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Article

Issues and challenges confronting the achievement of zero plastic waste in Victoria, Australia

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Abstract: Despite the increase in popularity of Zero Waste (ZW) concept, the successful implementation of this concept in waste management is still facing many challenges. The plastic recycling rate in Australia is currently only about 9.4%, which could leave up to 90.6% of plastic consumption being sent to landfills. The state of Victoria (in Australia) has proposed an ambitious plan to upgrade its waste and recycling system and to divert about 80% of waste from landfills by 2030. The aim of this research is to study Victoria's current waste management plan and to develop a simulation model to assess the feasibility of it achieving zero plastic waste by 2035. In this direction, a fundamental knowledge of global ZW implementation needs to be acquired in order to understand the challenges, obstacles, and uncertainties in achieving ZW target. A simulation model is established using a method called double baselines. This method was developed as an improvisation to address the limitation of data availability for the model development. The model will run on 4 scenarios including one from Victoria's current plan. Outcomes from the model are produced in comparative charts covering 6 key considerations including the rates of plastic consumption, waste to landfill, diversion, recycling, relative accumulative cost and effort. The findings of this study pointed out that Victoria's current plan are feasible for its goal and presented with opportunities for improvement especially towards zero plastic waste. Besides, study results also reveal that the Victoria's current plan to achieve 80% diversion rate by 2030 is possible but the zero plastic waste target by 2035 is less likely to happen.

Keywords: zero waste; plastic waste; circular economy; recycling performance

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1. Introduction

Zero Waste (ZW) was initially defined in 1973 and its application was to remove chemical contamination from waste; afterward, this concept has started to become a growing concern from the community since the end of the 20th century [1,2]. Among numerous solutions relating to waste management, landfills are regarded as a conventional method which is detrimental to the environment. Beside the environmental issues, governments all over the world are also facing the shortage of landfills in urban space, and they must be seeking for other effective and eco-friendly solutions [3]. From those demands, the appearance of ZW concept has been an alternative waste management system which helps to reduce waste diverted to landfills. A significant number of policymakers in several countries has involved ZW concept in urban development planning and this concept was concluded as the most remarkable initiative of the 21st century for contributing to the sustainable waste management [4]. Nevertheless, the successful implementation of this concept in waste management is still hindered. Leading countries regarding environment protection have introduced their strategies to achieve ZW; however, majority of them are currently at the beginning stage as well as struggling with reaching their targets within the expected timeframe. The reasons behind those difficulties could possibly be the rapid population growth, unforeseeable changes in residents' lifestyles and behaviours, and the variability of the waste market.

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A low recycling rate of plastic waste was recorded at only 9.4% in 2017-2018 in Australia [5]. In a broader picture, the country properly recycled only 12% of total produced waste in 2019 [6]. The state of Victoria is one of the Australian states suffering the recycling issues the most due to a sudden termination of its major plastic waste collection partner [7]. On the other hand, this state exported a significant amount of materials, especially for plastic (62%) for reprocessing [8]. The strong dependence on global waste exportation made the state involved in a chaotic situation after the suspension of waste flows into China and Malaysia [9,10]. The state government responded to the crisis by issuing a 10-year reform program as an effort to reduce waste production, divert more waste from landfills, and enhance the recycling rate by 2030 [11]. The aim of this research is to study Victoria's current waste management plan and developing a simulation model to assess the feasibility of achieving zero plastic waste in Victoria by 2035. To achieve this, a fundamental knowledge of global ZW implementations needs to be acquired. Based on the lessons obtained from several ZW leading cities, an understanding about challenges, obstacles, and uncertainties tackling ZW target will be a firm foundation to ensure the accuracy and reliability of the proposed model.

2. Background

2.1 Plastic waste

2.1.1. An overview on global plastic waste

Plastic waste has been documented the most for several years due to its huge impact on the environment. The increasingly large quantity of plastic products such as packaging could be explained by a mixed various of benefits obtained by businesses and their customers. They include economical aspects, durability, transportation, and satisfaction of looking and feeling purposes of customers [12]. In the study of Geyer, *et al.* [13], the researchers estimated that 8.3 billion metric tons (MT) of plastic had been manufactured, and a significant leap in generation of resins and fibres from 2 million MT in 1950 to 380 MT in 2015. By contrast, recycling rate of plastic products in 2015 was calculated at approximately 9% and it is projected to dispose 12 million MT to landfills or the environment by the middle of the 21st century (**Error! Reference source not found.**).

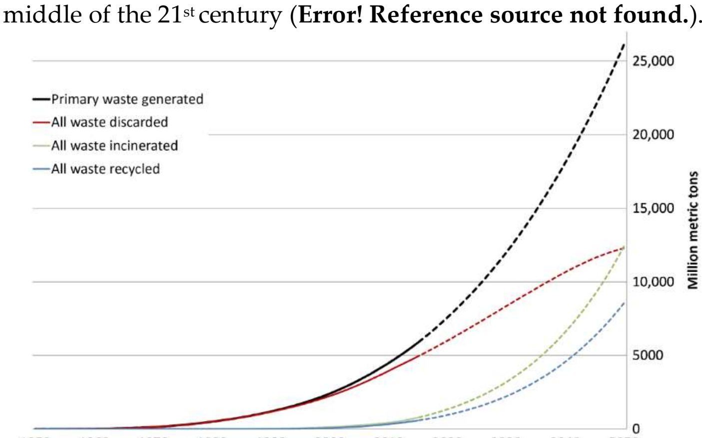

Figure 1. A summary of accumulative quantity of plastic waste in generation, disposal to landfills, incineration, and recycle (Soli lines indicating the analysis of 1950-2015 data, and dashed lines indicating the projected values) [13]

Additionally, the pollution caused by plastic waste on land also affects the living environment of aquatic plants and animals. A report done in 2015 illustrated a calculation of 275 million MT of plastic waste arising from the activities of 192 countries adjacent to the ocean in 2010 [14]. A range from 1.75% to 4.62% of this estimated quantity of generated plastic waste became marine debris. On the other hand, apart from the conventional treatment, plastic waste was also locally reprocessed or trade globally for reprocessing [15]. The global waste trade networks play a major role in transforming discarded waste into new plastic products [16]. This trading activity has consecutively

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been increasing utterly sharply from 1993 to 2016, the study of Brooks, Wang and Jambeck [12] estimated the values of 723% and 817% for yearly importation and exportation respectively in this period. China was the country that imported plastic waste the most as they also accounted for 45.1% of imported plastic waste accumulated between 1993 and 2016 [10,12]. With the considerable influence on global waste market, the China's ban on imported plastic waste which has been in place since 2018 would cause massive changes in global plastic generation and waste management [12,17]. This ban also results in an even more urgent requirement for implementing ZW strategies.

2.1.2. Plastic waste in Australia and the state of Victoria

O'Farrell [5] investigated how plastic waste was recycled from 2017 to 2018 in Australia. Key findings from the survey illustrated that Australians consumed 3.4 million tons of plastics in this period with an estimated recycling rate of only 9.4%. In 2018, Australia spent 2.8 billion dollars for the export of 4.5 million tons of waste primarily to China, Vietnam, and Indonesia *[6]*. Besides, the problem could be more negative after China announces a ban of export of plastic waste from Australia in 2018. Australia who export half of its recovered plastic waste every year is one of the impacted countries from the Chinese importation ban [12]. Similar issue, however, continues to arise when up to 100 tons of plastic waste exported to Malaysia for reprocessing were too contaminated to recycle and required to return to Australia [9]. Australia recorded the highest rate of plastic export for reprocessing in the period of 2017 to 2018, which was a significant increase as comparing with only 26% in 2000 [5,18]. **Error! Reference source not found.** illustrates the noticeable difference between the amount of plastic waste recycled in local facilities and for export. The market for plastic packaging depends solely on the contamination level of the baled materials. The exports of mixed plastic packaging have dropped dramatically from 42,000 tons in 2016 to 29,000 tons in 2018 with a projection to be at a similar rate in 2019. This is entirely due to the lost sale to China [10] and to Malaysia [9].

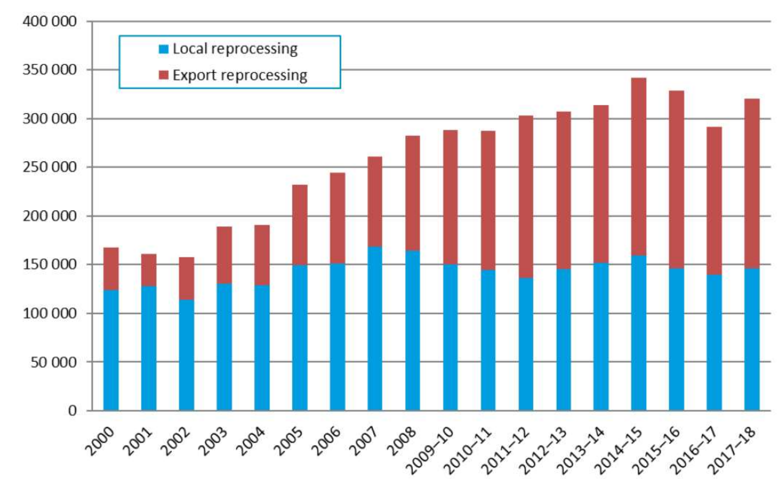

Figure 2. Australian plastics (in tons) for reprocessing locally (blue columns) and globally (red columns) from 2000 to 2017-2018 [18]

Take a further look at Victoria, it is one of the states to suffer from this crisis the most. This could be attributed to the fact that its largest plastic waste collection partner, SKM, suddenly went into a pause due to incidents happened at the facilities [7]. The state of Victoria achieved the highest rate of recycling plastics at 15.6% in 2017-2018. Nevertheless, this impressive result was caused by the uneven distribution of large plastic producers which are primarily located in Victoria [5]. Despite Victorian highest recycling rate compared to other states, plastic recycling performance still remained unsatisfied. During the period of 2016-2017, Victoria reportedly sorted its kerbside waste into 3 categories including garbage, recycle, and organics [19]. The materials accepted in the recycling bins typically include paper & cardboard, glass, metal, and plastics with the contamination rate at 4-16%

by weight. Despite having separate bins for recycling, the recycling rate still remained inconsiderable because of the ineffective sorting methods and different materials mixed up together causing high-level contamination.

Between 2017 and 2018, 69% of total generated waste was diverted from landfills and 137,000 tons of plastic waste were recovered [8]. Where 62% of that recovered plastics was exported to other countries for reprocessing, only 38% was reprocessed locally. The interstate and international plastic waste market in 2017-2018 can be explained in **Error! Reference source not found.**. Though Victoria has the largest reprocessors, the state only reprocessed around 30% of recovered plastics generated locally comparing with more than half of SA and Queensland [5]. There are 25 processing facilities in Victoria with most of them can process more than one types of plastic and 60 plastic types were handled in the Victorian facilities. Victoria's plastic reuse rate is still unknown and is estimated to contribute only to a small fraction of the recycling rate. The recovery rate for packaging plastic is 20.6% which is relatively high. This fact is also supported by the fact that Victoria relies so much on mechanical recycling which is viable in processing packaging plastic.

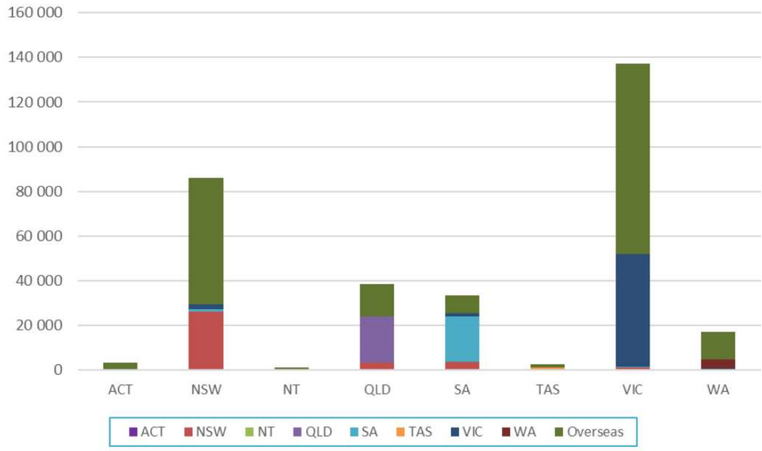

Figure 3. The movements of recycled plastics between states and from states to overseas (tons)[18]

The establishment of the Environment Protection and Heritage Council (EPHC) which was a party involving Australian and New Zealand ministers of environment departments could be considered one of the first attempt to address the impacts of plastic waste. They introduced a plan in 2003 to completely avoid using single-use plastic bags by 2008. The plan was then terminated in 2005 to move forward to another national approach. However, governments of eight Australian states and territories failed to achieve an agreed legislations across the country, which resulted in only four regions of SA, the Northern Territory (NT), ACT, and Tasmania passing their own rules with the first action of SA in 2008 [20]. ACT is also known as the first municipality in the world to pass ZW legislations in 1996 [21]. Additionally, the law which has been in place since November 2019 in Victoria turning NSW into the only jurisdiction without similar prohibition on plastic bag.

In the early beginning of 2020, the premier of Victoria announced a 10-year strategy to Victoria's recycling system to reduce pollution, create job opportunities, and economic development [22]. According to the plan, Victoria will obtain a reduction in waste diverted to landfills by 80% by 2030. New proposed recycling plan consists of new method for collecting kerbside and upgrade recycling system by 2030; a container deposit scheme in 2022-2023; a 100 dollar-investment for local waste and recycling industry; and new regulations on waste and recycling against unlawful activities [11].The new kerbside collection will introduce a Fourth bin to the current 3-bins system to separate glass from other recyclable materials. Every household will be required to dispose their waste into different bins accordingly as identified by different colours of lid. [23]. The container deposit scheme is still being developed to ensure its operation perfectly collaborating with new recycling system and schemes in other states [24]. This solution will make Victoria no longer be the only state in Australia with no similar scheme. An analysis from the Parliamentary office suggested that the program would cost $9 million over the course of 4 years and return $253.5 million through uncollected deposit [25]. At the moment, Victoria has started constructing Advance Circular Polymers which is a plastics recycling facility to process 70 thousand tons of plastic waste annually [26]. This plant located in Somerton in North Melbourne is able to handle more than 10% of current plastic waste generation in Victoria and result in 46 new occupations.

2.2. *Zero waste inplementation around the world*

The ZW concept has been implemented in many cities around the world; however, they rather share similar stories and their practical aspects hardly differ from one another. This review narrows down the case studies and only includes 3 cities to cover regions with completely different scenarios in terms of approaches and cultural communities including Kamikatsu (Japan), San Francisco (USA) and Hernani (Spain).

2.2.1. Kamikatsu, Japan

Kamikatsu, a small city in Japan has managed to reach 81% recycling rate in 2016 (**Error! Reference source not found.**) since the city declared the goal of ZW in 2003 and intended to reach the target by 2020 [27]. The city's small population is especially of beneficial to implementing the initiatives in many ways. Waste segregation methods were introduced gradually over the years and Kamikatsu successfully achieved 45 waste segregation in 2016-2017 [28]. Plastic waste is sorted into 6 categories including clean and uncleaned packaging products, white Styrofoam tray, Styrofoam, PET bottles and PET bottle caps. Though this municipality has not achieved the target in 2020 yet, the significant efforts made by local government and residents led to several positive outcomes for the globally sustainable development [29]. Several actions applied in Kamikatsu after its ZW declaration, they were the public engagements, the contributions of local businesses and manufacturers, the establishments of centres for reused and remade products, campaigns, and effective encouragements of local authorities and Zero Waste Academy (ZWA), a local non-profit organization [27,29]. For example, residents were instructed how they process their waste including cleaning non-biodegradable waste before disposing them by themselves to the Hibigatani Gomi Station where the waste segregation was then accomplished by local residents [30]. One of the applied rewards being the Recyclable Paper Point campaign introduced in 2014 where residents can collect points upon bringing paper waste to exchange for toilet paper and paper string.

In 2019, the average recycling rate in the town is around 80% leaving 20% of the remaining waste that is currently un-recyclable [31]. The implemented recycling process also contributed to a save of 30% of the expenditure for incineration [32]. In spite of the impressive results, Akira Sakano, chairperson of ZWA, maintained that recycling had to be integrated with waste reduction to reach the ZW target [29]. The contribution of people in Kamikatsu to 45 categories of waste was impressive but the process was partly time-consuming and required a lot of efforts which could be only applicable in such a small town having residents with high personal responsibility and enthusiasm (no governmental enforcements applied) [33]. However, if it were to adopt in a higher density city, considerations for alterations need to be taken to ensure possible benefits can outweigh current living lifestyle and residents' income. By contrast, the engaging and encouraging rewards, and the involvement of businesses and manufacturers is also a significant fraction of the ZW plan.

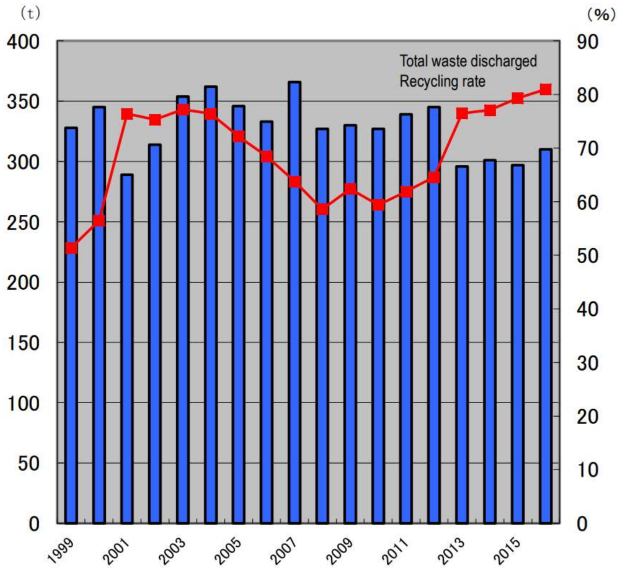

Figure 4. Kamikatsu's waste generation and recycling rate from 1999 to 2016 (columns show waste production in tons, red line illustrates recycling rate in percent) [27]

2.2.2. San Francisco, USA

Kamikatsu's strategies towards ZW sound impressive but San Francisco might have a better and less effort required approach especially in sorting their recyclable wastes. San Francisco targeted to achieve 75% waste diversion from landfills in 2010 and an ambitious goal, ZW, by 2020 [2]. The city organized three bins for waste including compostable, recyclable, and residuals in 2002, which is also known as "a three-cart collection" compulsorily involving both households and businesses in 2009 [34,35]. Rather than sorting plastic waste into 6 categories, the city's recyclable bin takes all recyclable waste like paper, glass, and bottles in a very similar manner to Victoria's. The reasons for the success of this city's waste management; however, lie in appropriate legislations and public participation through effective education [36]. Discounts were obtained by businesses to encourage using recycling and composting bins and penalties were applied as trash being mixed with different types of materials. Residents will be penalised for materials dumped into incorrect bin, which is identified by waste monitoring and trash inspectors. The advance facilities enhance the cleanliness and purity of recyclables which are easily marketed [37]. Another factor contributing to San Francisco's success was the partnership with only one waste management organization known as "Recology" facilitating the administration and long-term collaboration [36].

Krausz, *et al.* [38] concluded that the city authorities focused on applying several effective methods previously proved on waste reduction, behavioural transformation, laws and regulations, and innovations of material manufacture, in which all of those measures focused on increasing the responsibility of businesses and residents. San Francisco has managed to divert waste going to landfill and incineration by 80% in 2012 [39]. Nevertheless, the goal to achieve ZW by 2020 seems to be more difficultly obtained than the city expected when the city only diverted 51% of waste from landfills in 2018. As a result, in 2019, London Breed, current city mayor, thus decided to re-establish ZW target, particularly for diminishing waste generation by 15 percent, and diverting the waste from landfills by 50 percent by 2030 [37]. San Francisco's rapidly increasing population, growing richness of residents, and higher demand for plastic products due to their exclusive convenience are reasonable explanations. The city could be a reference for other cities with a mixed variety of successful measures as well as future uncertainties affecting the target. On the other hand, San Francisco's clear and strict policies are the keys to change people behaviours and establish recycling and composting culture [40]; however, while Kami Katsu shows promising results with rewarding system, San Francisco relies more on penalty system. This point needs to be further considered to maintain the balance of ethical and personal aspects against legislation system.

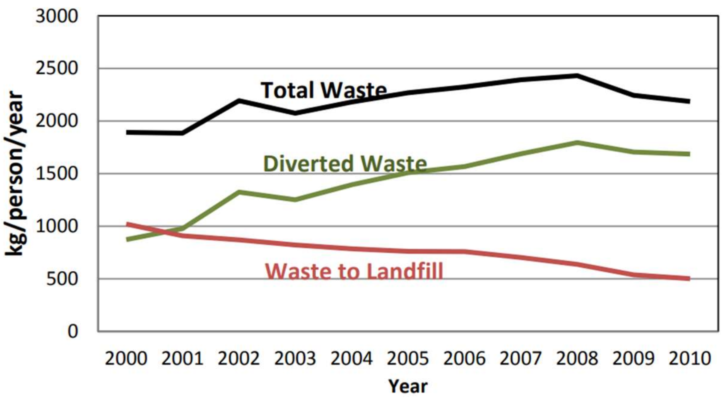

Figure 5. Yearly waste per capita (in kilograms) in San Francisco [38]

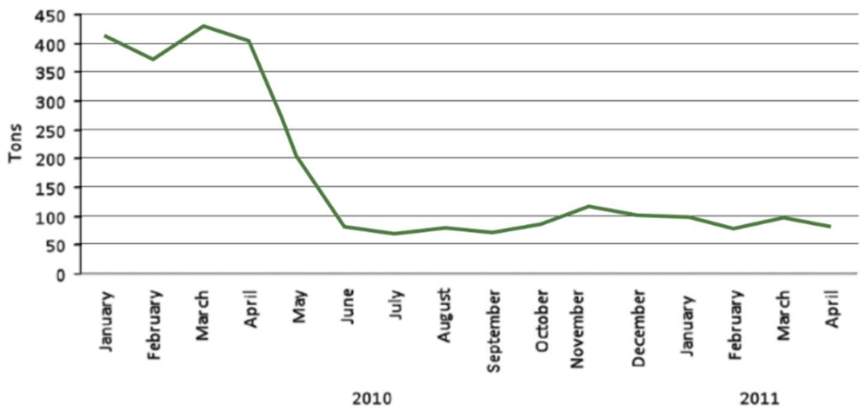

Figure 6. Municipal solid waste (in tons) landfilled in Hernani from January 2010 to April 2011 [41]

2.2.3. Hernani, Spain

The important lessons to learn from Hernani, Spain in ZW initiatives are the effective communication and voluntary community participation, political moves opposed to incineration, and the speedy spread of the program between the municipalities [40,41]. The capacity of San Marko landfills was about to be unable to take more waste in 2002. While the construction of new incinerators was highly opposed by the community, Usurbil was the first municipality to initiate the strategy of conducting a program known as "a door-to-door waste collection" for waste segregated by source, which brought them a drop by 80% of waste to landfills in the first six weeks and a recovery rate of 82% in the first year launching the program [41]. Hernani followed the successful model done by Usurbil in May 2010. The city removed large containers for recyclables on the streets, required each household with two bins placed in front of houses, waste separation became compulsory, and launched door-to-door collection system. The government controlled and managed waste segregation by applying an identifying system of waste source by code on each bin and hook. Each type of waste was collected in specific days for both businesses and households. People will receive warnings by stickers on the bin as they do not comply with the regulations. Glass was the only material still collected by large containers placed on the street, whereas other cities still remained the kerbside collection for this material [42]. Other materials not collected by the program could be dumped into drop-off sites. The municipality also encouraged the residents to compost at home through education, consultation, a supportive phone line, and sign-up composting benefit of 40% off of the municipal waste management fee.

The results from the door-to-door program showed that the waste contamination issue was almost solved at only 1.5% of impurities. Moreover, the waste to landfills in 2010 was 53.8% less than that in 2009, about 80% of waste was diverted from landfills in 2012 [41,43], and average 28.6% of

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reduction in total produced waste [44]. Regarding the financial matter, **Error! Reference source not found.** illustrates that the door-to-door collection beat the conventional container system in Usurbil, which could be explained by the income from the market of recyclable products. In general, differing from the two municipalities above, Hernani recycling system organized 2 bins for all waste types which were collected on designated days for each waste. Tag and stickers are used on residents-coded bins to warn of any breach of law. This was effective as it increased the residents' participation and obligation towards waste segregation. The awareness and proactive actions of Hernani residents aim to protect the environment were also reasons for the incredible achievements.

Table 1. Cost analysis of container and door-to-door collection methods (2008-2010) in Usurbil [41]

	Containers 2008	**Containers & Door-to-door (as of March) 2009**	**Door-to-door 2010**
Expenses (€)	493,444	565,961	670,015
Income (€)	135,447	202,669	452,269
Net cost (€)	357,997	363,292	217,746
Self-finance rate	27.40%	35.80%	67.50%

3. Methodology

To predict the feasibility of Victoria's achieving zero plastic waste by 2035, a simulation model is established using general baseline prediction approach with a slight twist to include more than one use of the baseline term; specifically only to this study, the method is then called double baselines. This method was developed as an improvisation to address the limitation of data availability for the model development. Since the latest audit on plastic recycling was in 2018, the year is taken as a baseline year or a reference point where, later in the result, the predicted effort and cost are based on. This baseline year is embedded in all scenarios including baseline scenario which similarly acts as a reference point for comparison. Despite the improvisation, this model is adopted from a conceptual approach to zero waste simulation modelling by Krystyna A. Stave of University of Nevada Las Vegas [45].

The key lessons, gaps, and potential improvements from early reviews will be used to form the main input factors. The inputs include *Product recyclability*, *Packaging* and *Non-packaging polymer consumptions*, *Processing facilities capacity*, *Recycling option efficiency*, *Reuse/end-of-life proxy rate*, and *sorting efficiency*. These input factors represent components that form the recycling system and will be used as the simulation model's inputs. Scenarios are proposed in the model in an effort to learn different aspects of the recycling system, thus, alterations on the input factors in each scenario are made accordingly. A full process of this study is illustrated below.

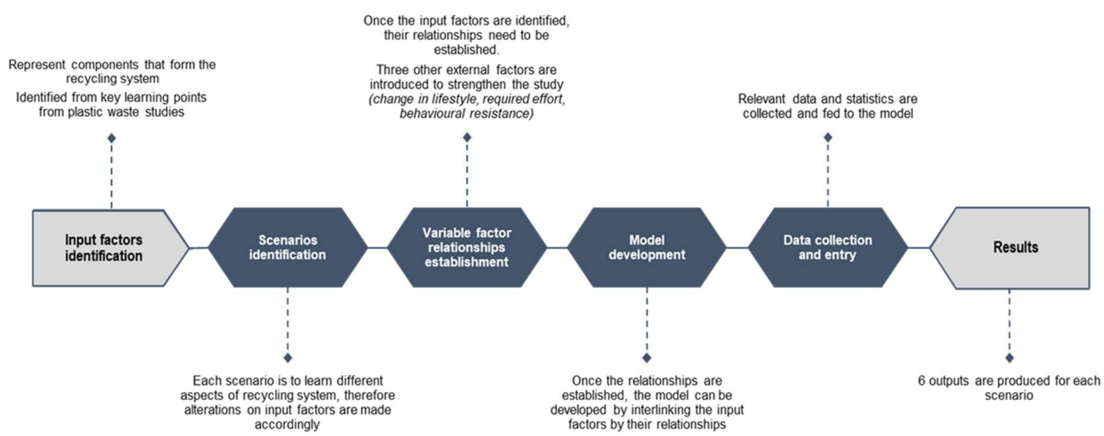

Figure 7. Overall research methodology

3.1. *Scenario identification*

The model will run on 4 scenarios including one from Victoria's current plan called Recycling Victoria: A new economy [46]. These scenarios are formed based on projections from available data in an effort to study their effects on plastic waste recycling performance as well as searching for possible alternatives to ZW. Details on each scenario are discussed in Table 2.

Table 2. Running scenarios of the simulation model

Input factors	Victoria's current plan (Baseline)	Scenario 1	Scenario 2	Scenario 3
Product recyclability	x3	*NA*	x5	x4
Packaging polymer consumption	-20%	-30%	*NA*	-25%
Non-packaging polymer consumption	-20%	-30%	*NA*	-25%
Processing facilities capacity	x3	x3.6	*NA*	x4
Recycling options efficiency				
• ***Mechanical***	+10% & 0%	+10% & 5%	*NA*	*+10% & 2%*
• ***Chemical***	+2.5% & 0%	+2.5% & 0%	*NA*	+2.5% & 0%
• ***Feedstock***	+2.5% & 0%	+2.5% & 0%	*NA*	+2.5% & 0%
• ***Energy***	+10% & 0%	+10% & 5%	*NA*	*+10% &2%*
Reuse/end-of-life proxy rate	@10%	*NA*	@15%	@10%
Sorting efficiency	x3	*NA*	x6	x3

Victoria's current plan or Recycling Victoria: A new economy is formed based on the information provided publicly by The State of Victoria Department of Environment, Land, Water and Planning. Since the policy has already been rolled out and in place, this plan will be used as a baseline scenario to compare with scenario 1, 2 ,and 3. While none is mentioned in the publication by how much the government planned to improve those key input factors, the values in the table are approximation only and not without flaws. Nevertheless, each value was reasonably estimated by considering the goals established by the Victorian government. For example, the 2020 Recycling Victoria: A new economy package proposes a plan to achieve 15% decrease in consumption per capita and 80% diversion rate by 2030 with an interim rate of 72% by 2025. This makes diversion rate goal achieved by 90%. Two third of the targeted diversion rate which is defined as the amount of waste not being disposed into landfills is contributed by reducing waste, that would make a consumption rate at around 10% fall in the first 5 years. Assuming the rate peaks at a constant rate of 1% annually, reduction in consumption rate will be at 15% by 2030 and 20% by 2035. The two third of diversion rate achieved by waste reduction is based on the fact that diversion rate in Victoria rather relies heavily on consumption than recycling capacity and the package allocates only one sixth of the fund to facilities investment which adds up to the first argument.

Scenario 1 focuses on alterations made towards consumption and recycling capacity, in other word, this scenario looks into the effect recycling supply and demand have on overall performance without promoting other aspects of ZW. The supply and demand in this context infer to plastic consumption and recycling capacity, respectively. **Scenario 2** is the reversed study on recycling performance compared to scenario 1. Rather than asking consumers to reduce their consumption and build more recycling facilities, the state government provide education and promote the recyclability of products, reuse, and better sorting efficiency. The values under scenario 2 in the table are proposed to meet the highest efficiency existed as seen in Kamikatsu, Japan where plastics is sorted into 6 categories with the highest recyclability rate. **Scenario 3** compliments on Victoria's current plan and is the ultimate alteration where zero plastic waste is ensured to be met by 2035. It takes long term goal and the State's plan pattern into consideration on top of what has been considered to amplify its effectiveness.

Table 3. Explanation to values used in Victoria's current plan from Table 2

Input factors	Explanation
Product recyclability (x3)	Regardless of how recyclable plastic is, if there is no improvement to consumers sorting efficiency, plastic waste will still end up as mixed contamination batch. Therefore, the rate of product recyclability should be increased alongside sorting efficiency that is by 3 times (see sorting efficiency below).
Consumption (-20%)	As described earlier, the reduce in consumption rate of 20% is estimated by interpolating values based on targeted achievement and required effort.
Processing capacity (x3)	Diversion rate is the rate of recovery over consumption. The estimated values in 2020 are around 1108,000 tonnes (consumption) and 207,200 tonnes (recovery). For the plan to achieve 80% diversion rate with 15% consumption reduction, the equation would yield recovery at 659,300 tonnes or 3.18 times to that in 2020. The model adopts this value as 3 instead of 3.18 due to some variations to accommodate errors in estimated values.
Recycling option efficiency (+10% & 0%)	The values of, +10% represents a boost in the first 5 years of the period while & 0% represents the later 10 years. Existing annual growth rate is estimated based on increase in reprocessors from 2016-2018 to be 2%to the later 10 years. Since in this model, processing capacity above is defined to have direct relationship with recycling options efficiency, we could work backward to diminish the growth by 2% which the remaining after 10 years in doing so is worked out to be a 10% boost on top of its 2%.
Reuse/end-of-life proxy rate (@10%)	The government plans to allocate about $1.8 million of the budget towards improving reuse economy and charitable sector which spend about $13 million and divert around 31,600 tonnes of waste donation from landfill. Assuming direct relationship, the grant could increase the sector's diversion rate by 14% resulting in end-of-proxy rate at 3.2% which is 0.5% on top of the 2020's rate. If the rate is constant throughout 15 years period, the rate should be projected to be at 10%.
Sorting efficiency (x3)	Since Victoria waste sorting system only sort plastic in one recycled bin, the efficiency can be considered as x1. The new plan separates glass into a new bin and introduce container deposit scheme which effectively cut down the process of segregating plastic and glass from carboard, metal and other materials. The efficiency from this plan could arguably be considered to increase by 3 times.

3.2. Variable factor relationship establishment

The input factors, despite their simplicities, have tangible relationship with one another which require a thorough analysis to breakdown. Due to limitation on resources, this study only takes the important ones into consideration. To address these relationships, variable factor relationship is presented in **Error! Reference source not found.** where each input is configured interrelatedly to obtain certain factorized values defining their relationships and how changes in one area would affect the others. The purpose of introducing this factor relationship is to project as realistic results as possible despite limitation on resources and to better understand the relationship between areas of plastic recycling. Table 5 contains explanations to how each value in table 4 is obtained.

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Table 4. Variable factor relationship

Inputs:	Product Recyclability	Reuse/end-of-life proxy rate	Sorting efficiency	Change in population & lifestyle	Required Effort	Behavioural resistance
Product Recyclability					10%	0.9
Packaging consumption		0.9		3%	20%	1.03
Non-packaging consumption		0.9		3%	20%	1.03
Processing capacity					10%	
Recycling options efficiency	11%		25%		10%	
Reuse/end-of-life proxy rate					15%	0.85
Sorting efficiency	15%				15%	0.85

Table 5. Explanation to values used in variable factor relationship from Table 4

Inputs	Explanation
Product recyclability	While there is no direct study on how much effect product recyclability has on other inputs, the values used in table 2 are estimation based on indirect relationship found in the following studies. One study suggests how promoting recyclable waste will be transformed into new products can increase recycling rates. 6 tests were conducted with varying results, the least effective of which is an audit of two university residence hall waste collection stations where signage was placed to show how the recyclables can be made into products. Approximately 11% recorded increase in recycling rate [47]. Since human behavior has direct effect on sorting and recycling efficiency, the value can be adopted as a factorized value. In Kamikatsu, Japan, the highest sorting categories for plastic is 6 where even products like water bottles are sorted separately from their caps. From this example, assuming water bottle and its cap are made from the same material and can be sort in the same category, it would increase the sorting efficiency by one sixth that is 15%.
Reuse/end-of-life proxy rate	Victorians have been very supportive in banning low density plastics like plastic bags. This type of polymer represents roughly 10% of total plastic consumption in Victoria. Assuming products with low density plastic are banned, plastic consumption can be cut down by around the same rate that is 10%.
Sorting efficiency	In facilitating term, there are 4 recycling options in Victoria, each of which recycles different mixes of polymers according to its contamination. Thus, any alterations to sorting efficiency should influence recycling option by 25%.
Change in population & lifestyle	This is based on population growth rate in Victoria. The rate varies from year to year, toping at 2.55% [48] which could be rounded up to 3% for conservative purpose.
Required Effort	While there is no information on how much effort is required to conduct certain campaigns, all values are obtained through process of ranking based on delivery plan laid out by the government and its allocated budget to each aspect.
Behavioural resistance	Most of the resistance values are reflective to those of the required effort. The resistance values to consumption are based on the example of banning lightweight plastic bags where public consultation was conducted and only 3% of individual respondents opposed (Victoria State Government, 2019). If banning other types of plastic for the same reasons and purpose, there is a high chance to receive similar response.

3.3. Model development

With input factors and their relationships being well established (table 4), the development of model can be started by using simple conditioning clauses in Excel spreadsheet to bine the relationships as explained in table 6 below. Afterward, the output section of the model is developed by formulating it according to their definitions (see table 7). There are 6 outputs to be produced from the model, Plastic consumption, Plastic waste to landfill, Diversion rate, Recycling rate, Relative effort and Relative cost.

Each output is plotted in a form of line chart against a timeframe from 2016-2035. There are 4 critical points long the timeframe, year 2020 as the starting point, 2025, 2030 and 2035 as the next 3 milestones. It can be seen that only results from 2020 onward are the important ones. However, the decision to include results from year 2016-2019 lies in the fact that 2018 is used as baseline year; thus, it is practical to include a closest period of two years to bring consistency to the overall result.

Table 6. Explanation to how input factors are interlinked by their relationships

Inputs	Explanation
Product recyclability	Given condition that if the selected year's value is greater than that from its baseline year that is 2018, the result must yield a product of selected year's value and behavioural resistance, otherwise it can be used as it is.
Consumption	Given that if the selected year's value is greater than that from its baseline year that is 2018, the result must yield a product of selected year's value with its according factorized and reuse rate values and behavioural resistance, otherwise no resistance value needed.
Processing capacity	To simplify the process, processing capacity is set to be the product of total recycling option efficiency and the constant pre-calculated value of capacity per efficiency.
Recycling option efficiency	Because of the nature of its relationship, recycling option efficiency is affected by product recyclability and sorting efficiency. Given condition that if the two affecting values increase, the result must yield a product of the 3 values with their according factorized values, otherwise no factorized values needed.
Reuse/end-of-life proxy rate	Given condition that if the selected year's value is greater than that from its baseline year that is 2018, the result must yield a product of selected year's value and behavioural resistance, otherwise it can be used as it is.
Sorting efficiency	Given condition that if product recyclability value increases, the result must yield a sum of sorting efficiency value and the difference in increased recyclability along with its factorized values, otherwise equals to the efficiency value itself.

Table 7. Explanation to how the 6 outputs are formulated

Results	Explanation
Plastic consumption	The sum of packaging and non-packaging consumptions.
Plastic waste to landfill	The deduction of plastic consumption and plastic recovered or processing capacity for simplicity.
Diversion rate	Diversion rate equals to plastic recovered (plastic consumption – plastic waste to landfill) over plastic consumption.
Recycling rate	For simplicity yet not entirely dependable, recycling rate is the additional rate of reuse or end-of-life proxy to diversion rate.
Relative effort	Calculated based on required effort values in table 4 where the value is broken into percentage per unit. The percentage per unit values are then used to multiply by the units to get the original required effort values minus 100% to get 0% as a baseline value in 2018.
Relative cost	Relative cost values are calculated based on allocated budget of Recycling Victoria: A new economy plan and the recently opened $20 million facility that has capacity of about half of that in 2018 (Victoria State Government, 2020). The procedure is very much the same to that from relative effort.

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3.4. *Data collection and entry*

Once the technical stages are well established, relevant data are collected and fed to the model. These data (raw data) are taken from multiple sources to form values that are used in input factors. Since the input factors are interlinked by their relationships, the model will then configurate and adjust those values accordingly. These new adjusted data are then used to produce the outputs.

Inconveniently, since the latest audit on plastic waste is done in 2018, data from 2019 to 2020 could not be obtained. Therefore, a projection is necessary to be done at a conservative steady rate to complete the model. It is also critical to point out that since studies on plastic waste and waste audits possess uncertainties to the accuracy of data, it is expected to encounter slight errors which regardless is still viable to support the study.

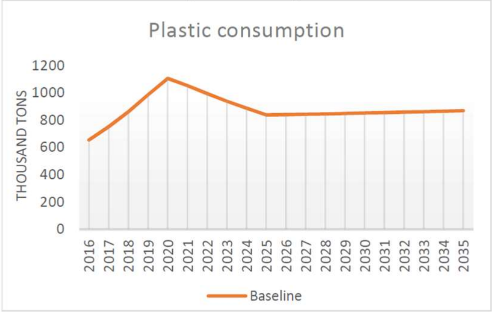
4. Results and analysis

The 6 graphs as shown in outputs from baseline scenario (**Error! Reference source not found.**8), scenario 1 (**Error! Reference source not found.**9), scenario 2 (**Error! Reference source not found.**10), and scenario 3 (**Error! Reference source not found.**) are used to compared with one another where results and discussion draw upon. The comparison will look critically not only on ZW criteria but also the feasibility of it in terms of cost and effort required and the timeframe during which it will take to reach the goal.

4.1. *Victoria's current plan (baseline scenario)*

The simulation result of baseline scenario is described in **Error! Reference source not found.**. Plastic consumption rate drops by 21% from 1108000 tonnes in 2020 to 870000 tonnes in 2030. It represents a feasible outcome with 6% over the target. However, it starts since 2025 and slightly increase throughout the rest of the timeframe and remains on the range input rate of 20% by 2035. The rate significantly drops during the period of the rolled-out plan and increase at a respectable rate considering growth in population. While this could look concerning to some extent, it is in its natural state of consumption growth over time and can be backed by an optimistic decrease in rate of plastic waste going to landfill. The goals to achieve 80% diversion rate by 2030 and an interim rate of 72% by 2025 are showed by the result to be credible and achievable.

From the diversion rate graph of **Error! Reference source not found.**, 67.7% can be achieved by 2025 and 73.5% by 2030 with recycling rates of 73.7% and 81.54% respectively. As we take an average value to their respective years, the rates will settle closely at 70.7% and 77.5%. As mentioned earlier, recycling rate is the inclusion of reuse or end-of-life proxy to diversion rate but is not entirely dependable due to its uncertainty in auditing. Therefore, it is practical to average the two values although it is recommended to rely on diversion rate under most circumstances. With these achievements, it is estimated that the government will have to exert 200% effort from 2018 to 2035 with around 30% annually during the period of roll-out plan that is from 2020-2025. The expenses are also made in a similar manner where most of the major ones occur during the plan roll-out period accumulating to approximately 400%. Aside from these promising figures, the plan will not bring Victoria's recycling system to achieve zero plastic waste by 2035 since the average values to diversion rate in year 2035 is only 87%. The steady growth rate projects an outcome for ZW by at least another 10 years considering no changes made towards the system.



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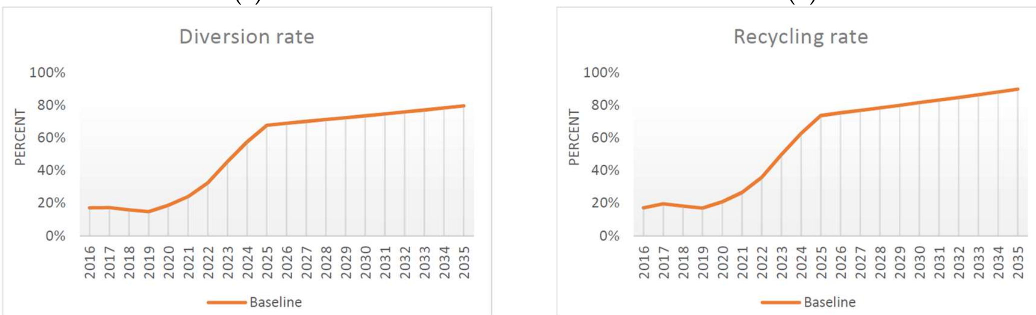

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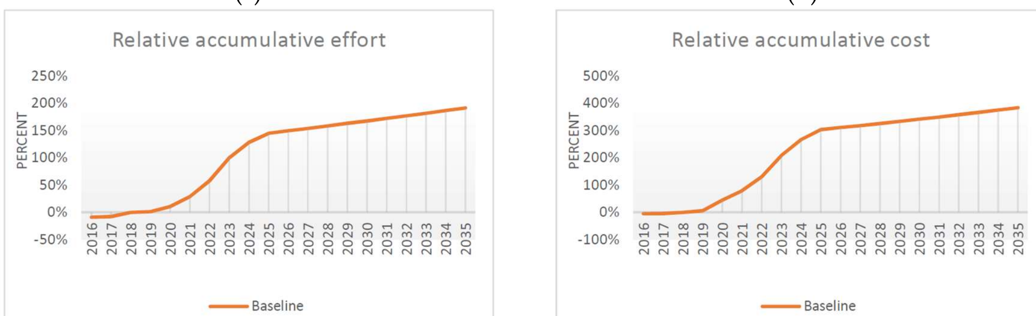

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Figure 8. Baseline scenario outputs (the 6 outputs – Plastic consumption, Plastic waste to landfill, Diversion rate, Recycling rate, Relative accumulative effort and Relative accumulative cost in graph a,b,c,d,e,f respectively)

4.2. *Scenario 1 – study on supply and demand*

The simulation result of scenario 1 is indicated in **Error! Reference source not found.**. The plastic consumption is predictable since the scenario pushes further to reduce consumption. The rate goes down steadily from 1108000 tonnes in 2020 to 870000 tonnes (-21%) in 2025, 825000 tonnes (-25%) in 2030, and 76700 tonnes (-31%) in 2035. The input for this scenario was set to outperform that in baseline scenario by only one third, yet it produces a much desirable outcome. The rate is projected to decrease for another 8 years before it starts to stabilize and increase again. The output of plastic waste to landfill in this scenario, however, behave differently from baseline scenario. Instead of diving down in the first 5 years, the rate takes a steady slide to 97% decrease throughout the timeframe. The gap area between the two lines in the first 5 years represent how much factors affecting recycling capability such as product recyclability, reuse rate and sorting efficiency have on behaviour and performance of recycling system. Diversion rate tops at 97% while recycling rate at 99% which can be averaged to 98% and can be considered as achieving ZW by the study date.

The main difference between this scenario and baseline scenario lies in their timelines of achievement alongside relative effort and cost. **Error! Reference source not found.** shows that scenario 1 peaks at a steady rate throughout the study period with diversion rate of 38% in 2025, 60% in 2030 and 97% in 2035, whereas baseline scenario gives 67.7%, 73.5% and 82% respectively. Recycling rate does not play an important role in this scenario since there was no alteration to it and its value is growing constantly at 2.2% on top of diversion rate as a result from the early years. Relative effort, on the other hand, presents a huge difference with baseline scenario requiring twice the total effort to scenario 1. The highlight point is during the first 5 years where baseline scenario skyrocket to 152% against 29% which is about 5 times the difference. Relative cost starts off similar to relative effort but ends with a close rate of 385% against 400%. The results show that by not altering product recyclability, reuse rate, and sorting efficiency, zero plastic waste can be achieved by 2035 with 50% less effort the government has to put in. To further support how statistically viable this

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scenario is, at the outperforming point in diversion rate, which is by 2032 at 78.5%, scenario 1 requires much less effort and cost compared to baseline scenario.

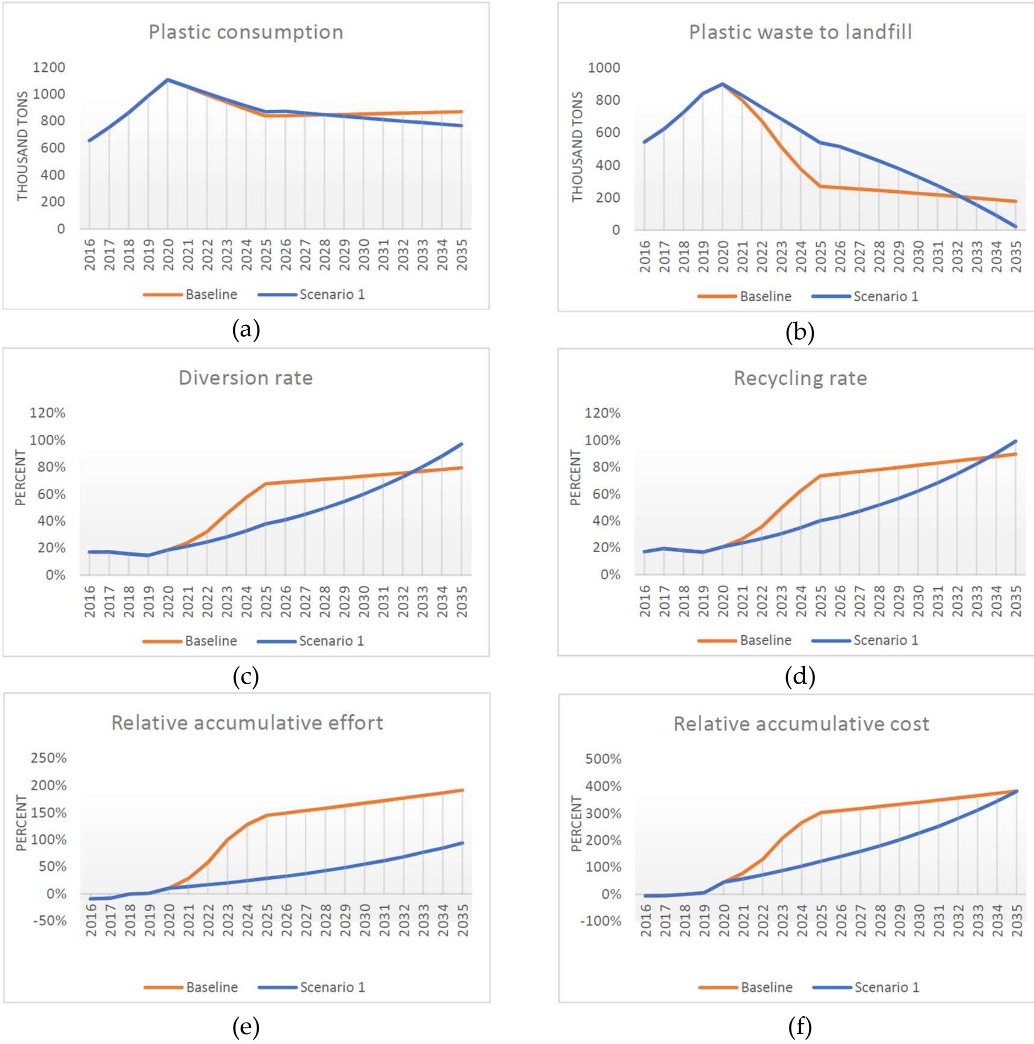


Figure 9. Comparison between baseline scenario and scenario 1 (the 6 outputs – Plastic consumption, Plastic waste to landfill, Diversion rate, Recycling rate, Relative accumulative effort and Relative accumulative cost in graph a,b,c,d,e,f respectively)

4.3. *Scenario 2 – Study on recycling capability*

The simulation results of scenario 2 is displayed in **Error! Reference source not found.**. This scenario looks into the reverse effect to scenario 1 where sorting efficiency, reuse and recyclability rates are altered while leaving the other inputs stationary. It is obvious for the plastic consumption graphs to behave the way they do since there is no encouragement to reduction in plastic consumption. While the 15% of reuse rate flattened the rise by a bit, the results from diversion and recycling rate still present at a downturn. It is clear at this stage that this scenario is nowhere near achieving zero plastic waste nor feasible for any implementations. However, a proper analysis should be made to fully grasp its effects on the system. Plastic consumption is estimated to climb at an exponential rate to 1953000 tonnes by 2025 if nothing is being done to prevent it from. The rate in scenario 2 is at 1870000 tonnes which yields a reduction rate of 4.2%. On the same note, diversion rate shows similar positive result during the first 5 years where the rate increases from 18.7% to 32.4% that is around 2.7% annually. All of these outcomes, however, came with a huge amount of effort and cost by 2025, it would take 219% effort from the government that is at 67% more than that of baseline scenario and 360% on expenses or 43% more than baseline scenario. While sorting efficiency, reuse and recyclability are important factors for recycling system, their effects are much less significant compared to consumption rate and recycling capacity.

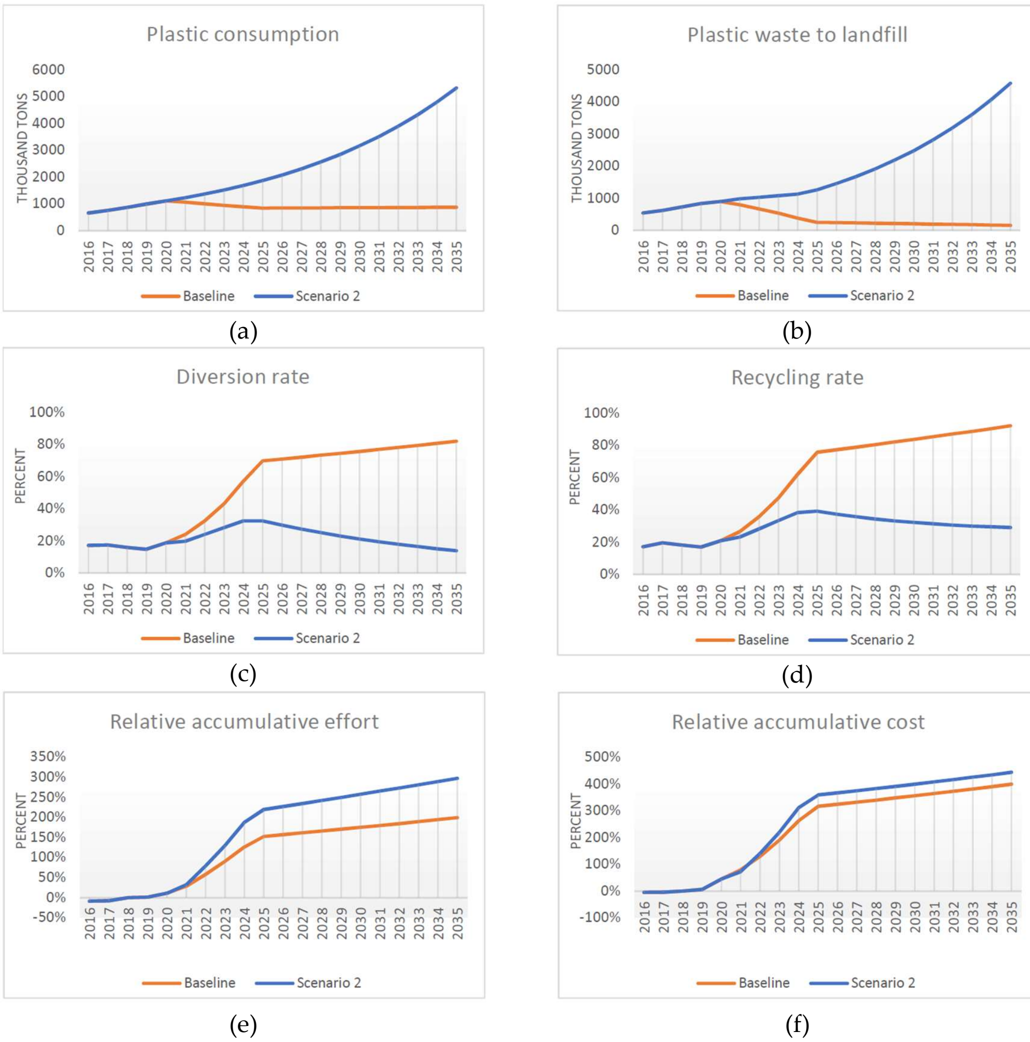
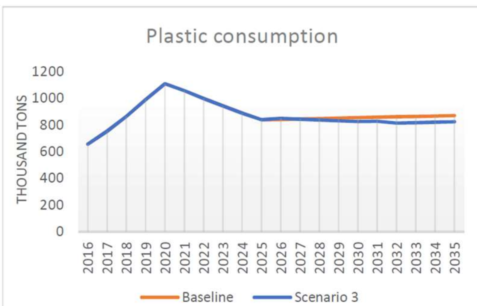


Figure 10. Comparison between baseline scenario and scenario 2 (the 6 outputs – Plastic consumption, Plastic waste to landfill, Diversion rate, Recycling rate, Relative accumulative effort and Relative accumulative cost in graph a,b,c,d,e,f respectively)

4.4. Scenario 3 – Complementation to Victoria's current plan

The simulation results of scenario 3 is illustrated in **Error! Reference source not found.**. The point of this scenario is to emphasize more on improving inputs that are significant in the long run and will increase the feasibility of zero plastic waste with consideration to economic and required effort. Improvements on consumption reduction and recycling capacity are essential, while improvements on product recyclability is secondary and no improvements are made towards reuse rate and sorting efficiency. The reasons behind these complementing values are based on what can be learned from scenario 1 and 2. Consumption and recycling capacity have great importance on the system. However, raising them excessively is only statistically viable and might impose further concerns, especially in the long run. Therefore, a more conservative approach is introduced and promotion on product recyclability as well seems appropriate to add up to long-term consideration. As a result, a more feasible outcome is produced and can be considered suitable to adopt to achieve zero plastic waste by 2035. Plastic consumption is seen doing better at 26% reduction by 2035 compared to 21% from baseline scenario. Rather slightly increase after 2025, scenario 3 remains stable throughout the period. Plastic waste to landfill also drops accordingly and reaches zero tonnes by 2035.

Additionally, as we compare these two inputs, the change is only by a slight in plastic consumption whereas in plastic waste to landfill, the change is quite substantial. This is because plastic waste to landfill is influenced by all the inputs which in this case is under the combined effects from further reduced consumption, higher recycling efficiency and capacity. Diversion and recycling rates from scenario 3 start to outperform that from the baseline scenario by 2025 and as well reach 100% by 2035. These results require 25% more effort and 76% more expenses to achieve with most of it are towards increasing recycling capacity. Although 76% extra expense on this plan might give a costly impression, considering this plan will run on a 15 years period, the different is not as significant.



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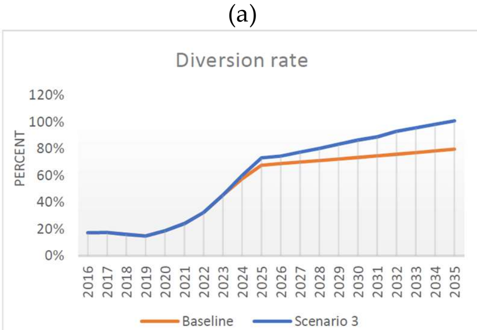

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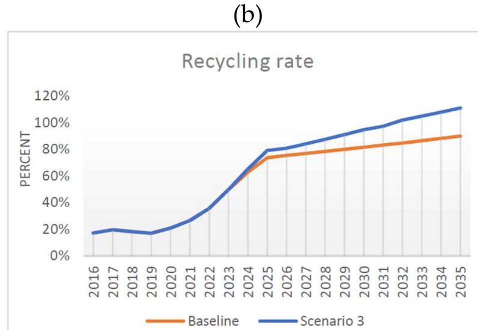

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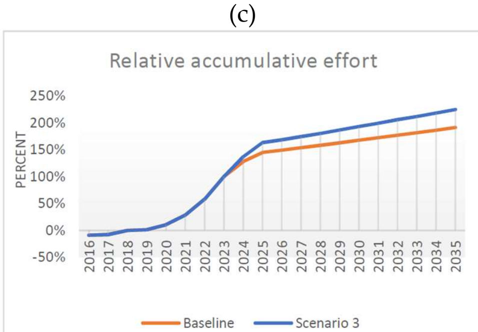

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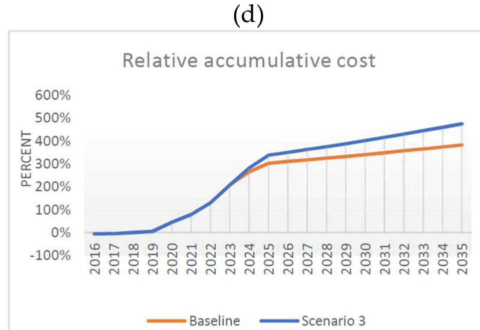

(f)

Figure 11. Comparison between baseline scenario and scenario 3 (the 6 outputs – Plastic consumption, Plastic waste to landfill, Diversion rate, Recycling rate, Relative accumulative effort and Relative accumulative cost in graph a,b,c,d,e,f respectively)

5. Discussion

Error! Reference source not found. highlights the overall performances of the proposed scenarios as well as providing convenience to form the discussion. The rate of plastic consumption drop in baseline scenario deserves a good explanation since it could be misleading from information provided previously. Initially, this scenario estimates that by 2035 consumption rate should reduce

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by 20% based on assumption described in step 1. Since the government's plan is a 10 years' policy where most of the programs are to be rolled out in the first 5 years, whereas the program will operate at a normal rate in the remaining years, it is obvious to expect a much stronger commitment in the early period. For this reason, the model applies full target effect of 15% reduction in the first 5 years followed by 10% in the rest of the years assuming that the assumed rate of 10% is achieved by 2025. The result is expected to be around 15-25% by 2025 because this high rate is achieved to accommodate with consumption growth due to increase in population. With this process of assumption in mind, baseline scenario, and scenario 1 and 3 show similar changing pattern when plastic consumption is altered. The drops in the first 5 years are mutual, however, the latter of the graphs vary.

Table 8. Outputs summary

Outputs	Baseline	Scenario 1	Scenario 2	Scenario 3
Plastic consumption	(-22.8%) ǀ (-22.1%) ǀ (-21.2%)	(-21%) ǀ (-25%) ǀ (-31%)	(+68%) ǀ (185%) ǀ (+380%)	(-23.7%) ǀ (-25%) ǀ (-26%)
Plastic waste to landfill	(-72%) ǀ (-76.7%) ǀ (-82.6%)	(-40%) ǀ (-64%) ǀ (-97%)	(+40%) ǀ (+176%) ǀ (+410%)	(-75%) ǀ (-87%) ǀ (-100%)
Diversion rate	67.7% ǀ 73.5% ǀ 82%	38% ǀ 60.1% ǀ 97.2%	32.4% ǀ 21.2% ǀ 14%	73% ǀ 86.5% ǀ 100%
Recycling rate	92%	99%	30%	100%
Relative effort	200%	94%	296%	225%
Relative cost	400%	385%	443%	476%

Note: The consecutive values of diversion rate reflect their milestone period of 2025, 2030, 2035.

The important point to take out from this output is how the latter graphs behave. The flatter the graphs, the more desirable they are considering how difficult it is to reduce plastic consumption with constant increase in population. Scenario 2 demonstrates a perfect example to the said difficulty when no commitment made towards decreasing plastic consumption. The final outcomes of these scenarios alone, despite indicating how feasible and successful each scenario is, could not provide full understanding on the recycling system. Baseline scenario and scenario 1, for example, show feasible results of 82% and 97.2%; yet, their progressive outcomes behave differently throughout the period. As the analysis of scenario 1 has mentioned, the differences between the two lines in the first 5 years comparison are due to the effects of product recyclability, reuse rate and sorting efficiency. These inputs significantly improve recycling options efficiency; thus, it increases plastic waste recovery, decrease waste to landfill, and improve diversion rate. Their effects can be estimated by examining 2025's outcomes of all scenarios except scenario 3 since the values are complemented. Baseline scenario and scenario 1 have differences in value of 29.7% for diversion rate and 32% for plastic waste to landfill rate. Scenario 2 shows increase in consumption due to population growth by 68%, but only send 40% more of plastic waste to landfill which yield a difference value of 28%. Consequently, it is reasonable to conclude that in general, product recyclability, reuse rate and sorting efficiency can improve recycling system by about 30% on top of commitments to reduce waste.

Victoria's current plan or baseline scenario presents a viable result of 77.5% averaged diversion rate by 2030. Although it is 2.5% behind the target, it is still a good step towards ZW considering some cities around the world took more than 10 years to achieve the same result. This achievement, at the same time, came with a note that the prediction does not consider any disruptive events that could happen along the way. Therefore, while it is considered achievable, the real outcome might fall a bit below the target. The fact that the plan does not achieve ZW or 100% diversion rate by 2035 which is the sole focus in this study, however, is still an unsatisfactory finding and does not check the objective box of this study. Further development on this plan is recommended if it were to achieve zero plastic waste yet should be done with careful consideration with regards to effort and cost required and its long-term effect.

Scenario 1, the study on supply and demand, brings Victoria's recycling system to meet zero plastic waste by the targeted year without having to exert as much effort as the current plan while keeping over-time expenses at a sturdy rate. This scenario, despite its statistical viability, is less likely to happen due to concerns on long-term effect, its practicality and increase in behavioural resistance. Any ZW approaches should put long-term effect into consideration. For example, by encouraging people to reuse their plastic waste can saves energy from having to recycle it and processing in productions, reduces emission, and reduces the overall consumption. On the same note, approaches without improving recycling capability factors like sorting efficiency, reuse rate and recyclability are inefficient and impractical. The fact that scenario 1 reduces consumption and increase recycling capacity will result in an overwhelming increase in recovered material waiting to go into reproduction. Consequently, if those recovered material were to go into local reproduction, the recyclability rate should increase on its own to accommodate with the changes. To further support the argument, the fact that recycling capacity increases without increasing sorting efficiency and recyclability means a huge number of the same technologically inefficient recycling facilities are being built which returns to the long-term and environmental concern. Lastly, reducing plastic consumption at a certain rate over a long period of time might attract increase in behavioural resistance from consumers. The key to minimize this concern is the by-products of sorting efficiency and recyclability such as proper educational campaigns, strategical studies and council coordination which are not applicable in this scenario. This argument explains the projected low effort which much of it caters towards only drafting policies on plastic consumption. Nonetheless, this scenario provides values points on how significant plastic consumption and recycling capacity are to recycling system. It serves as an important piece of puzzle towards the understanding of their relationships.

Scenario 2 enables further understanding on input relationships on top of what scenario 1 offer, which to summarise, plastic consumption and recycling capacity have greater impact on the system compared to other inputs. Similarly, in this scenario where no alternations on the two inputs were made, the outcome is far from acceptable much less from achieving zero plastic waste. However, it can demonstrate how these inputs can go hand in hand in recycling system. The first indication to this claim can be found in plastic to landfill chart in scenario 1 where it goes down at a slower rate than the baseline scenario's due to the effects of product recyclability, reuse rate and sorting efficiency. The same chart in scenario 2, where these three inputs are at maximum, shows no progress at all. These two indications conclude that while reducing consumption and increasing recycling capacity helps diverting waste from landfill, the inclusion of product recyclability, reuse rate and sorting efficiency can amplify the effect by a significant rate. Correspondingly, without altering plastic consumption and recycling capacity in the first place, product recyclability, reuse rate and sorting efficiency are only with little to no use to the recycling system. This point also adds up with the concerns on long-term effect, practicality and behavioural resistance mentioned in scenario 1 above.

Scenario 3 compliments on baseline scenario in a way that agrees to what was discussed in the previous scenarios. By this stage, it is comprehensible to label the inputs by two groups, major inputs (plastic consumption and recycling capacity) and minor inputs (product recyclability, reuse/end-of-life proxy rate and sorting efficiency). The changes scenario 3 made on major inputs are kept minimal and enough to produce the desirable outcome while taking the priority to minimize the chance of stirring up behavioural resistance as well as impacting environment. Changes on minor inputs are made with consideration on the source of plastic products rather than demanding more commitment from consumers which again would have further concern on behavioural resistance. Therefore, no additional alteration made towards reuse rate and sorting efficiency and an increase of +1 is added to product recyclability. The difference of effort required from this approach is only 25% or by one twelfth to the baseline scenario. With the viable result and commitment to other considerations, this scenario is demonstrated to be fairly worthwhile and could potentially bring Victoria's recycling system to reach ZW in 15 years' time.

6. Conclusion

This research tends to study the current waste management strategy in Victoria and to develop a simulation model to assess the feasibility of achieving zero plastic waste in the next 15 years with the current plan. This study utilized the experiences of successful cities around the world in launching zero plastic waste programs to support the construction of the simulation model. The model outputs show that Victoria's current plan to achieve 80% diversion rate by 2030 is possible; however, the state will not reach 100% by 2035 which means zero plastic waste is less likely to happen. An improvement to the plan is proposed by introducing a slight upgrading on inputs (scenario 3) including product recyclability, packaging polymer consumption, non-packaging polymer consumption, processing facilities capacity, recycling options efficiency, reuse/end-of-life proxy rate, and sorting efficiency to ensure zero plastic waste is met. Further exploration on scenarios outside of the scope of this study can be done with different arrangements to input values to find the best possible outcomes. On the last note, it is understandable for judgement of scenarios with less effort and cost required to achieve this goal to be more desirable. It is also arguably equal in interest to both parties, consumers, and the government. However, not all outputs perceived as feasible are as they are. Reducing plastic consumption only requires effort on drafting and implementing policies and minor campaigns while increasing sorting efficiency and recyclability requires a lot of effort on educational campaigns, design and planning and coordination between councils and industries. None of the inputs should be left out despite their importance and a lower priority on effort and cost should be encouraged. By putting strong commitment and keeping a balance in all aspects, a circular economy can definitely be promoted, and an establishment of a better and more reliable recycling system can as well loom to life.

To conclude this study, despite its scope, the model provides great accessibility for a prediction tool which enables a possibility of extensive result analysis and discussion. Results from scenario 1 and 2 have significance on the understanding on how aspects like product recyclability, reuse, and sorting efficiency, can impact recycling system. Baseline scenario and scenario 3 shows feasible outcomes and reflect the aim and objectives of this study. Points mentioned in the discussion are valid and based on what the results suggest. The main idea to take out from this study is how each element of recycling system play their important roles in the system. Although some elements might give an impression of not providing usefulness or that might scale up the expenses, they could possess indirect effect which could be utilised to support the other elements to increase the efficiency. Last but not least, the findings of this study conclude that Victoria's current plan are feasible for its goal and presented with opportunities for improvement especially towards zero plastic waste. While numbers and graphs can be reliable means to support this predicted achievement, the progress in reality is expected to see challenges and unpredicted events that would cause disruption to the progress should be anticipated and embraced with all necessary precautions.

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