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Exploring the Design Framework for Food Waste Recycling Awareness in Chow Kit Wet Market

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Abstract

In Malaysia, the overall waste composition is dominated by food waste (FW) due to excessively convenient food accessibility, urbanisation and progressive prosperity. Due to mismanagement, FW problems are significant in most wet markets in Kuala Lumpur. Despite the significant waste stream and availability of FW recycling centres in urban areas, there is a relatively low rate of recycling organic waste compared with other major waste categories. Therefore, this research aims to explore the design framework for integrated recycling in the existing wet market to improve public outreach of FW recycling. Chow Kit Market was explored from a human-centric perspective to analyse the existing FW management and through observation of market workflow and spatial design. This research aims to investigate the challenges of current FW recycling practices in an existing wet market and propose appropriate design strategies to optimise FW recycling for improved public outreach. It supports the government's commitment to achieving Sustainable Development Goal (SDG) 12 of responsible consumption and production and SDG 8 by promoting sustained economic growth through improved resource efficiency and a new circular economy. This paper raises awareness for improving the implementation of FW recycling strategies in urban wet markets. It is hoped that the sustainability of the FW system for innovative recycling strategies provided in this paper can be further explored in other food retail operations in Malaysia.

Keywords: Wet Market, Food Waste, Recycling; Public Outreach, Human-Centric Design

Introduction

Food waste (FW) is a significant component of the global food system challenges. All food materials produced for human consumption that are left uneaten throughout the retail and consumer level are referred to as FW. According to the Food and Agriculture Organization (FAO) of the United Nations (UN) statistics, approximately one-third of global food production is wasted yearly. In Malaysia, FW represents the major waste stream of the overall waste

composition (Fauziah and Agamuthu, 2012; Mohd Yatim et al., 2019). FW occupied 44.5% of the overall waste composition, the highest composition over other major waste categories such as plastic (13.2%), paper (8.5%) and glass (3.3%) (Lie, 2020). The management of FW continues to be a major challenge in urban areas in developing countries. The UN estimated that more than half of Southeast Asia's population resides in cities. The changes in lifestyle and consumption patterns linked to rapid economic development and population growth in urban areas have also contributed to an increase in waste generation (Lim et al., 2016; Papargyropoulou, Lozano, et al., 2014; Xiao and Siu, 2018).

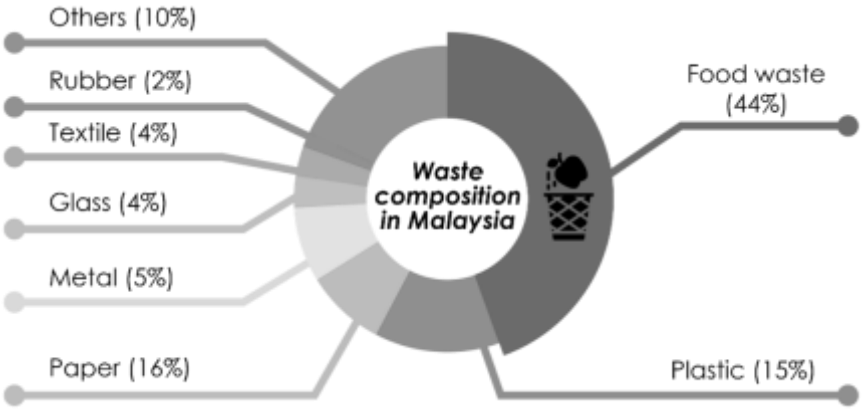

Figure 1. Pie chart of the overall waste composition in Malaysia shows that food waste represents the largest portion of the total solid waste produced by Malaysians.
Source: Lie (2020)

Wet markets, as a traditional form of food retail, are one of the essential parts of our local food culture, providing diverse fresh produce at affordable and bargainable prices. Until today, wet markets continue to thrive in Malaysia due to the freshness of their food. Most consumers consider freshness a valued feature as it is also associated with food quality and safety. Therefore, market vendors tend to fulfil consumers' demands by trimming off or discarding undesired parts as FW, even though they may still be edible or have not lost quality. Unsold and unfresh food is discarded at the end of the day due to its reduced physical appearance. According to Jereme et al. (2016), markets are the second largest FW generator in the nation, amounting to more than a quarter of FW generation per day during the fresh food sorting and processing workflow. The food scraps will either be hosing away on the damp floors or end up in landfills.

Wet markets in Kuala Lumpur nowadays are degenerating into sorry sights of filth. FW and murky puddles have become synonymous with most wet markets in the city. Based on an observation conducted by the author in 2022, the operational conditions in the Chow Kit wet market reveal improper planning in space and circulation for food waste management (FWm). Due to the unsystematic waste management, vendors overlook hygienic practices when sorting and processing their fresh food. Furthermore, littering and hosing food scraps with water can be observed mainly in the meat market section. Meat parts, fish scales and fins are small scraps from the butchered meat, which might be challenging to handle and dispose of in waste bins. Vendors usually hose counters and chopping boards to keep them clean, contributing to the slippery floors and drains stained with heaps of FW. As a result, drains have turned into "rat hideouts". According to a newspaper report, the main factors contributing to the abundant presence of rats in markets are the water, FW and shelters, such as holes in the drain (Five KL markets, 2015). With the high reproduction rate of rats, most

wet markets face rat infestation and the risk of being exposed to potential food safety hazards (Ali, 2022). During the COVID-19 pandemic, wet markets were under intense speculation that the Wuhan wet market in China was ground zero for the coronavirus outbreak (Australian Centre for International Agricultural Research, 2020). Indeed, there are worries about diseases that can spill over from animals into humans, arguing that wet markets are unsafe.

With the mismanagement of FW in wet markets becoming significant, Kuala Lumpur City Hall has ensured that the Solid Waste Management Component (SWMC) collects waste daily from urban wet markets. However, the market users are still unaware of their daily behaviour on the environmental impacts and possess very low intention in FWm. The Kuala Lumpur Vegetable Wholesalers Association's president, Wong Keng Fatt, credits the unpleasant market environment to a lack of good hygiene practices and food-related routines among market vendors and buyers despite routine cleaning done by SWMC (Jun, 2020). Given the circumstances, it is not surprising that nobody will eventually want to visit wet markets anymore. Urban wet markets as the cultural identity could soon vanish from Malaysian food culture.

Currently, the FWm in wet markets is dominated by landfilling as the waste management system was implemented solely to remove wastes from and near living spaces. However, this linear cycle, simply removing wastes, became unsustainable. Due to leachate and methane gas emissions, FW dumps became major sources of regional environmental pollution. Transporting FW from the urban wet market to landfills on the outskirts contributes to extra carbon emissions (Fauziah and Agamuthu, 2012). FAO (2014) reports suggest that FW accounts for 4.4G tons of CO_2 and 8% of Greenhouse gases (GHGs) emissions globally. Despite its recyclable value, FW remains unutilised sustainably as a resource to enhance future production. Even with the increased interest in solid waste management (SWM), FW remains the stream that has not obtained sufficient attention. Regarding FWm, the treatment of FW in Malaysia is still minimal due to a lack of sound innovation and strategies. In other developed countries, reducing FW can be measured using the 3R methods – reducing, reusing and recycling. The rate of food waste reuse and recycling (FWr) in Malaysia is relatively low. The current rate of FWr is estimated to be only 5% in comparison with other waste categories, such as paper (60%) and plastic (15%) (Lim et al., 2016).

This situation creates a crucial need for improvement in FWm in urban wet markets. There have been many studies regarding the treatment of solid waste. However, FW, as a special category of solid waste, has high moisture, salinity, organic and grease content, which requires different treatment methods from common solid waste (Anqi et al., 2017). The more prominent FW treatments that have been discussed in previous studies are composting, anaerobic digestion and animal feeding, which is also the more sustainable options to be implemented in Malaysia, replacing incineration and landfill (Anqi et al., 2017; Lim et al., 2016; Mohd Yatim et al., 2019). FW is also called organic waste, in which over 90% is biodegradable. Composting organic waste is popular due to simple operation management and high economic efficiency. However, the rate of recycling and reusing FW is still shallow compared to other major waste categories (Lim et al., 2016). Unlike paper and plastic, no systematic disposal methods and strategies for FW are available. Based on an initial survey conducted by the author in Chow Kit Market, the result reveals that none of the vendors practices FWr, and only a few buyers have requested FW for their composting purposes. The awareness of FWr among Malaysians is still poor. Despite many researchers examining the study directions of operations management to reduce FW, a comprehensive and human-based analysis of planning approaches regarding FW awareness is missing. In general, users' knowledge of the

environmental effects of FW could influence their FWm intention. Hence, awareness should apply to vendors and buyers to encourage a proactive FW reduction and separation practice in wet markets and at the household level.

This paper aims to propose the design framework for integrated recycling in Chow Kit market to improve public outreach of FWr. The objectives of this study are as follows:

RQ 1. To investigate the challenges of food waste recycling practice in the Chow Kit wet market.

RQ 2. To identify the design strategies for integrating food waste recycling in Chow Kit wet market for improved public outreach.

Literature Review

Food Waste Recycling

The phrases "food surplus," "food loss," and "FW" are often used interchangeably, yet their definitions and scope differ. According to Irani et al. (2018), FW is defined as food materials produced for human consumption left uneaten at the retail and consumer levels. Food loss refers to decreased food quantity or quality, making it unfit for human consumption throughout the harvest and distribution levels. In contrast, food surplus is food supply beyond our demand for it. Therefore, FW is more appropriate to describe the by-product generated at the wet market operation stage through fresh food processing. Market vendors normally pre-process fresh produce to fulfil consumer demands for freshness. For instance, they trim off dried stalks and leaves from vegetables, peel off fruit skin and husks, and discard undesired or inedible meat parts, to name a few. Moreover, unsold and unfresh food is discarded at the end of the day due to its reduced physical appearance. Irani et al. (2018) further argued that this wasted food may still fit human consumption or can potentially enhance resource utilisation.

A waste hierarchy was introduced and adopted worldwide as the principal waste management framework as early as the 1970s. The waste hierarchy provided a theoretical foundation for the Food Waste Hierarchy proposed by Papargyropoulou et al. in 2014. The framework aims to guide establishing the most appropriate options for minimising and managing FW throughout the food supply chain. The priority is to prevent an oversupply of food beyond human needs with the aim that the undesirable food surplus can be avoided. Redistributing unconsumed food surplus to people affected by food poverty is then proposed as the second favourable option. Furthermore, recycling FW into animal feed and compost is a third option of the resolution framework. Research by Cecchini (2017) also suggested the possibility of FWr in producing new bioplastic materials. According to the researcher, various vegetable, animal and microbial matters from the FW could be a great alternative to non-renewable synthetic polymers. Finally, Papargyropoulou et al. (2014) proposed energy recovery followed by landfill disposal as the least favourable option for managing the remaining fraction of unavoidable FW. This is supported by Anqi et al. (2017), that the anaerobic fermentation technique applied for energy recovery requires high cost and strict startup conditions, while landfilling demands a large land area and comes with a significant amount of GHG emissions. Therefore, based on the review, it is recommended that an appropriate option for the FWm system in a wet market setting can be determined through the Food Waste Hierarchy according to the properties of FW generated.

Considering the environmental, economic and social benefits of FWr, industrial ecology concepts such as "Cradle to Cradle" and "Circular economy" have become the leading principles for addressing sustainable waste management (SWM). An announcement by the

Housing and Local Government (KPKT) Minister Datuk Seri Reezal Merican in a cabinet meeting in 2022 stated that a specific law to support sustainable FWm would be introduced in Malaysia soon. According to him, the efforts will focus on accelerating the transition from the concept of SWM, including FW, in a linear economy to a cyclical economy. This is aligned with research by Anqi et al. (2017), who suggested that FW can be a valuable resource when managed reasonably and effectively while reducing its environmental impacts. Mirabella et al. (2014) also discussed the great potential of waste produced by the food industry to be reused in other production systems. In addition to a loss of valuable materials, FW also possesses serious management problems from economic and environmental points of view. Therefore, the recycling of market FW could be an opportunity to promote greater economic sustainability. As wasted food in the wet market indicates food lost from its intended selling purpose, this could be a huge loss of investment cost and profit from market vendors. Instead of disposing to landfill, transforming FW into value-added products can help market vendors cover part of the profit loss from wasted food. In other words, by-products or waste from the market industry could sustainably become a resource for another industry. At the same time, it spurs local recycling industries that boost economic and job creation due to technological upgrading and innovation needs.

FW generated by wet markets is derived from different stages of food processing. They are often categorised as wet or dry waste. The wet wastes are produced by cutting the edible meat portion and removing hides in the meat market section. In contrast, the vegetables, fruits, and dry food market sections produced dry waste while trimming and disposing of unwanted parts. Therefore, the segregation of wet and dry wastes is the key to an effective FWm and to minimising the growth of bacteria (Al-Gheethi et al., 2021). According to Al-Gheethi et al. (2021), FWm technologies have developed greatly from simple processes to more efficient ones that can be classified into four categories: direct usage, biological processes, and physical and thermo-chemical processes. Currently, the reuse of edible surplus food, anaerobic digestion and composting are widespread in Malaysia due to the affordable operating cost and market demand.

By implementing a circular business model, manufacturing companies can gain stronger value chain relationships and yield long-tail revenues. In an article by Wang (2020), bakery companies like Renewal Mill Co. produce high-fibre gluten-free powder through sustainable solutions to FW. The company upcycles pulp by-products from soymilk processing into baking flour equivalent to whole wheat flour, which can be used to make cookies and baked goods. Furthermore, research by Cecchini (2017) also investigates manufacturing biopolymer products from FW instead of specially grown crops. According to him, there are various organic wastes, such as fruit peels, eggs and seafood shells, potentially helpful in recovering and reusing valuable carbohydrates and cellulose fibres. Starches, cellulose, pectin, chitin, lactic acid, collagen, blood proteins, and gelatin form the basis of bioplastics and can be extracted directly from these organic wastes or by mechanical or chemical processes. In addition, Fairus et al. (2022) also suggested a biocomposite material created through a natural biological process suitable for the manufacturing of biofoam and packaging materials. The foam-like mycelium composite is a composite material produced by combining the matrix and natural fibre results from the filamentous fungal growth on agricultural wastes. According to them, this biocomposite material could be a vital alternative to non-renewable packaging materials. Table 2.1 summarises some techniques and products that could be produced from wet market FW.

Challenges of Food Waste Recycling Practices

It is well acknowledged that public acceptance is the main driving force in determining the success factor of FWr initiatives. Substantial studies have investigated challenges affecting public acceptance of waste recycling. Siu and Xiao (2016) pointed out inconvenience in the waste programme design as the main barrier to community participation. According to their research in Hong Kong, the existing planning is generally based on policymakers and experts assuming they share a common understanding of convenience rather than focusing on the users' point of view. Therefore, the current public recycling facilities failed to meet individual preferences due to a lack of consideration of convenience in the planning and implementation. In addition, this standpoint was further expanded by Vassanadumrongdee and Kittipongvises (2018), who suggested that inconvenience can be categorised into two characteristics. First, it can be associated with limited storage space, additional time requirements, or perceived risks associated with the practice. Second, sending recyclables to the waste collection facility requires excessive energy. Meanwhile, the present study by Jereme et al. (2016) identifies a lack of information and unconsciousness about the environment as the reason for food wastage. This is due to an individual without environmental consciousness not being able to relate food wastage to FW generation and the environmental impacts on future generations. A study by Ramli et al. (2020) also proves that knowledge is the most prevalent factor in public acceptance of FWr.

In Malaysia, the findings revealed that the government's current initiative in encouraging good habits of FW disposal failed to address a more comprehensive FWm framework. These initiatives include the NSPFWMM, although the planning relaunched in 2020 is still underway in the planning and development phases. The NSPFWMM was already announced in 2010 with almost similar ideation. This is aligned with research by Lim et al. (2016), stating that most countries face incomplete legislation and policy obstacles, inadequate management, weak enforcement and a lack of allocation budget in recycling planning. Nevertheless, the government's attention generally draws only to high-value recyclables such as paper, plastic and aluminium. Only one out of 532 pages of the Twelfth Malaysia Plan mentions FW. Thailand's government seems to focus more on waste-to-energy while less budget is provided to expedite recycling initiatives (Vassanadumrongdee & Kittipongvises, 2018). With a general lack of political will to invest, Thailand's recycling programmes mainly rely on market mechanisms operated by the informal sector. However, market incentives so far draw only high-value recyclables, though low-value recyclables are discarded with other wastes. Vassanadumrongdee and Kittipongvises (2018) also pointed out another barrier related to recycling infrastructures is certain mistrust owing to low, transparent recycling processes due to unclear and ineffective policy measures that drawback public perception of the recycling scheme. In Indonesia, Soma (2017) further discussed urbanisation factors as rapid urbanisation further disconnects the urban population from sustainable management. This is partly due to the lack of programmes to support the separate management of FW. Therefore, in planning the FWr programme, a comprehensive management system yet transparent process should be considered.

Public Outreach

Public outreach is an effort to bring awareness about the FW issue to market communities. Adopting meaning from the Sustainable Development Goal (SDG) Accountability Handbook (Cardinal, 2018), awareness-raising is a process that seeks to inform and educate people about the FW issue to influence their attitudes, behaviours and beliefs towards the

achievement of encouraging FWr practice. Comber and Thieme (2013) define awareness-raising as a key stage in behaviour change. The Theory of Perceived Behaviour (TPB) is a psychological theory adopted in some prior literature to aid the understanding of the public's recycling intention and behaviour. TPB model as the theoretical framework for examining the intentional disposal behaviour is adapted in their study schemes regarding FW reduction and recycling (Comber and Thieme, 2013; Abadi et al., 2021; Cheng, 2020; Karim Ghani et al., 2013; Vassanadumrongdee and Kittipongvises, 2018; Zainal and Hassan, 2019; Seng et al., 2021).

Attitude in the TPB model depicts a person's favourable or unfavourable attitude towards a specific behaviour. For recycling, belief and knowledge towards ecological sustainability, as well as perceptions of the responsibility to act ecologically friendly, is linked to the intentions to carry out environmentally friendly behaviour. Furthermore, Abadi et al. (2021) indicated that attitude towards FWm positively affects behavioural intention. They suggested that the present studies provide evidence that a person with a positive attitude towards FWm is more likely to be aware of environmental problems and, subsequently, consider such concerns substantial. In the case of encouraging FWr practice in the wet market, the public can be educated on the method used in the recycling market's FW and the processes involved from collection to recycling. Therefore, a positive attitude towards FWr shapes their recycling intention and behaviour.

Behavioural change also occurs through normative social influence or pressure, where a person is encouraged by the desire to obtain social approval and avoid rejection by others, as justified by Comber and Thieme (2013). In other words, social norms can be explained as the beliefs about the normative expectations of others and the motivation to comply with these expectations. According to Abadi et al. (2021), norms influence people as they interact with those around them in social circumstances. Alternatively, a recycling programme or cluster facilities may be implemented to foster group participation among the market communities. This can be extended through the power of social influence in motivating the public's performance of FWr in the wet market.

Perceived Behavioral Control (PBC) is a person's sense of self-efficacy as it relates to implementing a particular behaviour. According to Karim Ghani et al. (2013), it implicates the belief about the presence of additional factors, such as perceived habit, perceived inconvenience and perceived effort, that may facilitate performance or engagement of the behaviour. The suggestion in terms of recycling has been pointed out by Comber and Thieme (2013) that there is a high potential to perform recycling behaviour when the possibility of perceived inconvenience is low. Additionally, a similar perception was supported by Seng et al. (2021) when PBC was adopted in their research to assess the convenience of households in managing FW. The results reveal a higher intention to practice FWm among households when they perceived managing FW as easy practice. Thus, improving perceived convenience during the planning of the wet market is of utmost importance for engaging public participation in the FWr. In a nutshell, the more favourable the attitude and subjective norm, and the greater the perceived control, the stronger the intention to perform a behaviour. Hence, addressing habitual FWr behaviours, motivating people to move beyond the most manageable behaviour, and evaluating the appropriate FWm pose a significant design challenge.

Design Strategies

It was indicated that knowledge was one of the predictors of recycling behaviour. Research on encouraging recycling conducted by Amanda in 2016 suggested the need to address improved awareness and increased access to designing a recycling system. Ganglbauer et al. (2012) also recommended making FW topics visible through technology, which could be an enabler for awareness. In addition, doing so makes it possible to reflect wasteful behaviour to the users and draw their attention to the FW issue. Klunbut et al. (2017) proposed an option development of waste management in their research focusing on waste generation, handling, separation and storage, and collection. The proposal was designed to lessen initial waste generation through source reduction, reuse and recycling to minimise the volume of material sent to landfills. Furthermore, this operation could be a model guiding future planning of the FWr system in wet markets. A comprehensive system serves to acknowledge the public understanding process of FWr. In addition, with an appropriate selection of recycled products based on the market setting, the entire system can function towards the circular economy concept.

Efficiency is the basis for a dedicated recycling facility dealing with waste disposal and collection. As suggested by Klunbut et al. (2017) in their research on market SWM in Thailand, the market, as the facilitator of the SWM system, should provide appropriate waste management equipment for the vendors. In addition, the idea of a "Cluster" proposed by Amanda (2016) signified the idea of efficiently collecting recyclables and organic waste in the private realm. Businesses and residentials grouped near the market can use the cluster's design elements to share waste collection facilities. On top of that, the recycling facility can be further instilled with new functions such as a research laboratory, gallery, and workshops. The ideation should also encourage the non-participating public to be part of the community and encourage their participation in recycling behaviour. In other words, when designing recycling facilities, the main idea is to conceive this system as services and nodes to engage diverse audiences and empower willingness to participate in sustainable practice.

Substantial studies on recycling indicate that convenience is necessary for designing a recycling programme. Convenience is defined by the Oxford English Dictionary (2014) as the ability to proceed with something without difficulty. According to Siu and Xiao (2016), the convenience categories can be further narrowed to two dimensions: time and energy. However, the busyness of working lives limits urbanites' available time and energy. A lack of time and energy for excessive activities is a crucial point where intentions do not translate into behaviour. Therefore, increasing recycling accessibility in urban areas is crucial in determining the success factor of a recycling programme. One way is by providing a collection point or drop-off bins at optimal locations. An example of an underground vacuum waste management system was opened in the housing development in London in 2008. The waste collection system has the advantage of making more convenient access and efficient use of urban space for waste separation and collection. In comparison, the most fundamental constraint on the location of collection facilities is determined by the walking distance acceptable for the public to transport waste along the circulation path that the public used to pass by.

Method

A qualitative research approach was adopted in this study as it allows for a more in-depth understanding of the current practice of FWm and identifies challenges and strategies to redesign the Chow Kit wet market with FWr integration. As pointed out by Xiao and Siu (2018),

qualitative research may provide valuable insights into the complexities of people's behaviours. Interviews, field observations and case studies have been widely adopted in the present studies by Siu and Xiao (2016); Xiao and Siu (2018); Vinck et al. (2019); Viva et al. (2020); Riesenegger and Hübner (2022).

Table.1
Research Questions and Research Methodology.

Research Question (RQ)	***Data Sources***
RQ1: What are the challenges of food waste recycling practices in the Chow Kit wet market?	In-depth interview and Observation
RQ2: What are the design strategies for integrating food waste recycling for improved public	Case studies analysis

In-depth interviews and field observations were conducted in the Chow Kit wet market. It was revealed from the literature that waste segregation is critical to an effective FWr. Therefore, the interview aims to identify the challenges of FW segregation practice in the market. Considering the need to propose design strategies for integrated FWr in the wet market, observation was performed to gain insight into current waste collection practices and determine how FW is created and disposed of. Furthermore, information about the current waste management was obtained by interviewing market operators. Both interviews and observations were conducted by the researcher alone. To document the observations, notes and photos were taken with a phone during the tour. Stalls and the market's floor map were created to gather information about the workspace. Moreover, the vendors were interviewed during observation to obtain additional qualitative data. Interview data was recorded using an audio recording. The data were presented by translating direct respondent quotes from the original colloquial language into English and recorded in Appendix A. Pseudonyms were used to name respondents. Following that, all data were analysed qualitatively.
Case study research is an empirical inquiry that enables reflective learning from another project with similar attributes. This study conducted a comparative analysis of case studies from local and international food-related developments with integrated FWr facilities. The purpose is to further analyse the success strategies for FWr best practices. Four case studies (two international and two local) were selected for the study. They were selected based on the geographical location of Southeast Asia to ensure a similar composition of FW, source of FW generation, which limits to retail and consumption level, and type of the FWr operations from their source. Additionally, both international case studies were conducted through desk review using secondary data from publications, websites and official records. On the other hand, personal visits to local case studies were conducted to collect primary data. T

Result and Discussion
Nine respondents participated in this research, including three vendors, five buyers and one sanitation worker in the Chow Kit wet market. The three vendors operated stalls in the Chow Kit wet market, while the sanitation worker was responsible for garbage collection and cleaning. The five buyers were regular customers in the market.
Limited space was one of the most significant challenges emphasised by the respondents. Due to the high density of living environments, most of the kitchen spaces were very small. Many respondents mentioned that their limited living space made it difficult to store FW at home.

Time requirement was another challenge mentioned by respondents. Many respondents felt that they lacked time to separate the waste. Some did waste separation at home; however, they did not have much time to deliver waste to the market or collection centre. Besides, the provision of equipment also affected the perception of convenience. Many respondents found it needless to do waste separation since no facilitated equipment was provided. Equipment such as separation bins was suggested by respondents.

Most of the buyer respondents had a high level of FW separation awareness. Most of them were doing waste separation practice at home. However, accessibility to proper waste management information was still insufficient in the market. During the site visit, a few recycling practices were discovered in the Chow Kit wet market, indicating some recycling awareness in the market. Most of the buyer respondents had the habitual behaviours of waste separation. They felt it was the usual practice, so they were more willing to manage FW properly. Moreover, social influence was also one of the determinants of the individual's decision to perform or not perform waste separation behaviour. Vendors generally indicated less interest in separating waste due to their perception of responsibility. Thus, they demonstrated less concern about managing waste properly.

There was no enforcement in the current waste management scheme. The level of mistrust in policy was high due to non-transparent schemes and recycling pathways. Generally, respondents indicated less motivation and sustainable behaviour. Manpower consideration was highlighted by a few respondents, especially the Chow Kit wet market sanitation workers, who had put effort into the current waste management. Despite the large amount of waste the market generates daily, he mentioned that they could still properly handle the collection in the market area. However, introducing waste separation would increase burdensome duties to their sanitation staff members. Incentives were one of the stimuli that contributed to changing attitudes and behaviours. For example, reward-giving was highlighted by one of the respondents. Monetary rewards also drove the existing recycling practice by sanitation workers.

A comparative analysis of the FWr facilities is summarised in Table 2.

Table. 2
Case Studies Comparative Analysis Table

Case Study				
Type of Operation	***Case Study A Smart Waste Solution Lab***	***Case Study B W.I.S.E with Food***	***Case Study C Our Tampines Hub***	***Case Study D East Coast Lagoon Food Village***
Selection Criteria				
Country	Malaysia	Malaysia	Singapore	Singapore
Typology	Stand-alone recycling facility	In-house recycling facility	In-house recycling facility	In-house recycling facility
Source of FW	Wet and morning markets, food courts	F&B outlets in a shopping centre	Hawker stalls	Hawker stalls
Enforcement	No	Yes	Yes, with a tenancy agreement	No

Collaborator	Petaling Jaya City Council (MBPJ), CH Green Sdn. Bhd.	One Utama Shopping Centre, Microbs Sdn. Bhd.	National Environment Agency (NEA), The People's Association (PA)	National Environment Agency (NEA), National University of Singapore (NUS), National Parks Board (NParks)
Overview	The Lab promotes circular economy initiatives by recycling FW into value-added products to benefit society.	As a step towards being environmentally friendly mall, the program commits to a "table to farm" approach in the shopping centre.	The FWm system serves as a platform to educate and nurture a culture to reduce FW in Singapore, contributing towards being a zero-waste nation.	The FWm system aims to examine the feasibility of using anaerobic digestion as an on-site treatment solution.
Operational practice				
Collection	✓	✓	✓	✓
Transportation		N/A	N/A	N/A
Incentivising tool	✓	✓		
Monitoring		✓	✓	✓
Recycling treatment	✓	✓	✓	✓
Recycling system	Anaerobic digestion	Fermentation	Aerobic digestion	Anaerobic digestion
By-product	Liquid compost, bio-charcoal, biogas, detergent	Organic fertiliser	Organic fertiliser, liquid plant nutrients, non-potable water	Electricity, fertiliser
Practice involved	Bring-points, Urban farming	Waste bins return, Training program, Monitoring Smart Card & weighting	Training program, Tenancy agreement	Waste bin loading, sorter, shredder and feeder
Space required for operation	Waste sorting space, Composting facilities, Organic farm, Retail space, Education Centre	Recycling room	Tray return station, Digester system space, FW collection conveyance system	Digester system space
Approach to promote FWr	Learning tour, Public visitation, Demonstration of vegetable cultivation, Sale of	Guided tours, Training	Learning tour, Training	Reminding posters and wall stickers, Public engagement

Equipment provided	Collection bin, Monitoring card	Collection bin

Based on the data collected, the challenges of FW segregation practice were investigated through interviews and observation. At the same time, strategies for integrating FWr for improved public outreach were identified from case studies. The findings could be classified into three final themes, as tabulated in the thematic analysis matrix in Table 3.

Table. 3
Thematic Analysis Matrix to Conclude Research Questions.

Research Question (RQ)	***Deductive Code (DC)***	***Coding***	***Final Theme***
RQ1. What are the challenges of food waste recycling practices in the Chow Kit wet market? *RQ2.* What are the design strategies for integrating food waste recycling for improved public outreach?	DC1: Convenience	1. Time 2. Space 3. Equipment	Increase accessibility for convenient access
	DC2: Attitude	1. Recycling awareness 2. Habitual behaviour 3. Perception of responsibility 4. Knowledge	Increase education to raise recycling awareness
	DC3: Policy	1. Enforcement 2. Effective process 3. Incentives	Increase efficiency to establish confident

By the end of the interviews, the researcher discovered that many of the vendors could not identify which other materials could be recycled besides paper and plastic. In practice, they threw a large amount of FW into the dumpster since they were unaware it could be recycled. Moreover, collecting all waste into one container became habitual among vendors. They considered waste separation to be the responsibility of sanitation workers and exhibited less intention to change their habitual waste disposal pattern when a question was asked to segregate FW. This indicates that unsustainable behaviour is not easy to change since people grow accustomed to their habitual behaviour. That is why all the buyer respondents mentioned that they were used to the waste separation practice at home.

Therefore, the educational programme should be considered in planning the FWr system. This was aligned with the suggestion by the other respondents that information accessibility and social influence could take place to achieve sustainable awareness. As proven by the Smart Waste Solution Lab officer, demonstrations and public visits were frequently held at the facilities to better understand the FWr system and the importance of food conservation. Furthermore, Siu and Xiao (2016) suggested that informational strategies such as information, persuasion and social support are significant for achieving environmental sustainability. This can be explained by Tran (2018), who discovered that providing information on waste and recycling improved individual recycling behaviour and helped develop a positive attitude towards recycling. According to Abadi et al. (2021), people with a positive attitude towards waste management tend to be more conscious of environmental problems and engage in more efficient and sustainable behaviour.

Improving waste management knowledge alone is insufficient to encourage the FWr practice, but convenience and easily accessible facilities could increase motivation to carry out recycling behaviour. The argument in terms of convenience has been pointed out by Comber and Thieme (2013) that there is a high potential to perform recycling behaviour when the possibility of perceived inconvenience is low. Based on a survey conducted by Siu and Xiao (2016) in the housing estate in Hong Kong, convenience is necessary for the public in designing waste recycling programmes. Hence, they further narrowed the convenience categories to two dimensions: time and energy.

A lack of time and energy for excessive activities is a crucial point where sustainable intentions do not translate into recycling behaviour. Waste separation is more time-consuming than regular waste disposal. Therefore, design considering reducing the allocation of time, spatial consideration, and equipment provision are the main approaches to encouraging FW separation practice in the Chow Kit wet market. These were the few challenges frequently highlighted by respondents during the interview; all the recycling facilities analysed in the case studies aimed for direct collection from the FW source. Three out of four case studies were in-house facilities, whereas only one stand-alone facility was located near its FW sources. This ensures a convenient and direct recycling network, saving time and energy for the FW collection and transport process. In order to generate the context of FW generation, market workflow and workspace should also be integrated into the planning of the FWm system. Identification of the current workflow and organisation of the workspace was conducted in the Chow Kit wet market. The researcher discovered that the space available for stalls was always limited. Based on observation, a single-stall space must contain a display, storage, and workspace. It was observed that the waste containers were stacked along the walkway. Vendors explained this as lacking space to store garbage in the common area. Therefore, a clear space division should be reflected in planning the stall organisation for a convenient FWm workflow. Research regarding organic waste recycling in urban restaurants by Vinck et al. (2019) also suggested integrating waste management devices in the workspace, such as cleaning and washing. According to the researchers, keeping containers close to the working space allows efficient workflow and ensures a clean working area. For example, the provision of equipment includes recycling facilities, collection points, material transfer centres and recycling centres. In short, the convenience and accessibility of the FWr system design were of great concern.

The findings also suggest that applying an appropriate system is paramount in the market FWm. As proven by the case study in OTH, installing an automated FW collection system increases their participation rate and improves the safety of FWm in the hawker centre. In addition to providing facilities, Xiao and Siu (2018) argued that attitudes and suggestions from different stakeholders should also be considered to ensure a long-term and effective recycling scheme. For example, the sanitation worker in Chow Kit wet market highlighted the issues with manpower and workload for managing market waste. According to him, the current waste management imposed a heavy workload on the sanitation worker due to handling a large amount of market waste, and cooperativeness from vendors was generally low. His concern was about additional burdensome duties to them if an FW separation enforcement is to be implemented in the market. Therefore, a more tightened enforcement can be implemented through application design. For example, regular or more frequent waste collection is suggested by some respondents. In OTH, the food segregation practice supporting the FWm programme was also incorporated into the tenancy agreements to ensure the tenants' commitment.

Mistrust in the recycling scheme was one of the challenges mentioned by respondents. The poor implementation of the previous scheme has decreased public enthusiasm and satisfaction. During the interview, most vendor respondents demonstrated little interest in FWr due to the non-transparent recycling network and experience. Despite that, Vassanadumrongdee and Kittipongvises (2018) stated that mistrust could be reduced if policymakers set clear and effective policy measures on waste separation and recycling schemes for the public. According to a study on recycling behaviour, perceived policy effectiveness is defined as the perception of a specific policy measure referring to the public's feelings on how well the government provides effective and adequate policies. As concerned respondents, a clear recycling path should ensure a systematic process and clear information to acknowledge the purpose and usage of recyclables. Furthermore, rewards were one of the strategies respondents suggested to motivate their FW separation intention. It can be in the form of financial support, monetary rewards or commodities as feedback for active recycling. The incentive system is believed to be the stimuli that could contribute to changing attitudes and behaviours towards recycling. In addition, Siu and Xiao (2016) discovered that economic incentives could shift the degree of convenience in line with the discourse above. In their research on recycling management in high-rise housing, residents were willing to actively collect recyclables due to their recycling efforts' positive feedback.

Overall, the design and implementation of the existing waste management in the Chow Kit wet market ineffectively encourage FW segregation and recycling practices. Researchers and policymakers must reconsider ways to improve the existing market's FWm design to encourage pro-environmental behaviour. The research findings formed the basis for developing a design framework for FWr awareness in the Chow Kit wet market. The proposed design framework is illustrated in Figure 2.

In the proposed framework, the three final themes were perceived convenience, implementation and management, and an inculcated positive attitude. Each of the themes influences the provision of recycling facilities in the market. Firstly, ensuring the quality and accessibility of FWR facilities is exclusively important. Convenience can be improved through increased accessibility by enhancing time-saving workflow, integrating efficient spatial design, especially in the vendor's workspace, and providing more infrastructure nodes accessible by more people. Providing recycling facilities alone is not enough to ensure long-term recycling behaviour. Secondly, it is necessary to ensure implementation and management of the design, as effective management can continuously enhance social collaboration. The FWr system implementation and management can be more effective through enforcement application design, exposure of the recycling process, and incentive system. These strategies can gain the public's confidence towards the recycling system. Thirdly, a positive attitude can be developed by increasing FWm education about recycling and its importance through engagement in shared responsibility programmes, information accessibility, and a habit formation setting to ensure behaviour changes towards a sustainable community.

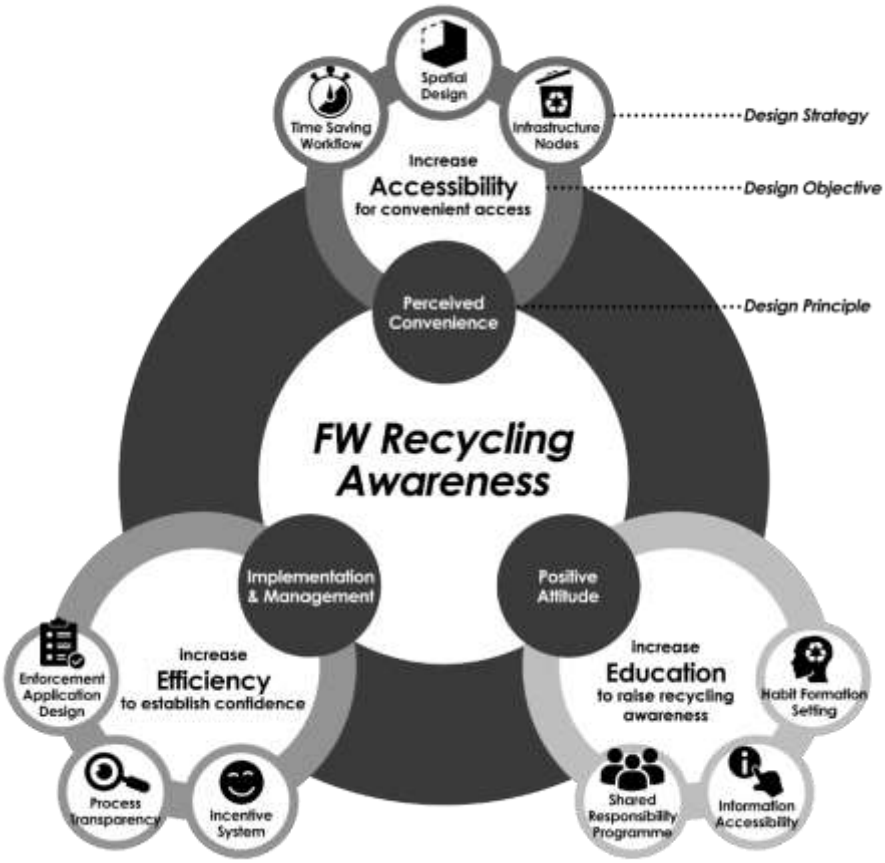

Figure. 2 Proposed Design Framework For Fwr Awareness in Chow Kit Wet Market.
Source: Author (2023)

Conclusion

This dissertation explored the design framework for FWr awareness in the Chow Kit wet market. The study addressed the challenges of FWr practices in the market and identified design strategies for integrating FWr for improved public outreach. Through interviews, observations, and case studies, the research provided valuable insights into the current state of FWm in the market and proposed a design framework to enhance recycling practices. Furthermore, the research findings revealed several significant challenges in FWr practices in the Chow Kit wet market. These challenges included convenience issues related to time, space, and equipment, vendor's attitudes towards waste separation, and the need for effective policies and enforcement. Lack of awareness, improper waste segregation habits, and mistrust in the recycling scheme were also identified as barriers to effective FWr. To address these challenges, the proposed design framework emphasises three key themes: convenience, implementation and management, and an inculcated positive attitude. Moreover, the framework suggests improving convenience by increasing accessibility to recycling facilities through efficient spatial design and infrastructure placement. Implementation and management can be enhanced through effective enforcement, transparent recycling processes, and incentive systems. Lastly, developing a positive attitude towards FWr can be achieved through educational programs, information accessibility, and habit formation. The proposed design framework offers a practical approach to integrating recycling into the market and enhancing public outreach.

In addition, this research addresses the global issue of FW and its environmental impact. The study potentially addresses the SDGs beyond SDG 12, Responsible Consumption and Production. It promotes SDG 8, Sustained Economic Growth, through higher economic productivity and technological innovation on FWr while sustaining inclusive economic growth of wet markets despite the rapid expansion of modern retailers. The findings of this research have practical implications for policymakers, market administrators, and other stakeholders involved in FWm. The design framework provides guidance for planning and implementing effective FWr systems in wet markets, fostering a more sustainable market ecosystem, creating economic opportunities, and upholding the cherished attribute of produce freshness that wet markets are renowned for.

This study focused on the specific context of a wet market. However, the case study samples are limited, with only a few relevant projects in Malaysia and Southeast Asia. Also, the findings may not be directly applicable to other food retail environments. Future research should consider exploring the applicability of the design framework in diverse settings. The sample size for the interview analysis was also limited. The research intended to receive 11 responses from both user and key-person groups, as discussed in Chapter 3. However, it was challenging to secure the key person's participation. Therefore, the gathered data may have an inherent bias in the participants' responses and limited generalizability. Future studies could employ quantitative research methods and larger sample sizes to validate and expand upon the findings of this dissertation.

Further research can explore specific architectural interventions that can improve FWr practices in wet markets. This could include designing efficient FW segregation systems, innovative storage solutions for food scraps, and integrating recycling facilities within the market layout. Investigating the spatial organisation and circulation patterns that facilitate convenient and accessible FWm processes can be a valuable avenue for future research. Furthermore, future studies can also explore the use of innovative materials and structural systems that promote FWr in wet markets. This could involve designing recyclable and biodegradable building components. Additionally, the exploration of sustainable construction methods and technologies that minimise waste generation during the building process can contribute to a holistic approach to FWm in wet markets.

References

Al-Gheethi, A., Ma, N. L., Rupani, P. F., Sultana, N., Yaakob, M. A., Mohamed, R. M. S. R., & Soon, C. F. (2021). Biowastes of slaughterhouses and wet markets: an overview of waste management for disease prevention. Environmental Science and Pollution Research. https://doi.org/10.1007/s11356-021-16629-w

Ali, S. (2022, Oct 17). Huge effort to address scourge of little vermin. News. Kuala Lumpur, Malaysia: the Sun Daily.

Amanda, S. (2016). Recycling as Play: Encouraging Recycling Through a Participatory Design Process with Children. October, 1–6.

Anqi, G., Zhenyu, T., Ronald, W., & Qie, S. (2017). Comparison between the technologies for food waste treatment. Energy Procedia, 105, 3915–3921.

Cardinal, N. (2018). Raising Awareness through Public Outreach Campaigns. In N. Cardinal, SDG Accountability Handbook (pp. 80-83). New York: SDG Accountability.

Cecchini, C. (2017). Bioplastics made from upcycled food waste. Prospects for their use in the field of design. Design Journal, 20(sup1), S1596–S1610. https://doi.org/10.1080/14606925.2017.1352684

Cheng, K. W. (2020). Attitude, Perceived Behavioral Control and Subjective Norms in Waste Segregation-at-Source Behavior: An Empirical Study. Sustainable Business and Society in Emerging Economies, 2(1), 83–93. https://doi.org/10.26710/sbsee.v2i1.1312

Comber, R., & Thieme, A. (2013). Designing beyond habit: Opening space for improved recycling and food waste behaviors through processes of persuasion, social influence and aversive affect. Personal and Ubiquitous Computing, 17(6), 1197–1210. https://doi.org/10.1007/s00779-012-0587-1

Fairus, M. J. M., Bahrin, E. K., Arbaain, E. N. N., & Ramli, N. (2022). Mycelium-Based Composite: a Way Forward for Renewable Material. Journal of Sustainability Science and Management, 17(1), 271–280. https://doi.org/10.46754/jssm.2022.01.018

Fauziah, S. H., & Agamuthu, P. (2012). Trends in sustainable landfilling in Malaysia, a developing country. Waste Management and Research, 30(7), 656–663. https://doi.org/10.1177/0734242X12437564

Ganglbauer, E., Fitzpatrick, G., & Molzer, G. (2012). Creating visibility: Understanding the design space for food waste. Proceedings of the 11th International Conference on Mobile and Ubiquitous Multimedia, MUM 2012, December. https://doi.org/10.1145/2406367.2406369

Irani, Z., Sharif, A. M., Lee, H., Aktas, E., Topaloğlu, Z., van't Wout, T., & Huda, S. (2018). Managing food security through food waste and loss: Small data to big data. Computers and Operations Research, 98, 367–383. https://doi.org/10.1016/j.cor.2017.10.007

Jereme, et al. (2017). Food wastes and food security: The case of Malaysia. International Journal of ADVANCED AND APPLIED SCIENCES, 4(8), 6–13. https://doi.org/10.21833/ijaas.2017.08.002

Jereme, I. A., Siwar, C., Begum, R. A., & Abdul Talib, B. (2016). Addressing the problems of food waste generation in Malaysia. International Journal of ADVANCED AND APPLIED SCIENCES, 3(8), 68–77. https://doi.org/10.21833/ijaas.2016.08.012

Jun, S. W. (2020, May 21). Even with MCO lifted, traders fear filthy wet markets in Klang Valley a turn off for customers. News. Kuala Lumpur, Malaysia: Malay Mail.

Karim Ghani, W. A. W. A., Rusli, I. F., Biak, D. R. A., & Idris, A. (2013). An application of the theory of planned behaviour to study the influencing factors of participation in source separation of food waste. Waste Management, 33(5), 1276–1281.

https://doi.org/10.1016/j.wasman.2012.09.019

Klunbut, P., Mongkolchati, A., Ussawarujikulchai, A., Ounsaneha, W., & Rattanapan, C. (2017). Appropriate option of market solid waste management based on the stakeholder perspectives: A case study in a central market of agriculture products, Thailand. Journal of Materials and Environmental Science, 8(7), 2391–2402.

Lie, H. (2020, Oct 8). Malaysia is eyeing waste-to-energy solutions. Retrieved from Green Denmark Southeast Asia: https://www.greendkinsea.com/post/malaysia-is-eyeing-waste-to-energy-solutions

Lim, W. J., Chin, N. L., Yusof, A. Y., Yahya, A., & Tee, T. P. (2016). Food waste handling in Malaysia and comparison with other Asian countries. International Food Research Journal, 23(December), S1–S6.

Mirabella, N., Castellani, V., & Sala, S. (2014). Current options for the valorisation of food manufacturing waste: A review. Journal of Cleaner Production, 65, 28–41. https://doi.org/10.1016/j.jclepro.2013.10.051

Mohd Yatim, S. R., Ku Hamid, K. H., Noor Ismail, K., Rashid, Z. A., Zainuddin, N. A., Shafie, F. A., & Azmi, A. (2019). Study on Waste Generation and Composition in Rapid Residential Development of Sub Urban Area in Kuala Selangor District, Selangor. Journal of Wastes and Biomass Management, 1(1), 01–05. https://doi.org/10.26480/jwbm.01.2019.01.05

Papargyropoulou, E., Lozano, R., K. Steinberger, J., Wright, N., & Ujang, Z. Bin. (2014). The food waste hierarchy as a framework for the management of food surplus and food waste. Journal of Cleaner Production, 76(April), 106–115. https://doi.org/10.1016/j.jclepro.2014.04.020

Papargyropoulou, E., Rory, P., Rupani, P. F., & Zakaria, Z. (2014). Towards Sustainable Resource and Waste Management in Developing Countries: The Role of Commercial and Food Waste in Malaysia. International Journal of Waste Resources, 4(3), 1–6.

Pentas Flora. (2020, Mar 29). What Is Cradle To Cradle Recycling? Scheduled Waste.

Priya, S. S. (2020, May 9). Rats infest PJ wet market. News. Petaling Jaya: The Star.

Ramli, N., Rosli, N. S., Abdul Wahap, F., Wan Nawawi, W. N., & Mohd Abd Majid, H. A. (2020). Acceptance of Food Waste Recycling Products among Public toward Sustainable Food Waste Management. In Charting a Sustainable Future of ASEAN in Business and Social Sciences. https://doi.org/10.1007/978-981-15-3859-9_33

Riesenegger, L., & Hübner, A. (2022). Reducing Food Waste at Retail Stores—An Explorative Study. Sustainability (Switzerland), 14(5). https://doi.org/10.3390/su14052494

Seng, K. W. K., Masdek, N. R. N., Sharifuddin, J., Teng, P. K., Li, W. W., & Song, L. K. (2021). Assessing urban households' intention to reduce food waste. Malaysian Journal of Consumer and Family Economics, 27, 72–97.

Siu, K. W. M., & Xiao, J. X. (2016). Design and management of recycling facilities for household and community recycling participation. Facilities, 34(5–6), 350–374. https://doi.org/10.1108/F-08-2014-0064

Soma, T. (2017). Wasted infrastructures: Urbanisation, distancing and food waste in Bogor, Indonesia. Built Environment, 43(3), 431–446. https://doi.org/10.2148/benv.43.3.431

Tran, T. T., & Knowledge, E. (2018). The Effect of Environmental Knowledge on Improving Recycling Behavior: A Case Study at University of California, Berkeley's International House Thao T. Tran. 1–30.

Vassanadumrongdee, S., & Kittipongvises, S. (2018). Factors influencing source separation intention and willingness to pay for improving waste management in Bangkok, Thailand. Sustainable Environment Research, 28(2), 90–99.

https://doi.org/10.1016/j.serj.2017.11.003

Vinck, K., Scheelen, L., & Du Bois, E. (2019). Design opportunities for organic waste recycling in urban restaurants. Waste Management and Research, 37(1_suppl), 40–50. https://doi.org/10.1177/0734242X18817714

Viva, L., Ciulli, F., Kolk, A., & Rothenberg, G. (2020). Designing Circular Waste Management Strategies: The Case of Organic Waste in Amsterdam. Advanced Sustainable Systems, 4(9). https://doi.org/10.1002/adsu.202000023

Wang, A. (2020). To reduce 1.3 billion tons of food waste, see how these food companies "turn waste into treasure" to save the earth? Jiemian News.

Xiao, J. X., & Siu, K. W. M. (2018a). Challenges in food waste recycling in high-rise buildings and public design for sustainability: A case in Hong Kong. Resources, Conservation and Recycling, 131(December 2017), 172–180. https://doi.org/10.1016/j.resconrec.2018.01.007

Xiao, J. X., & Siu, K. W. M. (2018b). Challenges in food waste recycling in high-rise buildings and public design for sustainability: A case in Hong Kong. Resources, Conservation and Recycling, 131(January), 172–180. https://doi.org/10.1016/j.resconrec.2018.01.007

Zainal, D., & Hassan, K. A. (2019). Factors Influencing Household Food Waste Behaviour in Malaysia International Journal of Research in Business, Economics and Management. International Journal of Research in Business, Economics and Management, 3(3), 56–71.

Zainal, F. (2021, May 20). Daily food waste staggering. News. Petaling Jaya, Malaysia: TheStar.