

Research paper

Towards Net Zero and a Zero Landfill Future: Leveraging Hong Kong's Municipal Solid Waste Charging Scheme for Sustainable Waste Management and Carbon Neutrality

Ellice Dane W. Ancheta¹, Maria Obiminda L. Cambaliza^{2,3} and Laurence L. Delina^{4,*}

Handling Editor: Kris Hartley

Received: 10.03.2025 / Accepted: 11.07.2025

Abstract

Hong Kong confronts significant sustainability challenges in waste management and climate change, with an alarming daily disposal rate of 1.51 kg per person and a landfill capacity that is nearing exhaustion. This situation contributes to substantial greenhouse gas emissions. In response, the city has set ambitious targets to reduce per capita Municipal Solid Waste (MSW) disposal by 45% and to increase recycling rates to 55%. This paper investigates how Hong Kong's prolonged MSW Charging Scheme can facilitate the achievement of its 2050 carbon neutrality target and its goal of attaining zero landfill waste. Under a business-as-usual scenario, 68% of MSW is projected to be landfilled, with emissions projected to rise by 21% by 2050. However, adopting a Zero Landfill approach could potentially halve these emissions, emphasising the urgency for aggressive waste reduction and recycling initiatives. The study proposes three key strategies: (1) implementing mandatory waste segregation, (2) enforcing the developments outlined in the Waste Blueprint 2025, and (3) enhancing public engagement with climate and waste management policies. The successful execution of these strategies hinges on robust public support and education, which are essential for fostering a sustainable future for Hong Kong.

Keywords: Hong Kong · Municipal Solid Waste · Waste Reduction · Waste Management · Emissions Reduction · Waste Emissions · Carbon Neutrality

1. INTRODUCTION

Effective waste management is not only a local concern but also a critical pillar in the global fight against climate change, as it directly influences greenhouse gas (GHG) emissions and resource sustainability. In Hong Kong, the indefinite postponement of the Municipal Solid Waste (MSW) Charging Scheme underscores the significant challenges associated with implementing waste management policies and, by extension, climate policy in the city. Initially proposed in 2005 as part of the "Policy Framework for the Management of Municipal Solid Waste (2005-2014)," the Scheme aimed to impose fees on households for waste disposal (Hong Kong Environment Protection Department (HK EPD), 2005). After nearly two decades of deliberation, the Hong Kong Legislative Council enacted this legislation in 2021 (HK SAR Government, 2021). As part of the city's broader aspiration for a zero-landfill approach, this regulation seeks to mitigate the alarming daily disposal rate of 11,130 tonnes of MSW recorded in 2022 (HK EPD, 2023). This figure translates to approximately 1.51 kilograms of waste generated per person daily, which is 30-70% higher than levels observed in other major Asian cities, including Tokyo (0.880 kg/person/day), Seoul (0.950 kg/person/day), and Taipei (1.139 kg/person/day) (MOE Japan, 2024; MOE Korea, 2023; Environmental Protection Administration Taiwan, 2022).

This paper argues that the MSW Charging Scheme can address Hong Kong's waste management challenges and make a significant contribution to the city's carbon neutrality ambition by 2050. The MSW sector faces

¹ Ibis Consulting, Hong Kong SAR; dane.ancheta@ibisconsulting.com; dane.ancheta@connect.ust.hk

² Department of Physics, School of Science and Engineering, Ateneo de Manila University, Loyola Heights, Quezon City, Metro Manila, Philippines; mcambaliza@ateneo.edu

³ Air Quality Dynamics Laboratory, Manila Observatory, Ateneo de Manila University; Loyola Heights Campus, Quezon City, Metro Manila, Philippines

⁴ Division of Environment and Sustainability, The Hong Kong University of Science and Technology, Clear Water Bay, Kowloon, Hong Kong SAR; lld@ust.hk

* Corresponding author: lld@ust.hk

substantial challenges, including high waste loads, limited local recycling capabilities, and excessive reliance on landfills, which are projected to reach capacity in the coming years. Historical MSW policies have largely failed to achieve their objectives, primarily due to implementation difficulties and the absence of economic policies and market instruments specifically designed for MSW management (Lee, 2020). Although the waste sector accounts for only 7.7% of the city's total GHG emissions—approximately 2.58 million tonnes of CO₂e (Hong Kong Environment Bureau, 2023)—it faces urgent pressure to accelerate decarbonisation to meet Hong Kong's carbon neutrality target by 2050 (The Government of the Hong Kong Special Administrative Region (HK SAR Gov, 2021).

This study investigates the research question: How can the MSW Charging Scheme and associated policies contribute to GHG emission reductions while addressing Hong Kong's waste management challenges? To explore this topic further, we pose three sub-research questions: What are the main barriers to decreasing reliance on landfills in Hong Kong's waste management system, and how can the Scheme help overcome these challenges (RQ1); how can implementing mandatory waste segregation improve recycling rates and lower GHG emissions under the Scheme (RQ2); and what strategic policies can be integrated with the Scheme to encourage public engagement and behavioural change towards sustainable waste management practices (RQ3)?

Addressing the issue of MSW management and a low-carbon future for Hong Kong is crucial for several reasons. Firstly, as the city grapples with rising waste generation and limited landfill space, understanding the effectiveness of the Scheme can provide insights into sustainable waste management practices and the efficacy of the city's Waste Blueprint 2025 (Hong Kong Environment Bureau, 2023). Secondly, given Hong Kong's commitment to achieving carbon neutrality as outlined in the Climate Action Plan 2050 (HK SAR Government, 2021), it is essential to identify policies that can reduce waste and significantly lower GHG emissions. This study aims to fill a critical gap in the current literature and inform policymakers and stakeholders about the potential of the Scheme as a viable solution for enhancing waste management and climate mitigation in Hong Kong.

The paper is structured as follows: Section 2 evaluates the status of management and policies in Hong Kong, including waste and climate policies, to highlight the necessity of assessing the Scheme and related policies regarding their potential to reduce GHG emissions while addressing waste management challenges. Section 3 outlines the study's methodology, employing complementary quantitative methods to simulate four scenarios derived from Hong Kong SAR's policy documents, alongside qualitative methods through key informant interviews to enrich the discourse. Section 4 presents and discusses the findings, and Section 5 concludes with a summary, discusses the study's limitations, and suggests avenues for future research.

2. THE STATE OF MANAGEMENT AND POLICIES RELATED TO HONG KONG'S MSW AND LOW-CARBON AMBITIONS

2.1 Hong Kong's MSW Sector

MSW generation: In 2022, the average individual in Hong Kong generated approximately 2.18 kg of waste per day, which includes garbage processed through landfilling and waste diverted for recycling (Author 1's calculations, utilising data from the HK EPD, 2020). Notably, per capita landfill disposal rates have consistently increased (HK EPD, 2021). In 2023, approximately 68% of MSW was directed to landfills, while the remaining 32% underwent resource recovery and recycling (HK EPD, 2023) (**Figure 1**). Food waste alone accounted for 30%, or 3,300 tonnes, of daily landfill disposal, a figure that has steadily risen each year (HK EPD, 2020). Paper

and plastics followed closely behind in terms of landfill contributions (HK EPD, 2020). Consequently, landfills are projected to reach full capacity within the next few years (HK EPD, 2021).

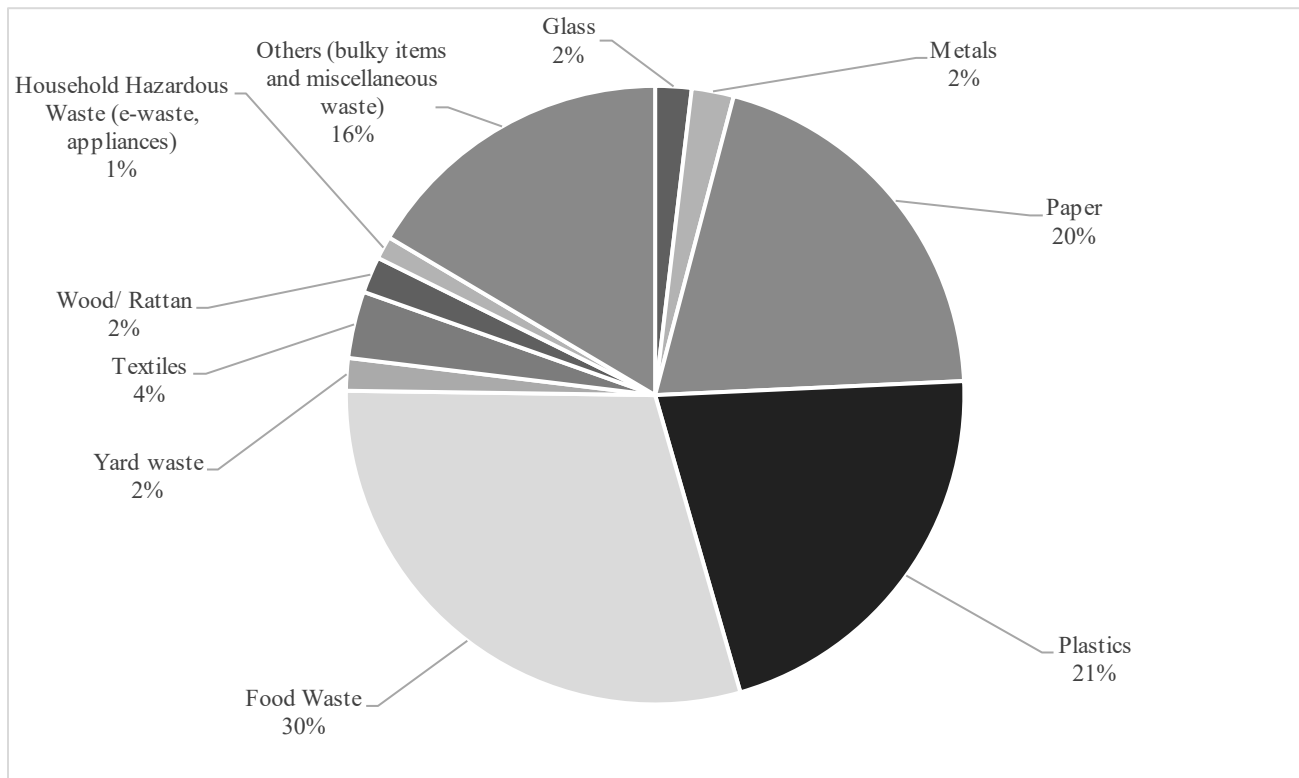


Figure 1. Hong Kong's Landfilled MSW by Waste Type, 2022

Source: Drawn by Ellice Dane W. Ancheta from the HK EPD Waste Statistics (2023)

MSW Recycling and Recovery: Since 2019, Hong Kong has consistently increased its recycling rates. In 2022, the city recovered 1.91 million tonnes of waste, representing 32% of total MSW generated a 7% increase over three years. Notably, 78% of recovered resources were exported to Mainland China for processing, while the remaining 22% were recycled locally (HK EPD, 2023).

Globally, Hong Kong ranks among the largest exporters of plastic waste, contributing nearly 22% (or 3,184,176 tonnes) of the world's annual total (Wen et al., 2021). However, stricter regulations on waste imports imposed by the State Council of China in 2017 (General Office of the State Council, 2017) have complicated the situation. These regulations were introduced in response to the overwhelming volume of plastic waste and inadequate local recycling infrastructure, resulting in significant difficulties in recovering plastic waste and diminished economic returns (Hossain et al., 2021). The ban on imported waste, combined with a decline in the global plastic recycling market, has led to a substantial increase in plastic waste being sent to Hong Kong's landfills. Similarly, the paper recycling sector has faced considerable challenges due to China's waste import ban and a significant decline in the market price for waste paper (Gu, 2021).

In response to these challenges, Hong Kong has established the EcoPark, its first dedicated recycling facility. This initiative involves the Government leasing public land to private enterprises that recycle various recovered resources, including cooking oil, rubber, metals, wood, and batteries (Hong Kong Environmental Protection Department, 2021).

Landfills and waste-to-energy facilities: Hong Kong's MSW is primarily disposed of in the North East New Territories Landfill (NENT) and West New Territories Landfill (WENT) (Figure 2). The WENT Landfill is the larger facility, receiving approximately 53% of the city's daily total MSW, which amounts to about 5,933 tonnes. In contrast, the NENT Landfill accommodates the remaining 47%, roughly 5,195 tonnes (HK EPD, 2023). Since 2016, the South East New Territories (SENT) and SENT Extension Landfills have been exclusively designated for the disposal of construction waste (The Government of Hong Kong SAR, 2016).

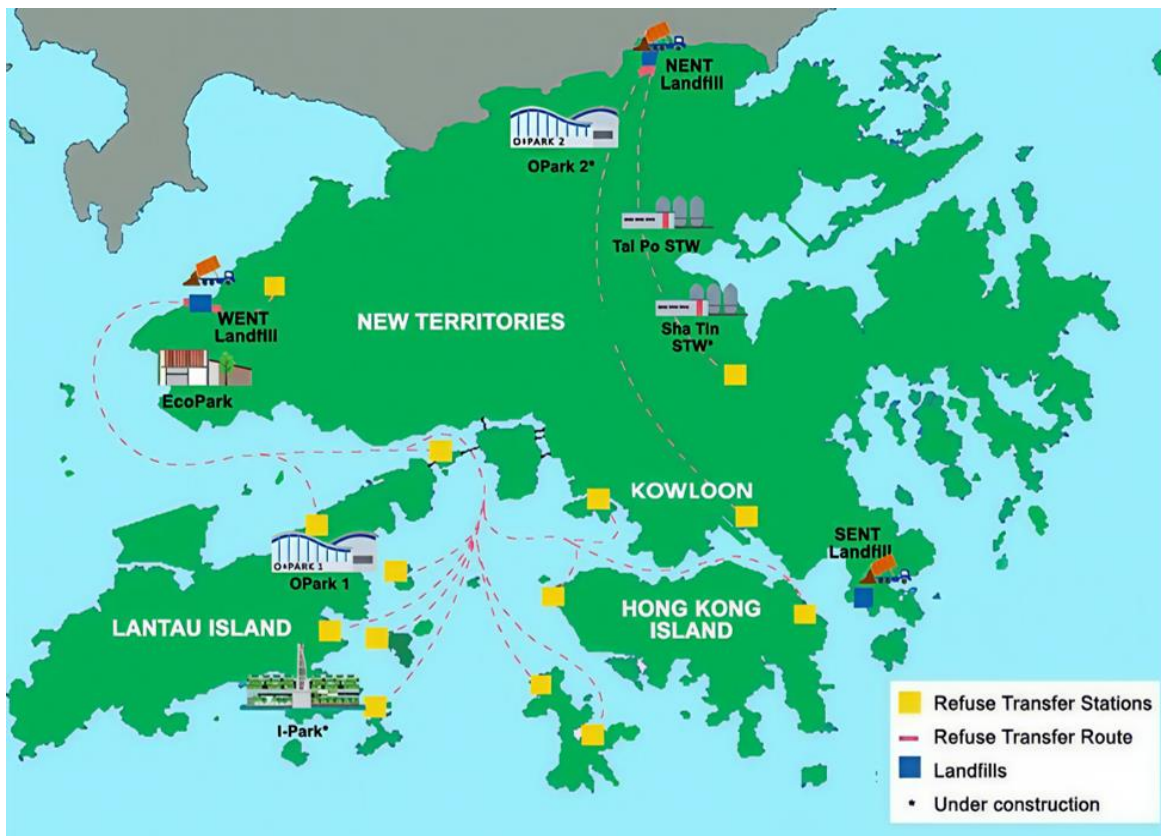


Figure 2. Hong Kong's MSW Management, Transport and Infrastructure

Source: Drawn by Ellice Dane W. Ancheta

Although landfilling remains the predominant method of waste management in the city, the public regards it as the least desirable option due to sustainability concerns linked to limited land resources (Civic Exchange and HK PORI, 2021). Climate-wise, the anaerobic decomposition of organic materials in landfills releases GHGs, primarily methane, which has a significant global warming potential (Buendia et al., 2019).

Hong Kong's landfills are equipped with systems for recovering and utilising landfill gas for waste-to-energy production; any excess gas produced is flared off (HK EPD, 2021; HK EPD, 2016). The recovered gas serves multiple purposes, including on-site power generation, leachate treatment, process heating, and grid export. The city has also established Organic Resource Recovery Centres (O-Park) and sewage co-digestion plants for processing food waste, employing anaerobic digestion technologies to recover biogas for energy generation (HK EPD, 2020). One facility, O-Park 1, has a processing capacity of up to 200 tonnes per day (tpd) (HK EPD, 2021), while O-Park 2 boasts a higher capacity of 300 tpd. Furthermore, two co-digestion facilities treat 50 tpd each, and YPARK focuses on processing yard waste, including fallen trees and other organic materials.

2.2 Hong Kong's Waste and Climate Policies

To understand the dynamics between climate action and waste management in Hong Kong, we focus on two key policies. The Hong Kong Climate Action Plan 2050 outlines the city's climate-related mitigation actions across all sectors, including waste, to achieve carbon neutrality by mid-century (HK SAR Gov, 2021). Additionally, the Hong Kong Waste Blueprint 2035 outlines the city's waste management strategies, including current and planned policies and infrastructure, as well as the MSW Charging Scheme (Hong Kong Environment Bureau, 2021).

The Blueprint present a three-pronged approach to waste management: waste reduction, resource circulation, and zero landfill (Hong Kong Environment Bureau, 2021). It establishes ambitious targets for waste reduction, recovery, and recycling, aiming for a recycling rate of 55% and reduction targets of 40% to 45% relative to 2020 levels (Low, 2021). Although the Scheme was initially intended for introduction by 2023, it has since been postponed. The next objective of the Blueprint is to regulate the use of disposable plastic tableware in a phased

manner by 2025 to minimise plastic waste at the source. Furthermore, the Blueprint aims to develop adequate waste-to-energy facilities by 2035 to reduce reliance on landfilling.

The Hong Kong MSW Charging Scheme has two mechanisms: garbage-designated bags or labels, and weight-based gate fees. The former involves volume or per-litre charging, set at HK\$0.11 (~US\$0.01) for different-sized designated garbage bags. Irregular or large waste requires a label charged HK\$11 (~US\$1.41) before disposal (HKEB, 2024). The latter mechanism involves weighing waste in collection vehicles and charging private collectors before disposal at landfills or transfer stations (HK SAR Gov, 2021). Evaluating how the Scheme can effectively contribute to GHG emission reductions, as envisaged in the Climate Action Plan 2050, while addressing these waste management challenges is crucial, especially in light of the city's net-zero targets.

2.3 Lessons from Successful Waste Management Policies

Hong Kong has looked to its regional peers for lessons on successful waste reduction policies, using Taiwan and South Korea as case studies within the 2013-2022 Waste Blueprint (HKEB, 2013). These regions were selected due to their similarities in lifestyles and the implementation of waste reduction initiatives over the past two decades. For example, Taiwan has demonstrated effective waste management practices, achieving a recycling rate of 55% and significantly reducing waste from 1.14 kg per person in 1997 to 0.4 kg per person in 2015 (Rossi, 2019; Bakshi, 2016). Although waste generation has increased since then, the substantial reduction during this period can be attributed to a series of actions, including the implementation of policies and public engagement programmes (Rossi, 2019). Studies conducted in Taiwan, such as those by Huang and Shaw (2021), reveal that unit-based pricing for municipal solid waste and mandatory recycling programmes have effectively reduced mixed waste volumes while increasing the quantity of biodegradable waste.

Beyond the case studies in Hong Kong's Waste Blueprint, Japan serves as another example of a successful waste reduction strategy, having reduced its municipal waste by approximately 73% from 17 million tonnes in 1990 to 4.6 million tonnes in 2012 (Ministry of the Environment, Japan, 2014). Since the 1990s, the Japanese government has enacted recycling laws aimed at diminishing waste generation and promoting enhanced recycling practices through the 3R model: Reduce, Reuse, and Recycle. Precise definitions for waste categorisation, utilising coloured bins and information dissemination, were established (JW Centre, 2023), along with corresponding processing methods. By law, all companies and individuals are required to sort their waste according to government guidelines. The combination of policies, waste segregation enforcement, behavioural change initiatives, educational programmes, and infrastructure for waste management has led to a significant decline in waste generation while simultaneously increasing the recycling rate from 5.3% in 1990 to 19.9% in 2021 (MOE Japan, 2024).

3. DATA SOURCES AND METHODS

To address the RQs, this study employs quantitative scenario development (Section 3.1) and qualitative expert interviews (Section 3.2). For RQ1, we utilised qualitative interviews to examine the challenges associated with managing MSW in Hong Kong. To address RQ2, we developed GHG emissions scenarios extending to 2050. We conducted a comparative analysis against business-as-usual (BAU) emissions to identify potential challenges and opportunities for climate action in the waste sector. This scenario development involved a quantitative assessment projecting MSW emissions under various scenarios. Finally, RQ3 was addressed by formulating strategic policy recommendations based on findings from both the quantitative projections and qualitative interviews.

3.1 Scenario Development

We utilised the open-source, Excel-based, Solid Waste Emissions Estimation Tool (SWEET) (US EPA, 2021) to estimate GHG emissions across four scenarios. SWEET is particularly well-suited for estimating and projecting emissions in Hong Kong's MSW sector, given the city's population and geographic size, and the tool's capability to estimate emissions at the landfill level. SWEET quantifies emissions from MSW sector sources for baseline setting and allows for comparisons of emissions reductions resulting from various mitigation actions. The tool can account for annual GHG emissions, estimate city-level emissions to establish baselines, set alternative scenarios, and monitor progress over time. Several cities, including those in Serbia (Milovanovic et al., 2021) and Ghana (Kanhai et al., 2021), have successfully utilised SWEET in their MSW management planning.

We collected data for the tool from publicly available government reports, site observations, key informant interviews, and private communications (**Table 1**).

Table 1. Data and Sources for GHG Emissions Assessment

Data	Sources
Waste generation and recovery rates	HK EPD (2023)
Waste composition	HK EPD (2023)
Information on 3 Strategic Landfills	HK EPD (2023); Communication with HK EPD (2021 September 3)
Landfill Gas Recovery	HK EPD (2023); Author 1's personal communication with HK EPD (2021 June 17); Towngas (nd); CLP (2021)
Waste road transport and emission factors	Emfac-HK (2021); Hong Kong Food and Environmental Hygiene Department (2021)
Waste Handling Equipment	Tchobanoglous et al. (1993)
Waste-to-Energy Infrastructures	Hong Kong Environment Bureau (2023); HK SAR Gov, 2021; Author 1's site visits

Using SWEET, we assessed and projected emissions from Hong Kong's MSW sector from 2000 to 2050, using 2022 as the baseline year and developing four scenarios (**Table 2**). We constructed Scenarios 1, 2, and 3 based on existing and planned infrastructures outlined in the Hong Kong Waste Blueprint 2035 (HK Environment Bureau, 2021) and the city's net-zero climate objectives (HK SAR Government, 2021). We discuss our assumptions for each of the scenarios next.

Table 2. Scenario Chart with Corresponding Infrastructures and Strategies for MSW Management

Scenarios	Waste generation rates, in kg/capita/day	Waste reduction rates per capita	Recovery rates	Anaerobic Digestion facilities, tpd	Waste-to-energy via incineration, tpd
BAU	2.06	Historical rates at +1.1%	2022 level: 32%	220	3,000
Scenario 1: Zero Landfill by 2035	2.06	45% by 2035	55% by 2025	600	3,000
Scenario 2: Zero Landfill but no incineration by 2035	2.06	45% by 2035	55% by 2025	400	None
Scenario 3: Increased Ambition to Decarbonise	2.06	60% by 2035	55% by 2025	600	3,000

In the **BAU scenario**, data indicates that Hong Kong's MSW is growing at an annual rate of 1.1 per cent, with a waste disposal rate of 11,057 tpd and recovery and recycling rates at 32 per cent. Within this BAU framework, we have considered several existing infrastructures: (1) the Integrated Waste Management Facilities, an incineration plant anticipated to process 3,000 tpd by 2025; (2) O·Park 1's food waste processing facility, which has successfully converted 160-180 tonnes of food waste into biogas since 2018; and (3) co-digestion facilities for sewage treatment.

As articulated in the Waste Blueprint 2035, Hong Kong aims to implement a "zero landfill" strategy to optimise land use and advance carbon neutrality (HK EPD, 2021). This policy outlines two principal objectives: a 45% reduction in MSW per capita by 2035 and a target resource recovery rate of 55% by 2025. **Scenario 1** assumes the full implementation of the Blueprint, where all proposed waste-to-energy infrastructure is expected to be operational. This infrastructure is projected to facilitate the anaerobic digestion of 600 tpd of food waste, alongside the incineration of 3,000 tpd of waste.

Scenario 2 parallels Scenario 1 but excludes the incineration component due to significant public opposition to the associated costs and adverse socio-economic and environmental impacts (Williams, 2011; Cheung, 2014). This scenario considers the 42% of the Hong Kong population that supports the "no landfill, no incinerator" alternative (Civic Exchange and HKPORI, 2021). This support reflects a growing awareness and concern

regarding sustainable waste management practices, highlighting the need for viable options that prioritise public health and environmental protection.

Scenario 3 aligns with Hong Kong's objective of achieving carbon neutrality by 2050 (HK SAR Gov, 2021) and investigates the potential for maximising emissions reductions alongside MSW management as outlined in the Blueprint. In this scenario, we posit the following assumptions: (1) a 60% reduction in per capita waste by 2035 compared to 2022 figures, (2) a recycling rate of 55%, (3) the operational status of all organic waste resource recovery centres, and (4) incineration processes functioning at full capacity. Furthermore, Scenario 3 incorporates (5) the daily composting of 12 tonnes of waste, corresponding to the capacity of the city's pilot composting facilities, and (6) the operational effectiveness of two new anaerobic co-digestion sewage treatment works.

3.2 Qualitative Data Sources and Methods

Ellice Dane W. Ancheta conducted twelve expert interviews between November and December 2021, employing both in-person and Zoom formats. The participants were specialists in environmental sustainability, energy, and waste management from various sectors, including academia, government bodies, environmental organisations, consultancy firms, and private enterprises. The interviews continued until thematic saturation was achieved. The Human Research Ethics Protocol Committee of the Hong Kong University of Science and Technology approved the human research ethics protocol for this study on 19 October 2021 (HREP-2-21-0182). Detailed profiles of the study participants (**Table 3**) illustrate their breadth of expertise and perspectives. The number of respondents aligns with Polkinghorne's (1989) recommendation that a sample of five to 25 knowledgeable participants is adequate for qualitative research.

Table 3. Descriptions of Study Participants

Respondents	Description
Respondent 1	Male; with master's degree; engineering background; 30 years in environmental protection field
Respondent 2	Female; with doctorate degree; 25 years an environmental professional in private company
Respondent 3	Male; with doctoral degree; with over four decades of research publications; waste expert in academia
Respondent 4	Male; with master's degree; engineering background; working in energy company
Respondent 5	Male; 15 years' experience in the environmental and sustainability field; consultant
Respondent 6	Male; with master's degree; more than five years' experience in circular economy and waste; civil organization
Respondent 7	Male; with doctoral degree; extensive publications in waste-to-energy research; 20 years working in environmental policy; academia
Respondent 8	Female; with master's degree; experience in resource and recycling enterprise
Respondent 9	Female; experience in resource and recycling enterprise
Respondent 10	Male; with doctoral degree; experience in environmental conservation and consultancy
Respondent 11	Male; with doctoral degree; publications and research on waste management; academia
Respondent 12	Male; with master's degree; a decade experience in environmental management and consulting field

The interviews were structured around five open-ended questions designed to elicit multidisciplinary commentary on (1) the management of MSW in Hong Kong, (2) the challenges faced in realising the city's waste management vision, and (3) potential solutions. Ellice Dane transcribed, coded, and analysed each interview using MAXQDA 2022 (VERBI Software, 2022), employing an inductive approach to facilitate the identification of common themes that emerged from the discussions.

4. RESULTS AND DISCUSSIONS: TRANSFORMING MSW MANAGEMENT IN HONG KONG

This section presents the study's results, discussing (1) the challenges of Hong Kong's MSW management (Section 4.1), (2) the relationships between MSW management and decarbonisation pathways under various policy scenarios (Section 4.2), and (3) strategic solutions and policy recommendations (Section 4.3).

4.1 Challenges in Hong Kong's MSW Management

Our qualitative data indicate that overreliance on landfills, substantial waste volumes, and limited local recycling facilities significantly hinder Hong Kong's MSW management (**Table 4**). Given the city's constrained land resources and projections suggesting that landfills will reach capacity in the coming years, there is an urgent need to reduce the quantity of waste sent to landfills while enhancing recovery and recycling efforts. Respondents unanimously acknowledged the city's dependence on landfills as both a prevalent practice and a significant challenge (see **Table 4**). Historically, landfilling has been the primary method for managing the city's MSW (Lou & Fabian, 2019), with data indicating that 68% of the MSW generated was disposed of in landfills throughout Hong Kong (HK EPD, 2023).

Table 4. Themes, Subtopics, and Code Frequencies

Major Themes	Sub-themes (code frequency)	Challenges (code frequency)	Solutions (code frequency)
Resource Recovery and Recycling	Mandatory Waste Segregation (11)	Waste segregation challenge (11)	Mandatory waste segregation policy (9); Space in buildings for waste segregation (4)
	Circular Economy (11)	Sorting; Recycling; financial feasibility; Lack of production capabilities (11)	Less Packaging; (3) Regional Cooperation (3) Recycling and Reuse
Waste Infrastructures	Landfills (11)	Reliance on landfills; need to reduce dependence on landfills (11)	Waste reduction (10)
Policy and Governance	Waste reduction through MSW scheme (8)		
	Hong Kong Waste Blueprint 2035	Towards a circular economy; carbon neutrality (3); Words not translating to action (2)	Set specific recycling targets instead of having one target recycling rate for all materials.
Public Behaviour	Education and information on proper waste segregation (6)	Build trust in the recycling system (5)	Carrot and stick approach (1)

Respondent 12 identified the most significant challenge in the city's MSW management as the need to transition away from landfilling, which requires a fundamental change in people's mindsets and attitudes. This behavioural change is crucial, as residents have long relied on landfilling as a waste management strategy.

Respondent 10 noted that this traditional reliance complicates the implementation of the MSW Charging Scheme.

Landfilling incurs considerable costs. Respondents 1, 2, 6, and 7 pointed out that the public pays substantial fees to landfill operators, funds that could otherwise be allocated to waste sorting, collection, and recycling. Supporting this assertion, public documents indicate that the operational cost of the WENT landfill was HK\$331 million (~US\$42.5 million) per year (HK EPD, 2021). Additionally, the expense of the WENT landfill extension was reported at HK\$44,277 million

4.2 Emissions Reduction Pathways Under Strategic Policy Scenarios

Reducing MSW is critical for decreasing emissions in Hong Kong and is a critical contributor to the city's carbon neutrality goal. Under the BAU scenario, MSW emissions are projected to rise by 21% by 2050 compared to the 2022 baseline (**Figure 2**). In contrast, Scenario 1, which meets all targets outlined in the Waste Blueprint 2035, is expected to reduce emissions by nearly half, resulting in approximately 1 million tCO₂e reductions (**Table 5**). Achieving a similar level of emissions offsetting is necessary for Hong Kong to meet its target of carbon neutrality by 2050. Immediate action and increased allocation of technological and fiscal resources will be vital to realise this scenario. As anticipated, landfilling is the most emissions-intensive method for managing MSW due to the substantial methane it produces, which has a high global warming potential (Iqbal et al., 2019; Hong et al., 2010; Xin et al., 2020). Emissions from the city's three landfills account for nearly 40% of total emissions under the BAU scenario, highlighting the importance of achieving zero landfills to reach net-zero emissions by 2050.



Figure 3. Hong Kong's MSW Sector Emissions Until 2050 in Million tco₂e Under Various Policy Scenarios

Table 5. Hong Kong's MSW Sector Emissions, 2050, in MtCO₂e

	BAU	Scenario 1: Zero Landfill by 2035	Scenario 2: Zero Landfill but no incineration by 2035	Scenario 3: Ambition to Decarbonise
Waste Collection and Transport	14,356	2,518	2,518	1,884
Landfills and Landfill Gas Combustion	1,431,255	659,044	903,838	399,585
Organics Management	11,331	7,376	7,376	7,717
Waste Handling Equipment	74,336	14,350	18,331	10,009
Waste Combustion	844,757	315,595	0	243,567
Total Emissions	2,376,035	998,883	932,062	662,762
% difference relative to the base year	21%	-49%	-53%	-66%

Comparing all scenarios to the BAU indicates that most emissions reductions will result from decreased MSW volumes and increased recycling. Such actions are expected to prevent approximately 1.38 million tCO₂e in emissions by 2050, based on the 2022 value of 1.97 million (**Figure 3**). Waste combustion for energy production is anticipated to emit 0.84 million tCO₂e by 2025, marking its initial year for the BAU scenario and excluding emissions avoided from electricity generation. Emissions from waste combustion primarily consist of CO₂, chiefly from the incineration of petroleum products, while emissions from organic management arise from anaerobic digestion and composting.

While Scenario 1's zero-landfill target is expected to significantly reduce emissions through waste reduction and recycling, the waste sector is still projected to emit approximately 1 million tons of tCO₂e by 2050. These emissions stem from degradation processes in landfills and CO₂ emissions from incineration. Methane emissions persist decades after landfills close, revealing the enduring environmental impact of landfill gas generation on climate change.

A comparison of emissions from Scenario 1 and Scenario 2 reveals a significant trade-off between landfill and incineration emissions. In the no-incineration scenario (Scenario 2), landfill emissions increase by nearly 37% as more organic waste is deposited in landfills rather than being diverted to incineration, as in Scenario 1. Conversely, Scenario 1 directs waste from landfills to incineration, generating direct CO₂ emissions from waste combustion. This redirection prevents organic waste from producing methane emissions if deposited in landfills. Nevertheless, Scenario 2, which excludes incineration, ultimately results in lower overall emissions by approximately 67,000 tCO₂e by 2050. These findings suggest that, given the comparable emissions from both scenarios, waste management practices should also consider practical factors such as resource efficiency and the importance of reducing waste volume.

Another significant challenge is achieving a 40% reduction in waste compared to 2019 levels, as indicated in Hong Kong's waste and climate policy documents. Over the past fifteen years, this rapid decline in waste generation has necessitated extensive policy implementation and behavioural changes. However, Taiwan has demonstrated that such a transition is achievable (Tsai et al., 2023), having reduced its waste disposal by nearly two-thirds within two decades following the introduction of the Waste Disposal Act of 1998 (Davidson, 2022).

The Hong Kong MSW Charging Scheme is therefore vital for both MSW reduction and climate mitigation; however, its effectiveness will only become apparent over time as it is implemented and evaluated. In addition to segregation, enhancing recycling capabilities is crucial. The city's recycling industry must significantly improve its capacity to boost local recycling rates, particularly in light of China's restrictions on waste imports. We address this and other recommendations in the following section.

4.3 Policy Recommendations for Enhancing MSW Management in Hong Kong: Public Engagement and Behavioural Change

This section discusses key themes associated with policy recommendations derived from our interview data.

4.3.1 Recommendation 1: Mandatory MSW Segregation

Key informants unanimously concurred that enforcing mandatory waste segregation is crucial for effective waste reduction (cf. Wang et al., 2021; Dickella, Gamaralalage et al., 2022). This practice is intimately linked to recycling, the circular economy, and public behaviour. Respondent 7 emphasised that “*regulation alone may not effectively reduce Hong Kong’s waste without a robust mandatory separation policy,*” thereby highlighting the need for a holistic approach that integrates regulatory measures with public engagement. Taiwan serves as an exemplary model with its successful implementation of waste charging and mandatory separation (Tsai et al., 2023). Respondent 7 reiterated “*the critical role of separation in achieving successful recycling outcomes.*” Taiwan’s achievements stem from effective policies and public engagement initiatives (Rossi, 2019). Huang et al. (2021) demonstrated that unit-based MSW pricing and mandatory recycling significantly reduced mixed waste and increased biodegradable waste. Such findings suggest that public participation and proper waste segregation are essential for enhancing recovery rates.

Other Asian cities further illustrate the effectiveness of mandatory segregation policies. In South Korea, Seoul has established a rigorous waste management framework mandating the separation of food waste and recyclables (Lee, 2018). This programme exemplifies how clear regulations, combined with public education, can lead to significant improvements in waste management outcomes. Japan’s “Sound Material-Cycle Society” initiative enforces strict waste separation rules, requiring residents to segregate recyclables, burnable waste, and non-burnable waste. This initiative has contributed to Tokyo achieving one of the highest recycling rates globally (Aoki-Suzuki et al., 2023). The success of these programs demonstrates that educating residents about waste segregation and providing the necessary infrastructure can increase compliance and improve recycling rates.

4.3.2 Recommendation 2: Expand Recycling Rates

Reusing and recycling are vital strategies for managing MSW, as identified by Respondents 4, 6, 7, 9, and 11. However, these strategies face challenges, including waste separation, collection costs, and market dynamics affecting the recycling industry’s profitability. Addressing these issues is essential for enhancing recycling rates in Hong Kong. A significant concern for Hong Kong’s EcoPark recycling facility is its financial sustainability. The viability of the recycling industry is critical for achieving high recycling rates. Respondents 1, 6 and 12 suggested solutions, including “*offering short-term subsidies for small recyclers and providing greater technological and infrastructure support for recycling businesses until they achieve self-sufficiency.*” This assistance is crucial given the initial costs of establishing recycling operations.

Another strategy proposed by Respondents 2, 7, and 12 involves “*utilising public-private partnership models to promote and encourage recycling enterprises.*” Such partnerships can leverage the strengths of both sectors—public entities can provide regulatory support and infrastructure, while private enterprises can drive innovation. For instance, collaboration between local governments and private recycling companies in Japan has led to successful recycling programmes, significantly increasing urban recycling rates (Kuan et al., 2022).

Hong Kong has set a general recycling rate target of 55% per year (HKEB, 2021); however, this target lacks disaggregation by material type, which limits its effectiveness. Respondent 6 suggested that “*recycling targets should be broken down by material type.*” This targeted approach is exemplified by South Korea’s waste management strategy, which includes specific recycling goals for various materials. Seoul has established distinct recycling targets for plastics, paper, and food waste, enabling more focused resource allocation and tailored support for recycling businesses (Lee, 2018; Vuk, et al., 2025). Taiwan’s implementation of unit-based pricing for waste disposal has incentivised higher recycling rates for specific materials, particularly plastics and paper (Huang et al., 2021). Establishing clear and measurable targets for individual materials has demonstrated that it is possible to enhance recycling rates while supporting the financial sustainability of recycling operations.

4.3.3 Recommendation 3: Food Waste Recycling

Food waste constitutes approximately 30% of landfilled waste, making its recovery essential for reducing MSW and mitigating GHG emissions. However, recovering food waste for anaerobic digestion presents unique challenges, primarily due to its perishability and health concerns during separation, collection, and transportation. Respondents 3, 8, and 9 identified critical challenges related to food waste management: (1)

proper waste separation, (2) efficient collection from households, (3) the sustainability of collection services for businesses, and (4) transport logistics and costs. Effective waste separation requires public education and behavioural change to ensure the effective segregation of food waste from other waste types. Respondent 8 noted that “*only a limited number of food waste collectors operate as sustainable businesses,*” complicating food waste recovery efforts. This limited capacity can hinder the overall effectiveness of food waste recycling initiatives.

To address these challenges, Respondent 8 proposed that “the government facilitate new entrants into the waste collection sector and assist private contractors in expanding their operations by charging for food waste collection services in restaurants and estates.” This approach aligns with successful models in other Asian cities. For instance, South Korea has established a comprehensive food waste recycling system that includes mandatory separation and collection, supported by public education campaigns. The Seoul Metropolitan Government has effectively promoted the installation of food waste disposal units in households and businesses, thereby enhancing collection efficiency (Robinson & Ji, 2022; Yoo & Yi, 2015).

In Japan, cities like Tokyo have also implemented robust food waste recycling initiatives involving partnerships between local governments and private waste management companies. These partnerships facilitate efficient collection systems and technologies for converting food waste into valuable resources, such as biogas or compost (Kuan et al., 2022). Taiwan’s experience demonstrates the importance of public participation and technological innovation, with its “Pay-As-You-Throw” system incentivising households to minimise food waste generation and promoting the separation of organic materials for composting and anaerobic digestion (Huang et al., 2021). This model illustrates how financial incentives and community engagement can lead to significant improvements in food waste recovery.

4.3.4 Recommendation 4: Strengthen Public Engagement

Respondents unanimously emphasised the importance of informed and participatory approaches to MSW management (cf. Kuang and Lin, 2021). Respondent 1 proposed “*a combination of incentives and regulations to encourage desirable MSW management behaviours, such as providing tax reductions to companies implementing sustainability programmes or waste reduction efforts.*” Building public trust in the recycling system is crucial for increasing household recycling rates, as noted by Respondents 1 and 9 (cf. Cohen et al., 2021). Convenience significantly impacts public engagement. Respondents 5, 9, and 12 stressed the need for “*convenient and accessible recycling facilities, particularly in high-rise buildings or estates, which are prevalent in Hong Kong.*” Respondent 9 suggested “*designating spaces within buildings for homeowners to segregate and recycle their waste,*” while Respondent 5 proposed “*encouraging property owners, huge ones, to adopt centralised or uniform MSW management practices.*”

Encouraging public behavioural changes in effective MSW management necessitates a multifaceted approach, including long-term public education, community engagement, robust policy implementation, and fostering trust in the MSW management system (Cohen et al., 2021; Kuang & Lin, 2021). As Hong Kong confronts its unique waste management challenges, it can draw valuable insights from neighbouring cities, where innovative policy instruments have successfully engaged the public in reducing waste and increasing recycling rates. For instance, Singapore’s “Zero Waste Masterplan” aims to reduce landfill waste by 30% by 2030, supported by public education campaigns and community involvement in recycling programs (Zhou et al., 2022). Singapore’s success stems from its emphasis on community participation and the integration of technology in waste management, such as smart bins that provide real-time data on waste levels. Similarly, Taiwan’s “Pay-As-You-Throw” programme incentivises households to minimise waste by charging fees based on the amount of trash generated, resulting in one of the highest recycling rates globally (Huang et al., 2021). This experience underscores the importance of aligning economic incentives with environmental goals to drive public participation in waste management.

In South Korea, Seoul has introduced mandatory food waste separation and recycling initiatives, which have successfully reduced food waste generation through composting and food waste recycling machines in residential areas (Yoo and Yi, 2015). This approach highlights the effectiveness of clear regulations combined with public education campaigns that encourage citizen involvement in sustainable practices. Tokyo’s “Waste Management Plan” prioritises reducing waste at the source, promoting recycling, and enhancing public awareness through a robust waste separation system and regular educational programmes (Aoki-Suzuki et al., 2023). The city’s experience illustrates the significance of a well-structured waste management framework that prioritises community engagement and education.

Challenges with domestic recycling in Hong Kong include waste mixing in recycling bins (Begum, 2022), contamination from food and liquid waste (Santagata et al., 2021), and the presence of unclean materials that render items unsuitable for recycling. To address these issues, Hong Kong can learn from Singapore's public awareness campaign, which utilises online content and distributes recycling bins throughout residential estates to enhance accessibility and convenience (Begum, 2022).

While efforts have been made to educate the Hong Kong public about the recycling aspects of the Scheme, the implementation of pilot programmes has faced delays due to public confusion, possibly stemming from a lack of engagement. Hong Kong could consider adopting similar approaches from neighbouring Asian cities, as discussed above (Babaei et al., 2015), alongside public education campaigns that utilise online content (Etim, 2024) and multilingual signage. Engaging sanitation workers, public cleaners, older populations, schools, and domestic helpers in public awareness campaigns can also contribute to effective waste segregation.

5. CONCLUSIONS

5.1 Summary of Findings

This study examines the challenges of MSW management in Hong Kong and identifies pathways to achieve carbon neutrality by 2050. The MSW Charging Scheme represents a significant step towards addressing waste issues while simultaneously reducing emissions from the waste sector. As the cornerstone of Hong Kong's waste reduction strategy, this policy aims to incentivise behavioural and cultural shifts crucial for aligning MSW management with the Climate Action Plan 2050 and the city's climate neutrality objectives. Therefore, its prompt implementation is imperative.

Key findings reveal that reliance on landfilling remains a significant barrier. In 2022, 68% of MSW was disposed of in landfills, with projected emissions under a BAU scenario indicating a nearly 25% increase by 2050. In contrast, implementing the Zero Landfill scenario, as outlined in the Waste Blueprint, could halve emissions, underscoring the critical need for aggressive waste reduction and recycling initiatives within both waste and climate policy.

The study presents three crucial findings. Firstly, mandatory waste segregation, supported by key informants and successfully implemented in other Asian cities, is vital for enhancing recycling and waste reduction, particularly when coordinated with the Scheme. Designated areas within buildings could facilitate waste separation and recycling by residents, while property owners could adopt centralised waste management practices. Secondly, enforcing mandatory waste segregation and executing planned waste infrastructure developments outlined in the Waste Blueprint could reduce emissions by 49% by 2050 compared to current levels. However, achieving these reductions depends on meeting the city's waste reduction and recycling targets set forth in its policy frameworks. Lastly, strategic public engagement is crucial to clarify uncertainties surrounding the Scheme and improve its pilot implementation.

While Hong Kong possesses a modern MSW management infrastructure, effective waste management must begin at the source. The successful rollout of the Scheme requires public endorsement and participation, which can be enhanced through educational initiatives targeting property managers, households, sanitation workers, and formal and informal recyclers. Simultaneously, it is essential to incentivise practices that further promote MSW reduction and recycling.

These findings suggest that Hong Kong should transition to a sustainable MSW management system through a multifaceted approach that incorporates mandatory waste segregation, enhanced recycling rates, and robust public engagement. The study also highlights the necessity of behavioural change among residents to facilitate the implementation of the Scheme. Moreover, the financial burden associated with landfilling presents an opportunity to redirect resources towards sorting, collection, and recycling efforts, ultimately improving MSW management while yielding benefits from reduced emissions.

5.2 Study Limitations and Potential Future Research Opportunities

This study acknowledges several methodological limitations. Its reliance on qualitative data from a limited number of key informants may not fully capture the perspectives of all stakeholders involved in Hong Kong's waste management ecosystem. Additionally, while quantitative emissions projections offer a useful framework for understanding potential outcomes, they are based on assumptions that may overlook unforeseen variables or changes in policy implementation. The decision to postpone the Scheme exemplifies such policy uncertainties.

Future research should consider broader, multimethod studies that incorporate a wider range of stakeholder perspectives, including the general public, private sector participants, and other actors within the waste-climate ecosystem. Investigating the long-term impacts of the Scheme on waste generation, recycling rates, and emissions reduction would also provide valuable insights. Comparative studies with cities that have successfully implemented similar waste management strategies, such as Singapore, Seoul, Tokyo, and Taiwan, could yield best practices applicable to Hong Kong. Additionally, exploring the role of technology and innovation in enhancing recycling capabilities and reducing waste generation could lead to more effective waste management and climate solutions.

In conclusion, addressing reliance on landfilling, enhancing recycling rates, and promoting public engagement are critical for Hong Kong to achieve its waste management and climate objectives. The findings of this study highlight the importance of a multifaceted approach that integrates regulatory measures, public education, and community involvement to foster a sustainable waste management and climate action culture in the city. As Hong Kong progresses, implementing these recommendations will be essential for mitigating the environmental impact of MSW and supporting the broader goal of carbon neutrality by 2050.

AUTHOR CONTRIBUTIONS

Ellice Dane W. Ancheta: conceptualisation, methodology, formal analysis, investigation, data curation, writing-original draft, writing-reviewing and editing, visualisation;

Maria Obiminda L. Cambaliza: supervision, writing-original draft;

Laurence L. Delina: conceptualisation, supervision; writing-original draft, writing-reviewing and editing

DECLARATIONS

Competing interests: The authors declare no competing interests.

Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third-party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>.

REFERENCES

- Aoki-Suzuki, C., Nishiyama, T., Kato, M., & Lavtizar, V. (2023). Policies and Practice of Sound Material-Cycle Society in Japan: Transition Towards the Circular Economy. In *Circular Economy Adoption: Catalysing Decarbonisation Through Policy Instruments* (pp. 37-66). Singapore: Springer Nature Singapore.
- Bakshi, G. (2016). Taiwan has one of the world's most efficient recycling systems. Global Citizen. <https://www.globalcitizen.org/en/content/taiwan-musical-garbage-trucks-recycling/>
- Babaei, A. A., Alavi, N., Goudarzi, G., Teymouri, P., Ahmadi, K., & Rafiee, M. (2015). Household recycling knowledge, attitudes and practices towards solid waste management. *Resources, Conservation and Recycling*, 102, 94–100.
- Begum S. (2022). Only 13% of S'pore's domestic waste was recycled in 2021, even as households throw out more rubbish. <https://www.straitstimes.com/singapore/environment/only-13-of-spores-domestic-waste-was-recycled-in-2021-even-as-households-throw-out-more-rubbish>
- Buendia, E., Tanabe, K., Kranjc, A., Baasansuren, J., Fukuda, M., Ngarize, S., ... & Federici, S. (2019). Refinement to the 2006 IPCC guidelines for national greenhouse gas inventories. *IPCC, Geneva, Switzerland*.
- CLP. (2021). Facts about the WE Station – Hong Kong's Largest Landfill Gas Power Generation Project. https://www.clpgroup.com/content/dam/clpgroup/channels/media/document/embedded_pdfs_en/20211028_WE_Station_Factsheet_en.pdf (Accessed November 12, 2021)
- Civic Exchange & HKPORI. (2021). Public Opinion Survey Results on The Municipal Solid Waste Charging Bill. <https://civic-exchange.org/wp-content/uploads/2021/05/MAY20MSW-Report-FINAL.pdf>
- Cohen, C., Halfon, E., & Schwartz, M. (2021). Trust between municipality and residents: A game-theory model for municipal solid-waste recycling efficiency. *Waste Management*, 127, 30-36.
- Davidson, H. & Lin, C. (2022). Classical trash: How Taiwan's musical bin lorries transformed 'garbage island'. *The Guardian*. <https://www.theguardian.com/world/2022/dec/26/classical-trash-how-taiwan-musical-truck-transformed-garbage-island>
- Dickella Gamaralalage, P. J., Ghosh, S. K., & Onogawa, K. (2022). Source separation in municipal solid waste management: Practical means to its success in Asian cities. *Waste Management & Research*, 40(3), 360-370.
- Dong, Y. H., An, A. K., Yan, Y. S., & Yi, S. (2017). Hong Kong's greenhouse gas emissions from the waste sector and its projected changes by integrated waste management facilities. *Journal of Cleaner Production*, 149, 690-700.
- Etim, E. (2024). Leveraging public awareness and behavioural change for entrepreneurial waste management. *Heliyon*, 10(21).
- Hong Kong Environment Bureau. (2021). *Waste Blueprint for Hong Kong 2035*. Hong Kong.
- Hong Kong Environment Bureau. (2024). Municipal solid waste charging. Government of the Hong Kong Special Administrative Region. <https://www.mswcharging.gov.hk/en/>
- HK EPD. (2021). EMFAC-HK Technology Group Indexes Version 4.3. https://www.epd.gov.hk/epd/sites/default/files/epd/Appendix%20IV_Exhaust%20and%20Evap%20Technology%20Group%20Indexes%20%28Ver%204.3%29%20.pdf

- HK EPD. (2022). Landfill Gas Utilization. https://www.epd.gov.hk/epd/english/environmentinhk/waste/prob_solutions/msw_lgu.html
- HK EPD. (2023). Integrated Waste Management Facilities. https://www.epd.gov.hk/epd/english/environmentinhk/waste/prob_solutions/WFdev_IWMF.html
- HK EPD. (2023). Monitoring of Solid Waste in Hong Kong Waste Statistics 2022. https://www.wastereduction.gov.hk/sites/default/files/resources_centre/waste_statistics/msw2022_eng.pdf
- Hong Kong Food and Environmental Hygiene Department. (2021, October). Cleansing Services. https://www.fehd.gov.hk/english/pleasant_environment/cleansing/clean1.html (Accessed November 17, 2021).
- Hong Kong Legislative Council. (2023). Report of the Subcommittee to Study Policy Issues Relating to Municipal Solid Waste Charging, Recovery and Recycling for submission to the Panel on Environmental Affairs. https://www.legco.gov.hk/yr2023/english/panels/ea/ea_msw/reports/ea_mswcb1-656-e.pdf
- Hong Kong Legislative Council. (2024). Organic Resources Recovery Centre Phase 2. <https://www.legco.gov.hk/yr2024/english/panels/ea/papers/ea20240122cb1-40-1-e.pdf>
- Hong Kong Special Administrative Region Government (HK SAR Gov). (2021). *Hong Kong's Climate Action Plan 2050*. https://cnsd.gov.hk/wp-content/uploads/2023/05/Climate-Target-of-HK_en.pdf
- Hong, J., Li, X., & Zhaojie, C. (2010). Life cycle assessment of four municipal solid waste management scenarios in China. *Waste Management*, 30(11), 2362-2369.
- Hossain, M. U., Ng, S. T., Dong, Y., & Amor, B. (2021). Strategies for mitigating plastic waste management problem: A lifecycle assessment study in Hong Kong. *Waste Management*, 131, 412-422.
- Huang, Y. K., Stevens, R. B., & Shaw, W. D. (2021). Waste reduction and waste spillovers: Evidence from unit-based pricing of municipal solid waste in Taiwan. *Journal of Environmental Economics and Policy*, 10(3), 223-42.
- Iqbal, A., Zan, F., Liu, X., & Chen, G. H. (2019). Integrated municipal solid waste management scheme of Hong Kong: A comprehensive analysis in terms of global warming potential and energy use. *Journal of Cleaner Production*, 225, 1079-1088.
- Japan Industrial Waste Information Center. (JW Center) (2023). Waste Management in Japan: Rules and Figures. https://www.jwnet.or.jp/en/assets/files/Waste_management_in_Japan_Rules_and_Figures_July2023.pdf
- Kuan, S. H., Low, F. S., & Chieng, S. (2022). Towards regional cooperation on sustainable plastic recycling: comparative analysis of plastic waste recycling policies and legislations in Japan and Malaysia. *Clean Technologies and Environmental Policy*, 24(3), 761-777.
- Kuang, Y., & Lin, B. (2021). Public participation and city sustainability: Evidence from Urban Garbage Classification in China. *Sustainable Cities and Society*, 67, 102741.
- Lee, K. C. (2018). Grocery shopping, food waste, and the retail landscape of cities: The case of Seoul. *Journal of Cleaner Production*, 172, 325-334.
- Lou, L. I. T., & Fabian, N. (2019). The struggle for sustainable waste management in Hong Kong: 1950s–2010s. *Worldwide Waste*, 2(1).

- Low Z. (2019). Hong Kong government announces halving rent for tenants of EcoPark to boost economy hit by US-China trade. *South China Morning Post*. <https://www.scmp.com/news/hong-kong/hong-kong-economy/article/3030364/hong-kong-government-announces-rent-cut-tenants>
- Ministry of the Environment. (2014). *History and Current State of Waste Management in Japan*. Office of Sound Material-Cycle Society, Policy Planning Division, Waste Management and Recycling Department, Minister's Secretariat, Ministry of the Environment. Tokyo, Japan.
- Ministry of the Environment, Japan. (2024, March 28). Municipal solid waste generation and disposal in FY2022 [Press release]. https://www.env.go.jp/en/press/press_02631.html
- Ministry of Environment, Korea. (2023, May 9). The amount of household waste per person has gone up by 2.2% as a result of COVID-19: 6th National Waste Statistical Survey results. <https://me.go.kr/home/web/board/read.do?boardMasterId=1&boardId=1592250&menuId=286>
- Ministry of Environment, Taiwan. (2025). Generation and treatment of municipal waste [Table 4-1]. Solid Waste Statistics. <https://www.moenv.gov.tw/en/information-service/statistics/solid-waste-statistics/1939.html?p=1&dc=45>
- Polkinghorne, D. E. (1989). Phenomenological research methods. In *Existential-Phenomenological Perspectives in Psychology: Exploring the Breadth of Human Experience* (pp. 41-60). Boston, MA: Springer US.
- Robinson, T., & Ji, M. (2022). Towards zero waste and the circular economy: Green governance remakes Seoul. In *Sustainable, smart and solidary Seoul: Transforming an Asian megacity* (pp. 11-37). Cham: Springer International Publishing.
- Rossi M. ((2019).) Taiwan's transition – from Garbage Island to recycling leader. Rapid Transition Alliance. <https://rapidtransition.org/stories/taiwans-transition-from-garbage-island-to-recycling-leader/>
- Santagata, R., Ripa, M., Genovese, A., & Ulgiati, S. (2021). Food waste recovery pathways: Challenges and opportunities for an emerging bio-based circular economy. A systematic review and an assessment. *Journal of Cleaner Production*, 286, 125490.
- Tchobanoglous, G., Theisen, H., & Vigil, S. (1993). *Integrated Solid Waste Management: Engineering Principles and Management Issues* (1st ed.). McGraw-Hill.
- The General Office of the State Council. ((2017).) Implementation plan for the reform of the import management system of solid wastes for the prohibition of foreign waste imports (in Chinese). http://www.gov.cn/zhengce/content/2017-07/27/content_5213738.htm.
- The Hong Kong and China Gas Company Limited [Towngas]. (2021). 沼氣應用項目 [Biogas Application]. <https://www.towngas.com/en/Sustainability/Environmental-Protection/landfillgas>
- Tsai, P., Kuo, Y. L., & Onishi, A. (2023). Environmental Policy for Waste Management in Taiwan: Regulatory Measures, Implementation Status, and Challenges. *Journal of Asian Geography*, 2(1), 56-63.
- United States Environmental Protection Agency. (2020). Solid Waste Emissions Estimation Tool (SWEET) (Version 3.1) [Computer software]. <https://ccacoalition.org/en/resources/solid-waste-emissions-estimation-tool-sweet-version-31>
- VERBI Software. (2019). MAXQDA 2020 [Computer software]. Berlin, Germany: VERBI Software.
- Vuk, A., Szűcs, I., & Bauerné Gáthy, A. (2025). Waste management and plastic waste recycling in Japan, China, Singapore and South Korea—What trends can be observed under different regulations. *International Review of Applied Sciences and Engineering*, 16(1), 118-131.

- Wang, Y., Shi, Y., Zhou, J., Zhao, J., Maraseni, T., & Qian, G. (2021). Implementation effect of municipal solid waste mandatory sorting policy in Shanghai. *Journal of Environmental Management*, 298, 113512.
- Wen, Z., Xie, Y., Chen, M., & Dinga, C. D. (2021). China's plastic import ban increases prospects of environmental impact mitigation of plastic waste trade flow worldwide. *Nature communications*, 12(1), 425.
- Xin, C., Zhang, T., Tsai, S. B., Zhai, Y. M., & Wang, J. (2020). An empirical study on greenhouse gas emission calculations under different municipal solid waste management strategies. *Applied Sciences*, 10(5), 1673.
- Yoo, K. Y., & Yi, S. (2015). Evaluation and development of solid waste management plan: a case of Seoul for past and future 10 years. *Journal of Material Cycles and Waste Management*, 17, 673-689.
- Zhou, J., Li, L., Wang, Q., Van Fan, Y., Liu, X., Klemeš, J. J., ... & Jiang, P. (2022). Household waste management in Singapore and Shanghai: Experiences, challenges and opportunities from the perspective of emerging megacities. *Waste Management*, 144, 221-232.