


Review

Institutional Analysis and Development (IAD) Approach for Determining the Effects of the Waste Charging Scheme on Household Food Waste Recycling

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Abstract: This review demonstrates the analytical application of Ostrom’s Institutional Analysis and Development (IAD) framework in identifying and evaluating possible outcomes of how the upcoming waste charging scheme could promote collective actions for post-consumption household food waste recycling in Hong Kong. This novel approach enables analysts to examine thoroughly complex collective action situations such as the case in this paper. A comprehensive review was performed on the published government documents and statistics, together with the past scholarly literature pertinent to the case. Previous studies and reports have shown due diligence on the part of the authorities in preparing infrastructure, educational campaigns, and recycling centres for the full implementation of the forthcoming waste charge scheme. Nevertheless, the findings also show the presence of an information gap in the practical aspect of the food waste collection and monitoring system. Some future research areas identified from this review are: how food waste can be collected from households; how illegal waste disposal be monitored; how the recent pandemic shapes households’ valorisation of food waste recycling; and how technological interventions can help optimise the collection efficacy of food waste.

Keywords: household food waste; Institutional Analysis and Development framework; waste charging policy; Hong Kong; action situation; rules-in-use



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1. Introduction

Institutional Analysis and Development (IAD) is a framework used widely by social scientists to study the effects of institutional arrangements as institutions emerge and change over time [1]. Studying how institutional arrangements affect human behaviour patterns is both a complex and daunting task [2,3], even more so if there are no *crutches* that aid the analytical process in sifting through the different intermingling variables that translate the rules to the stable behaviour of a group of people. One of these “crutches” could be the meta-theoretic framework called IAD [4]. The IAD framework involves analysing actors, norms, institutional settings, incentive structures, and rules, among others. It aids the analysts in examining complex collective action problems by logically dividing them into “action arenas” or “action situations”, that are smaller—but more practical and understandable—pieces of the whole problem. The IAD framework has been found useful for a complex network of factors and situations that needs to be considered to answer a question [5]. The IAD is also expedient because it presents six common criteria [6,7] to evaluate whether an institutional outcome—such as that from a policy—is satisfactory or not. Specifically, in this article, we would like to apply this promising framework to systematically identify and evaluate possible outcome options of household food waste reduction/recycling brought about by an upcoming waste charging policy. From what we

have known so far from the current government's waste statistics and scholarly literature, the review will gather relevant data to inform the IAD framework.

In 2020, food waste in Hong Kong amounted to 3255 tonnes per day, accounting for 30% of the daily municipal solid waste (MSW) dumped in the city's landfill [8]. The city's annual per capita food waste then is about 120 kg [8]. Figure 1 shows how this value is high compared to many places around the world. By aiming to discourage MSW generation and encourage waste recycling, the upcoming waste charging scheme in 2023 would be expected to affect food waste disposal practices in the city. However, it begs the question of how the policy would really give enough incentive to reduce food waste either through source reduction or recycling. Outside the possibility of illegal dumping, would the new policy induce collective action among households to send food waste off for recycling rather than just including the food waste in the official garbage bag or illegally disposing of it? If more food waste recycling does happen, would the demand-end of the food waste recycling process be sustainable enough [9–11]?

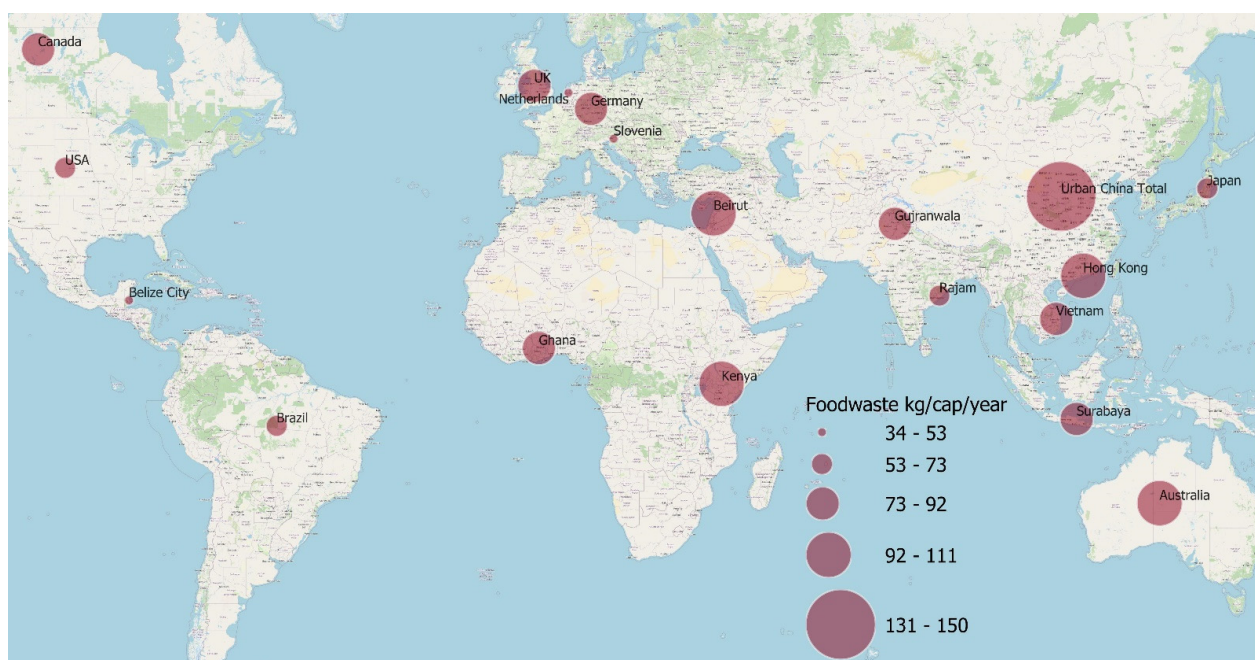


Figure 1. Annual food waste per capita of some selected places around the world (data from www.unep.org/resources/report/unep-food-waste-index-report-2021, accessed on 23 November 2022).

When a waste charging scheme is implemented, the residual waste (i.e., the total waste minus the recyclables) takes on some form of negative value or cost in the eyes of people. Assuming the prerequisite infrastructure is in place [12–14], this should make it feasible to reduce or reuse the waste by incentivising interested parties. In principle, when all the recyclables are completely recovered—which may not actually be the case, the householder would want the residual to be as little as possible. However, very few studies have proven the effectiveness of taxes and fees in reducing food waste production [15]. The worst scenario could lead to illegal dumping, which would cost the householder much more if caught. On the other hand, it could also lead to further recycling of other potential recyclables which were not considered by householders before the policy due to the higher opportunity costs of engaging in them back then.

The dynamics and outcomes of a given policy are mostly not isolated. They consider various factors, including related markets, cultural implications, perceptions, rules-in-use (de jure or de facto), and technology at that time [5]. If we wish to scrutinise the possible outcomes of this new policy, institutional arrangements matter because they can contribute to lowering or increasing transaction costs which could make the policy effective or not.

Analysis of such a complex degree can be daunting. In this case, the IAD framework may be of service. IAD offers the analysts a more structured flow that considers the different elements and institutions affecting the situation under study. MSW is a very large field of study and can be beyond the scope of a short article if one wishes to go substantially in-depth. Therefore, for this study, the policy situation mainly relates to how the new waste charging scheme may effectively reduce household food waste entering landfill. The application of the IAD approach in the analysis of food waste recycling is a novel contribution of this review.

The second section of this article gives a short introduction to the IAD framework. In the same section, the description of the data and the method used for each variable is explained. This is followed by a description of the policy action situation and a further exposition of the external variables that affect the action situation under study. The discussion revolves around the interactions and possible outcomes of the action situation. The article ends with an evaluation of outcome options and an agenda for future studies.

2. Analytical Framework and Methods

This article takes advantage of the systematic schema in the IAD framework to analyse multi-variable and multi-actor scenarios. IAD originated from the so-called Ostrom Workshop, hosted by Indiana University [6]. As the name suggests, it was spearheaded by the 2009 Nobel laureate Elinor Ostrom. At first, this framework was used to analyse collective action cases in sustaining common pool resources [6]. This framework has evolved and continues to do so [1,16] and has been applied to various fields, including policy analysis [5]. IAD has also been used for analysing waste management issues, such as the works of Zhang and Zhao [17] and Oh and Hettiarachchi [18]. As household food waste recycling entails complex collaboration of different parties, the novelty of using the IAD approach lies in its capacity to break down the bigger problem into smaller and more manageable components. Moreover, these components could be examined in more detail without leaving them out of the bigger institutional picture. It further bridges our knowledge more systematically about mechanisms in which households are expected to respond to the upcoming policy in terms of food waste recycling. Figure 2 summarises the IAD framework process. The numbers in the figures indicate the sequence in which they will be discussed in this section.

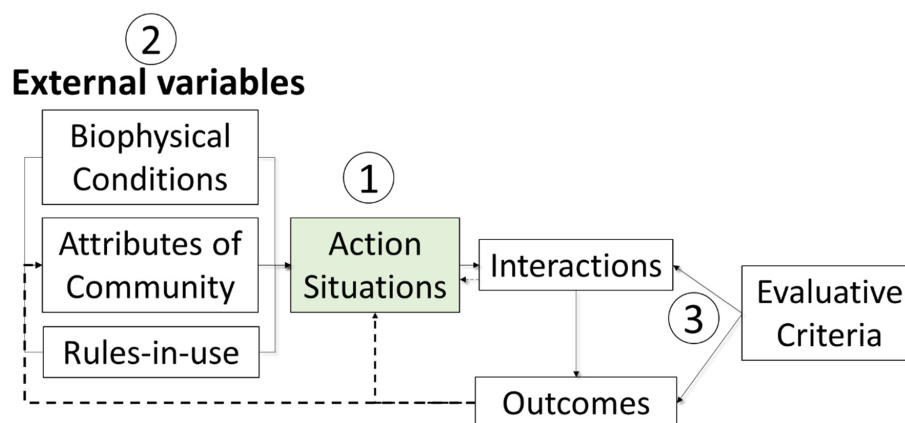


Figure 2. IAD framework (adapted with permission from Ref. [4]. 1972, John Wiley & Sons).

This study takes advantage of the extensive waste statistics from the Hong Kong Special Administrative Region government, and various scholarly research carried out recently about different aspects of municipal waste and food waste management. With the flexibility of IAD, this documentary approach has also been applied in other works [19,20]. In order to limit the scope of the study, this article covers only the MSW literature focusing on the aspect of post-consumption household food waste recycling and disposal. Based on the information available thus far, this article attempts to review the literature on

household food waste issues, followed by an evaluation of possible outcomes using the IAD framework to integrate the analysts' observations more holistically.

The IAD framework analyses how institutions influence the decisions and behaviour of different actors in a specific situation of interest, especially in complex scenarios wherein many factors are involved in the analysis. It begins by identifying the main situation of interest where the interactions of relevant actors take place. In our case, the main action situation is the scenario wherein households adopt or do not adopt behaviours that lead to reducing/recycling food waste in the presence of the MSW charging scheme. In the action situation, the way actors make decisions is treated like a game in game theory after making some assumptions about the attribute of the individual actors. In fact, the action situation was described by Ostrom as a generalised game, where the actors do not have perfect information and control in decision making and behaving [19].

In order to feed the framework data for analysing the actors' decisions in the action situation, the analysts try to gather as much information about external variables that may influence the action situation under study. Among these exogenous variables, informal and formal rules-in-use at different levels play a significant role. They determine how decision-related information is transferred and how rights and obligations are allotted among the actors. Hong Kong's formal rules and legislation process are well documented online. The information about informal rules is mostly gathered from past literature surveys.

Aside from rules-in-use, it is also important to take into account the attributes of the community, which may include the background, culture, and existing mindset of the people or organisations involved in the action situation. It tries to take the pulse of the community's common understanding and valuation of the rules [2]. Although we are faced with a large question here, the census data provide a substantial summary of some relevant attributes of the city. In addition, some surveys of independent research allow us to have a glimpse of the people's environmental mindsets that contribute to the action situation.

With respect to the third variable, biophysical conditions mainly refer to the economic nature of the resource under study. Here, the economic nature of the resource, food waste, will be adapted as partly a negative resource to be eliminated and partly a positive one with respect to its recycling potential. The nature of its measurability and exclusivity in reaping the benefits are attributes of this event [2]. As we are now considering food waste, we take advantage of the rich waste statistics of the city to elucidate this framework variable. Furthermore, the literature on food waste recycling was explored, particularly its economic side.

After exhaustively gathering information about these external variables, some patterns of interaction between actors and their corresponding outcomes were identified using a generalised game perspective mentioned above. We observed how the rules affect the components of the action situation (which will be expounded later in Section 3.4 below) to predict outcomes. In order to close the loop, the outcomes of the interactions are then evaluated against certain criteria, such as economic efficiency, accountability, and sustainability.

One of the limitations of the analysis presented in this article is the treatment of the households as one monolithic block. Although this may be a useful simplification at this stage of analysis, future work may explore differentiating different actor types among the households. For instance, when a household finds out that other households are illegally disposing of or simply including the waste in their refuse bags, one is less motivated to exert the effort to recycle. Evidence has shown that trusting that others are also recycling positively affects one's own recycling behaviour [21]. One can apply game theory in order to understand how economic incentives affect collective actions in recycling [22]. There are different payoffs of the recycling game between two households. Without interactions or information sharing, it is possible that both households will recycle or both households will opt for illegal disposal. When the two households interact, one's inclination to recycle increases when the household has a stronger belief that the other household will also recycle. This situation is similar to the assurance game [23] for collective action, wherein "each player can be motivated to cooperate by the mere assurance that others will do the same" [24]. Nevertheless, this type of interaction is not considered in this review article.

3. Defining IAD Action Situation and Variables

This section is intended to delineate the action situation to which the IAD framework is applied. It lays down some basic information to delimit the scope of analysis that is conducted in the succeeding sections of the article. We begin with the policy aims and expected outcomes.

The policy situation here revolves around the new waste charging policy which was institutionalized via the Waste Disposal (Charging for Municipal Solid Waste) (Amendment) Bill 2018. This policy aims to encourage waste reduction at source or more recycling in order to reduce landfill input when it starts in 2023 [25]. For the household, this scheme is expected to affect how people handle their waste and other types of recyclables, such as plastic, paper, and polystyrene. Clearly, this policy will influence how household food waste is managed. As food is essential for human sustenance, the authors deemed it worthwhile to study the policy's outcomes on food waste. Additionally, in order to fit such a complex issue into a few pages, this analysis limits the scope to only food waste from households and excludes waste coming from commercial (e.g., restaurants, markets) and industrial establishments. Although this issue involves more interconnected stakeholders aside from households and the government, the relation to other stakeholders is tangential to the discussion in this article.

Furthermore, it is worth noting that household food waste has a huge impact on the city, accounting for a third of MSW thrown away every day [8]. Moreover, the sources of household pre/post-consumption food waste are also spatially dispersed, which further compounds the problem and its significance. The option of illegal dumping is unfortunately also looming on the horizon [26], with the waste, one way or another, ending up in landfill. By taking these into consideration, the study emphasises the operational choice of the household in disposing of food waste in the new policy context.

The following subsections discuss the components of an action situation [27], followed by an explanation of the external variables that influence the action situation.

3.1. Components of the Action Situation

In an action situation, certain outcomes are produced when different actors—given their position—choose certain actions based on the information about and control over their decision making with respect to the resource in question and its net cost or benefit. These different components are found inside the box in Figure 3.

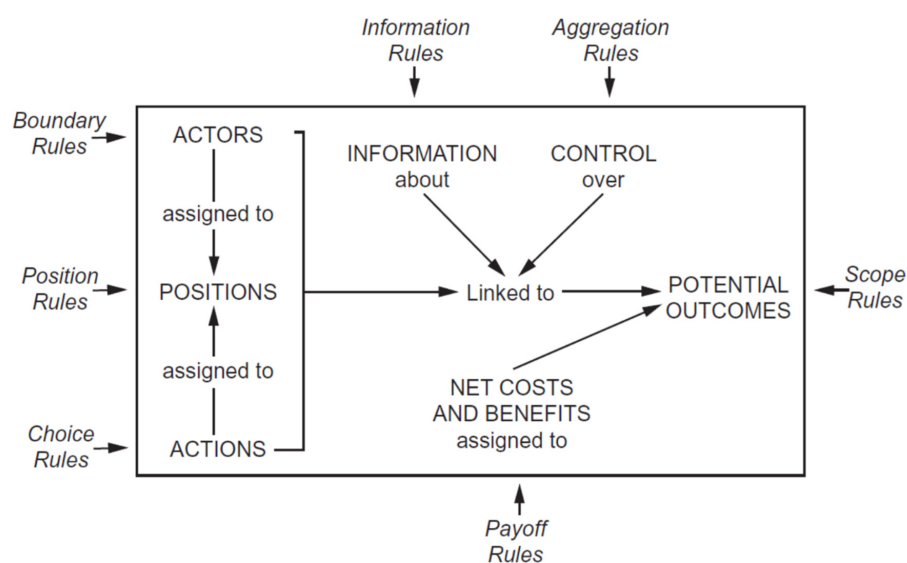


Figure 3. Rules as exogenous variables directly affecting the elements of an action situation (reprinted with permission from Ref. [27]. 2005, Princeton University Press, p. 189).

The main actors in this particular action situation are the households, as they interact with the government and food waste collectors/processors—possibly through estate managers—to determine how to best handle food waste. Having considered the external variables, Table 1 shows the relevant characteristics of the actors in the action situation that influence their decisions based on Polski and Ostrom’s work [5]. In the context of legislating the waste charging scheme, the households are on the receiving end. Only the government has the political and economic capacity to change, monitor, and implement the *de jure* policies. Nevertheless, households are very numerous and dispersed for the government to have full monitoring capabilities; if fully executed, increasing the “policing cost” [28] substantially. As an intermediary, the government may channel its efforts through estate managers to facilitate collecting the food waste from each household, and they may act as an intermediate monitoring arm of the government. They also have the option to set up estate-based food waste processing.

Table 1. Characteristics of different actors in the action situation.

	Household	Government	Recycler	Estate Managers
Resource	Producer of food waste stock	Has power and monetary resource	Has technology; Has specialised know-how; Has a connection to recycling market	Control over cleaning/collection facility
Valuation	Savings; Sanitation at home; Want a better environment	Sustainability in waste disposal	Constant stock; Better environment; Profit or financial sustainability	Sanitation of estate
Information processing (in recycling food waste)	How can I process food waste myself? Where can I send it to be processed? How much time/money will it cost me?	Has all statistical information about waste/waste management	Looking for quality/stable food waste stock; Looking for end product users	Professionally trained managers have an advantage
Selection process	Should I process it myself or outsource? Should I include it in the bag or throw it away illegally?	Social good	Does it make business sense to obtain from household rather than commercial/industrial establishments?	

Unavoidably, households and the government may have to link up with recycling specialists. These recycling operators have control and access to knowledge and manpower to carry out the technical aspect of food waste recycling. If the policy aims to encourage food waste recycling as a means of waste reduction, this actor is also crucial. These specialists also have the business network to sell and dispose of the end products of the recycling process. Some specialists are directly under the government, such as O-Park and Food Waste Pre-treatment Facilities. The government also funds projects that can help address the waste charging issues [29].

3.2. Biophysical Conditions: Economic Nature of Food Waste

With its high-rise multi-storey residential buildings, Hong Kong had more than 6810 people living in each square kilometre in 2021 [30]. This high-rise configuration provides very little private and public collaborative space to store and process food waste [31]. This very dense city produces 3255 tonnes of food waste, where 2477 is domestic food waste, while the other 778 tonnes are from commercial and industrial sources [8]. As a result, the Hong Kong government is estimated to have spent HKD 4.9 B (USD 700 M) on its waste programme in 2021 [32]. Currently, there are three landfills in Hong Kong; thirteen refuse transfer stations; and three primary recycling stations for food waste, namely O-Park 1 and a second one coming in 2023, and Food Waste Pre-Treatment Facilities [8]. With respect to

non-consumable food waste, there was a plan to use the existing sewerage system of the city to process industrial food waste [33].

In our analysis, we look at the nature of food waste as two goods with positive value: food waste as recyclable and food waste disposable service. Food waste may be considered a resource by recyclers and collectors. Similarly, the household may consider food waste positively as a possible recyclable material (e.g., gardening or home agricultural projects). On the other hand, households may most likely see its negative value in terms of personal liability within the context of the waste charging scheme and home sanitation. In this case, the household turns its attention to food waste disposal services as goods. These services include both collection and processing. Similarly, the government may also see it with a dual perspective: negative in terms of waste, but to a smaller degree, positive due to its recycling and energy recovery potential.

Let us take a look at the food waste disposal service as the goods in question. Currently, prior to the bill, there was no metered fee for municipal solid waste disposal [34]. In general, the waste disposal service for households could fall into a public good category with low subtractability and excludability (Table 2). It is very difficult to exclude anyone from using the service, which may result in some form of freeriding. For instance, in Hong Kong's dense multi-storey configuration, refuse collectors collect the garbage put out in the communal corridor or staircase, and it is very costly for the collectors to differentiate who has paid for the service or not. Moreover, households could also dispose of their garbage in the garbage bins on the public streets for free. The waste disposal service also has low subtractability because one user does not "lessen" the space that can be used by another, at least not until the landfill is nearly full [35]. Table 2 illustrates that the waste charging scheme shifts the disposal service from a public good type to a good with a slightly higher excludability or toll good. This form of toll system allows each resident to shoulder their respective waste disposal expenses, which are dictated by their own waste management behaviour. The latter is something the residents have more control over, and that is not compounded by other people's behaviour.

Table 2. Nature of refuse collection and disposal service in Hong Kong [5].

	High Excludability	Low Excludability
High subtractability Low subtractability	Private Toll	Common Pool Public refuse collection system

Aside from the food that can still be consumed by other human beings, food waste can be used as animal feeds, soil supplements, and biofuel, to name just a few uses (Table 3). Some known technologies for recycling food waste into biofuel are already available [36,37]; some bio-processors can reduce up to 80% of the mass of waste [37]. Not needing to be the main substrate, certain glycerin-rich food wastes may also be used as an additive to increase the efficiency of biogas formation [38]. There is also a proposal to use food waste disposers to grind food waste into the sewerage pipes and transport it to sewage treatment plants for processing into possible biofuel [39,40]. The government also plans a long-term collection system, but the details are yet to come [41].

Table 3. End uses of food waste (compiled from various works [40,42–44]).

	Processing Needed	Processing Cost	Collection	Output Characteristics
Composting	Medium processing	Minimal, space constraint	-	Very little end demand in HK
Animal feed	Minimal processing, but quality not stable	Minimal	For pets: minimal, For frame animals: significant	Very little end demand in HK
Biofuel	Needs bio processing	High initial capital cost	Significant	Possible for HK
Wastewater	Disposer grinds, Dilution needed	Invest in disposer; Adjust waste water facility capacities	Utilise existing waste water pipes	Possible energy generation but still more energy consumption

3.3. Community Attributes

Contextual factors of different places were found to significantly affect food waste behaviours [45]. This is why we have to look at the attributes of the city. Hong Kong has a GDP per capita of HKD 387,110, even amid the pandemic in 2021 [46], which is still within the world's top 20. The median monthly household income straddled around HKD 27,000 to HKD 29,000 in 2021/22 [47]. A typical household consists of 2.8 people [48], with each person estimated to produce 0.9 kg/day [8]. This amount is far less than the 1.27 kg/person/day in 2011 [49], which shows, among other things, an improved awareness on the part of citizens. An average household in Hong Kong spends 26.8% on food monthly, 62% of which is meals out or take out [50]. This translates into the amount of post-consumption food waste, food packaging, or unconsumed stored food [51]. Considered a world-class financial hub, the city's pace of life is one of the world's fastest, so would a slow process such as recycling and bioprocessing be attuned to the current way of life in the city? A study showed that the modern city lifestyle has some implications for food waste behaviours [52].

We now look at the perception of Hong Kong residents about food waste recycling. Attitude and perceived behavioural control toward food waste affect intentions to reduce or send them for recycling [13,53,54]. In the 2021 Population Census, 81.6% of the Hong Kong population aged 15 and over had attained at least secondary education, with 34.6% achieving post-secondary education. Environmental awareness is very much part of the educational content promoted in the city [49]. For instance, a pilot educational programme for food waste recycling in 2011 was found effective in reducing the food waste generation of the participating residents in the 11 sample estates [55]. In a survey of 192 Hong Kong residents, 39% percent say they carry out recycling activities once or twice a week of mostly paper/plastic/metal, while 10% never recycle at all [56]. With respect to food waste, this same sample does not recycle food waste, and only 37% have heard of any food collection scheme in the city [56]. Historically, health issues such as Severe Acute Respiratory Syndrome (SARS) in 2003 increased the awareness of the residents about sanitation [31]. The recent pandemic is expected to have had a similar effect on the resident, but to what degree is yet to be determined. Positive food waste management was observed in Japan during the pandemic [57]. In a recent Canadian example, the total food waste generated did not change much during the pandemic; however, the unavoidable portion, such as inedible peel or bones, increased substantially [58].

What values do contemporary residents have about saving food? What is the perception of food waste? Since 2013, the per capita food waste disposed of each day dropped by 17% in 2019 to 0.3 kg [49]. In a survey of 603 Hong Kong local respondents, 40% do not actively participate in any food waste source reduction activity, while 37% say they do [42]. In the same study, 66% agree that there should be a mandatory food waste reduction scheme, and over 90% of the sample find wasting food objectionable.

In considering the perception of households towards illegal dumping, Chu [26] found that respondents justify illegal dumping (when the waste charging scheme is implemented) by blaming the newness/ambiguity of the law, that no one is harmed, and when there is a real necessity. The study also found that women were less likely to intend to dump illegally [26]. By using a response distortion mitigation technique, another study of 223 respondents found that there is generally less tendency of people in Hong Kong to intend to dump illegally [59]. It may be interesting to survey if people think the government can monitor and catch them if they illegally dump waste.

3.4. Rules-in-Use

Rules affect how the interactions in the action situation play out. IAD helps to break down the rules into different dimensions. This section begins by explaining the details of the official policy, and it then proceeds to briefly discuss how its implementation affects the different dimensions of the rules-in-use in the action situation [4,5].

In 2014, the Environmental Protection Department implemented a pilot scheme on MSW charging in seven housing estates in the city. This pilot scheme aimed to try out various MSW charging options, such as weight-based vs. volume-based charging and building-based charging vs. household-based charging. Eventually, the government of the Hong Kong Special Administrative Region selected the option “volume-based by households”. In 2023, it will implement a waste charging scheme wherein only municipal waste disposed of using specific bags would be collected and deposited into the landfill through the government or private waste collector [25]. These bags will range from 3 L to 100 L, costing 0.11 Hong Kong Dollars (HKD, roughly USD 0.07) per L. For oversized items such as furniture, special tags could be purchased at HKD 11 per piece [25]. Any waste disposed of outside the scope of the abovementioned bag and tag will be deemed to be illegally dumped. One desired course of action is for people to recycle some of the waste to reduce the cost of paying for the official bag or tag. This formal policy manifest in the different dimensions of the rules-in-use. These rules-in-use are enumerated below:

Position rules specify the role of participants, such as that of the household, government, and estate managers. Boundary rules indicate how you become part of this action situation, such as how one is covered by this policy. Authority rules specify what actions the participant, such as the household or government, could take. Aggregation rules speak about how much control the households or government have over their actions. Information rules are about how accessible the information is to help actors decide what actions to take. Payoff rules indicate the cost and benefits of the actions chosen, whether to reduce, recycle or dispose of food waste. Scope rules show the possible outcomes, such as how food waste reduction/recycling increases and less waste is dumped into landfill.

3.5. Network of Adjacent Action Situation

Although this study focuses on households’ food waste, other types of waste and other stakeholders also influence the household’s behavioural choices. The external variables affecting our focal action situation may also come from related action situations. Some of these action situations produce rules that influence how the elements interact in the focal situation. The following paragraphs provide some examples of relevant action situations. McGinnis [19] mentioned the significance of the network of adjacent action situations in the IAD analysis. For our purposes, we briefly discuss these adjacent action situations but leave a deeper discussion of them for another article.

For instance, commercial food establishments can “compete” for the household. Recyclers have a limit on the maximum amount of food waste they can process. As of now, O-Park collects its food waste from restaurants, food processors, and other big organisations [60,61]. Commercial and industrial food establishments have the advantage of more volume per source, which makes it more economical to collect and send this waste to the processing facility. For instance, this action situation may affect the aggregate rules of the focal action situation.

As the export of food waste for processing is not as feasible [49], local consumption of food waste products is more desired. Hong Kong has very little agricultural industry left. Raising pigs and livestock in most places in Hong Kong was banned in the 1990s (see the Waste Disposal Ordinance of the Laws of Hong Kong, Cap. 354). Nevertheless, there is still a possible local demand for food waste compost by-products. Other markets for food waste processing by-products include fish feed and animal feed. However, maintaining the stability of quality and quantity is a perennial concern [10]. The large area of the country park where vegetation is still present may be an option to explore.

In converting food waste into biofuel either from food waste directly [11] or in the sewerage system [40,61], the action situation of how the end product demand could be sustained is a relevant aspect to consider. The biofuel market can be relevant to the food waste issue because the end product of the recycling process could eventually be bought or used here. The price and usage rate of these biofuel products can dictate how feasible it is to install more bio-processors for food waste [44]. It may even dictate the quality

requirements of food waste acceptable for processing [11]. This may affect the scope and payoff rules of the focal action situation.

4. Patterns of Interaction and Outcomes in the Action Situation

In this section, we attempted to detect some patterns of interaction among actors using the generalised game theoretic approach described above [19]. Specifically, as listed below, we identified possible outcomes produced as the different rules-in-use affect the corresponding elements of the action situation (Figure 3), also taking into account the community attributes and biophysical conditions.

Position rules and boundary rules with respect to actors and position: By temporarily or permanently residing in the city, one is covered by this policy. As long as one is a producer of waste, one is affected by the policy. The municipal waste scheme excludes waste from construction and hospital waste. Strictly speaking, these other types of waste fall under another policy (e.g., Waste Disposal (Charges for Disposal of Construction Waste) Regulation, Cap. 354N), although they could be included once they are mixed with waste coming from residential areas. The government has the main role of implementing the scheme, together with monitoring compliance and sanctions. The other actors formally bound by this government's policy include households, recyclers, estate managers, commercial food establishments, food processing industries, and wet markets, among others. The household has *de jure* obligations to obey.

Authority rules with respect to actions: In the formal arena, households have some options for actions. The simplest is for the household to include the food waste in the official waste bag and simply absorb the cost. Alternatively, when facilities allow, they could grind and dilute the food waste and flush it into the sewerage system of the city [40]. Another option is for them to reduce the food waste by reducing them at the source (change in some habits) or recycling them or sending them for recycling. This leads to less cost for the household. Lastly, there seems to be no physical impediment to prevent households from illegally disposing of their food waste. Obviously, the risk of paying the fine if they are caught exists.

Aggregation rules with respect to control: For households in Hong Kong, most of the waste is collected by the government through contractors, which limits what actions households can take. In each multi-storey building, there is a collection chute that collects the block or estate's refuse collection points. For instance, there could be conventional and automated refuse collection systems in the blocks [62]. Woon and Lo [43] proposed using optical sensors to segregate food waste bags mechanically, which may demand some investment on the part of the estate. From there, cleansing contractors or other contractors of the government's Food and Environmental Hygiene Department (FEHD) transfer the waste to one of the refuse transfer stations scattered around the city [34]. The Environmental Protection Department—another government agency—contractors, or equivalent, would then transfer these to the landfill.

Regarding control, the government can impose this policy by controlling the official bags' supply, monitoring and punishing illegal dumping with fines, further limiting landfill disposals, promoting food waste reductions in schools, etc. In Hong Kong, the government gives subsidies to many environmental and social organisations, which provides the government with some form of control over its operations. Since 2011, the Environment and Conservation Fund (ECF) has funded the "Food Waste Recycling Projects in Housing Estates" scheme [63]. Some 10 estates were granted almost HKD 7 M for food waste separation in their estate since 2017 [29]. This is on top of almost HKD 65 M in funding from ECF Community Waste Reduction Projects during the same period. The government is also slowly installing smart collection bins for domestic food waste in public housing estates [64]. Nevertheless, the government may have limited *de facto* capabilities to directly control what the households do. Given the number and spatial distribution, households seem to have *de facto* control over choosing which action to take. In the current physical configuration of Hong Kong's multi-storey residential buildings, it seems easy to freeride,

avoiding the fines for illegal dumping. Building managers still need to invest in monitoring or filtering systems to separate waste into legal and illegal containers. In any case, the aim is to fine the culprit and not punish those who uphold the rules.

Information rules with respect to access to relevant information: Information about the policy is available on the internet. Moreover, publicly funded information campaigns are being conducted, and subsidies are being awarded to estate management in order to prepare them for the coming of this law [29]. Recycling concepts are an important part of the schools' curriculum. Information about where bags and tags can be purchased from, including over 4000 establishments, can be easily disseminated. As stated in the ordinance, these establishments are not allowed to sell these bags at a lower price, or they will be subject to penalties. As a form of feedback mechanism, policies legislated in the city normally pass through some form of public consultation system prior to full implementation. In this respect, the special administrative region has a channel to find out the opinions of different stakeholders. This consultation was also applied to the volume-based charging scheme coming in 2023 [34].

In this action situation, it was found that some information is clearer and more accessible than others. For instance, most households can use the internet to find information about different processing plants and organisations related to food waste. Nevertheless, there is limited information about how to dispose of post-consumption food waste through recycling or recycling centres, where to send by-products, and the delivery process. With the hope of gaining more experience, the government has set up another food waste collection trial scheme for 30 blocks in 5 public housing estates [65]. The online apps and maps made available by government agencies show around 25 collection points primarily for pre-consumption food waste, but there seems to be no clear signage of post-consumption food waste collection points (Figure 4). Pre-consumption food waste is waste that can still be consumed by other human beings. The latter includes the waste only fit for bio-processing, decomposition, or disposal. This scarcity of options seems to limit that part of the population who are already convinced to recycle food waste. Information to the public about the government's plan to use the sewerage system for food waste is also upcoming [41].

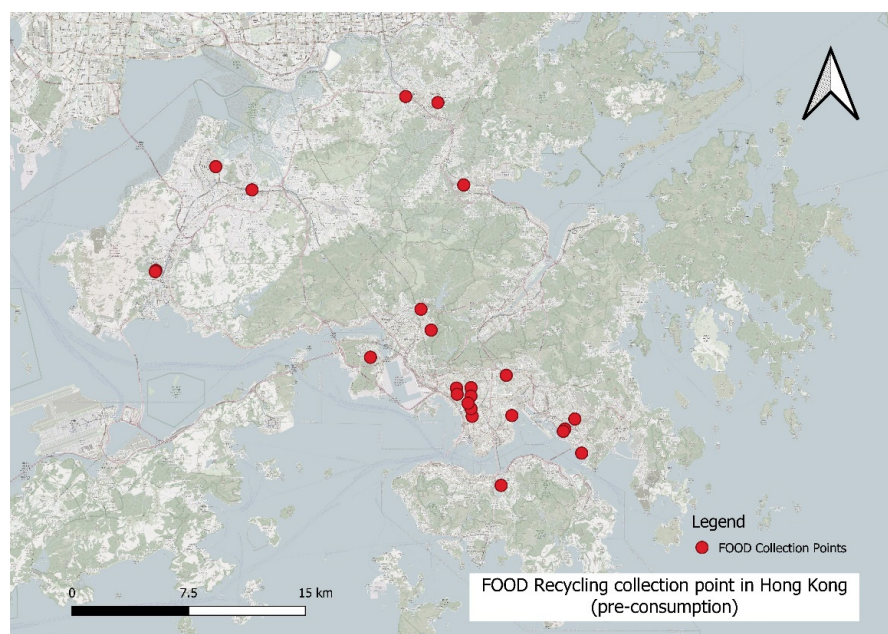


Figure 4. Location of food waste collection points, which are primarily for pre-consumption food waste (data from geodata.gov.hk, accessed 23 February 2022).

In tandem with the information cost, it also costs the household time and resources to establish and maintain relationships [66] with these neighbourhood recycling organisations. Wan and colleagues [67] show that the information gap is more on the practical issue of how to recycle rather than the why of recycling. By bridging such information gaps, the waste charging scheme may better incentivise people to reduce food waste by recycling and may truly induce the desired behavioural change. It may give rise to a reduction in the transaction cost—information cost—on the side of the household. On the other hand, the government may also find this approach a less expensive option making the policy more effective as this information is already in its hands.

Payoff rules and scope rules with respect to the cost and benefits of the actions chosen and their corresponding outcomes: The environmental benefits envisioned by this policy are quite apparent. It will prolong the landfill's operating lifetime. The sanitation situation of the city would also improve, not to mention lowering its carbon footprint. Nevertheless, how to translate these benefits into more palpable and pragmatic advantages that each household can immediately perceive could be further investigated. Conversely, the negative aspects are more evident. For instance, in regularly purchasing these official waste bags, household expenditure will definitely increase. If one is caught dumping illegally, the fine for illegal dumping is HKD 1500. Considering the costs and benefits of the different allowable actions for households once the waste charging scheme is implemented, the following are some potential outcomes:

- Change habits to reduce post-consumption food waste: this would create a better environment and prolong the landfill's utility. For this to be a dominant choice, the city has the advantage of financial resources, infrastructure building capacity, and citizens being educated about the environment. Furthermore, it appears support for this kind of waste charging law increased from 51% to 68% in 2012 and 2021, respectively [68,69]. This hints at some willingness on the part of citizens for change. Nonetheless, food waste management intention need not always translate to behaviour [13,54].
- Recycle food waste themselves or send the food waste to be recycled elsewhere: in addition to generation reduction, this would create a better environment and prolong the landfill's utility. As mentioned above, information on the specific know-how seems to be lacking, especially for food waste. Wan et al. [67] proposed to promote more effort in helping people learn how to do it rather than why to recycle. As infrastructure is crucial for the success of the waste charging scheme in general [14], better linking infrastructure to people who would use it seems necessary for food waste.
- Include it in the official waste bag for disposal: this marginal food waste would contribute to filling up the landfill despite the cost and effort. It is still unknown how much of the population would consider this.
- Throw it away illegally: adding to nuisance and sanitation problems in the immediate surroundings. Food waste can be dumped illegally in alternative routes such as drains, street kerbs, and other public areas.
- In the future, the possibility of using the sewerage system to transport the waste for bioprocessing seems a double-edged sword as the solid waste is transported via a liquid medium, which increases the load on sewerage treatment [39]. Although the by-products could be used as biofuel [40], the implication and cost of the transit could be another topic for study [44]. As this option has minimal behavioural change requirements, it may be excluded from our analysis and left for later studies.

A summary of possible interactions is found in Table 4. The way these patterns were analysed was by attempting to answer the questions from Polski and Ostrom's work [5] corresponding to the third column of the table. In the table, information and control (on the part of monitoring and eventual sanctioning) seem more dominant in influencing the decision of households to carry out food waste recycling. Furthermore, the heightened awareness of the need for sanitation due to the recent pandemic may also have some implications. It is in these aspects that further studies could be conducted.

Table 4. Possible interactions and outcomes in the Action Situation.

Rules-in-Use	Action Situation Component	Guide Questions [5]	Possible Interaction and Outcome by Different Actors after Considering External Variables			
			Households	Government	Recyclers	Estate Managers
Position rules	Positions	What are the positions or roles that actors play in this situation?	Producer of food waste; follow the waste charging rules; give feedback if called for.	Collect waste, monitor and sanction offenders, and also provide financial and infrastructure support	Technology and service provider	Mediating entity between households, government, recyclers
Authority rules	Actions	What actions can participants take, and how are actions linked to outcomes?	Household can pay for the cost of dumping food waste in the official bag; Household may recycle; or Dump illegally.	Strictly implement monitoring and sanctioning, or de facto be lenient	Collect and process food waste from households, or focus on collecting more commercial and industrial food waste	Proactively facilitate food waste collection/processing; be more passive
Information rules	Information	What information about the action situation is available to participants?	CLEAR information: sanctioning rules, where to purchase bags, location of O-Park, etc. CLEAR info for some estates: How food waste can be collected; where to send food waste; how to do it oneself efficiently	CLEAR information: citywide food waste statistics; UNCLEAR information: distribution of household food waste	CLEAR information: collecting from commercial/industrial; where to send food waste after processing NOT SO CLEAR information: how exactly food waste is collected from households	CLEAR information: estate level statistics. UNCLEAR information: monitoring system
Aggregation rules	Control	What is the level of control that each participant has over action in this situation?	Can recycle if they have incentive (time/convenience); to take initiative to find out where to send food waste for recycling or learn the know-how	Policing is limited because households are highly dispersed in the city	Invest or not invest in providing this service	Has more direct control than the government of households in the estate
Payoff rules	Benefits and costs	What costs and benefits do participants incur when they take action in this situation?	Benefit is a better environment. Cost: of official bag. Time/cost to recycle/send for recycling. If one chooses to dump illegally, a fine may be incurred when caught.	Benefit: the landfill will last longer, Cost: policing cost, infrastructure capital and operations	Benefit: source of quality food waste for processing Cost: infrastructure capital and operations	Benefit: good environment in the estate; better reputation Cost: monitoring, capital, and operations
Scope rules	Potential outcomes	What outcomes are possible in this situation?	Status quo in food waste production; more recycling of food waste; more illegal dumping			

5. Evaluation of Outcomes

This section would like to demonstrate how IAD could be used for benchmarking the performance of a policy by evaluating its outcomes. It would then recommend some future areas of study based on the gaps found in this review.

IAD proposes six evaluation criteria: economic efficiency, equity (both fiscal and distributional), accountability, conformance to general morals, and adaptability/sustainability. Given that the policy is not yet fully implemented, we evaluated the worst-case scenario among the possible outcomes identified above, as shown below:

Economic Efficiency: This criterion answers whether this scheme is the least costly to achieve decreased food waste disposal in the landfill. The worst scenario seems to be if most of the households simply include their food waste in the waste bag and/or if illegal dumping of food waste becomes rampant. There are debates about the effectiveness of a volume-based scheme such as the one that will be applied in Hong Kong in influencing recycling behaviour [70]. If this happens, this means both routes of collection and monitoring did not meet the target. This is costly because the government has and is still investing a

huge sum in building processing facilities to take in organic waste and installing smart bins in estates [49,64], but information about how the general collection system of food waste from households to these facilities may be sparse. Moreover, rampant illegal dumping also would incur more policing costs and investment in monitoring facilities. This is over and above the sanitation problem that this will produce, which in itself is not inexpensive.

Fiscal Equivalence: Thus far, the greatest investor in this action situation is the government using taxpayers' money. Subsidies are continuously being given out, and infrastructure is being built. Financial burden may be offset nonetheless with energy savings from biofuel utilisation [36–38]. The shift of the collection services from a public good to a toll good allows the household to feel the cost burden of disposing of waste. The direct cost each household may incur in relation to food waste can be estimated (Appendix A). It would be around HKD 2.6 per month, which some households may find negligible. Of course, this is normally paid in bulk with the other types of waste. It is still left to be seen if it is high enough to induce certain changes in behaviour. The government is mainly motivated by its public role to achieve the reduction in waste disposal to landfills for the social good. Households, on the other hand, may have slightly different motives or incentives. Factors such as convenience, the individual's environmental convictions, and the economic means of the household may play an important role in the preference or valuation of actors [51,71]. In this sense, this initial gap or the mismatch of priorities may be reduced by the new waste fee imposed.

Distributional Equity: Different households have different income levels. Each level is affected in a particular way. One of the issues of the waste charging scheme is that it will affect the poor more due to the additional expense of the waste bag. Despite some saying that the amount of waste produced is minimally correlated to household income (citing a UK government report), the burden of time and monetary cost is foreseen to affect people with less economic means to a greater extent [72].

Accountability: For this criterion, we focused on the illegal dumping scenario. The extent of the future illegal dumping is yet to be seen. It seems that the intention to dump waste illegally is, on average, low [59]. Information about the monitoring system to reduce illegal dumping is not yet very clear. Closed-circuit television cameras are already installed in most private and public estates. These may be employed to monitor illegal activities, as has been performed in certain locations for construction waste [59].

Conformance to General Morality: In Hong Kong, the average level of intention to dump waste illegally is low [59]. Educational programmes promoting reduction/recycling are also underway [49]; only time will tell how far they will go. Although there is a moral dimension in lifestyle and waste disposal behaviours [35,73] implicated here, nevertheless, some measures do facilitate certain behaviours more than the rest [71]. In order to facilitate more awareness of the behavioural implications, measurement methods can still be refined in order to determine better the percentage of avoidable food waste in what is thrown currently [74].

Sustainability/Adaptability: This refers to the long-term viability of the policy's outcome. Would this new institutional arrangement be accepted and sustainably upheld by the community? The upcoming scheme introduces a paradigm shift to now treat this service as a toll good that has its own merit in encouraging waste reduction [75]. Lou and Fabian [76] attribute the current attitude towards waste in Hong Kong to the colonial government's laissez faire administration approach in many aspects of the former colony, including property, land, and waste. Implementing this policy at this stage of the city's history raises expectations and doubts about whether the people would be able to adapt to such a scheme, which is already long implemented in nearby places such as South Korea [77] and Taiwan. In other places, such as Singapore, waste collection is bundled with other metered public utilities, such as water and electricity [78]. Will the initial stages of the implementation be adaptable enough to help people assimilate the scheme better? The government has been introducing smaller-scale trials in private and public estates [65]. From past studies, Ostrom [79] also alludes to a graduated sanction scheme as

a design principle for a more sustainable institutional arrangement. As in other contexts, the pandemic brought with it some changes in food waste management [57,58], which may also be a good experimental opportunity to examine the policy's viability.

Some solutions proposed in previous studies are as follows: A home-to-home food waste pickup system improves people's perception of their capacity for household food waste separation, and this, in turn, increases waste separation [13]. One challenge the authorities could face for this is the high density and dispersion of the household population of Hong Kong. Similarly, this could be augmented by a form of communal smart bins specific for food waste, such as the ones still on trial at present [65]. An increase in waste recycling bins and a decrease in rubbish bins in public areas were also proposed to encourage waste recycling [67]. In Singapore, setting up decentralised—instead of centralised—community waste processing facilities was also broached to make the food waste supply for these processes stable [9]. Limited space seems to be a challenge for the authorities to implement this approach. When engaging the community in food waste recycling, inviting further the residents and other stakeholders to participate in designing the configuration of the recycling space has also been suggested [31]. Along this line, one of the challenges the authorities seem to face is how to encourage these types of bottom-up initiatives to address some of the issues mentioned above. Technologically advanced processing facilities and infrastructure are built and are being built, but there still seems to be a lack of linkages to complement these superb facilities. From a bottom-up collective action angle, some authors look at the prospect of technological interventions [15,52] as a promising means to bridge the information and optimise the capacities of different sectors to address the food waste collection issue found in this review. Simple initiatives have already sprouted in the city. For example, a start-up firm has installed padlocked food waste bins around certain areas of the city wherein clients could pay to get the code and dispose of their food waste for processing [80]. Smart mobile applications similar to the ones mentioned in previous studies for pre-consumption food waste [15] that help match disposers and collectors may scale up these types of initiatives.

6. Future Agenda for Study and Concluding Remarks

All the above analyses were performed in the context before the policy is implemented. Research gaps were also identified using the IAD framework. Once the waste charging scheme is enacted in 2023, it would be interesting to understand the new dynamics that will evolve. Below are some areas identified for further research with respect to household food waste reduction/recycling in the context when the waste charging policy is already implemented:

- Further research could be conducted on how households—especially the front liners—have the know-how on how food waste can be sent or collected for recycling. It is more important to find out what people know about how to process food waste and where to send food waste for processing. For instance, data from a recent trial scheme [65] could shed more light on the policy's effectiveness. It would bring to light the actual mechanism and direction where more support from the government can be inserted with respect to reducing the information cost.
- Along this line, other actors to investigate could also be the recycling processors themselves or estate managers.
- Although some estates have their own collection bins, many still do not have a clear designation where they themselves can send food waste for processing. A study reported using visible kerbside collection bins to engage the community in segregation behaviours [81]. Studies on this area of environmental education may offer more efficient means for continuous reinforcement of green behaviours.
- Economic and technical comparisons of different food waste collection system or strategies seem to be a useful direction of study.
- How effective would the monitoring of illegal dumping be? When the policy is already implemented, what is the most cost-effective monitoring system?

- One may explore whether the cost of including food waste disposal seems not prohibitive enough for some households to include it in the official waste bag. Convenience seems to be a more critical factor than environmental education in food waste recycling [71].
- It is also worth exploring how adaptable the policy is toward future shocks. For instance, how did the recent pandemic and other social events in the city shift how residents value the cost and inconvenience of handling food waste?
- Further exploration of how technological interventions similar to mobile phone apps are used for reducing food waste generation or connecting receivers of pre-consumption food excesses [52] may also be capitalised more in post-consumption food waste collection and other areas.
- It is also worthwhile studying how the waste charging policy performs after some years of implementation by applying the IAD evaluation criteria.

This article offers a fresh means to analyse how a new institutional arrangement affects a complex waste management issue, such as household food waste recycling, using a generalised game theoretic approach with IAD. This approach is compatible with various methods [6]. The method chosen here is a review of documents, reports, and literature revolving around food waste management in the city. Future research may explore other quantitative and qualitative methods to gather data for analysis. This may also expand to other much larger environmental issues beyond food waste disposal, such as general recycling and sanitation. IAD would also be useful in elucidating these issues [5].

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Appendix A

If each person in 2019 was estimated to throw away 0.3 kg/person/day [49], and a typical household has 2.8 persons, we could estimate the cost each household could spend in a 30-day month. Based on the work of Yesiller and colleagues [82], we can assume that the specific gravity of food waste is 1.07. We can obtain 23 L of food waste per month. Multiplying this with HKD 0.11/L, we arrive at around HKD 2.6 extra per month cost connected with food waste.

References

1. Cole, D.; Epstein, G.; McGinnis, M. The Utility of Combining the IAD and SES Frameworks. *Int. J. Commons* **2019**, *13*, 244–275. [CrossRef]
2. Kiser, L.; Ostrom, E.O.E. The three worlds of action: A metatheoretical synthesis of institutional approaches in strategies of political inquiry. In *Strategies of Political Inquiry*; Ostrom, E., Ed.; Sage: Beverly Hills, CA, USA, 1982; pp. 179–222.
3. Ostrom, E. Analyzing Collective Action. *Agric. Econ.* **2010**, *41*, 155–166. [CrossRef]
4. Ostrom, E. Background on the Institutional Analysis and Development Framework. *Policy Stud. J.* **2011**, *39*, 7–27. [CrossRef]

5. Polski, M.M.; Ostrom, E. An Institutional Framework for Policy Analysis and Design. In *Elinor Ostrom and the Bloomington School of Political Economy Volume 3, a Framework for Policy Analysis*; Cole, D.H., McGinnis, M.D., Eds.; Rowman & Littlefield Publishers, Inc.: Lanham, MA, USA, 1999; pp. 13–47.
6. McGinnis, M.D. An Introduction to IAD and the Language of the Ostrom Workshop: A Simple Guide to a Complex Framework. *Policy Stud. J.* **2011**, *39*, 169–183. [CrossRef]
7. Ostrom, E. Zooming in and Linking Action Situation. In *Understanding Institutional Diversity*; Princeton University Press: Princeton, NJ, USA, 2005; pp. 32–68.
8. Hong Kong Environmental Protection Department. Monitoring of Solid Waste in Hong Kong. Available online: <https://www.wastereduction.gov.hk/sites/default/files/msw2020.pdf> (accessed on 26 August 2022).
9. Ng, B.J.H.; Mao, Y.; Chen, C.-L.; Rajagopal, R.; Wang, J.-Y. Municipal Food Waste Management in Singapore: Practices, Challenges and Recommendations. *J. Mater. Cycles Waste Manag.* **2017**, *19*, 560–569. [CrossRef]
10. Ho, K.S.; Chu, L.M. Characterization of Food Waste from Different Sources in Hong Kong. *J. Air Waste Manag. Assoc.* **2019**, *69*, 277–288. [CrossRef] [PubMed]
11. Yeo, J.; Oh, J.; Cheung, H.H.L.; Lee, P.K.H.; An, A.K. Smart Food Waste Recycling Bin (S-FRB) to Turn Food Waste into Green Energy Resources. *J. Environ. Manag.* **2019**, *234*, 290–296. [CrossRef]
12. Allison, A.L.; Lorencatto, F.; Michie, S.; Miodownik, M. Barriers and Enablers to Food Waste Recycling: A Mixed Methods Study amongst UK Citizens. *Int. J. Environ. Res. Public Health* **2022**, *19*, 2729. [CrossRef]
13. Oehman, J.M.; Babbitt, C.W.; Flynn, C. What Predicts and Prevents Source Separation of Household Food Waste? An Application of the Theory of Planned Behavior. *Resour. Conserv. Recycl.* **2022**, *186*, 106492. [CrossRef]
14. Morlok, J.; Schoenberger, H.; Styles, D.; Galvez-Martos, J.-L.; Zeschmar-Lahl, B. The Impact of Pay-as-You-Throw Schemes on Municipal Solid Waste Management: The Exemplar Case of the County of Aschaffenburg, Germany. *Resources* **2017**, *6*, 8. [CrossRef]
15. Schanes, K.; Dobernig, K.; Gözet, B. Food Waste Matters—A Systematic Review of Household Food Waste Practices and Their Policy Implications. *J. Clean. Prod.* **2018**, *182*, 978–991. [CrossRef]
16. Whaley, L. The Critical Institutional Analysis and Development (CIAD) Framework. *Int. J. Commons* **2018**, *12*, 137–161. [CrossRef]
17. Zhang, Z.; Zhao, L. Voluntary Monitoring of Households in Waste Disposal: An Application of the Institutional Analysis and Development Framework. *Resour. Conserv. Recycl.* **2019**, *143*, 45–59. [CrossRef]
18. Oh, J.; Hettiarachchi, H. Collective Action in Waste Management: A Comparative Study of Recycling and Recovery Initiatives from Brazil, Indonesia, and Nigeria Using the Institutional Analysis and Development Framework. *Recycling* **2020**, *5*, 4. [CrossRef]
19. McGinnis, M.D. Networks of Adjacent Action Situations in Polycentric Governance. *Policy Stud. J.* **2011**, *39*, 51–78. [CrossRef]
20. Bertacchini, E.; Gould, P. Collective Action Dilemmas at Cultural Heritage Sites: An Application of the IAD-NAAS Framework. *Int. J. Commons* **2021**, *15*, 276–290. [CrossRef]
21. Harring, N.; Jagers, S.C.; Nilsson, F. Recycling as a Large-Scale Collective Action Dilemma: A Cross-Country Study on Trust and Reported Recycling Behavior. *Resour. Conserv. Recycl.* **2019**, *140*, 85–90. [CrossRef]
22. Yau, Y. Domestic Waste Recycling, Collective Action and Economic Incentive: The Case in Hong Kong. *Waste Manag.* **2010**, *30*, 2440–2447. [CrossRef]
23. Rapoport, A.; Guyer, M.J.; Gordon, D.G. *The 2 × 2 Game*; The University of Michigan Press: Ann Arbor, MI, USA, 1976.
24. Heckathorn, D.D. The Dynamics and Dilemmas of Collective Action. *Am. Sociol. Rev.* **1996**, *61*, 250–277. [CrossRef]
25. GovHK. Municipal Solid Waste Charging. April 2022. Available online: <https://www.gov.hk/en/residents/environment/waste/management/mswcharging.htm> (accessed on 16 March 2022).
26. Chu, A.M.Y. Illegal Waste Dumping under a Municipal Solid Waste Charging Scheme: Application of the Neutralization Theory. *Sustainability* **2021**, *13*, 9279. [CrossRef]
27. Ostrom, E.; Crawford, S. Classifying Rules. In *Understanding Institutional Diversity*; Ostrom, E., Ed.; Princeton University Press: Princeton, NJ, USA, 2005; pp. 186–215.
28. Demsetz, H. Toward a Theory of Property Rights. *Am. Econ. Rev.* **1967**, *57*, 347–359.
29. Environment and Conservation Fund. Approved Projects: Waste Separation Projects to Pave the Path for Municipal Solid Waste Charging. Available online: https://www.ecf.gov.hk/en/approved/msw_index.html (accessed on 19 October 2022).
30. Census and Statistics Department. 2022 Land Area, Mid-Year Population and Population Density by District Council District. 2021. Available online: <https://www.censtatd.gov.hk/en/EIndexbySubject.html?pcode=B1130301&scode=150> (accessed on 11 April 2022).
31. Xiao, J.X.; Siu, K.W.M. Challenges in Food Waste Recycling in High-Rise Buildings and Public Design for Sustainability: A Case in Hong Kong. *Resour. Conserv. Recycl.* **2018**, *131*, 172–180. [CrossRef]
32. Hong Kong SAR Government. Budget: Environment Protection Department. 2022. Available online: <https://www.budget.gov.hk/2022/eng/pdf/head044.pdf> (accessed on 21 April 2022).
33. Hong Kong Environmental Protection Department. Problem & Solution. 2022. Available online: https://www.epd.gov.hk/epd/english/environmentinhk/waste/prob_solutions/codigestion_trial_scheme.html (accessed on 19 October 2022).
34. Hong Kong Environmental Protection Department. Public Consultation—Archive. Available online: http://www.epd.gov.hk/epd/msw_consult/english.html (accessed on 19 October 2022).

35. Buchanan, J.M. Public goods and public bads. In *Financing the Metropolis*; Sage Publications: Beverly Hills, CA, USA, 1970; pp. 51–71.
36. Lam, C.M.; Iris, K.M.; Medel, F.; Tsang, D.C.W.; Hsu, S.C.; Poon, C.S. Life-Cycle Cost-Benefit Analysis on Sustainable Food Waste Management: The Case of Hong Kong International Airport. *J. Clean. Prod.* **2018**, *187*, 751–762. [CrossRef]
37. Yeo, J.; Chopra, S.S.; Zhang, L.; An, A.K. Life Cycle Assessment (LCA) of Food Waste Treatment in Hong Kong: On-Site Fermentation Methodology. *J. Environ. Manag.* **2019**, *240*, 343–351. [CrossRef]
38. Romaniuk, W.; Rogovskii, I.; Polishchuk, V.; Titova, L.; Borek, K.; Wardal, W.J.; Shvorov, S.; Dvornyk, Y.; Sivak, I.; Drahnev, S. Study of Methane Fermentation of Cattle Manure in the Mesophilic Regime with the Addition of Crude Glycerine. *Energies* **2022**, *15*, 3439. [CrossRef]
39. Zan, F.; Dai, J.; Hong, Y.; Wong, M.; Jiang, F.; Chen, G. The Characteristics of Household Food Waste in Hong Kong and Their Implications for Sewage Quality and Energy Recovery. *Waste Manag.* **2018**, *74*, 63–73. [CrossRef]
40. Zan, F.; Iqbal, A.; Guo, G.; Liu, X.; Dai, J.; Ekama, G.A.; Chen, G. Integrated Food Waste Management with Wastewater Treatment in Hong Kong: Transformation, Energy Balance and Economic Analysis. *Water Res.* **2020**, *184*, 116155. [CrossRef]
41. Hong Kong Chief Executive Policy Address 2021. 6 October 2021. Available online: <https://www.policyaddress.gov.hk/2021/eng/index.html> (accessed on 11 April 2022).
42. Woo, P.K. Food Waste in Hong Kong: A Study on Source Reduction. Master's Thesis, University of Hong Kong, Hong Kong, China, 2014.
43. Woon, K.S.; Lo, I.M.C. A Proposed Framework of Food Waste Collection and Recycling for Renewable Biogas Fuel Production in Hong Kong. *Waste Manag.* **2016**, *47*, 3–10. [CrossRef]
44. Feiz, R.; Johansson, M.; Lindkvist, E.; Moestedt, J.; Pålledal, S.N.; Ometto, F. The Biogas Yield, Climate Impact, Energy Balance, Nutrient Recovery, and Resource Cost of Biogas Production from Household Food Waste—A Comparison of Multiple Cases from Sweden. *J. Clean. Prod.* **2022**, *378*, 134536. [CrossRef]
45. Secondi, L.; Principato, L.; Laureti, T. Household Food Waste Behaviour in EU-27 Countries: A Multilevel Analysis. *Food Policy* **2015**, *56*, 25–40. [CrossRef]
46. Census and Statistics Department. Gross Domestic Product (GDP), Implicit Price Deflator of GDP and Per Capita GDP. 2022. Available online: https://www.censtatd.gov.hk/en/web_table.html?id=31 (accessed on 19 October 2022).
47. Census and Statistics Department. Survey Results of 2020 Annual Earnings and Hours Survey. Released 30 March 2021. Available online: <https://www.censtatd.gov.hk/en/EIndexbySubject.html?pcode=B1050014&scode=210> (accessed on 26 May 2022).
48. Census and Statistics Department. Population and Household Statistics Analysed by District Council District. 2020. Available online: <https://www.statistics.gov.hk/pub/B11303012020AN20B0100.pdf> (accessed on 11 April 2022).
49. Hong Kong Environmental Bureau. Waste Blueprint for Hong Kong 2035. 2021. Available online: https://www.eeb.gov.hk/sites/default/files/pdf/waste_blueprint_2035_eng.pdf (accessed on 4 May 2022).
50. Census and Statistics Department. Household Expenditure Survey. 2019–2020. Available online: <https://www.censtatd.gov.hk/en/EIndexbySubject.html?pcode=B1060003&scode=290#section2> (accessed on 19 October 2022).
51. Evans, D. Beyond the Throwaway Society: Ordinary Domestic Practice and a Sociological Approach to Household Food Waste. *Sociology* **2012**, *46*, 41–56. [CrossRef]
52. Hebrok, M.; Boks, C. Household Food Waste: Drivers and Potential Intervention Points for Design—An Extensive Review. *J. Clean. Prod.* **2017**, *151*, 380–392. [CrossRef]
53. Abeliotis, K.; Lasaridi, K.; Chroni, C. Attitudes and Behaviour of Greek Households Regarding Food Waste Prevention. *Waste Manag. Res.* **2014**, *32*, 237–240. [CrossRef]
54. Kritikou, T.; Panagiotakos, D.; Abeliotis, K.; Lasaridi, K. Investigating the Determinants of Greek Households Food Waste Prevention Behaviour. *Sustainability* **2021**, *13*, 11451. [CrossRef]
55. Hong Kong Environmental Management Division; Hong Kong Productivity Council. Food Waste Recycling Projects in Housing Estates. 2013. Available online: <https://www.wastereduction.gov.hk/sites/default/files/resources/FWRP%20-%20Executive%20Summary.pdf> (accessed on 10 June 2022).
56. Lee, K.Y. A Study on Source Separation of Domestic Food Waste in Hong Kong. Master's Thesis, University of Hong Kong, Hong Kong, China, 2020.
57. Qian, K.; Javadi, F.; Hiramatsu, M. Influence of the COVID-19 Pandemic on Household Food Waste Behavior in Japan. *Sustainability* **2020**, *12*, 9942. [CrossRef]
58. Laila, A.; von Massow, M.; Bain, M.; Parizeau, K.; Haines, J. Impact of COVID-19 on Food Waste Behaviour of Families: Results from Household Waste Composition Audits. *Socioecon. Plann. Sci.* **2022**, *82*, 101188. [CrossRef] [PubMed]
59. Chong, A.C.Y.; Chu, A.M.Y.; So, M.K.P.; Chung, R.S.W. Asking Sensitive Questions Using the Randomized Response Approach in Public Health Research: An Empirical Study on the Factors of Illegal Waste Disposal. *Int. J. Environ. Res. Public Health* **2019**, *16*, 970. [CrossRef]
60. O-Park 1. Organic Resources Recovery Centre Phase 1. Available online: <https://www.opark.gov.hk/en/index.php> (accessed on 19 October 2022).
61. LCQ15: Handling of Food Waste. 16 January 2019. Available online: <https://www.info.gov.hk/gia/general/201901/16/P2019011600577.htm> (accessed on 11 April 2022).

62. Chan, E.H.W.; Lee, G.K.L. A Review of Refuse Collection Systems in High-rise Housings in Hong Kong. *Facilities* **2006**, *24*, 376–390. [\[CrossRef\]](#)
63. Hong Kong Environmental Protection Department [EPD]; Hong Kong Productivity Council [HKPC]. Technical Guidelines for Food Waste Recycling Projects in Housing Estates. January 2016. Available online: https://www.wastereduction.gov.hk/sites/default/files/hd-fwrs/technicalguideline_en%20Jan%202016.pdf (accessed on 10 June 2022).
64. LCQ16: Waste Reduction and Recycling Programmes Implemented in Public Housing Estates. 8 June 2022. Available online: <https://www.info.gov.hk/gia/general/202206/08/P2022060700655.htm> (accessed on 11 April 2022).
65. Hong Kong Government. EPD Launches Food Waste Collection Trial Scheme in Public Rental Housing Estates (with Photos) (info.gov.hk). Available online: <https://www.info.gov.hk/gia/general/202210/30/P2022103000254p.htm> (accessed on 31 October 2022).
66. Williamson, O.E. Transaction-Cost Economics: The Governance of Contractual Relations. *J. Law Econ.* **1979**, *22*, 233–261. [\[CrossRef\]](#)
67. Wan, C.; Shen, G.Q.; Choi, S. Differential Public Support for Waste Management Policy: The Case of Hong Kong. *J. Clean. Prod.* **2018**, *175*, 477–488. [\[CrossRef\]](#)
68. Chung, R.T.Y.; Pang, K.K.L.; Lee, F.W.K.; Tai, E.C.F. *Public Survey on Waste Charging Scheme*; Public Opinion Programme: Hong Kong, China, 2012.
69. Civic Exchange; Hong Kong Public Opinion Research Institute. Public Opinion Survey Results on the Municipal Solid Waste Charging Bill. 2021. Available online: <https://civic-exchange.org/report/public-opinion-survey-on-the-waste-disposal-charging-for-municipal-solid-waste-amendment-bill-2018/> (accessed on 27 September 2022).
70. Bel, G.; Gradus, R. Effects of Unit-Based Pricing on Household Waste Collection Demand: A Meta-Regression Analysis. *Resour. Energy Econ.* **2016**, *44*, 169–182. [\[CrossRef\]](#)
71. Bernstad, A. Household Food Waste Separation Behavior and the Importance of Convenience. *Waste Manag.* **2014**, *34*, 1317–1323. [\[CrossRef\]](#) [\[PubMed\]](#)
72. Dresner, S.; Ekins, P. Charging for Domestic Waste in England: Combining Environmental and Equity Considerations. *Resour. Conserv. Recycl.* **2010**, *54*, 1100–1108. [\[CrossRef\]](#)
73. Francis, P. *Laudato Si: On Care for Our Common Home*; Vatican Press: Rome, Italy, 2015.
74. Elimelech, E.; Ayalon, O.; Ert, E. What Gets Measured Gets Managed: A New Method of Measuring Household Food Waste. *Waste Manag.* **2018**, *76*, 68–81. [\[CrossRef\]](#) [\[PubMed\]](#)
75. Bilitewski, B. From Traditional to Modern Fee Systems. *Waste Manag.* **2008**, *28*, 2760–2766. [\[CrossRef\]](#)
76. Lou, L.I.T.; Fabian, N. The Struggle for Sustainable Waste Management in Hong Kong: 1950s–2010s. *Worldw. Waste* **2019**, *2*, 10.
77. Park, S.; Lah, T.J. Analyzing the Success of the Volume-Based Waste Fee System in South Korea. *Waste Manag.* **2015**, *43*, 533–538. [\[CrossRef\]](#)
78. Shang, K.; Haomiao, H.E. The Innovation Research of the Life Garbage Charging System Research in Beijing. *High. Educ. Soc. Sci.* **2016**, *11*, 1–7.
79. Ostrom, E. *Governing the Commons: The Evolution of Institutions for Collective Action*; Cambridge University Press: Cambridge, UK, 1990.
80. Li, A. *From Trash to Treasure: NGO Takes Food Waste Recycling into Own Hands as Hong Kong Gov't Lags behind 10-Year Goal*; Hong Kong Free Press: Hong Kong, 2022.
81. Landells, E.; Naweed, A.; Pearson, D.H.; Karunasena, G.G.; Oakden, S. Out of Sight, out of Mind: Using Post-Kerbside Organics Treatment Systems to Engage Australian Communities with Pro-Environmental Household Food Waste Behaviours. *Sustainability* **2022**, *14*, 8699. [\[CrossRef\]](#)
82. Yesiller, N.; Hanson, J.L.; Cox, J.T.; Noce, D.E. Determination of Specific Gravity of Municipal Solid Waste. *Waste Manag.* **2014**, *34*, 848–858. [\[CrossRef\]](#)