



1. Introduction

1.1 In 2015, each resident of Hong Kong on average generated 2.14 kg of municipal solid waste per day, more than those places with good waste management practice.¹ Household waste is the largest component of local municipal waste, with an estimated share of 55%. Although the Government has introduced a number of waste reduction initiatives over the past decade or so, local households generally do not take much effort to reduce and separate the waste at source, leaving most of the household waste ending up in landfills and resulting in significant cost to the local community.² To address the problem, the Government has recently sought legislative approval to implement a producer responsibility scheme on waste electrical and electronic equipment and glass containers in 2017-2018.³ Reportedly, it is also planning to introduce a bill on mandatory charges on municipal solid waste for implementation in late 2019 at the soonest.

1.2 At the meeting of the Panel on Environmental Affairs on 24 October 2016, it was decided to set up the Subcommittee on Refuse Collection and Resource Recovery ("Subcommittee") to review local policies on the matter. The Research Office was then requested to study overseas good practice in separation, collection and recovery of household waste for the reference of the Subcommittee.⁴ Three cities namely Taipei, Seoul and Berlin are selected for further study, as their policies on separation and collection of household waste have effectively reduced the waste for disposal. This information note

¹ In Hong Kong, the daily amount of municipal solid waste generated was 15 629 tonnes in 2015 which was translated into a per capita generation rate of 2.14 kg per day, more than that of 0.96 kg in Japan, 1.33 kg in the United Kingdom and 1.32 kg in Finland.

² The recurrent expenditure of waste management programme (including collection and transfer cost) was HK\$2.05 billion in 2014-2015, equivalent to an unit cost of HK\$520 per ton in disposing municipal waste.

³ See Environment Bureau (2017).

⁴ In all the three selected cities as well as Hong Kong, collection and transportation of commercial and industrial waste is largely the responsibility of the business firms concerned, while the collection of household waste is largely the responsibility of local governments. As such, this study focuses on the collection and recovery of household waste.

presents the relevant findings, along with summary tables on the salient features of their waste collection systems (**Appendices I-V**).⁵

2. Waste separation and collection in Taipei

2.1 In the 1990s, the city of Taipei encountered severe problems of saturated landfills on the one hand and strong public opposition against building more incineration plants on the other. In face of this deadlock, the Taipei City Government ("TCG") launched a number of waste reduction initiatives. In July 2000, TCG introduced a mandatory quantity-based charging scheme on municipal waste known as "Per Bag Trash Collection Fee Programme", in accordance with the pay-as-you-throw principle ("PAYT").⁶ Under the charging scheme, residents should dispose of their residual household waste in designated pre-paid trash bags, and TCG will only collect waste kept in such bags. At present, the price of the trash bags vary from NT\$ 1.05 (HK\$0.26) for a 3-litre bag to NT\$ 43.2 (HK\$10.7) for a 120-litre bag, providing a financial incentive for residents to reduce waste and separate recyclable items from the trash at source (**Appendix I**).⁷

2.2 Since March 2001, pursuant to the Waste Disposal Act,⁸ TCG has made it mandatory for the residents to separate recyclable items from trash before disposal. Currently, they need to sort their waste into the following four broad categories:

- (a) **Recyclable items:** Recyclable (or resource) items are divided into three major types for collection, namely: (i) **flat items** like paper, clean plastic bags, textiles; (ii) **cubic items** like cans, containers made of non-glass materials, small electrical appliances and computer equipment; and (iii) **other items** like fluorescent lamp, battery and cooking oil. All three categories are collected free of charge by the cleaning teams of the

⁵ The study on overseas practice comprises two parts, one on waste separation and collection and the other one on resource recovery. This information note addresses the first part, with another note on the second part of waste recovery scheduled for completion in the next two months.

⁶ The charging scheme replaced the old one which was tied to water consumption level and largely unrelated to the amount of household waste discarded.

⁷ The trash bags have six standard sizes which are available for sale in 2 200 authorized outlets in Taipei.

⁸ Mandatory waste separation was officially introduced across Taiwan in 2005, upon the approval of the Review and Prospect of Garbage Disposal Plan in 2003.

Department of Environmental Protection ("DEP")⁹ five days a week with different days dedicated to different categories of items, in accordance with the pre-set collection routes and timetable.¹⁰ Alternatively, residents may bring the recyclable items to about 40 fixed collection spots across Taipei open daily. The items collected will then be sent to transit points for further sorting, before selling to secondary material dealers or recycling companies for further processing (**Appendix II**).¹¹

- (b) **Food waste:** Collection of food waste has been mandatorily required across Taipei since end-2003. Food waste must be first divided into (i) **waste suitable for reuse as livestock feed**; and (ii) **waste for compost and for fertilizer**. They must be separately stored in buckets or ordinary bags for free collection five days a week by the cleaning teams at designated place and time. For residents living in apartment buildings, DEP will provide food waste bins for collective collection.¹² Alternatively, residents may also send the waste to any of the 40 fixed collection spots open daily, or some dedicated food waste collection points open on Wednesday and Sunday (**Appendix III**).
- (c) **Bulky waste:** At least 16 household items (e.g. mattress and large furniture) are classified as bulky waste.¹³ While the district cleaning teams collect bulky waste free of charge, there is no door-to-door collection service.¹⁴ Residents need to make a booking with the local cleaning team to fix a date and a pick-up location (**Appendix IV**).

⁹ Each of the 12 districts of Taipei has one dedicated cleaning team which follows a pre-set route (over 180 routes with over 4 000 collection points) and timetable of waste collection. The teams have a total strength of 4 000 people.

¹⁰ Flat recyclable items like waste paper, old clothes and clean plastic bags are collected on Monday and Friday, while cubic recyclable items and clean styrofoam are collected on Tuesday, Thursday and Saturday.

¹¹ 25% of the sale revenue is distributed to the teams as bonus.

¹² The bins will be placed in a dedicated common area of the buildings. Building management may either make appointment with the cleaning teams to pick up the filled bins or hire private contractors to dispose of the food waste.

¹³ They include bed mattress and frame, cart, bicycle, electric fan, gas stove, large water dispenser, sofa, table and chairs, cabinet, waste electrical appliances (television set, refrigerator, washing machine and air-conditioner) and luggage cases.

¹⁴ Door-to-door collection in this note does not necessarily mean collection directly from the doorstep of a household. It could be collection from the curbside that is close to a building or house.

- (d) **Residual waste:** Netting out recyclable items and food waste, residual waste for disposal must be kept in the aforementioned pre-paid trash bags.¹⁵ Residents need to pass the trash to the cleaning teams of DEP in person at a designated place and time each day, except Wednesday and Sunday. For residents of apartment buildings, they may hire contractors to discharge the residual waste on their behalf. Alternatively, residents who miss the collection schedule may discard the residual waste at any of the fixed collection spots run by DEP during opening hours. Non-compliance to the above requirements is subject to a fine of NT\$6,000 (HK\$1,500) (**Appendices V-VI**).

2.3 On top of the waste collection services provided by DEP, there are other channels for collection of recyclable items. In particular, there are hundreds of **community recycling stations in residential buildings** across Taipei, with containers placed there for collection of various kinds of recyclable items. These stations are important channels in the entire collection system of recyclables, accounting for 69% of all 485 000 tonnes of recyclable items recovered in Taipei in 2015.¹⁶ The items recovered by the stations can be sold directly to recyclers or collectors, bypassing DEP and providing financial rewards to the participants. While **schools** and **other organizations** (like charitable or religious bodies) took up 1% and 24% respectively of the recovered recyclables, DEP took up the rest of 6%. Moreover, vendors like supermarkets and convenience stores are required to provide recycling bins for used containers under the Waste Disposal Act.¹⁷

2.4 Public litter bins for pedestrian use on the streets only play a supplementary role in Taipei's waste collection system. There are just about 3 000 such bins in the city mostly provided and managed by DEP, equivalent to one bin per 900 residents.¹⁸ While there were concerns about illegal waste dumping in the litter bins after the implementation of the quantity-based waste charging in 2000, some of the recent concerns were about under-provision of such litter bins, and hence, waste overflowing in areas with heavy

¹⁵ Since August 2016, some groceries' plastic shopping bags are also allowed to be used as trash bags too.

¹⁶ Community collection is particularly effective in collecting paper, plastic containers and iron cans while DEP's cleaning teams are more effective in glass containers and packing foam collection.

¹⁷ So far 11 types of vendors are regulated, including operators of automatic vending machine which by law are required to provide recycling bins of a size at least 50 litres.

¹⁸ In Hong Kong, there are about 40 000 public litter bins on the streets, or one bin per 184 people. On top of these, there are also 16 000 sets of waste separation bins in the public streets or areas.

pedestrian flows. Since 2015, DEP began to replace the old litter bins with a new twin-bin design (120 litres each), one for trash and the other for recyclables. On average, public litter bins are emptied three times a day.

2.5 In 2014, the total cost of public waste collection service provided by DEP was NT\$3,880 million (HK\$970 million). Sales of pre-paid trash bags generated an income of about NT\$300 million (HK\$75 million), less than 10% of the total cost. Moreover, only part of such sales income is transferred to a fund for capital spending on waste collection and disposal by DEP.¹⁹ General government revenue remains the principal funding source for public waste collection provided by DEP.

2.6 The policies on mandatory waste separation and collection in Taipei have achieved positive results, as shown in the following figures. **First**, per capita generation of household waste in Taipei had fallen by a total of 31% in 15 years, from 1.26 kg in 1997 to 0.87 kg in 2015. **Secondly**, overall recycling rate in the city had surged by almost 30-fold over the same period, from 2% to 57%. **Lastly**, as a result of falling waste volume, the average monthly expenditure on waste collection per household had fallen by almost 75% in 15 years, from NT\$144 (HK\$36) in 2000 to only NT\$37 (HK\$9.3) in 2015.

3. Waste separation and collection in Seoul

3.1 Seoul also experienced severe landfill shortage and controversy over incineration expansion plans during the 1980s, forcing the government to launch a number waste management policies.²⁰ In 1995, the Seoul Metropolitan Government ("SMG") introduced a mandatory quantity-based charging scheme on municipal waste, requiring households to put their waste into pre-paid trash bags for disposal. Currently, the price of such bags ranges between 52 won (HK\$0.32) for a two-litre bag to 1,840 won (HK\$12.3) for a 100-litre bag.²¹ In 2005, SMG prohibited disposal of food waste at landfills,

¹⁹ Only 36% of sales income is transferred to a fund dedicated for environmental protection purpose, while the rest goes to the general revenue account of TCG. DEP also takes income from the operation of the waste treatment facilities such as incinerators.

²⁰ Since 1978, Seoul had relied entirely on Nanjido Landfill for waste disposal. This landfill was originally scheduled for closure in 1983, but it was eventually used for ten more years until 1993. To ease landfill shortage, the Seoul Metropolitan Government once considered to build 11 incinerators in the capital area, but only four have been built amid fierce opposition.

²¹ Before 1995, the waste collection fee in Seoul was included in the property tax and its level varied with the house or apartment size.

before launching another volume-based charging scheme dedicated for food waste in 2010.

3.2 Residents in South Korea have a "duty" to separate waste at source under the Act on the Promotion of Saving and Recycling of Resources enacted in 1992. Building owners, occupants or managers need to discharge recyclable waste from the buildings "in accordance with the criteria as determined by the Ministry of Environment or store them separately by kind, character and condition" for subsequent recycling. Failure to do so may be subject to a fine of up to 1 million won (HK\$6,700). Generally, the following four broad categories of household waste are separately collected:

- (a) **Recyclable waste:** Each of the 25 administrative districts of Seoul needs to set up its own collection and disposal system for recyclable items.²² Recyclable items can be largely grouped into three major types: (i) **packaging waste** like carton packs, glass bottles, aluminium cans, plastic containers and styrofoam; (ii) **waste products** like battery, tires, lubricant, waste electrical and electronic equipment²³ and fluorescent lamps; and (iii) **other recyclables** like paper (books, newspaper), scrap metal, clothing, cooking oil, etc.²⁴

For apartment buildings, residents can put the recyclable items in various recycling bins located in a dedicated common area of the buildings free of charge. These recyclables will then be collected once a week by contract waste collectors commissioned by the building management. For residents of houses, in the absence of dedicated recycling bins, all recyclable items are kept in bags or mesh in a co-mingled manner and placed at the front of the house for door-to-door collection by contractors commissioned by the local government. These co-mingled recyclable items are usually sent to sorting facility for further processing. It is noted that separation of household

²² Seoul consists of 25 autonomous administrative district known as "gu", with population ranging from 140 000 to 670 000. Each district needs to handle waste generated within its own jurisdiction. The public cleaning agency in each district is primarily responsible for street cleaning, tackling illegal dumping and collection of bulky waste. The household waste collection is mostly outsourced to private haulers.

²³ They cover televisions, refrigerators, washing machines, air-conditioners, computers and mobile phones.

²⁴ The items can cover 42 existing waste items for which their manufacturers or importers are obliged to meet certain recycling quota under the extended producer responsibility scheme implemented throughout South Korea since 2003.

waste from houses has been rather unsatisfactory, due to the mixing of recyclable items and residual waste.²⁵

- (b) **Food waste:** Food waste became a concern after the launch of the volume-based waste charging in 1995, along with the rise in the relative proportion of smell-inducing organic waste. Since 2013, a specific quantity-based charging scheme²⁶ for food waste has been implemented throughout Seoul. Residents are required to sort and dispose of food waste in accordance with the established guideline.²⁷ Failing to do so is subject to a fine of 50,000 won (HK\$335) for first offence.²⁸ Generally, food waste can be stored in (i) **pre-paid disposal bags** which will then be disposed of in designated containers in the common area of their buildings; (ii) **waste bins** on which a chip or a sticker purchased from local government offices must be put on for collection; and (iii) **container with RFID**²⁹ which can record the weight-based billing details. All food waste in buildings is collected door-to-door by private contractors up to six days a week in some districts.³⁰ Collected food waste is then transferred to transfer stations, before uploading to larger trucks for recycling facilities.
- (c) **Bulky waste:** Bulky household waste in Seoul generally refers to furniture and electrical appliances. A waste sticker must be purchased from local government and attached to such waste for disposal, with collection fee varying across items and across 25 districts.³¹ Residents need to bring the bulky waste to a

²⁵ According to SMG, recyclable items from houses are often mixed with residual waste. Hence, it began to set up "recycling stations" on a trial basis in the neighbourhood of the houses (within 100 metre from any house) in 2012. Residents are encouraged to bring their recyclable items anytime to the stations. Senior citizens who have been scavenging recyclables in the neighbourhood are also hired to organize and sort the items. It was reported the trial improved the quantity and quality of recyclables.

²⁶ In Dobong district, a 5-litre bag for food waste is priced at 500 won (HK\$3.35), more than the 130 won (HK\$0.87) for a residual waste bag of the same size to reflect differential in collection and treatment cost.

²⁷ According to the guideline, seafood shell and bones are not food waste but residual waste. Prior to disposal, the moisture of the waste must also be removed.

²⁸ Fine level varies among districts. In Seongbuk district, the second offence will be subject to a fine of 100,000 won (HK\$670) and third offence 200,000 won (HK\$1,340).

²⁹ The containers are usually placed in the common area of apartment buildings for shared use among residents. It is reported that each costs about 1.7 million won (HK\$11,390), and is capable to cater for the need of 60 households.

³⁰ Residents living in houses are required to discharge their waste stored in prepaid bags into a container usually placed outside the gate of their houses.

³¹ Taking Seocho district of Seoul as an example, the collection fee was 5,000 won (HK\$33.5) for a 42-inch television, 3,000 won (HK\$20) for a washing machine, 15,000 won (HK\$100) for a double bed.

designated location for pick-up or bring it to local recycling centres. For disused (but not broken) home appliances, the Ministry of Environment has introduced a free collection service in Seoul since 2012. Upon booking with local government, most of the white goods (e.g. refrigerators, washing machines and air conditioners) longer than one metre in length will be collected door-to-door.³² These collected items will be sent to local recycling centres for repair, reuse or recycling.

- (d) **Residual waste:** As discussed above, household waste unfit for recycling must be mandatorily deposited in pre-paid trash bags. While households living in apartment buildings may discard their residual waste into containers installed in the building's common area for collection two to three days a week, those living in houses can place their trash bags outside their gates at designated hours usually at night for collection. Each district government has different collection frequency and schedule.

3.3 Public litter bins for pedestrian use on the streets play a small part in public waste collection in Seoul. Since the introduction of volume-based waste charging, the number of such bins has declined by a cumulative 26%, from 7 600 in 1995 to about 5 600 in 2016.³³ There was about one public litter bin per 1 800 people. In 2014, SMG also collaborated with private companies to test smart trash bins equipped with fill-level sensor at selected locations.³⁴

3.4 Waste disposal cost in Seoul totaled at 448 billion won (HK\$3 billion) in 2012. However, sales of pre-paid trash bags for residual waste and food waste generated a total income of 148 billion won (HK\$990 million), covering only 30% of the total outlays on waste collection and disposal. As such, general government revenue is still the most important funding source for public waste collection in Seoul.

³² Residents are also allowed to dispose of smaller items like mobile phones along with the bulky appliances when requesting the service. In 2013, 91 174 items weighed 3 872 tonnes were collected through the scheme.

³³ About 500 such bins are managed by SMG, and the rest are managed by 25 local district governments, according to the Seoul Institute.

³⁴ A test location was in Bukchon Hanok Village, a popular tourist attraction with high pedestrian flow. The sensor of the bin can send out signals when the bin is about full so as to prevent waste overflow from the bin.

3.5 Widely regarded as a city with sound management in solid waste, the policies adopted by SMG have effectively mitigated the pressure on landfills. **First**, per capita generation of household waste in Seoul had been reduced by 28% in 20 years, from 1.3 kg in 1995 to 0.93 kg in 2014. **Secondly**, the recycling rate reached 67% (including food waste recycling) in 2014, more than three times the respective rate of 21% in 1994. **Lastly**, all food waste was collected for recycling, with none sent to landfill since 2005.

4. Waste separation and collection in Berlin

4.1 In the 1990s, like other cities in Germany, Berlin ran out of landfill space in face of rising municipal waste. The shortage was even more acute for Berlin, as its past practice of cross-border waste disposal became less desirable.³⁵ That widespread problem of landfill shortage eventually led to a shift in the national waste policy, from waste end-treatment to waste avoidance.³⁶ More specifically for Berlin, it has been a practice for property owners to pay waste collectors for pick-up of their waste since the late 1950s.³⁷ Under the existing fee structure, on top of a quarterly fixed charge of €6.15 (HK\$53) per household, there is a variable charge depending on the bin size and collection frequency. Currently, the variable charge ranges from €55 (HK\$472) for a 60-litre bin to €261 (HK\$2,242) for a 1 100-litre bin.

4.2 As early as 1999, the Recycling and Waste Management Act was enacted in Berlin, mandating separate collection of seven types of recyclable items for recovery.³⁸ It also requires building owners to "tolerate the erection of separate disposal containers as far as they can and is reasonably expected". Coupled with residual waste, households in Berlin altogether need to sort their waste into eight broad categories for collection by Berliner Stadtreinigungsbetriebe ("BSR"), the public waste collector.³⁹ Below are the details:

³⁵ Before the unification of Germany in 1990, West Berlin had been disposing its incineration ash and containerized solid waste in substandard landfills in the former East Germany territory.

³⁶ This is particularly manifested in the enactment of a landmark legislation known as the Packaging Ordinance in 1991 which mandatorily requires producers to take back and recycle packaging materials.

³⁷ Based on information provided by BSR.

³⁸ The law preceded the European Union's Waste Framework Directive in 2008. The Directive requires its members to collect recyclable items separately. This was then transposed into the "Closed-loop Waste Management Act" in Germany in 2012, requiring that waste shall be "kept and processed separately".

³⁹ BSR is a non-profit making company wholly owned by the Berlin government. It is the biggest player in waste collection in Berlin, providing about 450 000 bins for different kinds of waste to households and running 15 recycling centres in the city.

- (a) **Paper and cardboard:** Scrap papers like used newspaper and periodicals can be put into over 80 000 blue-coloured wheeled bins distributed to households. Depending on types of residential premises, BSR provides free door-to-door collection services from every week to every four weeks.⁴⁰
- (b) **Glass containers:** Glass must be further sorted into white or coloured-glass bottles, before putting into green-coloured or white-coloured bins. There are about 90 000 such bins in the city, which are emptied bi-weekly by BSR free of charge⁴¹.
- (c) **Plastics and metals:** Berlin introduced a new unified recycling bin (yellow or orange coloured)⁴² in 2013 to facilitate better collection of recyclables in a co-mingled manner. There are about 150 000 of such bins in Berlin, taking packaging waste and similar materials made of plastic, metal or their composite. BSR and another private company are responsible for emptying the bins. This load of co-mingled waste will then be further separated by that private company operating a sorting facility.
- (d) **Bio-waste:** Collection of "bio-waste" including both food waste and organic waste began in 1996. Residents need to wrap such waste in newspaper or bio-degradable bags, before putting into a dedicated bins. BSR will clear the bins once per week or two weeks at a charge depending on the bin size and collection frequency. BSR usually imposes an annual collection fee on owners of tenement buildings, and building occupants will share such cost. House owners or occupants are directly charged according to the bin size and collection frequency. The collection charge for a standard 60-litre bin is about €26 (HK\$223) per quarter. Bio-waste is sent to recycling facilities.

⁴⁰ Monthly collection for house and up to once a week for other types of residential premises. Collection is generally free of charge.

⁴¹ Collection is carried out by Berlin Recycling which is a fully-owned subsidiary of BSR. There are also 6 000 "bottle bank" containers on Berlin streets which are emptied by various companies.

⁴² The old yellow bins used to collect light packaging waste such as milk carton by a company commissioned under the producer responsibility scheme. The orange bins used to collect other plastic and metal items.

- (e) **Bulky waste:** Furniture and electrical appliances are collected by BSR on request and upon a collection fee based on the volume of the items disposed. Advance booking one to six weeks prior to disposal is required. As there is no direct pick-up service from home, residents have to place their bulky items in front of their doors or curbsides. Dropping off any bulky item under 3 cubic metres in volume at BSR's recycling centres is free of charge.

- (f) **Discarded electrical and electronic appliances:** There are "eBox" placed on the streets of Berlin for collection of small appliances by BSR. Alternatively, these appliances can be brought to prescribed vendors and 15 recycling centres run by BSR. Vendors are also obliged to take back the old equipment for free when a new one is sold under the producer responsibility scheme.

- (g) **Residual waste:** Netting out all the above recyclable waste, residual waste goes to the grey-coloured bins. BSR collects the waste once or twice a week from apartment buildings, and charges them according to the bin size. In apartment buildings, owners have the responsibility to install the bins, while tenants' rental will cover the charge. Residual waste collected is sent to incineration facilities for energy recovery.

4.3 As to the pedestrian waste, there are 21 000 public litter bins on the streets of Berlin by now, equivalent to one public litter bin per 171 residents. BSR is also responsible for emptying these bins. They empty such bins about 5.7 million times each year, translating into an average collection rate of 0.7 times per day. Smart bins equipped with fill-level sensors have also been tested in Berlin.

4.4 According to a study conducted by the Copenhagen Resource Institute for European Commission, the annual cost for running the waste collection service in Berlin was estimated to be €272 million (HK\$2.3 billion) in 2013-2014. Revenue from residual waste collection fee had been used to cross-subsidize other free collection services, while sales of recyclables also formed a source of revenue for BSR. At this juncture, there is no publicly

available information to show whether the revenue is large enough to cover the public waste collection services in Berlin.⁴³

4.5 As one of the front-runners in municipal waste management in Europe, Berlin's waste management policies have also achieved positive results. Per capita waste generation had fallen by a total of 18% in 18 years to 1.07 kg in 2014. Its overall recycling rate had also doubled from 21% in 1996 to 42% in 2012.

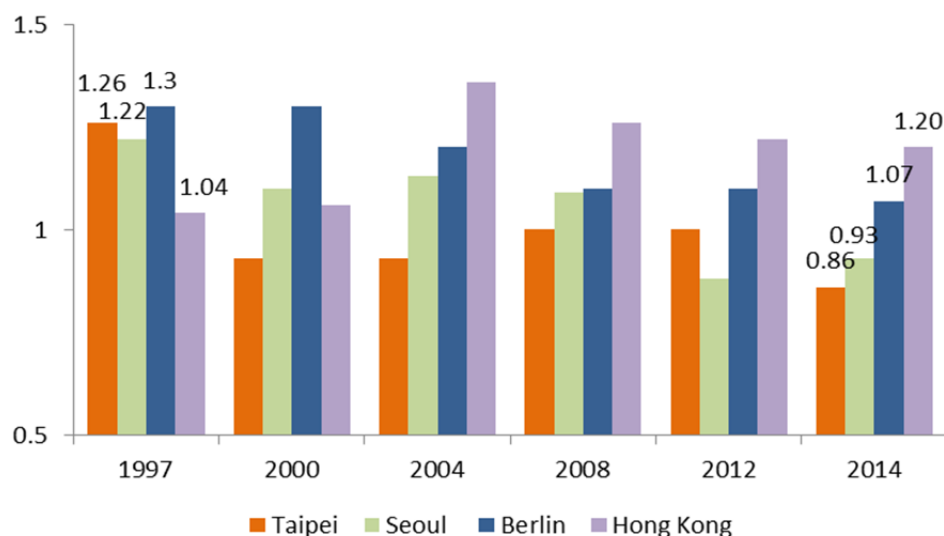
5. Observations

5.1 Based on the experience of waste separation and collection in the three selected cities, the following observations can be made:

- (a) **Mandatory separation of household waste more effective than voluntary schemes:** There is legislation on mandatory separation of household waste at source for all three selected cities. They appear to be more effective in waste separation, recovery and reduction, compared with voluntary schemes in place beforehand.
- (b) **Quantity-based charges on household waste incentivizing waste reduction:** Waste charging schemes in accordance with PAYT principle have been in place for at least a decade in all three selected cities. In particular, household waste volume in both Taipei and Seoul was reduced after implementation of the charging scheme. It is noted that such waste charges are not meant for full-cost recovery, but to make people think twice before discarding waste (**Figure 1**).

⁴³ BSR had a surplus of €12 million (HK\$1,236 million) in 2014 and €16 million (HK\$1,376 million) in 2015.

Figure 1 — Per capita generation of household waste per day (kg)⁴⁴



(c) **Tackling food waste:** Food waste is collected in all three selected cities. For the two Asian cities covered in this study, there is no collection fee in Taipei, but quantity-based collection charge is required in Seoul. Their separation and collection policies with respect to food waste are largely effective, slowing its growth pace and saving landfill space.

(d) **Mode and frequency of waste collection:** For all the three selected cities, door-to-door collection of recyclable waste appears to be more effective, time-saving and convenient than the "bring" mode of collection. Moreover, the distance between collection facilities and household residences, as well as collection frequency, also affect the willingness of residents to separate and recycle household waste.

⁴⁴ Figures for Berlin refer to municipal waste, as household waste generation figure is not publicly available.

Key indicators on waste management in selected cities in 2015

		Hong Kong	Taipei	Seoul	Berlin
1.	Territory size	• 1 100 km ² .	• 270 km ² .	• 605 km ² .	• 891 km ² .
2.	Population size	• 7.3 million.	• 2.7 million.	• 10 million.	• 3.6 million.
3.	Daily household waste⁴⁵ generated (tonnes)	• 8 619 (2015).	• 2 349 (2015).	• 9 613 (2014).	• 2 994 (2012).
4.	Share of household waste in municipal waste	• 55%.	• Not available.	• Not available.	• 81% (2012).
5.	Recycling rate of household waste	• 25% (2015).	• 57% (2015). ⁴⁶	• 67% (2014). ⁴⁷	• 38% (2012).
6.	Volume-based charging for municipal waste	• Bill to be tabled in 2017.	• Pre-paid trash bag since July 2000.	• Pre-paid trash bag since January 1995.	• Charge based on bin size since the late 1950s.
7.	Volume-based charge for non-recyclable waste	• Under study.	• Ranging from NT\$ 1.05 (HK\$0.26) for a 3-litre bag to NT\$43.2 (HK\$10.8) for a 120-litre bag.	• Ranging from 52 won (HK\$0.35) for a 2-litre bag to 1,840 won (HK\$12.3) for a 100-litre bag.	• Ranging from €55 (HK\$451) for a 60-litre bin to €261 (HK\$2,140) for a 1 100-litre bin. ⁴⁸

⁴⁵ As coverage of household waste may differ across cities, figures are for broad indicative purpose only.

⁴⁶ Excluding food waste.

⁴⁷ Including food waste.

⁴⁸ On top of the volume-based charge, there is also a fixed charge of €6.15 (HK\$50.4) per household and per quarter.

Separation and collection of recyclable items from households in selected cities

		Taipei	Seoul	Berlin
1.	Legislation on mandatory waste separation at source	<ul style="list-style-type: none"> Introduced since 2001 pursuant to the Waste Disposal Act (first enacted in 1974). 	<ul style="list-style-type: none"> Act on the Promotion of Saving and Recycling of Resources enacted in 1992. 	<ul style="list-style-type: none"> Recycling and Waste Management Act Berlin enacted for Berlin in 1999.
2.	General categories of waste for separate collection	<ul style="list-style-type: none"> Four categories: recyclable or resource, food waste, bulky waste and residual waste. Recyclable items are then grouped into (a) flat; (b) cubic; and (c) others.⁴⁹ 	<ul style="list-style-type: none"> Four categories: recyclable, food waste, bulky waste and residual waste. 	<ul style="list-style-type: none"> Eight categories: Paper, glass containers, bio-waste, plastic, metal, bulky waste, electrical appliances and residual waste.
3.	Major mode of collection	<ul style="list-style-type: none"> Hand to cleaning team at designated place and time; bring to fixed points or discard in bins in buildings for collection by contractors. 	<ul style="list-style-type: none"> Discard in collection bins in apartment buildings or in bags placed outside houses for collection by contractors. 	<ul style="list-style-type: none"> Discard in collection bins for collection by contractors or bring to recycling stations.
4.	Collection frequency	<ul style="list-style-type: none"> Flat: Monday and Friday; cubic: Tuesday, Thursday and Saturday; others: daily except Wednesday and Sunday. 	<ul style="list-style-type: none"> Once or twice a week.⁵⁰ 	<ul style="list-style-type: none"> Weekly or once per two weeks with the date scheduled by the collector.
5.	Collection fee	<ul style="list-style-type: none"> Free of charge. 	<ul style="list-style-type: none"> Free of charge. 	<ul style="list-style-type: none"> Free of charge.
6.	Destination of the recyclables	<ul style="list-style-type: none"> Transfer stations for further sorting and packing. 	<ul style="list-style-type: none"> Material recovery facility. 	<ul style="list-style-type: none"> Material recovery facility.

⁴⁹ Flat waste Include paper, old books, clean plastic bags, old clothes. Cubic waste include cans, bottles, containers, small home appliances, metals, computer equipment such as hard disk, keyboard, printer and monitor. Other recyclable include include waste like lamps and light bulbs, battery, used cooking oil, lubricant, broken umbrella and luggage case.

⁵⁰ The schedule is set by local authority. For instance, recyclable is collected twice a week in Gangbuk district. Collection date may vary from building to building.

Collection of food waste from households in selected cities

		Taipei	Seoul	Berlin
1.	Coverage of food waste	<ul style="list-style-type: none"> Raw and cooked food (except tea bags, sea shells, fruit seed). 	<ul style="list-style-type: none"> Food left-over (except bones, tea bags, shell, etc.). 	<ul style="list-style-type: none"> Food waste (part of bio-waste) includes raw and cooked food left-over.
2.	Major disposal requirements prior to collection	<ul style="list-style-type: none"> Sorted into two types: (a) for livestock feed; and (b) compost for fertilizer and must be put into a bin or bag. 	<ul style="list-style-type: none"> Kept in a designated pre-paid bag for food waste only, or disposed of into containers with RFID to record bill details. 	<ul style="list-style-type: none"> Wrap the waste in paper or in a biodegradable bag before putting into the bin.
3.	Major mode of collection	<ul style="list-style-type: none"> Hand to cleaning team at designated place and time; bring to fixed collection points and discard in bins in buildings for collection by contractors. 	<ul style="list-style-type: none"> Discard the bags in collection bins in apartment buildings or outside the houses for collection by contractors. 	<ul style="list-style-type: none"> Discard the waste in bio-waste collection bins for collection by contractors.
4.	Frequency of collection	<ul style="list-style-type: none"> En-route collection five days a week (except Wednesday and Sunday). 	<ul style="list-style-type: none"> Subject to the district's own arrangement. In some districts, six days a week during specified hours.⁵¹ 	<ul style="list-style-type: none"> Once every two weeks (or once every week during summer).
5.	Collection fee	<ul style="list-style-type: none"> Free of charge. 	<ul style="list-style-type: none"> Charges vary with the size of pre-paid bags.⁵² RFID users are billed according to the weight of food waste. 	<ul style="list-style-type: none"> Charges vary with the size of bins used and emptying frequency. The standard charge is €26 (HK\$213) per quarter for a 60 litre bin.
6.	Destination of food waste	<ul style="list-style-type: none"> Treatment facilities. 	<ul style="list-style-type: none"> Treatment facilities. 	<ul style="list-style-type: none"> Treatment facilities.

⁵¹ In Seongbuk district, food waste is collected every day except Sunday.

⁵² In Dongbong district, a 5-litre bag for food waste is priced at 500 won (HK\$3.4), compared to 130 won (HK\$0.9) for the standard trash bag of the same size.

Collection of bulky waste from households in selected cities

		Taipei	Seoul	Berlin
1.	Coverage of bulky waste	<ul style="list-style-type: none"> About 16 types such as furniture and electric appliances. 	<ul style="list-style-type: none"> Furniture and appliances. 	<ul style="list-style-type: none"> Furniture, carpet, beds, electrical appliances, etc.
2.	Disposal requirements prior to collection	<ul style="list-style-type: none"> Usually disposed of at night at an agreed location for pick-up in the next morning. 	<ul style="list-style-type: none"> Stick an appropriate sticker bought from local office to the item to be removed. 	<ul style="list-style-type: none"> No specific requirement.
3.	Mode of collection	<ul style="list-style-type: none"> No direct removal service from household and need to bring to a pick-up point. 	<ul style="list-style-type: none"> Items placed in front of a house or the designated areas in apartment buildings for collection, or directly sent to local recycling centres. 	<ul style="list-style-type: none"> Items placed in front of door for collection or directly sent to the recycling centres of BSR.
4.	Collection schedule	<ul style="list-style-type: none"> Pick-up service by telephone appointment made at least one day before scheduled disposal. 	<ul style="list-style-type: none"> Pick up service by appointment made at least three days before scheduled disposal. 	<ul style="list-style-type: none"> Pick-up service by appointment with local authority with a lead time of 1-6 weeks.
5.	Collection fee	<ul style="list-style-type: none"> Free of charge. 	<ul style="list-style-type: none"> Large home appliance longer than 1 metre and unbroken can be picked up for free. A fee still applies to other appliances and furniture. 	<ul style="list-style-type: none"> Fee depending on the waste size and collection schedule.⁵³ Disposal of waste less than 3 cubic metres can be disposed of free of charge at recycling centres.

⁵³ The saving rate charges €50 (HK\$410) for disposing of 5 cubic metres of bulky waste (1 double bed, 1 couch, 4 chairs, 1 armchair, 1 bench and 2 tables). An express service charges €96 (HK\$787) for up to 2 cubic metres waste for collection within 1 week.

Collection of residual waste from households in selected cities

		Taipei	Seoul	Berlin
1.	Disposal requirement prior to collection	<ul style="list-style-type: none"> Must be put into pre-paid garbage bag. 	<ul style="list-style-type: none"> Must be put into pre-paid garbage bag. 	<ul style="list-style-type: none"> Must be put into a designated collection bin.
2.	Major mode of collection	<ul style="list-style-type: none"> Hand to cleaning team at designated place and time or bring to fixed collection points. Discard in bins in buildings for collection by contractors. 	<ul style="list-style-type: none"> Discard the bags in collection bins in apartment buildings or place the bags outside houses for collection by contractors. 	<ul style="list-style-type: none"> Discard the waste in collection bins for collection by contractors.
3.	Collector of residual waste	<ul style="list-style-type: none"> District cleaning team of the Department of Environmental Protection. 	<ul style="list-style-type: none"> Mostly outsourced to private operators. 	<ul style="list-style-type: none"> Berlin Municipal Cleaning Company ("BSR"), a non-profit making enterprise owned by the Berlin government.
4.	Frequency of collection	<ul style="list-style-type: none"> Five days a week (except Wednesday and Sunday). 	<ul style="list-style-type: none"> Subject to district's own arrangement, with collection on two to three days a week in some districts. 	<ul style="list-style-type: none"> Apartment: once a week. House: once every two weeks.
5.	Cost incidence of collection	<ul style="list-style-type: none"> Mostly funded by government revenue, as sales of pre-paid bags can recover only 10% of public collection cost. 	<ul style="list-style-type: none"> Mostly funded by government revenue, as sales of pre-paid bags can recover only 30% of waste disposal cost. 	<ul style="list-style-type: none"> Residual waste collection is financed by the charge collected from users.
6.	Destination of residual waste	<ul style="list-style-type: none"> Incineration. 	<ul style="list-style-type: none"> Incineration. 	<ul style="list-style-type: none"> Incineration.

Figures on waste management practices in Taipei, Seoul and Berlin

(a) Pre-paid trash bags and recycling bins in Taipei



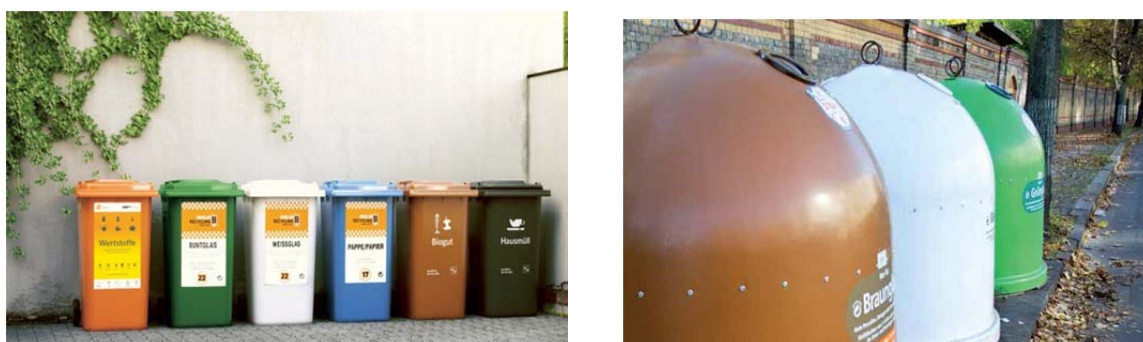
Source: Department of Environmental Protection, Taipei.

(b) Pre-paid trash bags and food waste containers with RFID in Seoul



Source: Seoul Metropolitan Government.

(c) Recycling bins and curbside glass bottle bank in Berlin



Source: Berlin Senate Department for Urban Development and the Environment Communication.

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