

## 環保基金 校園「減廢·減費」計劃 閉幕式暨頒獎典禮暨經驗分享會

### Implementation of Food Waste Collection System for Catering Services 餐飲業自動廚餘回收系統試行計劃

Department of Building Environment and Energy Engineering  
The Hong Kong Polytechnic University

Presentation speaker:  
Ir Prof. K.W. Horace Mui, Associate Head and Professor

For inquiry  
Email: [horace.mui@polyu.edu.hk](mailto:horace.mui@polyu.edu.hk)



## Introduction

Food waste management is a critical global environmental issue and it is of particular importance in cities nowadays 廚餘管理是現今一個關鍵的全球問題

Poor food waste management causes 管理不善會導致:

- loss of natural resources 損失自然資源
- shortage of landfill sites 佔用堆填區空間
- public health issues 公共衛生問題
- air and water pollutions 空氣和水污染
- waste of recyclable energy and resources 浪費可回收的能源和資源

## Potential challenges

- The catering industry was generally willing to allocate 1-4% of total manpower or invest an extra 1-2% labour for the separation and collection of food waste<sup>1</sup> 餐飲業普遍願意撥出 1-4% 的人力或投入額外 1-2% 的勞動力用於廚餘分類和收集
- As studies show that only 2% of the food waste in Hong Kong is recovered and recycled annually 研究指出香港每年只有 2% 的廚餘被回收和循環再造



1. Eriksson M, Osowski CP, Malefors C, Björkman J, and Eriksson E. Quantification of food waste in public catering services—A case study from a Swedish municipality. Waste management 2017; 61: 415-422.

## Recycling Facilities in HK ...

Commenced Operation	
<p><b>O-PARK 1</b></p> <p>Commencement Year: July 2018</p> <p>Treatment Capacity: 200 tonnes of food waste/day</p> <p>Surplus Electricity Generation: 14 million kwh/year</p> <p>Reduction of Greenhouse Gas Emission: 42 000 tonnes/year</p>	<p><b>Food Wastes/Sewage Sludge Anaerobic Co-digestion Trial (Tai Po Sewage Treatment Work)</b></p> <p>Commencement Year: May 2019</p> <p>Treatment Capacity: 50 tonnes of food waste/day</p> <p>Surplus Electricity Generation: (mainly for internal use of the STW)</p> <p>Reduction of Greenhouse Gas Emission: 650 tonnes/year</p>
<p><b>Under Construction</b></p> <p>Food Waste/Sewage Sludge Anaerobic Co-digestion Trial (Sha Tin Sewage Treatment Work)</p> <p>Commencement Year: 2023 (expected)</p> <p>Treatment Capacity: 50 tonnes of food waste/day</p> <p>Surplus Electricity Generation: (mainly for internal use of the STW)</p> <p>Reduction of Greenhouse Gas Emission: 650 tonnes/year</p>	<p><b>Under Construction</b></p> <p><b>O-PARK 2</b></p> <p>Commencement Year: 2024 (expected)</p> <p>Treatment Capacity: 300 tonnes of food waste/day</p> <p>Surplus Electricity Generation: 24 million kwh/year</p> <p>Reduction of Greenhouse Gas Emission: 67 000 tonnes/year</p>

## Automatic refuse collection systems

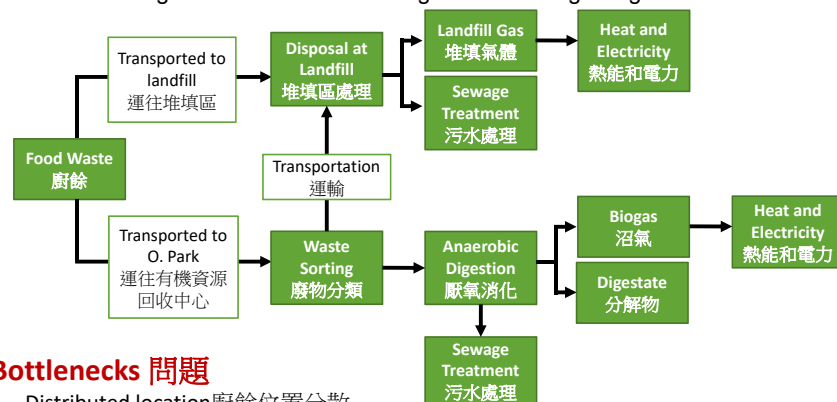
- Developed in Sweden in the 1960s 六十年代在瑞典開發
- Widely adopted in Europe and Asia to improve food waste collection capacity 在歐洲和亞洲廣泛採用以提高廚餘收集能力
- Reduce labour input through the automatic processes, such as the large-scale food waste collection system implemented for the catering facilities in the Hong Kong International Airport 通過自動化流程減少勞動力需求，例子：香港國際機場餐飲設施的大型廚餘收集系統
- Collected of over 2,000 tonnes of food waste for recycling in 2017/18 在 2017/18 年度收集超過 2,000 噸廚餘

## Food waste collection in future

- To yield further reduction in both volume and weight of the food waste to be handled, food waste dewatering is a practical way 為了進一步減少廚餘的體積和重量，廚餘脫水是一種實用的方法
- Currently, data on cost-effective food waste collection and management practices for small-scale catering and other food preparation facilities in East Asia is lacking 目前我們缺乏有關東南亞小型餐飲和其他食品製造設施的廚餘收集和管理實踐的數據

## Enhancing Food Waste Collection

Process diagram of food waste management in Hong Kong

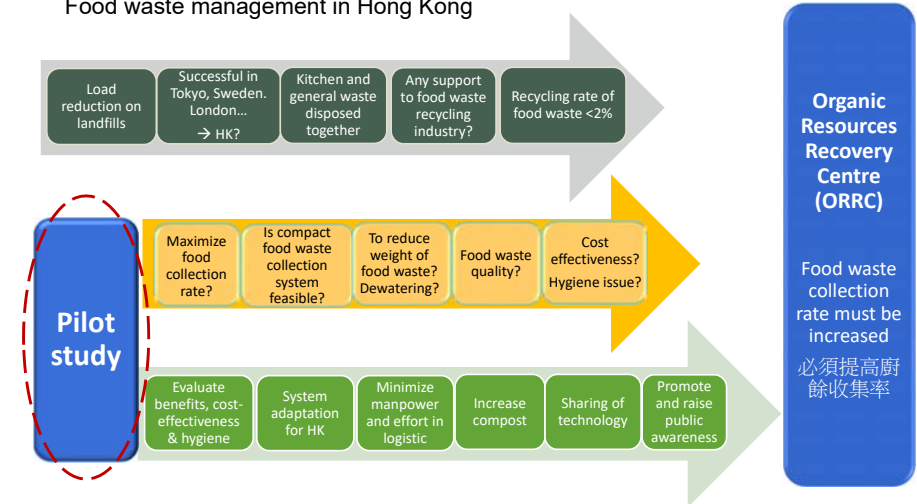


### Bottlenecks 問題

- Distributed location 廚餘位置分散
- Source separation problem 源頭分類問題
- Transportation concern 交通問題

## Inputs from HKPolyU

Food waste management in Hong Kong



## Project Objectives

In this project, we evaluated 在這項目中，我們：

- the cost-effectiveness of a centralized food waste collection system as a replacement of the manual waste collection process 評估自動廚餘收集系統的成本效益
- the benefits of the collection system through lifecycle costing analysis, and to analyze behavioral changes of users 通過成本分析評估收集設施帶來的好處，並分析因系統而引起的廚餘收集行為變化

## Project Background

- To facilitate efficient and cost-effective food waste collection and recycling on campus, a small-scale food waste collection system, first in Hong Kong and East Asia, has been installed for the catering facilities at The Hong Kong Polytechnic University 為促進校園廚餘收集的成本效益，香港理工大學在其中三間食堂安裝了香港和東亞首個小型廚餘收集系統
- The system features a dewatering unit that can remove water content from food waste. System operation began on 5 July 2019 該系統具有脫水裝置，可以去除廚餘中的水分，系統於2019年7月5日開始運作

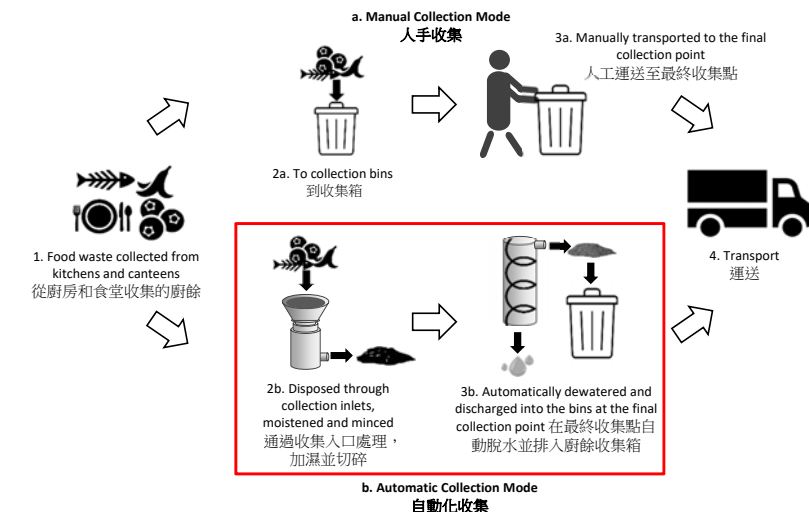


## Targeted Location

	Communal Building	Seats	Food Served
4/F	Communal Staff Restaurant 文康職員餐廳	250	Dim sum, Northern dishes, home-style dishes 點心、家常菜
	Communal Student Restaurant 文康學生餐廳	200	Noodles, congee, steamed rice and dim sum 麵、粥、蒸飯和點心
3/F	Communal Student Canteen 文康學生飯堂	520	Fast-food items, bakery items, BBQ specialties 快餐、烘焙食品、燒味

- The facility opens about 13 hours a day and closes on public holidays. It serves a variety of foods and beverages, including Chinese and Western set meals, fast-food items, Chinese dim sum, BBQ specialties, vegetable dishes, noodles, bakery products and baked goods 設施每天開放約 13 小時，並在公共假期關閉。它供應各種食品 and 飲料，包括中西式套餐、快餐、中式點心、燒烤特色菜、蔬菜菜餚、麵條和烘焙食品

## Food Waste Collection Methods





## How to Improve?

Existing manual approach:

- The collection bins located in the kitchen and dining areas for food waste collection were manually delivered to the final collection point in the same building for waste pickup 位於廚房和用餐區的廚餘收集箱，由人工運送到最終收集點

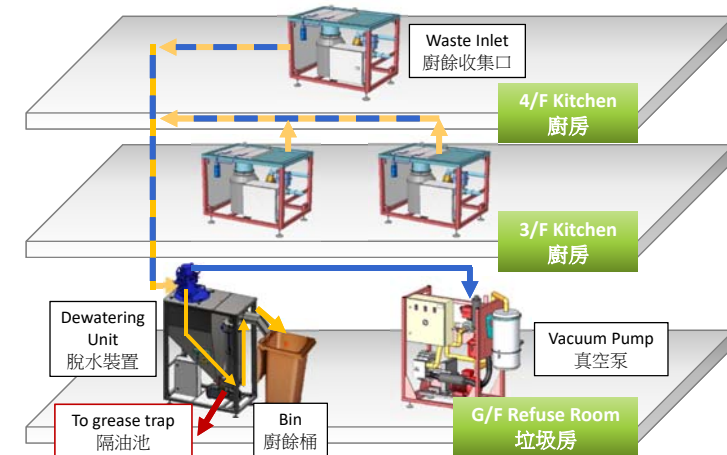
New automatic approach:

- Food waste was disposed through the collection inlets (each inlet could hold food waste up to a capacity of 6 L) 通過廚餘收集口處理（每個入口最多可容納 6 升的廚餘）
- Using the automatic approach, food waste could be collected at 180 L/hr 使用自動收集系統，可以以每小時 180 升的速度收集廚餘

## System Description

Schematic diagram of food waste collection system

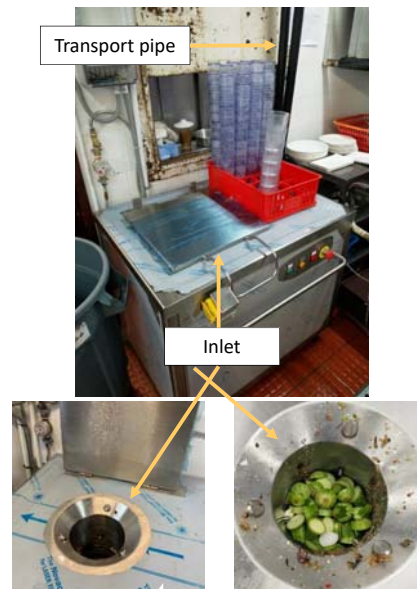
- Food waste & Air 廚餘和空氣
- Food Waste 廚餘
- Air 空氣
- Wastewater 污水



## System Description

Waste Inlets 廚餘收集口

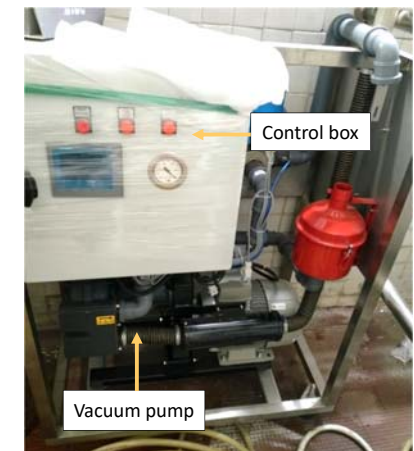
- Food waste is collected at bench units at kitchen, and is first broken down into smaller pieces by internal mincing machine 廚餘由廚房的廚餘收集口收集。收集機內的攪拌器會先將廚餘攪拌成小塊
- Water is added to waste before transported by pipes 加水後，再通過管道運輸到地下收集站
- Each inlet has 6L capacity and can process up to 180L of waste per hour 收集口每次最多可處理6公升廚餘，每小時處理量為180公升



## System Description

Vacuum Pump 真空泵

- Suction force is created by the vacuum pump unit to transport food waste from upper floors to the dewatering unit on ground floor 真空泵產生吸力，將廚餘從上層廚房經管道運送到地下的脫水裝置



## System Description

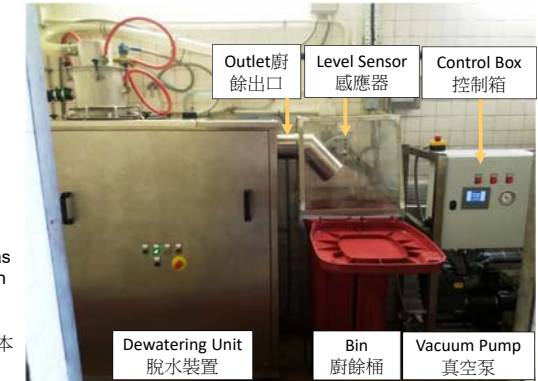
### Dewatering Unit 脫水裝置

- The dewatering unit presses waste up against a screw chamber. The chamber rotates and presses wastewater out through a screen (3mm) 脫水裝置以圓筒形旋轉器，通過篩網 (3mm) 壓出廚餘中的水份
- The dewatering unit can process up to 220kg of food waste per hour 脫水裝置每小時可處理最多220公斤的廚餘



## System Description

- Processed food waste is temporarily stored in collection bins (180L) 脫水後的廚餘會暫時存放在廚餘收集桶 (180公升)中等待收集
- Level sensor will notify staff when bin is over half full 當廚餘桶超過半滿時，感應器會通知員工換桶



\* Although thermal dewatering could reduce the moisture content to 10%, it was not considered in this study due to its high energy demand and long processing time 雖然熱脫水可以將水分含量降低至 10%，但由於其高能量需求和較長的處理時間，本研究並未考慮使用此技術

## System Operation

### Step 1

- Disposal of sorted food waste at waste inlets 把已分類的廚餘放入廚餘收集口



## System Operation

### Step 2

- Close lid and start system by pressing the green button 關閉蓋子並按下綠色按鈕啟動系統



## System Operation

### Step 3

- Dewatered food waste is collected by food waste bin at the food waste collection point 脫水後的廚餘會暫時存放在廚餘收集桶中，等待廚餘收集商收集



## System Operation



Sample kitchen food waste  
廚餘例子

Food waste after mincing and  
dewatering processes  
經攪拌和脫水後的廚餘

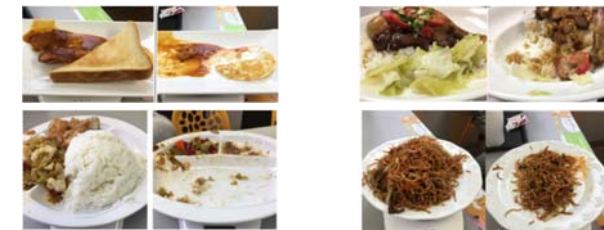
## Data Collection

Data collection & system monitoring 數據收集和系統監測: July – November 2019 (19年7月 – 19年11月)

- Food waste generation in PolyU 產生情況
- Weight and water content of food waste 廚餘收集量，廚餘含水量
- Wastewater testing 水質測試
- System utilization 系統的使用率
- Users' behaviour 商戶的廚餘收集變化

## Food Waste Generation in PolyU

- Pre-consumption food waste produced in kitchen during food preparation 準備食物時產生的廚餘
- Number of meals served 提供的餐食數量
- Net weights of set meals 套餐淨重
- Post-consumption food waste produced in dining area 用餐區產生的廚餘
- Customer interviews on food waste generation habit 客戶對廚餘產生習慣的數據調查





## Weight and Water Content of Food Waste

Daily output of the system 廚餘收集量

- Monthly waste data 每月廚餘收集量
  - Number of bins used per day 每日廚餘桶使用量
- From food waste contractor 廚餘收集商數據

Water content of food waste 廚餘含水量

- Determined by dry weight experiment 通過乾重法量度



Gather and weigh food waste samples  
收集和量度廚餘重量



Place sample in oven  
將廚餘放入焗爐



Weight dried sample  
量度烘乾廚餘重量

## Wastewater Testing

Water samples are collected from dewatering unit each month for water quality tests 每月收集水樣進行水質測試:

- Oil and grease content 油脂含量
- Biochemical Oxygen Demand (BOD) 生化需氧量
- Chemical Oxygen Demand (COD) 化學需氧量
- Total suspended solids 懸浮固體總量



\*Waste water collected from dewatering unit is discharged to **grease trap**

\*脫水裝置收集的廢水會排放到**隔油池**

## System Utilization

- Activity log, electricity and water consumption of system are collected 系統的活動日誌將存儲在系統控制板中



Electric & Water Meter

	Data Log Example
Inlet Bench 收集口	No. of operations 系統操作次數
	Mincer fault 攪拌器故障
	Electricity & water consumption 耗電和耗水量
Pump 泵	Pump fault 泵故障
	Electricity consumption 耗電量
Dewatering Unit 脫水裝置	Pump / screw fault 旋轉器故障
	Electricity & water consumption 耗電和耗水量



Maintenance log



System Control Panel

Month	No. of fault(s)	Description of fault
Jul-19	2	Clogging of one of the inlet units (once) and emergency button accidentally pressed by staff (once).
Sep-19	5	Dewatering unit clogged, leading to high levels of food waste in temporary storage tank.
Oct-19	2	Dewatering unit clogged, leading to high levels of food waste in temporary storage tank.
Mar-20	1	Transport pipe connecting inlet Unit 1 on 3/F kitchen came off loose.

## Users' Behaviour

- User behavior towards the system are surveyed and analyzed for any change with the implement of the system 收集和 analyses 商戶對系統的看法和評語，並分析因系統而引起的廚餘收集行為變化

Direct system users 系統用家

- System usability, and changes in waste collection behaviour 系統可用性，以及廚餘收集行為變化

Canteen managers 飯堂經理

- Impact of the system on workflow, and health and safety conditions 系統對運營成本，工作流程以及員工健康和安全的影響

## Summary of Interview Outcomes Before System Implementation

Categories	Interviewees' responses
Management Practice 管理實踐	<p>Not inconvenient 不會不方便</p> <ul style="list-style-type: none"> <li>Part of day to day work when collecting and washing plates</li> </ul> <p>Little workload 工作量少</p> <ul style="list-style-type: none"> <li>One staff carrying a bin once per day (5 to 6 minutes per trip)</li> <li>A bit more walking required to dispose food waste to collection bin</li> </ul> <p>Not time consuming 不費時間</p> <ul style="list-style-type: none"> <li>Manageable within working hours</li> </ul>
Quantity of Food Waste 廚餘量	<p>About one bin per kitchen area 每個廚房區域大約一個垃圾箱</p>
Health and Safety 健康和安全	<p>Little health and safety concerns 很少有健康和 safety 問題</p> <ul style="list-style-type: none"> <li>No injuries or health issues related to food waste collection</li> <li>Little odor as waste is removed daily</li> <li>Trays filled with food waste can be heavy and harder to handle, will ask others to help to carry trays if needed</li> </ul>

## Users' Comments After System Implementation

Categories	Interviewees' responses
Inlet capacity and location 入口容量和位置	<p>Inlet is too small 入口容量太小</p> <ul style="list-style-type: none"> <li>Additional time is required for sorting out large items</li> </ul> <p>Inlet location is far away from food waste generation location 入口位置離廚餘產生位置太遠</p> <ul style="list-style-type: none"> <li>Inconvenient for transportation</li> </ul> <p>Changing the waste bin at refuse room is inconvenient 在垃圾房更換垃圾箱不方便</p>
Inlet operation	<p>Collection cycle at inlet is about 2 min</p> <ul style="list-style-type: none"> <li>Cannot process large amount of food waste in short period of time (during peak hour) 無法在短時間內處理大量廚餘 (高峰時段)</li> </ul>
Health and Safety	<p>Some health and safety concerns 一些健康和 safety 問題</p> <ul style="list-style-type: none"> <li>Pest was found near inlet bench and collection bin at refuse room</li> <li>Odor issue when the bin is awaiting for collection</li> <li>Detergents cannot be used for cleaning the inlet</li> <li>Using hot water for degreasing raises safety concerns</li> </ul>

## Food Waste Generation

### Overview of meal served

Meal	Quantity
Meal per day 每天餐量	4,363
Meals per seat per day 每個座位每天餐量	8.4

### Food waste generation

Food waste	Quantity
Weight per day, $m_1$ 每天廚餘量	13.9-29.2 kg/d
Weight per seat per day 每個座位每天廚餘量	0.019 kg/d/st
Volume 體積	45.7-92.9 L

### Meal served at various period

Period	Proportion	Meals per seat	Net weight
Breakfast 早餐 (730-1100)	12-18%	1.3	0.39-0.6 kg
Lunch 午餐 (1100-1430)	23-69%	3.8	0.42-0.72 kg
Afternoon tea 下午茶 (1430-1730)	11-17%	1.2	0.15-0.39 kg
Dinner 晚餐 (1730-2000)	8-42%	2.1	0.15-0.66 kg

## Post-consumption Food Waste Composition

Categories	Grains 穀物	Vegetables 蔬菜	Non-vegetables 非蔬菜
Composition	46%	36%	18%
Food waste items	<p>a1. Rice</p> <p>a2. Toast</p> <p>a3. Noodles</p> <p>a4. French fries</p> <p>a5. Potato</p> <p>a6. Chinese bread</p>	<p>b1. Tofu puff</p> <p>b2. Winter melon</p> <p>b3. Onion</p> <p>b4. Cloud ear fungus</p> <p>b5. Chestnut</p> <p>b6. Broccoli</p> <p>b7. Carrot</p> <p>b8. Mushroom</p> <p>b9. Corn</p> <p>b10. Tofu</p> <p>b11. Green bell pepper</p> <p>b12. Eggplant</p> <p>b13. Zucchini</p>	<p>c1. Sausage</p> <p>c2. Fish fillet</p> <p>c3. Salted egg</p> <p>c4. Red sausage</p> <p>c5. Chicken</p> <p>c6. BBQ pork</p> <p>c7. Spring roll</p> <p>c8. Pork rib</p> <p>c9. Fish stew</p> <p>c10. Ham</p>



## Food Waste Moisture Content and Volume

Average moisture content 平均水分含量

- Food waste moisture content 廚餘水分: 76%

Example Item	Moisture content
BBQ pork	33%
Fried rice	55%
Green pepper	91%
Eggplant	92%

- After dewatering 脫水後: 64%

Waste compaction by system 廚餘壓實

- Volume reduction at inlet (after mincing) 切碎後體積: -60%
- Volume reduction after dewatering 脫水後體積: -11%

## Food Waste Collection

	Before System Operation (Only manual collection) 系統運行前	After System Operation <sup>^</sup> (Both manual and automatic collection) 系統運行後	Change
Amount of food waste 廚餘收集量	205 kg/d	217 kg/d	+9%
Number of bins used 廚餘桶使用量	3.8 bins/d	2.9 bins/d	-24%
Bin volume 廚餘體積	344 L/d	249 L/d	-28%
Handling efficiency* 處理效率	0.58 kg/L	0.85 kg/L	+47%

<sup>^</sup>Usage of system not compulsory 系統的使用不是強制性

\*The food waste handling efficiency  $\rho$  ( $\text{kg L}^{-1}$ ) is used to evaluate the performance of the two food waste collection approaches, given by  $\rho = \frac{m}{v}$ , where  $m$  (kg) and  $v$  (L) are the weight and bin volume of the collected food waste

## Electricity, Water and Effluent

	Manual	Automatic
Electricity 用電量 (kWh/kg)	0.005	0.027
Water 用水量 (L/kg)	0.512	0.406
Collection bin transportation 收集箱使用量 (bin/kg)	0.01	0.007

Effluent 污水量

- System average effluent quantity 平均污水量: 0.1 m<sup>3</sup>/day
- Average effluent quality 平均污水水質

	Quantity (mg/L)
BOD 生化需氧量	5,408
COD 化學需氧量	10,758
Oil & grease 油脂含量	164
Total suspended solids 懸浮固體總量	3,038

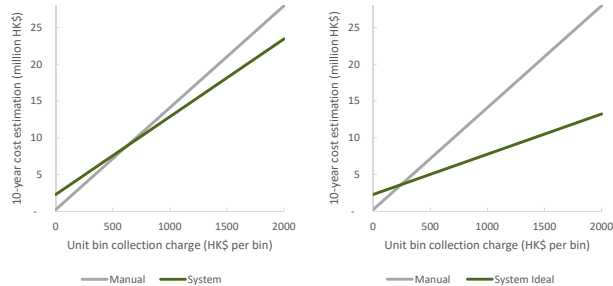
\*All effluent is discharged to **grease trap** 所有流出物均排放至隔油池

## Lifecycle Cost Analysis 生命週期成本分析

Cost (HK\$)	Manual	System	Ideal Case	Remarks
Storage bin	6,857	6,857	6,857	HK\$480/ bin; replaced once every 3.5 years
System	N/A	1,070,800	1,070,800	Inlet, vacuum, dewatering units, pipes
Installation	N/A	588,000	588,000	Installation, T&C, project management
Retrofitting	N/A	93,100	93,100	Wall, grease trap, electrical and water points
Installation cost	6,857	1,758,757	1,758,757	
Labor	219,000	219,000	219,000	Wage: HK\$60/ hr; Labour input: 1hr/ day
System operation	N/A	34,675	274,845	Water and electricity: HK\$1/ operation Reference tariff Electricity: HK\$1.28/ kWh (non-residential) Water: HK\$9.05/ m <sup>3</sup> (domestic tier 4) <u>No. of operations</u> System collection: 9.5/ day System ideal case: 75.3/ day
Maintenance	N/A	268,300	268,300	21-month warranty period: HK\$39,200 3 <sup>rd</sup> year: HK\$24,000 (+5% each year onward)
Waste collection charge	19,223,820	14,670,810	7,588,350	Bin collection fee: HK\$1,386/ bin Manual collection: 3.8 bins/ day System collection: 2.9 bins/ day System ideal case: 1.5 bins/ day
Operation cost	19,442,820	15,192,785	8,350,495	
Overall cost	19,449,677	16,951,542	10,109,252	
Cost per kg of waste 每公斤廚餘收集成本	26.8	21.4	13.9	

## Payback Period 投資回收期

	System Collection		System Ideal Case	
Initial system cost (HK\$)	1,751,900		1,751,900	
Discount rate	0%	10%	0%	10%
NPV (HK\$)	746,235	-216,904	7,588,530	3,987,390
Payback period 投資回收期 (year)	<b>7.0</b>	<b>11.4</b>	<b>1.9</b>	<b>3.1</b>



Comparison of 10-year food waste collection cost with varying unit collection charge by waste contractors (HK\$ per bin) Left: study case; Right: ideal case

## Reported Issues and Recommendation

Issue	Description	Recommendation
Inlet capacity and location 入口容量和位置	<ul style="list-style-type: none"> <li>Size and capacity of the inlet units are too small 收集口尺寸和容量太小</li> <li>Location of some inlet units is inconvenient 收集口位置不方便</li> </ul>	<ul style="list-style-type: none"> <li>Replace 50mm transport pipes to wider 200mm pipes 將 50mm 輸送管更換為更寬的 200mm 管</li> <li>Increase inlet capacity so it can process a larger volume of food waste per batch (if space permits) 增加收集口容量</li> <li>Inlet units placed close to food waste generation sources or incorporated in work benches for convenience, e.g. the food preparation and dish washing areas in kitchens 收集口放置在靠近廚餘產生的地方或安裝在工作台上，例如：廚房的食物準備和洗碗區</li> <li>Break large food waste items (e.g. whole chicken bones) into smaller pieces before disposal at inlet 將大型廚餘（例如整雞骨頭）先分解成小塊</li> </ul>

## Reported Issues and Recommendation

Issue	Description	Recommendation
Inlet operation time 操作時間	<ul style="list-style-type: none"> <li>Each cycle of inlet operation is too long 每次運行週期過長</li> <li>Catering staff do not have additional manpower and time for the disposal procedure 餐飲人員沒有額外的人手和時間進行處置程序</li> </ul>	<ul style="list-style-type: none"> <li>Replace 50mm transport pipes to wider 200mm pipes to shorten the processing time required to break down food waste as they can be transported in bigger pieces without clogging the system 將 50 毫米的運輸管道更換為更寬的 200 毫米管道，以縮短切碎廚餘所需的處理時間，因為它們可以以更大的塊狀運輸而不會堵塞系統</li> </ul>
Waste bin collection 垃圾箱收集	<ul style="list-style-type: none"> <li>The practice of replacing waste bins at refuse room after system implementation is inconvenient to catering staff 更換垃圾房廚餘桶的做法對餐飲人員不便</li> </ul>	<ul style="list-style-type: none"> <li>Switch dewatering unit with collection tank to eliminate the need for catering staff to replace waste bins 以罐式集裝箱收集，以免去餐飲人員更換垃圾箱的需要</li> </ul>

## Reported Issues and Recommendation

Issue	Description	Recommendation
Pest and hygiene 害蟲和衛生	<ul style="list-style-type: none"> <li>Flies and cockroaches are found around the inlet bench units at kitchens and around the collection bin in refuse room 在廚房的入口周圍和垃圾房的收集箱附近發現蒼蠅和蟑螂</li> </ul>	<ul style="list-style-type: none"> <li>Apply insect repellent on the interior and back of panels of inlet units 在收集口面板的內部和背面塗抹驅蟲劑</li> <li>Cover or enclose waste collection bin to prevent pest infestation and odour leakage during collection process 覆蓋或封閉廢物收集箱，以防止收集過程中蟲害和氣味洩漏</li> <li>Switch dewatering unit with collection tank for better odour control 以罐式集裝箱收集，以更好地控制氣味</li> </ul>
Odour problem 氣味問題	<ul style="list-style-type: none"> <li>Processed food waste gathered by the collection bin has created odour problems at refuse room 收集箱的廚餘在垃圾房造成氣味問題</li> </ul>	<ul style="list-style-type: none"> <li>Provide hot water supply to wash and flush food scraps out of inlet units 提供熱水供應以清洗收集口中的食物殘渣</li> <li>Provide ventilation at refuse room to remove odour and heat 在垃圾房提供通風以去除氣味和熱能</li> <li>Switch dewatering unit with collection tank for better odour control 以罐式集裝箱收集，以更好地控制氣味</li> <li>Regular washing and maintenance of temporary storage tank and screw press of dewatering unit 定期清洗保養</li> </ul>

## Summary of Results

### Increase in amount of food waste collected 增加收集的廚餘量

from 6,036 kg per month (199 kg per day) to 6,767 kg per month (217 kg per day)  
從每月 6,036 公斤 (每天 199 公斤) 到每月 6,767 公斤 (每天 217 公斤)

### Decrease in number of waste bins for food waste collection 減少廚餘桶的數量

- from 3.8 to 2.9 bins per day 每天 3.8 到 2.9 個垃圾箱
- in the ideal system usage scenario: reduce to 1.5 bins 理想系統使用：減少到1.5個
- ✓ reduces cost of food waste collection in the long run 降低廚餘收集成本
- ✓ reduces number of trips to ORRCs with less number of bins 使用更少的廚餘桶，從而減少前往 ORRC 的次數
- ✓ lower cost encourages the collection of food waste and deliver to ORRCs 較低的成本鼓勵收集廚餘並交付給 ORRC

## Summary of Results

### Reduce waste volume by about 60% 減少約 60% 的廢物容量

### Reduce moisture content of food waste by 12% 減少廚餘水分12%

### System collection provide around 13% cost savings 系統收集可節省約 13% 的成本

- The 10-year cost estimation 10年成本估算
  - manual collection 人手收集: HK\$19,499,677
  - system collection (in this study) 使用系統收集: HK\$16,951,542
  - system ideal case 理想案例: HK\$10,109,252

## Future Research Potential

### Environmental aspect 環境方面

- Food waste collection rate within the C&I sector 工商業的廚餘收集率
- Diversion of food waste from landfill to organic resources recovery facilities 將廚餘從堆填區轉移到有機資源回收設施

### Social aspect 社會方面

- Willingness and understanding of caterers on food waste recycling 餐飲業者對廚餘回收的意願和理解
- Technology transfer on food waste collection among the C&I sector 工商業界廚餘收集技術轉讓

### Economic aspect 經濟方面

- Cost-effectiveness of food waste collection system 廚餘收集系統的成本效益
- Capacity and efficiency in handling of food waste 處理廚餘的能力和效率

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