all types of plastic bags can be reused to line the garbage bin and reduction efforts should start by focusing on such single-use plastic bags. These single-use plastic bags include smaller bags given by bakeries, or plastic rolls placed at supermarkets to bag vegetables and fruits and are often disposed of with no apparent after-use. Public sector organisations and NGOs could partner with major privately owned supermarkets in Singapore to replace plastic bag rolls for vegetables and fruits with effective alternatives. For instance, reusable bags made from super light, durable ripstop nylon or reusable organic cotton muslin bags act as a good substitute. The same initiative should be taken for bakeries across Singapore where consumers are encouraged to bring their own reusable containers when purchasing bread from bakeries instead of using the small non-reusable plastic bags provided. In tandem with this replacement initiative for supermarkets, a campaign titled "Two-is-Enough" will serve to limit the number of plastic bags taken at the cashier and encourage customers to bring their own bags thus this serves as an effective two-pronged approach for plastics reduction.

5.4. Legislation & Policy Measures

A mandate is needed to increase the recycling rate from 6%.

1. **Packaging waste reducing initiatives – reporting and declaration**
   Countries such as Hong Kong, South Korea, and Taiwan have introduced mandates for packaging companies to declare the amount of plastics they use to package their products, as well as mandate to set targets to reduce the plastic packaging. Such mandates could facilitate engagement and collaboration between packaging and recycling companies and accelerate the transition to a circular economy. Packaging companies can work alongside industries to develop innovative methods to sell their products through smart packaging techniques.

   The statutory board in Singapore has announced that companies would be subject to mandatory reporting of packaging data and waste reduction plans by 2020. Mandating companies to print the recyclability information of their packaging products (such as resin number in PET bottles) would facilitate upstream sorting and recycling and is also necessary to ensure efficient collection of recyclables. This initiative, coupled with the campaign on creating awareness of the types of plastics that can be recycled, would target both upstream and downstream actors in the plastic ecosystem.

2. **Step-Wise Reduction of Plastic Bags and Plastic Packaging**
   A significant proportion of survey respondents (67%) indicated that bagging and disposing of general waste in a plastic bag is the most likely after-use pattern of consumers. Thus, big initiatives such as charging for plastic bags, or banning plastic bags in Singapore would affect consumers, and their habit to bag and dispose of waste in plastic bags. Instead, a step-wise approach to reduce single-use plastics can be adopted. The first immediate step could focus on reducing the use of those forms of plastics that are generally not reused by consumers for bin liners or for other purposes. These include small plastic bags obtained at bakeries, plastic packaging of vegetables and fruits at supermarkets, and plastic bag rolls to collect and weigh the fruits and vegetables.

3. **Recycling in commercial entities**
   The interviews with representatives from the waste management industry and academia underscored that commercial entities produce more plastic waste than consumers. Therefore, amending the National Recycling Programme to mandate PWC to provide recycling bin and recycling collection services to commercial entities in addition to the current provision may improve recycling rates in Singapore. Such an amendment to the National Recycling Programme could take into account the number of commercial entities operating in the public waste collection sectors, and accordingly, provide tender to PWC to collect recycles from the bins. As indicated by the prominent PWC professional interviewed, the cap on foreign labours should also be eased to support PWCs with recyclables collection and sorting.

6. CONCLUSION

Singapore needs to urgently address its high plastic consumption rates and improve its low and stagnating recycling rates. Singapore needs to reassess its plastic use, re-use and disposal habits to prepare for two major changes in its plastic ecosystem. China, Singapore's largest plastic waste export partner plans to ban imports of plastic waste. At the same time, Singapore's primary domestic landfill site is nearing capacity, other countries have developed processes and technologies to recover and recycle useful material to be re-used by the economy, Singapore seems to be lagging behind.

This position paper proposes two effective ways to approach the plastic problem in Singapore through mitigation and management (or the 2-Ms):

- Mitigating the use of single-use plastics
- Management of plastic waste to stimulate a transition from a linear economy to a circular economy

Convenience and habitual use of a range of plastics have resulted in high plastic usage in Singapore. As the majority of people re-use plastic bags, this position paper does not recommend the introduction of financial penalties, such as a per bag levy on consumers. Instead, this position paper recommends that more focused efforts should be targeted at mitigating the consumption of single-use, e.g., non-recyclable plastics, in Singapore. Low levels of awareness on the impact of single-use plastic could be countered through a step-wise approach to reduce plastic, which is needed to reduce the plastic waste load in Singapore. Step one can be to replace plastics that are generally not re-used by consumers, with environmentally friendly alternatives.

Effective management of plastic waste is also needed to recover recyclable materials and create a circular economy within Singapore. Low levels of awareness of people on the types of plastics that can be recycled could be overcome through targeted engagement and awareness raising. Campaigns targeted at consumers should provide information on the plastic lifecycle, and the types of plastics that can be recycled in Singapore. Upstream recycling measures coupled with awareness and concerted efforts to promote recycling downstream would lead to better recycling rates in Singapore. This will make recycling a profitable business within Singapore, and create a circular economy. For instance, the introduction of corporate subsidies or collaborative initiatives could incentivise and accelerate demand for recycled plastics.

The domestic plastic ecosystem in Singapore is complex with various factors and stakeholders involved. Learning from leaders in plastic waste recycling, such as Taiwan and Germany, highlight that all stakeholders have an equally important part to play in implementing a robust system of waste reduction and resource recovery. Only with a concerted effort by all stakeholders can Singapore progress to reduce dependency on plastics and effectively manage its waste.

APPENDIX

1. APPENDIX- A

Survey Questionnaire

1. Gender:

☐ Male ☐ Female

2. Age:

☐ 15 - 25 ☐ 41 - 60

☐ 26 - 40 ☐ Above 60

3. Number of people in my household:

☐ I live alone ☐ 4 - 5 people

☐ 2 - 3 people ☐ More than 5 people

4. Highest educational qualification:

☐ Primary / Secondary school ☐ Degree

☐ ITE / Diploma / A levels ☐ Post-graduate

☐ Others (please state): _____

5. Occupational status:

☐ Employed ☐ Student

☐ Unemployed ☐ Housewife/homemaker

☐ Others (please state): _____

6. Type of housing:

- ☐ Condominium / Apartment
- ☐ Landed property
- ☐ HDB
- ☐ Others (please state):

7. How many times do you shop at the supermarket per month?

- ☐ 1 - 2 times
- ☐ More than 10 times
- ☐ 3 - 5 times
- ☐ I do not shop at the supermarket
- ☐ 6 - 10 times

8. How many plastic bags do you take from the supermarket per shopping trip?

- ☐ 1 - 2 plastic bags
- ☐ 6 or more plastic bags
- ☐ 3 - 5 plastic bags
- ☐ I always bring my own bag
- ☐ Not applicable

9. Do you request for separate plastic bags to hold your wet and dry items at the supermarket?

- ☐ Yes
- ☐ No
- ☐ Not applicable

10. How many PP items do you purchase per week?

- ☐ 0 - 1
- ☐ 5 - 7
- ☐ 2 - 4
- ☐ More than 7

11. How many PET bottles do you use per week?

☐ 0 - 1 ☐ 5 - 7

☐ 2 - 4 ☐ More than 7

12. Please rank which action you are likely to take after using PP Items.
(Please drag and rank options in order, with 1 being most likely and 3 being least likely)

1 Dispose in garbage bin

2 Reuse item (please state what you would reuse item for):

3 Recycle

13. Please rank which action you are likely to take after using PET bottles.
(Please drag and rank options in order, with 1 being most likely and 3 being least likely)

1 Recycle bottle

2 Reuse bottle (please state what you would reuse bottle for):

3 Dispose in garbage bin

14. Please rank which action you are likely to take after using HDPE plastic items.
(Please drag and rank options in order, with 1 being most likely and 3 being least likely)

1 Reuse bottle (please state what you would reuse bottle for):

2 Dispose in garbage bin

3 Recycle

15. Please rank which action you are likely to take after using PP Items.
(Please drag and rank options in order, with 1 being most likely and 5 being least likely)

1 Use them to bag and dispose of general waste

2 Store them (please state what you would store the plastic bags for):

3 Reuse plastic bag (please state what you would reuse the plastic bags for):

4 Dispose in garbage bin

5 Recycle

16. Please select the types of plastics that can be recycled in Singapore.
(You may select more than 1 option)

- ☐ Plastic Bags
- ☐ Bottled Drinking water
- ☐ Take-away containers (Non-polystyrene)
- ☐ Detergent Bottles
- ☐ Styrofoam containers

17. Are you aware of where the nearest recycle bin is located?

- ☐ Yes
- ☐ No

18. Please rank which action you are likely to take after using HDPE plastic items.

- ☐ Too few items to recycle
- ☐ Will reuse it for other purposes instead of recycling
- ☐ Inconvenient to separate recyclables from normal waste
- ☐ Inconvenient to bring recyclables to the recycling bin
- ☐ Others (please state):

19. Please rank the recommendations to reduce unnecessary plastic usage.
(Please drag and rank options in order, with 1 being most effective and 5 being least effective)

1 Have more campaigns and activities to increase awareness on the importance of plastic waste reduction

2 More efficient bagging or packaging of items

3 Retailers to provide incentive (e.g. product discounts, shopping vouchers, membership points) when I bring my own bag/container

4 Implement a charge on plastic items (plastic bags, takeaway containers, cutlery, etc.)

5 Reminders from cashiers on the need for plastic bag/disposable container

6 Others (please state): _____

20. Please rank the options on what you would like to find out about plastic waste recycling.
(Please drag and rank options in order, with 1 being most useful, and 5 being least useful)

1 Type of plastics to be recycled

2 Others (please state): _____

3 Recycling campaigns/efforts in Singapore

4 Benefits of recycling

5 Location of recycling bins

21. Please rank the recommendations to encourage plastic waste recycling.
(Please drag and rank options in order, with 1 being most effective and 5 being least effective)

1 Place more recycle bins around my area/make recycle bins more accessible

2 Provide incentives for recycling (Please state what kind of incentive):

3 Weekly or monthly trainings/drives on recycling in housing complexes

4 Others (please state):

5 More media coverage on plastic waste recycling

6 Create awareness on the type of plastics that can be recycled and the method of recycling

22. Any other thoughts on plastic usage, waste and recycling in Singapore?

2. APPENDIX – B

Types of Plastics

LDPE Plastic Bags:

Source: https://www.polymersolutions.com/blog/differences-between-ldpe-and-hdpe/

PET Bottles:

Source: http://www.allpetbottles.com/

PP Disposables:

Source: https://www.alibaba.com/product-detail/clear-plastic-square-pp-disposable-fresh_60668249901.html

HDPE Bottles:

Source: https://www.tradeindia.com/fp3875697/HDPE-Plastic-Bottles.html

Styrofoam containers:

Source: http://www.liveinthenow.com/article/foam-cups-and-containers-officially-linked-to-cancer

3. APPENDIX – C

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APPENDIX

1. APPENDIX- A

Survey Questionnaire

1. Gender:

☐ Male ☐ Female

2. Age:

☐ 15 - 25 ☐ 41 - 60

☐ 26 - 40 ☐ Above 60

3. Number of people in my household:

☐ I live alone ☐ 4 - 5 people

☐ 2 - 3 people ☐ More than 5 people

4. Highest educational qualification:

☐ Primary / Secondary school ☐ Degree

☐ ITE / Diploma / A levels ☐ Post-graduate

☐ Others (please state): _____

5. Occupational status:

☐ Employed ☐ Student

☐ Unemployed ☐ Housewife/homemaker

☐ Others (please state): _____

6. Type of housing:

- ☐ Condominium / Apartment
- ☐ Landed property
- ☐ HDB
- ☐ Others (please state): _____

7. How many times do you shop at the supermarket per month?

- ☐ 1 - 2 times
- ☐ More than 10 times
- ☐ 3 - 5 times
- ☐ I do not shop at the supermarket
- ☐ 6 - 10 times

8. How many plastic bags do you take from the supermarket per shopping trip?

- ☐ 1 - 2 plastic bags
- ☐ 6 or more plastic bags
- ☐ 3 - 5 plastic bags
- ☐ I always bring my own bag
- ☐ Not applicable

9. Do you request for separate plastic bags to hold your wet and dry items at the supermarket?

- ☐ Yes
- ☐ No
- ☐ Not applicable

10. How many PP items do you purchase per week?

- ☐ 0 - 1
- ☐ 5 - 7
- ☐ 2 - 4
- ☐ More than 7

11. How many PET bottles do you use per week?

☐ 0 - 1 ☐ 5 - 7

☐ 2 - 4 ☐ More than 7

12. Please rank which action you are likely to take after using PP Items.
(Please drag and rank options in order, with 1 being most likely and 3 being least likely)

1 Dispose in garbage bin

2 Reuse item (please state what you would reuse item for): _____

3 Recycle

13. Please rank which action you are likely to take after using PET bottles.
(Please drag and rank options in order, with 1 being most likely and 3 being least likely)

1 Recycle bottle

2 Reuse bottle (please state what you would reuse bottle for): _____

3 Dispose in garbage bin

14. Please rank which action you are likely to take after using HDPE plastic items.
(Please drag and rank options in order, with 1 being most likely and 3 being least likely)

1 Reuse bottle (please state what you would reuse bottle for): _____

2 Dispose in garbage bin

3 Recycle

15. Please rank which action you are likely to take after using PP Items.
(Please drag and rank options in order, with 1 being most likely and 5 being least likely)

1 Use them to bag and dispose of general waste

2 Store them (please state what you would store the plastic bags for):

3 Reuse plastic bag (please state what you would reuse the plastic bags for):

4 Dispose in garbage bin

5 Recycle

16. Please select the types of plastics that can be recycled in Singapore.
(You may select more than 1 option)

- ☐ Plastic Bags
- ☐ Bottled Drinking water
- ☐ Take-away containers (Non-polystyrene)
- ☐ Detergent Bottles
- ☐ Styrofoam containers

17. Are you aware of where the nearest recycle bin is located?

- ☐ Yes
- ☐ No

18. Please rank which action you are likely to take after using HDPE plastic items.

- ☐ Too few items to recycle
- ☐ Will reuse it for other purposes instead of recycling
- ☐ Inconvenient to separate recyclables from normal waste
- ☐ Inconvenient to bring recyclables to the recycling bin
- ☐ Others (please state):

19. Please rank the recommendations to reduce unnecessary plastic usage.
(Please drag and rank options in order, with 1 being most effective and 5 being least effective)

1 Have more campaigns and activities to increase awareness on the importance of plastic waste reduction

2 More efficient bagging or packaging of items

3 Retailers to provide incentive (e.g. product discounts, shopping vouchers, membership points) when I bring my own bag/container

4 Implement a charge on plastic items (plastic bags, takeaway containers, cutlery, etc.)

5 Reminders from cashiers on the need for plastic bag/disposable container

6 Others (please state): _____

20. Please rank the options on what you would like to find out about plastic waste recycling.
(Please drag and rank options in order, with 1 being most useful, and 5 being least useful)

1 Type of plastics to be recycled

2 Others (please state): _____

3 Recycling campaigns/efforts in Singapore

4 Benefits of recycling

5 Location of recycling bins

21. Please rank the recommendations to encourage plastic waste recycling.
(Please drag and rank options in order, with 1 being most effective and 5 being least effective)

1 Place more recycle bins around my area/make recycle bins more accessible

2 Provide incentives for recycling (Please state what kind of incentive):

3 Weekly or monthly trainings/drives on recycling in housing complexes

4 Others (please state):

5 More media coverage on plastic waste recycling

6 Create awareness on the type of plastics that can be recycled and the method of recycling

22. Any other thoughts on plastic usage, waste and recycling in Singapore?

2. APPENDIX – B

Types of Plastics

LDPE Plastic Bags:

Source: https://www.polymersolutions.com/blog/differences-between-ldpe-and-hdpe/

PET Bottles:

Source: http://www.allpetbottles.com/

PP Disposables:

Source: https://www.alibaba.com/product-detail/clear-plastic-square-pp-disposable-fresh_60668249901.html

HDPE Bottles:

Source: https://www.tradeindia.com/fp3875697/HDPE-Plastic-Bottles.html

Styrofoam containers:

Source: http://www.liveinthenow.com/article/foam-cups-and-containers-officially-linked-to-cancer

3. APPENDIX – C

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