



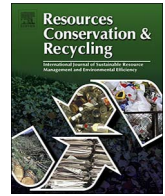
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Full length article

## Challenges in food waste recycling in high-rise buildings and public design for sustainability: A case in Hong Kong

Jia Xin Xiao, Kin Wai Michael Siu\*

School of Design, The Hong Kong Polytechnic University, Kowloon, Hung Hom, Hong Kong

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## ABSTRACT

In recent decades, various studies on policy, management, behaviour, norms and economic incentives related to food waste issues have been conducted. Many of the studies are from a quantitative perspective which has given a wider but general coverage of study and analysis on the matters. However, the impacts of context, such as living environments and social culture, on recycling activities from a qualitative as well as in-depth perspective have seldom been discussed, especially in densely populated communities. Taking Hong Kong as an example, some food waste recycling (FWR) initiatives have been launched in housing estates. However, most projects have been suspended due to many practical problems. Only a few cases are still on-going. Physical setting quality has been identified as a significant factor affecting sustainable behaviour. Inefficient and low-quality public designs that do not consider living environments and specific lifestyles may fail to encourage community participation. This study aims to provide a more in-depth investigation into people's attitudes and actual behaviour towards and to shed light on public design for sustainability. Using the FWR programme in Amoy Gardens as a case, this study uses qualitative research methods to explore FWR experiences and improve its weaknesses. The findings show three potential challenges to FWR in densely populated high-rise buildings: (1) limited space, (2) hygiene issues and (3) implementation and management. This study also provides implications for public design to improve sustainability in communities and encourage public participation in FWR in high-density residential areas.

## 1. Introduction

With increasing environmental concerns worldwide, food waste has become a vital issue in many cities. Although some researchers have insisted that food waste can be transformed into a valuable resource, waste is most often perceived as a disgusting and annoying matter that must be eliminated as quickly as possible (Hawkins, 2006). To get rid of massive food waste, incinerators and organic waste treatment facilities are built one after another. To deal with food waste issues, researchers and environmentalists have made tremendous efforts on policy and management initiatives. Various studies on waste management, norms and economic incentives have been conducted in recent decades (Chan and Lee, 2006; Chung and Poon, 1996; Fahy and Davies, 2007; Hage et al., 2009; Yau, 2010). 'Pay as You Throw' has been identified as an effective policy contributing to waste recycling (Chang et al., 2008). However, the impacts of context, such as living environments and social culture, on recycling activities and human behaviour have seldom been discussed, especially in densely populated communities. The quality of built environments and facilities has been identified as a significant

factor affecting sustainable behaviour (Xiao and Siu, 2016). Food waste generation is directly relevant to daily practices formed in specific environments (O'Brien, 2008). Steg and Vlek (2009) also state that where people live, from dwellings to neighbourhoods and communities, can significantly influence sustainable behaviour.

A number of early studies discussed the factors that influenced public participation in recycling and how to enhance recycling behaviour (Martin et al., 2006; Nigbur et al., 2010; Steg and Vlek, 2009). However, only few studies on public participation in household recycling have focused on particular medium- and high-density dwellings, which have been identified as problematic (Timlett and Williams, 2008). Some reference to surveys of Asian countries, such as Korea and Japan, would facilitate public participation in food waste recycling (FWR). In some Korean neighbourhoods, food processors that can weigh food waste and charge a disposal fee are provided on the ground floor, urging residents to participate in FWR (Lee and Paik, 2011). In Japan, different types of material, including food waste, are collected on a designated date. Residents have to store food waste at home and dispose of them according to a strict waste collection schedule (Siu and

\* Corresponding author.

E-mail address: [m.siu@polyu.edu.hk](mailto:m.siu@polyu.edu.hk) (K.W.M. Siu).

Xiao, 2016). Any improper or illegal disposal behaviour results in punishment. Compared with Korea and Japan, the high-rise living situation in Hong Kong is much more crowded and diverse. Due to the high density of the population, most residents live in housing estates with more than 20 storeys. The limited private and public space makes it difficult to conduct food waste separation in residential areas.

Most research on FWR in high-density populations has adopted quantitative methods to identify the barriers to and opportunities for FWR (Chung and Poon, 1999; Lee and Paik, 2011; Timlett and Williams, 2009; Yau, 2010). However, studies of design and living contexts that use qualitative methods, such as field observations and interviews, have been especially rare. The results of quantitative research can be used to gather major information with respects to respondents' beliefs, values and attitudes, however, they are not able to address how accurately or truthfully their behaviours and attitudes, and cannot address cause-and-effect relationship (Sommer and Sommer, 1997). As Yin (1993) states, qualitative research can gain useful insights into the complexity of people's behaviours. Qualitative methods are important since they truly reveal the way people operate and the reasons behind their behaviour (de Certeau, 1984).

Recently, some FWR initiatives were launched in housing estates in Hong Kong. However, most of these projects have been suspended due to many practical problems. Only a few cases are still on-going. It is an opportune time to examine FWR programmes by exploring the related experiences and challenges and to improve their weaknesses. Then, three questions arise. First, what are the constraints of and challenges to FWR in high-density high-rise residential areas? Second, what contextual factors affect recycling behaviour? Third, how can built environments and public facilities be improved to encourage public participation in FWR?

## 2. Food waste recycling in Hong Kong

In the past few decades, the Hong Kong government, environmentalists, non-governmental organisations (NGOs) and some industries have made tremendous efforts to develop policies and measures on waste disposal and recycling. According to the report from the Environmental Protection Department (EPD) in 2010, the local government set out a 10-year waste disposal plan to develop new facilities and strategies in 1989. The Programme on the Source Separation of Domestic Waste has been implemented territory-wide in Hong Kong

since 2005. It encourages people to separate recyclables from waste.

Table 1 shows the key schemes, measures, programmes and legislations on food waste that have been launched by governments and NGOs. According to EPD (2011), approximately 3600 t of food waste are generated every day, accounting for 42.3% of the amount of domestic waste. Two thirds of food waste come from households and one third comes from the commercial and industrial sectors. Compared with other materials, such as glass, metals, papers and plastics, the recovery rate of food waste is highly inefficient (0.6%). This low efficiency stems from the complexity and difficulty of FWR in high-rise buildings. Although the local government provides an ideal blueprint for handling the food waste problem, practical barriers make it difficult to effectively implement these strategies. Living environment and lifestyle are two major factors affecting FWR in residential areas (Siu and Lo, 2011). Some new residential buildings provide processors in the kitchen to deal with food waste. However, for most residential buildings that have already been used for a few decades, there exist certain physical FWR constraints. Units are relatively small, especially public housing units (< 40.0 square metres). The limited space of domestic kitchens is no more than 2 square metres, which is not big enough to install any food waste processors. Previous studies have indicated that the cooking and consuming habits of local residents are quite different from those in Western countries (Siu and Lo, 2011). In Hong Kong, people tend to buy fresh food from the wet market rather than frozen food from the supermarket. Their food waste contains a large quantity of water, which is putrescible and may lead to hygiene problems.

In 2003, a SARS epidemic occurred in Hong Kong. Due to the high-rise, high-density built environment, an intense outbreak occurred in Amoy Gardens, spreading via public facilities and infrastructures, such as floor drains. Over 300 residents were infected and moved out for isolation. The SARS outbreak affected not only the inhabitants of Amoy Gardens, but also the entire territory (Wong, 2010). It was a dark time in Hong Kong, but it triggered some positive changes. During this time of SARS outbreak, the government announced emergency measures, such as the cleaning and disinfection of public spaces in buildings. The enhancement and management of public spaces and facilities in terms of environmental issues became increasingly important in households and communities. After the SARS outbreak, residents throughout the community became highly concerned about hygiene-related issues.

Amoy Gardens was typical of the most common style of high-rise private housing estates in Hong Kong built in the 1980s and 1990s. It

**Table 1**  
The key schemes, measures, programmes and legislations on food waste in Hong Kong.

Key schemes, measures, programmes and legislations	Details
Launched by governments	
Electric Composters Trial Programme (2002)	Fifteen electric composters were provided in fifteen housing estates in Shatin. The participation rate was 4%.
Wet/Dry Sorting Trial (2003)	Aimed to encourage public participation in source separation. It was suspended because of severe acute respiratory syndrome (SARS).
'Pay as You Throw' Trial Programme (2006)	Launched in 20 housing estates and suspended 3 months later. The bags for collecting food waste were reported as being thin, small and unattractive to residents.
Kowloon Bay Pilot Composting Plant (2008)	The composting plant was set up for recycling food waste with a capacity of 1.5 t per day.
Waste to Food Community Pilot Programme (2009)	An initiative to develop a locally adaptable vermin-composting system. Sixty vermin-composting bins were provided in communities.
Food Waste Recycling Partnership Scheme (2009)	Promoted institutions and commercial and industrial sectors to recover kitchen waste. The collected food waste was delivered to pilot composting plants for recycling.
On-site Meal Portioning Projects in School (2009)	Subsidised schools to conduct conversion works and install facilities for 'on-site meal portioning'.
Food Waste Recycling Projects in Housing Estates (2011)	Funding of HK\$50 million was approved to encourage public participation in FWR in housing estates. The participating housing estates were subsidised to install facilities for FWR.
Food Wise Hong Kong Campaign (2013)	Campaign driven by the Food Wise Hong Kong Steering Committee to help the commercial and industrial sectors, schools and NGOs participate in food waste avoidance and reduction.
Green Delight in Estates – Food Waste Recycling Scheme (2014)	Campaign organised by the Hong Kong Housing Authority and Friends of the Earth (Hong Kong). Workshops, lectures and related activities were organised in several public housing estates.
Launched by NGOs	
'Labour Has Value' Food Recovery Programme (2012)	Distributed free vegetables to some families, such as single-parent families, and elderly living alone in the Tin Shui Wai community. However, most organisations had to suspend the project due to a lack of financial assistance and many practical problems.
Food Saving School Tours (2015)	Campaign driven by Friends of the Earth (Hong Kong) to encourage students to treasure food.



Fig. 1. Location and boundary of Amoy Gardens.

comprised 19 blocks, ranging from 30 to 40 storeys high, above a three-storey shopping mall. Over 5000 flats housed a total of 17,000 residents. The residential living spaces were densely packed around a central core of elevators, staircases and public services, and the semi-enclosed spaces between flats were very narrow. Such narrow spaces – sometimes as narrow as 1.5 m – were designed to meet the minimum requirements for natural lighting and ventilation. Given their narrowness, depth and height, these spaces were often dark and stuffy. A series of new initiatives was launched in an attempt to improve the living environment. In addition to the territory-wide separation of domestic waste at source launched by local authorities in 2005, some small-scale initiatives were conducted in 4 blocks, comprising 1024 flats (Fig. 1).

A flowchart was developed to explain the process of the FWR programme in Amoy Gardens. In contrast to other FWR programmes, which started with sorting and ended in collection, the FWR programme in Amoy Gardens included not only sorting and collecting, but also initial processing and gardening (Fig. 2).

The programme was conducted on a voluntary basis. It is clear from the flowchart that some of the food waste was still mixed with other waste and consequently dumped in landfills, although part of it was sorted and flows into the recycling process. It should be highlighted that the food waste was only dried and compressed *in situ*. After going through these initial processes, the treated food waste was sent out for decomposition and then returned in a few days. Each household that participated in the programme could get soil and organic fertiliser for planting. Public space for gardening was designated on the podium, along with amenities, such as pots and tools, to enable more residents to participate in the gardening process. Planting courses, competitions and other sustainable activities were frequently held in the public space to encourage more public participation.

There existed many challenges in conducting FWR within the physical and particular sociocultural contexts of Amoy Gardens. However, a growing number of residents were participating in recycling activities.

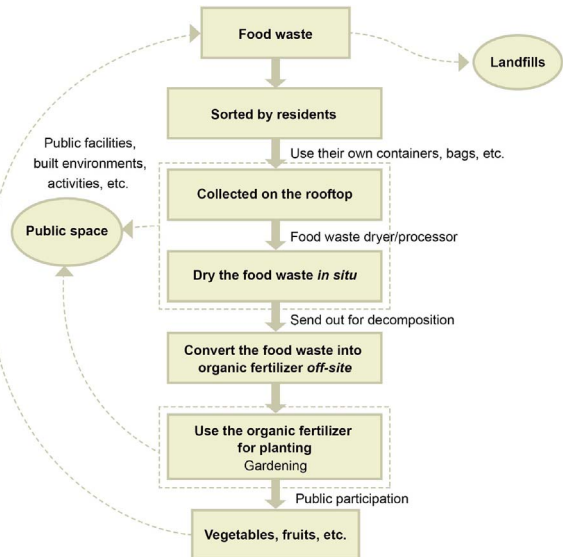


Fig. 2. The flowchart of the FWR programme in Amoy Gardens.

Using Amoy Gardens as a case study, the following sections identify the challenges of and opportunities for FWR in high-rise buildings in more detail.

### 3. Research methods

#### 3.1. Research design

An empirical study was conducted in Amoy Gardens in 2016. Cohen and Manion (1994) point out that triangulation helps researchers

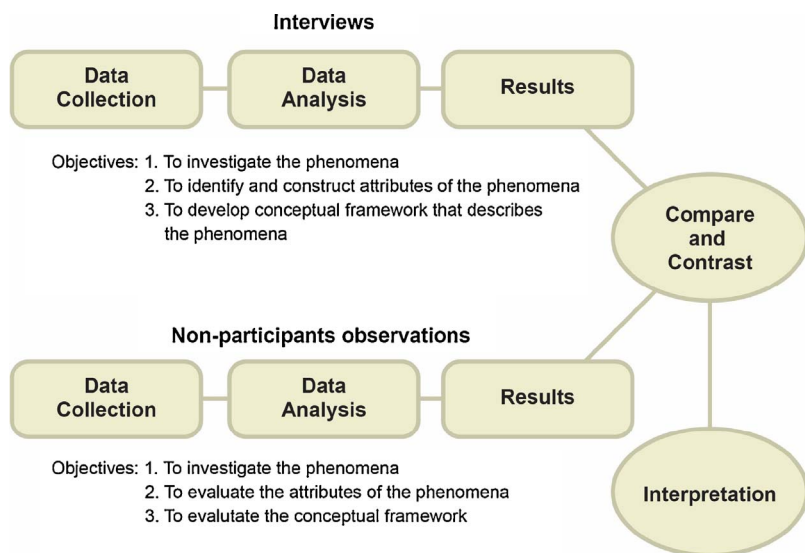


Fig. 3. Research framework.

Table 2  
The contents of interviews.

Interviewees	Contents
Residents (the main component of the interviews)	The attitudes towards FWR; daily routines; the means by which they disposed of food waste; the attitudes towards public design for FWR; suggestions
District councillor and Property management staff members	Difficulties of FWR; challenges to implementation and management; the attitudes towards FWR; the attitudes towards public design for food waste recycling; suggestions

explain the complexity of human behaviour from different points of view. It enables researchers to overcome the weakness or problems generated from a single source. Data and methodological triangulation were selected for this study (Fig. 3). Multiple viewpoints on a research question ensure greater accuracy of the judgments by collecting various data referring to the same phenomenon (Jick, 1979). Data triangulation attempts to map out a phenomenon with different time and spatial dimensions to render the results easier to compare. Methodological triangulation requires to crosscheck data regarding the same phenomenon using multiple methods. In this study, data and methodological triangulation were used in two ways: (1) using different methods to examine the same situation. Non-participant observations and interviews were carried out in residential housing. Face-to-face interviews enable potential aspects to be revealed from the conversation (Gillham, 2000); and (2) using the same method in different situations. For example, observations were conducted in the same space with the same group at different times, and vice versa.

### 3.2. Field observations

Observations enable researchers to describe the situation in natural setting and understand how people ‘interact’ with surroundings in everyday life (Babbie, 2009). They produce contextual data relating to the natural setting, and strive to observe what people actually do, instead of what they think they do.

In this study, observations were conducted on both weekdays and weekends, including different periods, such as the morning, afternoon, rush hour and evening. The research area included different public spaces, such as lobbies, podiums, ground floors and lifts, which enabled the researchers to obtain general information on people’s behaviour and living contexts.

Notes and reflections are supportive, however, they cannot ensure that subjectivity and bias are eliminated. Besides, it is not easy to identify why people act as they do because various factors affect human behaviour in the natural world (Beins, 2009). To protect the privacy

and to maintain the dignity of the participants, most of the people being photographed were informed that they would appear in the photographs and their knowledge or consent was obtained. In actual practice, it was difficult to obtain informed consent from all of the people who were observed. Further, some residents were not willing to be captured on camera. To treat participants with respect, notes were made to supplement the data. Cameras and notes were used to record the data as soon as possible. Hundreds of residents across four blocks of Amoy Gardens were observed.

### 3.3. Interviews

Both semi-structured and unstructured interviews were conducted in different settings with different participants. Table 2 shows the content of interviews with different stakeholders. The semi-structured interviews with the residents included questions such as, ‘Have you ever participated in the FWR programme?’ ‘How do you feel about the existing recycling activities in your community?’ ‘How do you deal with food waste in daily activities?’ and ‘Do you have any suggestions for improving public design for FWR?’ The interviews with the district councillor and property management staff members also included questions such as ‘Do you have any difficulties with the current FWR programme?’ ‘What are the challenges to implementation and management?’ and ‘Are you satisfied with the current settings for FWR?’. In the unstructured interviews, most of the questions were generated contemporaneously during the observations. The interviews were audio recorded. All of the participants were notified of this in advance. Nevertheless, some of the participants had concerns and were reluctant to be recorded. Others were uncomfortable and said they could not express their views freely when they realised that their interviews would be recorded. In these cases, notes were made to document their answers concurrent with or following the interview. The data collected from interviews were transcribed and then reproduced in a document. The layout of document was divided into two columns, which allowed for the researchers’ notes and comments to be recorded in addition to

participants' words. Both descriptive and In Vivo coding were adopted. The data and time were recorded to ensure each type of datum was stored in chronological order.

## 4. Results

### 4.1. Participant characteristics

Crouch and McKenzie (2006) propose that small sample size in a qualitative study helps the researcher to establish and maintain a close relationship with respondents and address the research problem in depth. The interviewees ( $N = 30$ ) recruited for the study included the district councillor, two property management staff members and 27 residents. In qualitative research, it is suggested that sample sizes should reach saturation and no new major concepts emerge in the next interviews (Guest et al., 2006). Examining the in-depth interviews conducted, we found that code saturation was reached at twelve interviews, whereby the range of major issues was identified. The sample of the respondents was by no mean representative; however, the diversity of socio-demography in terms of gender, age distribution, household income, education attainment was ensured. For interview-based qualitative research, if anything is being 'sampled', it is regarded as 'case' rather than individual 'of a kind' (Crouch and McKenzie, 2006). Therefore, one 'case' can provide new insights for the qualitative research (Frank, 1995). According to the report of population census for Amoy Gardens from Census and Statistics Department (CSD), 71.62% of the population were 25–64 years old. In terms of educational attainment, 35.46% had a tertiary degree and 45.48% had a secondary degree. In terms of the economic activity status, 61.88% were employed while 16.48% were retired or unemployed (CSD, 2011). The distribution of the sample in this study was similar to those in Amoy Gardens. The participants were randomly selected at different times. 21 respondents were employed full/part time, 6 were unemployed or retired and 3 were students. 16 participants had an income between HK\$10,000 and HK\$39,999 and 13 had an income of HK\$40,000 or above. 13 had a tertiary degree and 5 had a primary or lower degree (Table 3). 43.33% of the respondents participated in FWR programme. Each interview generally lasted from 30 to 45 min. Some of the respondents were interviewed twice or more at different stages of the research. The residents who participated in the FWR programme sorted food waste at home every day using their own containers or plastic bags. Food waste collection was organised from 8 pm to 10 pm every evening. As the collection point was located on the podium, most of the participants from different storeys had to take elevators and walk for some distance. Several buckets were provided on the podium to collect food waste.

**Table 3**  
Socio-demographic characteristics of the respondents ( $n = 30$ ).

Characteristics	Attribute	Number	%
Gender	Female	16	53.33%
	Male	14	46.67%
Age distribution	0–14	1	3.33%
	15–24	2	6.67%
	25–44	12	40.00%
	45–64	10	33.33%
	≥ 65	5	16.67%
Educational attainment	Primary or lower	5	16.67%
	Secondary	12	40.00%
	Tertiary	13	43.33%
Monthly household income (HK\$)	< 10,000	1	3.33%
	10,000–19,999	4	13.33%
	20,000–29,999	5	16.67%
	30,000–39,999	7	23.33%
	≥ 40,000	13	43.33%
Employment	Employed	21	70.00%
	Retired or unemployed	6	20.00%
	Others	3	10.00%

After collection, the property management staff members put the food waste into the dryer.

After the FWR programme was launched, more and more residents who lived within the four blocks began actively participating in it. Moreover, some residents who lived on other blocks showed enthusiasm for it and were willing to bring their food waste there. Not only local residents, such as kids, adults and older people, but also domestic helpers participated in it. According to the findings, nearly 100 households participated in this programme. Although this was not a high percentage, it provided a viable setting for constructing a sustainable community.

In the resident interviews, the quality of public spaces, such as built environments and facilities, and the social culture were frequently mentioned. The interview transcripts were coded and five categories were identified (Table 4). Three of the categories, which were negative factors, illustrated challenges to the FWR programme: (1) limited space, (2) hygiene issues and (3) implementation and management. Two of the categories, which were positive factors, represented the perceived opportunities to encourage greater public participation: (1) convenience and accessibility of public design and (2) collaboration. These five categories are described in the following sections.

### 4.2. Challenges to the FWR programme

#### 4.2.1. Limited space

Limited space was one of the most significant challenges mentioned by the respondents. Due to the high density of living environments, most of the accommodations were very small, especially the kitchens. Many respondents emphasised that their limited living space made it particularly difficult for them to store food waste in their kitchens. Moreover, the traditional high-rise dwelling spaces in Hong Kong differed greatly from the single-storey or low-rise buildings of other cities, making it a challenge to install additional equipment for food waste in the old-style kitchens.

Respondent: In my opinion, the best solution is to install a food waste processor in the kitchen, like in some modern buildings. It is very convenient...but I know it is impossible...there is not even space to store pots and pans...

As private living space was limited, public facilities played an important role in FWR. However, the communal spaces, such as refuse storage rooms on each storey, were also too narrow to allow for the installation of any FWR facilities.

Mr Yip: It was suggested by a consultant that a closed room could be built for collecting and processing food waste, and that the exhaust port should be orientated such that no one would oppose it...but you can imagine that there must be someone who will complain about the exhaust port in Amoy Gardens.

Given the limitations of both private and public spaces, only some of the open spaces in the podium were appropriate for installing FWR facilities.

#### 4.2.2. Hygiene issues

Hygiene appeared to be a significant challenge to FWR. Food waste was putrescible and may pose hygiene issues, as it contained a large quantity of water. Thus, many respondents indicated that they were not willing to store food waste at home for a whole night. Unlike the open space on the ground floor, the public space between the housing estates had some constraints and limitations on the public facilities. If food waste was not dealt with appropriately, the odour would spread far and wide and cause a lot of hygiene problems. Some respondents who lived close to the collection point expressed their main concerns about the FWR programme.

Respondent: I support food waste recycling...however, I worry about more small flying insects, such as mosquitos, appearing than before. You know, the collection point is located just downstairs and the odour would spread far and wide.

**Table 4**  
Categories and contents generated from the coded datum.

	Categories	Contents
Negative factors	(1) Limited space	Tiny kitchen; no space to store food waste; limited public space; small flat.
	(2) Hygiene issues	Dirty; smell; disgusting odour; wet waste; bacteria; putrid waste; cleanliness of environments; flying insects; attract roaches.
	(3) Implementation and management	Maintain facilities; supervise the process; burden and pressure; efficiency of the process.
Positive factors	(1) Convenience and accessibility of public design	A good place; accessible location; acceptable distance; transfer elevators; take a walk; availability of recycling facilities; convenience of FWR; equity of public design; provision of equipment.
	(2) Collaboration	Collaborate; help each other; develop skills; get to know each other; communicate with family; social involvement.

To meet more residents' satisfaction, the FWR programme used an alternative method of dealing with food waste. In general, processors decomposed food waste in situ, which were convenient but may generate a disgusting odour during the decomposition process. In Amoy Gardens, food waste was only dried and compressed in situ. After going through these initial processes, the treated food waste was sent out for decomposition and then returned as organic soil in a few days.

To facilitate recycling activities, food waste collection was organised from 8 pm to 10 pm every evening. Although the collection time was not 24 h, many of the households indicated that the collection time was acceptable and convenient. The designated collection time helped avoid the spread of smell and bacteria.

4.2.3. Implementation and management






In Amoy Gardens, the FWR programme was conducted on a voluntary basis. Most of the respondents indicated that they were increasingly aware of the environmental issues and social responsibility of FWR. Some of them described the implementation and management of waste recycling affecting their motivation and sustainable behaviour. Poor management decreased their enthusiasm and satisfaction.

Management staff members at Amoy Gardens put a lot of effort into the FWR programme, such as planning schemes, installation of public facilities, propaganda, education, management and maintenance. Providing public facilities was not enough in itself to ensure a long-term and effective recycling programme. When conducting the FWR programme, attitudes and suggestions from different stakeholders, such as residents, management staff members and cleaners, had to be considered. It was thus necessary to balance these suggestions. Increasing convenience for residents while introducing burdensome duties to management staff members and cleaners could result in failure. An easy and convenient way for management to reduce the burden and pressure on staff members and lead to an effective operation was proposed.

Management staff member: In some housing estates, property management staff members provide buckets for participants for food waste disposal at home and then clean for them. This inevitably increases the burden and pressure on our staff members...and it is not that necessary. We should also ensure that it is easy for us to implement and manage. So, I insist that residents use their own containers and clean themselves.

In general, residents used their own containers to transport their

**Table 5**  
Opportunities to public design.

Opportunities	Descriptions	Cases	Public design
Convenience and accessibility	Several buckets were provided on the podium to collect food waste.		Accessible collection point; semi-open/open space; buckets
	A woman was washing her hands after dealing with the food waste.		Anti-bacterial hand wash; basin; rubbish bin
Collaboration	The food waste was dried and compressed in situ and then sent out for decomposition.		Food waste dryer/processor; semi-open/open space
	Each container had a number plate that represented the household number sticking into the soil.		Accessible location; containers; organic soil; number plates; shelves; seeds; organic fertiliser
	Participants shared their tools and skills throughout the process.		Accessible public space; containers; planting course; competitions; activities; flower watering utensil

food waste to the collection point (Fig. 4).

4.3. Opportunities to public design

4.3.1. Convenience and accessibility

Table 5 shows the results of the examples of public participation in FWR from field observations. The convenience and accessibility of design for recycling were of great concern. Convenience in public design increased motivation for FWR. Ensuring the convenience of public design was exclusively important for residents. As mentioned previously, however, given some constraints of limited public space and hygiene



Fig. 4. Residents used their own containers to transport their food waste to the collection point.

issues, only some of the communal spaces in the podium were available for setting up FWR facilities. Some residents who lived on the blocks nearby described the location as accessible and the distance as acceptable. However, some respondents who lived on other blocks had different attitudes towards the accessibility and equity of public recycling facilities. Some respondents found them inconvenient to use because there were no facilities provided on their own blocks.

Respondent: It is impractical for me and my neighbours, who live far away, to bring our food waste to a collection point... basically, I have to take the elevator to the lobby and transfer to another elevator... carrying such smelly and wet food waste... it is so inconvenient. If these facilities were provided on my block, I would definitely participate in them.

#### 4.3.2. Collaboration

To encourage greater public participation, many of the respondents described the importance of collaboration. In Hong Kong, most local residents felt isolated in the community, as they lived in high-rise and high-density buildings. Consequently, the way they behaved seemed to have nothing to do with their surroundings, and they showed little interest in recycling. Enhancing the sense of community and social involvement was thus necessary to encourage public participation in FWR.

Respondent: It has very much to do with our cooperation... we should work together and help each other. Gardening in a public space is a very good idea... it not only encourages us to participate in food waste separation, but it also enables us to do this right thing together.

In the garden, each container had a number plate sticking into the soil, representing the household number. It was easy for participants to recognise their own and their neighbours' plants.

Activities such as planting courses and competitions were occasionally conducted, helping participants develop their skills and get to know each other (Fig. 5).

The garden was the public place that most of the residents passed through every day. The participants in the scheme said they often came to the garden in the evening after dinner or when they were passing by. When they were asked about their attitudes towards their neighbourhood, they showed a glow of satisfaction with having a good place that enhanced their opportunities to participate in community activities. They collaborated in garden recycling and shared their tools and skills throughout the process.

Respondent: This is a mixed pesticide made with ginger and other vegetables. It is organic... it doesn't contain any toxic substances! I learned it from the planting course. The teacher taught me how to make it. It is very useful! I put it on the shelf now so everyone can use it.

The public space on the rooftop was divided into several areas according to different types of vegetables. It provided an opportunity for residents to communicate with their family. Some of the participants brought their families to the garden during the harvest.



Fig. 5. Planting courses were occasionally conducted (source: photo provided by Mr Yip).

## 5. Discussion

This case study identifies the challenges of and opportunities for FWR in high-rise buildings by using qualitative research methods. Through interviews with residents and management staff members, five categories of challenges of and opportunities for FWR were identified. Contextual factors, such as built environments and social culture, have significant effects on public participation in recycling. The quality of built environments and facility design affects sustainable behaviour. It is thus necessary to consider the challenges to FWR and how to improve design for greater public participation.

### 5.1. Identifying contextual factors

Various factors, such as waste management policies, economic incentives, norms, attitudes and habits, have been identified as important reasons for low recycling rates (Chan and Lee, 2006; Foo, 1997; Hage et al., 2009; Yau, 2010). Contextual factors such as physical infrastructure, technical facilities and the availability of public facilities have also been considered as factors that are highly correlated with sustainable behaviour (Steg and Vlek, 2009). Different from cities with low population densities, the particular high-rise and high-density living situation in Hong Kong has brought many challenges to FWR. Studies of waste recycling have indicated that it can be difficult to conduct recycling projects without understanding living environments and specific lifestyles (Martin et al., 2006; Siu and Xiao, 2016).

Limited space, hygiene issues and implementation and management are three main challenges to FWR. Limited living space makes it particularly difficult for the residents to keep different types of recycling bins at home. Installing additional equipment for processing food waste in old-style kitchens is also difficult. In this regard, public facilities in communal spaces play an important role in FWR. However, many factors such as safety and space affect the systematic or effective implementation of food waste collection in public spaces. In most of the housing in Hong Kong, especially public housing estates, both private and public spaces are limited, which makes it difficult to set up FWR facilities. Hygiene issues should be taken into consideration at different stages of FWR, such as separating, storing, disposing and processing. The case in Amoy Gardens provides a good example for FWR without raising too many hygiene issues. Furthermore, the results of our study reveal that people's enthusiasm and willingness decrease when the programme is managed poorly and facilities are not maintained.

### 5.2. Public design for facilitating household and community participation

According to the findings and results, a framework of design process is proposed to provide a holistic understanding of how to use public design to facilitate household and community participation in FWR in high-rise buildings (Fig. 6). In this framework, local context includes physical, social, socio-cultural context. Each of the variables influences the provision of public space and facilities. Providing public facilities is not enough to ensure long-term recycling behaviour. It is necessary to ensure implementation and management of the design (Siu, 2010). High-quality of public design can increase residents' interest and encourage public participation in recycling at the beginning. Effective management and maintenance can continuously enhance social collaboration and ensure behaviour changes towards sustainable community.

Suggestions from various stakeholders, such as management staff members and cleaners, are also important. Increasing convenience for residents while introducing burdensome duties to management staff members and cleaners may result in failure. Indeed, it is not easy to balance their suggestions and meet all of the requirements. It is suggested that ensuring the convenience of implementation and management may reduce the burden on staff members and lead to long-term and effective recycling.



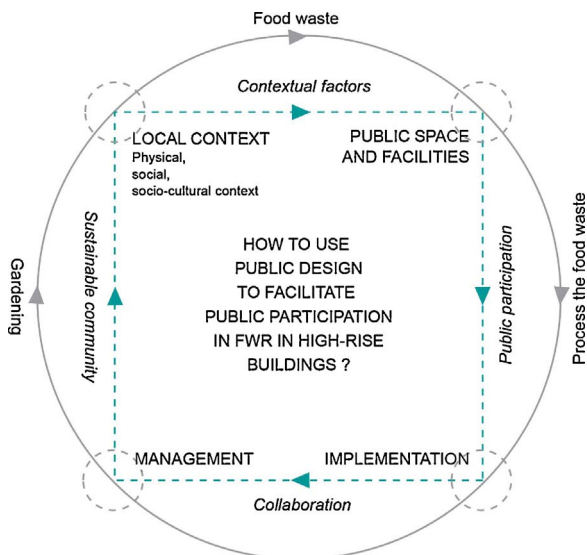


Fig. 6. The framework of design for public participation in FWR.

### 5.3. Improving public design for collaboration: from 'I urge you to' to 'we do it together'

The convenience of public facilities was one of the significant opportunities for enhancing participation. Ensuring the quality and accessibility of FWR facilities is exclusively important. However, a dilemma between convenience and limited space is apparent. There are considerable constraints of and barriers to installing FWR facilities in either private or public spaces. The findings suggest that public design should be provided according to living situation. It is impractical to apply FWR facilities to each building using a standardised 'broad brush' method. For example, many processors that decompose food waste *in situ* may not be suitable for some neighbourhoods, as it generates odour during the decomposition process. In this regard, an alternative solution that can reduce noise and odour is needed.

Improving built environments is beneficial for public participation. Due to the particular high-rise and high-density living situation, most residents live in neighbourhoods with low social involvement. Although they have lived in their neighbourhoods for long periods, they seldom communicate or participate in community activities. In Amoy Gardens, the podium has been improved. It serves as a public space that enhances social collaboration and encourages public participation in FWR, from sorting to planting. It has been suggested that built environments can be utilised to promote an atmosphere of social interaction and cultivate sustainable behaviour.

Compared with other strategies, such as information, education, economic incentives and punishment, design for collaboration is regarded as a modest strategy that indirectly changes undesired behaviour. In other words, all intervention attempts are passive in nature, from 'I urge you to' enabling approaches and 'I ask you to' motivating approaches to 'I order you to' constraining approaches. Collaboration attempts can be described as being active in nature, from 'I help you to' and 'you need me to' to 'we do it together'.

### 5.4. Implications for future research

The FWR programme in Amoy Gardens is an attempt at an individual-driven grassroots initiative. A key finding of this study suggests that enhancing the quality of public design based on particular physical and cultural contexts is helpful to develop recycling behaviour. In addition to traditional interventions, such as education, propaganda, economic incentives and waste management, public design for participation and collaboration can form an active environment in which to

establish relationships between individuals and their communities. It promotes an atmosphere of social involvement and encourages household and community participation in recycling. However, there is a critical flaw in such attempts. Their individual-driven nature indicates that they are highly reliant on support from the organiser, which may lead to failure if the organiser moves away or stops the programme. Establishing a community-driven approach with support from different stakeholders is important for long-term success.

We did not use a large representative sample of informants in this study. However, heterogeneity was ensured in terms of age, sex, household income, household size and position. The data collected from the interviews and observations exemplified some important issues that may be ignored in quantitative research. The study identifies challenges of and opportunities for household recycling by gaining an in-depth understanding of peoples' behaviour and living contexts. Future research may benefit from using a larger stratified sample size with stratified living environments and accommodations. More practical work is needed to evaluate the feasibility of implementing these opportunities. The findings of this study may not be widely applied to suburban areas and low-density residential areas. Nevertheless, it provides insights into public design in many similar high-rise residential buildings in Hong Kong as well as Singapore and Mainland China. Improving public design, such as that of built environments and facilities for collaboration, is an alternative way to facilitate active involvement in recycling in high-rise buildings.

## 6. Conclusions

This study contributes to the qualitative literature on waste recycling in high-rise and high-density buildings, which has mainly focused on public design based on physical and cultural contexts. Non-participant observations enable to describe the situation in natural settings and observe what people actually do, whilst interviews enable to identify why people act as they do and the reasons behind their behaviour (Yin, 1993).

Experiences with the FWR programme in Amoy Gardens demonstrate implications for encouraging household and community participation in recycling. This paper identifies three challenges to FWR in densely populated high-rise buildings. As there are considerable constraints such as limited space and hygiene problems in both private and public spaces, public design should be provided appropriately based on living situation and cultural context (Chan and Lee, 2006; Marans, 2015; Wang and Lin, 2013). Effective management and maintenance of public design can lead to long-term recycling and social collaboration. Clearly, high-quality and efficient public design is vital to the success of the FWR programme. However, attitudes and opinions from different stakeholders should be addressed in advance. To find appropriate solutions, policymakers, designers and management staffs should communicate with users and help them express their opinions frequently, especially in the early stages.

Furthermore, this study indicates that improving public design for collaboration is an alternative way of facilitating behavioural change. The approach, which includes sorting, collecting and gardening, can be described as active or 'from passive to active' strategy. It is a potential approach for increasing residents' motivation to FWR in high-rise buildings. Only when people have a close connection with the community do they care about their surroundings and become keen to participate in community recycling activities. This paper suggests that public design encompassing built environments and facilities can be utilised to enhance collaboration and establish community networks, which help influence sustainable behaviour. Future research would have been more convincing if proposed approach can be examined through more empirical studies in similar areas.

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**Dr Xiao** is Research Associate School of Design, The Hong Kong Polytechnic University. She was Visiting Scholar of Taiwan Shu-te University. Her research focus is on both sustainable design research and practice. She has been involved in several funded research projects related to participatory research and sustainable design. She has received more than 20 international and national design awards, including Design for Asia Awards (DFA), HKDA Global Design Awards and Hong Kong Awards for industries. She has published several peer-reviewed journal paper, international conference papers and book chapters.

**Prof. Siu is Eric C. Yim** Professor in Inclusive Design & Chair Professor of Public Design. He is Founder and Leader of Public Design Lab, The Hong Kong Polytechnic University. He is a chartered engineer and chartered designer. He is Fellow and Council Member of the Design Research Society. He was Visiting Scholar of UC Berkeley, ASIA Fellow of the National University of Singapore, Fulbright Scholar at MIT, and Visiting Scholar of the Engineering Design Centre of the University of Cambridge. He is Visiting Professor of Tsinghua University. His research and design focus is on both technological and social perspectives. He has been involved in a number of funded research and design projects related to public design and participatory design. He promotes action research and worked closely with end users. He has received more than 50 international design and invention awards. He owns more than 50 US and international patents. He has published over 300 journals in top tier research and design journals.