

Incentives for food waste diversion: exploration of a long term successful Chinese city residential scheme

Changjun Li, Yan Yan Huang, Marie K. Harder\*

**First Author:** Changjun Li

Department of Environmental Science and Engineering, Fudan University, Shanghai  
200433, PR China.

**Second author:** Yan Yan Huang

Department of Environmental Science and Engineering, Fudan University, Shanghai  
200433, PR China.

**Corresponding Author:** Marie K. Harder

Fudan Tyndall Center, Department of Environmental Science and Engineering, Fudan  
University, 220 Handan Road, Shanghai 200433, PR China.

Email-address: [M.K.Harder@Brighton.ac.uk](mailto:M.K.Harder@Brighton.ac.uk)

## **Abstract**

There are no academic studies of incentives schemes for household recycling which are successful or useful on large scales in the longer term. For food waste sorting very few successful schemes have been reported, with or without incentives. Here the authors report findings about a two-year old, 23,000-household scheme in Nanjing, China, from an exploratory case study designed to identify key factors using observations, measurements, company data and interviews. Results indicate that residents were initially motivated by the incentives (e.g. points exchanged for eggs) and social influences, but habit was the key factor for maintaining their behaviour, and cited as the main reason they would continue if the incentives stopped. Interestingly, a perceived improvement in the community site's cleanliness was also cited as an ongoing motivation, and social influences was not mentioned. The perceived success of the scheme was confirmed via measurements of participation rates (32%), the weight of food waste diverted (0.62 kg per household), and estimates of the contamination rate (<1%) and food capture rate (30%) 22 months after start. This work identifies key factors for further studies of positive incentives as habit (and thus duration), site cleanliness, and variation in ranking with time of social norms.

**Key words** Incentives schemes, food waste, cleanliness, habit, composting, recycling, source separation, social influences

## **1. Introduction**

### *1.1. The problem of residential food waste*

Municipal solid waste (MSW) has become an important issue all over the world. The quantity is expected to reach 2.2 billion tons per year by 2025 (Hoornweg and Bhada-Tata, 2012) as cities expand and grow. The volume of municipal solid waste (MSW) generated in China increased by 5% every year in 2002-2012, reaching 160 million tons in 2012 (MOHURD, 2012). The problem of MSW is acute in urban areas because land is less available for large scale waste processing via landfills or incinerators, in urban. Landfilling (91.4%) and incineration (6.4%) are the two main waste management techniques in China (Zhang et al., 2010). But food waste makes incineration very inefficient as it contains much water (Cheng and Hu, 2010), and food waste sent to landfill produces much methane and leachate (Zhang et al., 2010). According to a World Bank report in 2012, MSW is composed of 46% food waste averaged globally, but China has a high percentage of 64.5% (Zhuang et al., 2008). Thus food waste is a global problem in general and for China specifically.

Diversion of food waste is one approach to this problem, but collecting it suitably is difficult. Commercial food waste, and 'green' waste from gardens are easier, but food

and kitchen waste from households has been challenging, especially in dense urban areas. The former can in principle be made into compost: the latter is more suited for biogas production. Both processes have proven very difficult to maintain viably with such a highly variable waste feedstock.

### *1.2. Food waste sorting schemes*

Few examples of successful food waste sorting schemes are reported in the academic literature, and these are usually for small-scale, short-term and pilot projects in sub-urban areas. A capture rate of 2.6% was reported for food waste in the USA, based on 2007 EPA data (Levis et al., 2010); Taiwanese programs report a capture rate of 9.6% in 2010 after a decade of development (Chang et al., 2013); in Thailand a trial scheme over 20 weeks produced a capture rate of 58%, but no longer-term results were reported (Boonrod et al., 2015); in Sweden, capture rates of 27% and 28% with 8.9% contamination levels were reported in one study (Bernstad et al., 2013) and 20-26% capture rates with 2-8% contamination levels in another. The most successful example published seems to be the town of Umea where 55,000 households in single and apartment dwellings have had high and stable capture rates, published as 27% in 2010 (Seadi et al., 2013). Tangential benefits reported include the reduction of total waste generation after food waste collections begin (Miliute-Plepiene and Plepys, 2015).

Failures of schemes for residential food waste separation are not necessarily reported, because civic authorities will usually combine them with other activities. However, there are some reports of failure, (e.g. Seadi et al., 2013), and in some countries large-scale failures (e.g. Pariatamby and Tanaka, 2013; Dai et al., 2015). Many large composting plants tend to fail because of contamination, and high operating costs resulting from insufficient waste separation at source (i.e. by householders) (Hoornweg and Bhada-Tata).

Waste sorting clearly requires the involvement of residents, and scores of studies have explored different ways to encourage this. Many focus on the effect of different types of interventions on recycling behaviour, such as door stepping campaigns (Dai et al., 2015; Bernstad et al., 2013), feedback (Timlett and Williams, 2008) or awareness raising education (Read et al., 2009). Recently a framework of 13 domains of factors to be considered locally in a given intervention has been developed (Xu, 2016). Other examples are incentives, feedback, rewards and penalties (Steg and Vlek, 2009).

In this paper the authors report on an exploratory case study intending to clarify the factors for focus in further studies of incentivised recycling schemes. The case was an apparently successful, large-scale, long-term food waste sorting program in a high-

density urban area. Incentives were given to households via points available daily onto electronic ‘green account’ credit cards. First, background information on incentive schemes, food waste sorting and motivations for recycling is provided, followed by an introduction of the case study and methodology. The findings are then discussed in terms of clear lessons and also design factors for any future, large-scale, in-depth studies which could be linked to theory or improved practice.

### *1.3. Background on incentive schemes for recycling*

Various types of incentives schemes have been tried over time with easier materials, e.g. with plastic bottles and paper. Although many – successful and unsuccessful - are reported in passing in informal talks by government officials, very few appear to be rigorously studied or reported. Types range pecuniary incentives for individuals or communities, from lotteries with a small chance to win a big prize, to large chances of small rewards (Harder and Woodard 2007, Shaw and Maynard 2008).

Headline results are that they can sometimes be very effective and sometimes not at all; they work better when combined with household-level feedback; some community-level schemes can be as effective as household ones, and cheaper; the monitoring needed to determine who gets rewards can be expensive. Table 1 summarizes the main points found in the literature.

Many researchers comment in passing their expectation that positive impacts from incentives in recycling may be lost once the incentive ends, but no rigorous study of this is known to the authors. Some psychology-based researchers have suggested that the use of financial rewards may act as a disincentive for altruistic recyclers (Katzev and Pardini, 1987).

Table 1. Headline lessons reported from previous studies of incentives for household recycling: strengths and weaknesses of the approach

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#### **Strengths**

Have been shown to be highly effective in increasing participation rates and/or frequency and regularity of participation (in a UK study) (Harder and Woodard 2007; Defra, 2007)).

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Have been shown to be particularly effective where baseline recycling rates are low.

Have been shown to be highly effective in reducing contamination (in a UK study). (Maunder, 2006; Timlett and Williams, 2008)

A UK study found that improvements did not depend on deprivation indices of residents. (Harder and Woodard 2007).

Incentives encourage people to try recycling, discounts or premiums could be used to attract first time recyclers.(Dahab et al. 1995)

Can be tailored to local environment (i.e. schools, flats, rural and urban environments, etc.) (Maunder, 2006)

Rewards are well received by the public and are more politically acceptable than penalties (Defra, 2007)

Can be incorporated into current service infrastructure or local community structure to achieve reasonable financial costs

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### **Weaknesses**

1. Incentives appear to be less effective in increasing recycling where rates are already high (in a UK study) (Harder and Woodard 2007) only worked up to a certain level (they were only effective at increasing participation from a low baseline) and need to be of significant value to the householder. (Woodard et al., 2006)
  2. Incentives require an effective service delivery and communication in order to be effective themselves (Maunder, 2006; AEAT, 2006)  
Incentives can be expensive to deliver, averaging £5 per household in the target area. (Maunder, 2006), or very cost-effective (Harder 2007): careful design is needed.
  4. Reward schemes are often complex and it is difficult to isolate the effectiveness of the constituent parts. (This study mixed door stepping with rewards.) (Timlett and Williams, 2008)
  5. There is almost no reported research into the sustainment of any increases in recycling once rewards are removed. (Timlett and Williams, 2008)
  6. It is hypothesized that incentives could lead to people starting to recycle but then return to previous habits (Vining and Ebreo. 1990)
  7. Some psychology- based researchers have suggested that the use of financial rewards may act as a disincentive for altruistic recyclers. (Katzev and Pardini, 1987)
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#### *1.4. Background to key elements of food waste sorting schemes*

The separation of food (or ‘kitchen’) waste from other waste by householders is a relatively new activity in non-rural living worldwide. Only in recent years have the first few rigorous studies of food waste sorting schemes been published, laying out the key elements. Bernstad et al. (2012) reported on the value of face-to-face versus written provision of information, and later researched the importance of convenience (Bernstad 2014). Very recently, Xu et al. (2016) researched a large, successful, residential food waste sorting (recycling) program in urban high-density housing to elicit perceptions of the key elements of its success from various stakeholders, which were found to relate to clarification of roles and responsibilities, and the usefulness of

a ‘broker’ (an NGO (non-governmental organization)) to co-develop new boundaries for stakeholder responsibilities, and the involvement of volunteers. Lin et al. (2016) found that brightly coloured bin covers seemed to improve food waste diversion results through prompting and affect, but confirmed that personal modelling of the activity daily at communal bins was more effective.

The use of incentives as a strategy is an expensive undertaking, but this is compounded by the additional funds required for monitoring required to determine which participants deserve the rewards (Maunder, 2006; AEAT, 2006). Most reported schemes did not last beyond a year (Table 1). However, the Recycle Bank scheme in the USA (RecycleBank, 2016) and Nanjing’s Green Points incentive scheme are both smart systems using ‘credit cards’ where participating residents gain points by depositing waste, and then exchanging them for goods or services. These schemes embed a monitoring and evaluation system, and as their use extends over time, could provide opportunities for the much-needed studies on long-term effects and durability of incentives schemes, including variations against demographic parameters.

### *1.5. Motivating factors in recycling*

Incentive schemes contain complex elements, and it is difficult to isolate the effectiveness of the constituent parts. An analysis of the recycling behaviours of residents does not immediately reveal the aspects of the scheme that elicited each behavioural type. For instance, determining how much of these effects were due to the introduction of the scheme(s) and associated infrastructure, the financial reward, communications, feedback or local outreach workers) (Timlett and Williams, 2008).

A UK study showed that recycling attitude is a major determinant of recycling behaviour and that the attitudes are influenced, firstly, by appropriate opportunities, facilities and knowledge to recycle, and secondly, by not being deterred by operational issues of physically recycling (e.g. time, space and convenience) (Tonglet et al., 2004). However, other studies show that a positive attitude towards recycling identified through questionnaires and interviews does not necessarily relate to actual levels of recycling. Candidate motives for participation need to be explicitly assessed in recycling programs, e.g. financial incentives versus environmental concern or social norms (Dahlen and Lagerkvist, 2010; Timlett and Williams, 2008).

Hage et al (2009) indicated that both economic and moral motives influence household recycling rates in Sweden, but the latter much less. Gonnerman et al. (2000) found that more than half of residents (51.7%) return empty containers to shops or deposit centres to claim the deposits on them. This behaviour corresponds to the classic rational actor theory of economics, which suggest actions are driven by net gain.

Social norms can also play significant roles in motivation. Schultz et al. (2002) refer to several studies, concluding that there is a positive correlation between recycling and respondents' beliefs about the activities of others. High participation rates can also encourage more residents to join in recycling (Tucker, 1999). Barr et al., (2003), stress that social norms are particularly important factors in places where visibility of recycling behaviour is high.

Habit has been proposed as a significant factor in recycling literature. Knussen and Yule (2008) found that lack of recycling habit contributed significantly to the variance of intention to recycle, and moderated the attitude-intention relationship. Ittiravivongs (2012) researched the impact of habit on household waste recycling behaviour in Thailand with personal interviews, and found that habit was the second largest factor, after recycling intention.

Most recycling behaviour motivation studies have focused on recycling waste generally, not food waste in particular. Separately, there is paucity of information on motivation of financial incentives for household recycling. Thirdly, no studies explore factors leading to long-lived effects (durability). The work reported in this paper aims to contribute to these three gaps in knowledge by exploring a case of a successful, long-lived food waste incentives program. The findings will be used to design a more focused and deeper descriptive case study to follow, which should itself reveal key factors to consider in the field and in theory building.

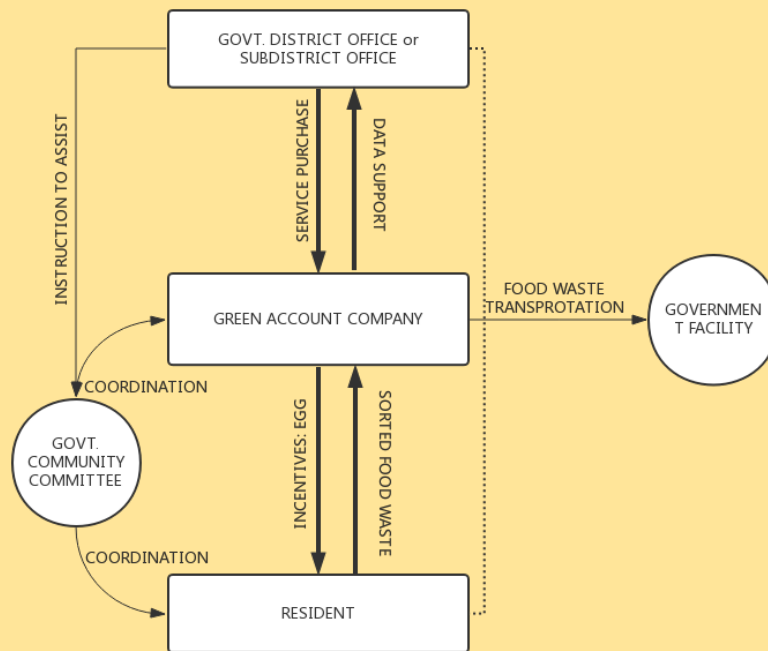
## **2. Back ground**

### *2.1 Waste management in Nanjing*

In 2013 the Nanjing Municipal Government launched a demonstration waste sorting program known as the Nanjing Green Account scheme, in which residents gain electronic points if they sort their food waste into designated containers separate to other waste. ('Dry' recycling such as plastic bottles, card and paper have a sell-on value and are not common in the waste.) Points are later exchanged for goods or services. City wards entered into a business agreement with Company A in a Public-Private Partnership, at roughly 20 RMB (\$2) per household per year. As shown in Figure 1, Company A is then responsible for publicity of the scheme, food waste collection, sorting operations on site, and transportation to further processing sites. Company A must cooperate with lowest level of the government - the Community Committee. In China households are in informally arranged compounds of 300-20,000 households, fenced and gated and with communal gardens and waste facilities, and each is allocated to a Community Committee which often as an office based on site. There were twenty-three communities (twenty thousand households in total), in Nanjing's pilot scheme, of which 6,000 households presently participate in the Green

Account scheme at a frequency level of sorting their food waste for 20 days or more each month.

Figure 1: Schematic diagram of the main stakeholders in the Nanjing incentives food waste sorting scheme.



#### 2.4. The Exploratory Case: “Community Fifteen”

Ward B is located in a suburb of Nanjing. Most of its communities are re-settlement residential areas, i.e. the residents have been moved there en masse from previous settlements in urbanization programs. Our case, which we denote Community Fifteen (C15), is typical of resettlement communities in Nanjing, and Table 3 shows its social demographics. Note that more than half the population are older than fifty and most (60.5%) have low education (ending at primary or junior high school).

Table 2. Social demographics of Community Fifteen

Total Households	1296
Number of buildings (Style)	36 (6 floors high)
Age of residents	Number
0-19	372
20-49	617
50-59	430
>60	613
Male: Female	34:43



Education of residents	Number
Primary School	419
Junior High School	930
High School	673
College Degree or above	249
Total residents	2271
Housing Price( RMB m <sup>-2</sup> )	13000-15000

### 3. Methods

For the research objective of identifying key factors in the success of the scheme, a grounded approach was chosen within an exploratory case study methodology. Grounded theory implies that the researcher goes into the field without preconceived ideas about what the findings should be (Babbie, 2010): a grounded approach is slightly different in that it allows pre-considered candidate concepts to be brought into the data collection phase as background material to raise receptivity, without using them to construct rigid framing for the data. Thus, for example in interviews, open questions were used first to elicit local responses without bias, and then followed by closed questions to check for presence or not of candidate concepts. Similarly, observations were focused on discovering key themes first, and then checking for presence or not of candidate concepts. Data collection included walk-through surveys, non-participant observations of the related activities and community activities in the public areas, notes on the relevant facilities available, and then interviews of residents, community committee members and company staff both in the field and central office. The company also provided data on participation rate and tonnages of waste collected, and various sources provided basic demographic data and historic waste data.

This particular community was chosen from the twenty-three available because it had been running long enough to establish the scheme's success, yet had no atypical demographic characteristics, and had stakeholders who were indifferent to the study taking place. The boundary of this exploratory case study is the residential community and the directly involved stakeholders of that community including the residents, Company A, and the Community Committee, within the 22-month period of the scheme. The following specific methods were carried out to obtain a range of data collection opportunities.

#### 3.1. Observation and notes about the Green Account scheme in the field

Non-participant observations were employed in May and June, 2015. The observers stood near the daily food waste sorting facility to watch the workers' and

residents' behaviours. Secondly, the 'hardware' of the food waste sorting schemes was noted, including waste bins, scales and cards readers. Thirdly, semi-structured interviews were used to initiate general information from the workers and residents (given in Supplementary Materials), and finally, observation was used to note the monthly egg exchange activities, and more generally the workers' and residents' general behaviours on site.

### 3.2. *Quantitative measures of behaviour*

Some parameters were identified for measurement as a means of ascertaining the success level of the scheme. These were participation rates, weights of waste and contamination of the food waste bins, described below.

#### 3.2.1. *Participation rate*

Self-reported participation rates are used by some researchers (Gamba and Oskamp, 1994; Thomas, 2001), but others criticize their validity for practical planning due to documented inconsistency with actual behaviour (Perrin and Barton, 2001; Williams and Kelly, 2003). In the Nanjing model, every household can register one smart card and receive one point each day they empty their sorted waste into a designated bin, manned 6.30-9.30 am. The participation rate ( $R_{AU}$ ), measured in family units participating per month (at least 20 days), was thus chosen:

$$R_{AU} = \frac{N_U}{N_{AH}}$$

$N_U$ : Number of participants in Community (defined as participating at least 20 days per month)

$N_{AH}$ : Number of all the households in Community

#### 3.2.2 *Capture Rate*

In this study the waste category of interest was household food waste and the extent to which it was sorted by residents from the general residual waste into the special bin for food waste. A suitable indicator for this is the Capture Rate (WRAP, 2010), also denoted 'Source Sorting Ratio' (Dahlen and Lagerkvist, 2008), calculated as:

$$FW_{CR} = FW * 100 / \text{Total FW}$$

Where Total FW = (Ratio of food waste in All waste) \* All waste and FW denotes food waste (with any contamination removed).

#### 3.2.3 *Contamination Level*

The contamination levels were monitored regularly by the company staff, and

reported in terms of the proportion of deposits contaminated against those which were not. Although the only contamination was usually the bag left on the waste, of negligible weight, the maximum contamination level was recorded e.g. 1 bag in 100 deemed 1% contamination.

### *3.3. Interviews of different stakeholders*

In-depth semi-structured interviews were used with the boss and workers of Company A, the leader of the Community Committee, regarding details of the scheme operation, interactions between stakeholders, challenges, and overview of any relevant data available e.g. demographics or derived from cards. A structured interview with a convenience sample of 35 participating residents, identified after depositing their waste, focused on communications, suitability of scheme to local context, opinions of the scheme, and motivation and challenges faced to initiate and continue participation. A further convenience sample of 19 non-participants were interviewed, identified by the Community Committee. This approach was deemed appropriate for a non-descriptive, exploratory study. All three questionnaires are given in full in the Supplementary Materials.

## **4. Findings**

### *4.1. Observations and enquiries of the Green Account scheme*

Traditional black bins for normal waste were located at the outside of each building. The sorted food waste had to be deposited at a specific time and place in order to obtain Green Points: 6:30 - 9:30 am in a central area, like a square, which is near the main gate. Many residents arrived early and have conversations with each other while lining up. When the company staff arrived, each person placed their bag of food waste on a portable scale for recording, and received one Green Point on their electronic smart card. The same staff regularly came, and knew the residents individually, and relaxed and friendly exchanges between them were the norm.

There were two types of waste bins observed: several green ones for the food waste and one yellow one for the empty plastic bags. Residents open their bags, empty out the food waste, and then place the bag in the yellow waste bin. On visual inspection there was no contamination of the food waste at all. A company staff member checked now and again, and if necessary removed a plastic bag from it – typically 2 per 200 participants daily. They also used a rag and water to clean all the food waste bins several times each morning. There were dedicated trucks for the collection and transportation of the food waste, noticeably different to those for the non-food waste.

Near the bins was a very large poster, showing the weight of food waste sorted in the previous month, and the number of green points awarded for each apartment

number. The best households were denoted with red text. A group of middle-aged women exercise in the nearby square by slow line-dancing (a common activity in China) after they have completed their food waste sorting. The square is close to the common residential recreational centre where such activities often take place. To the researchers, the waste sorting activity did not stand out as an activity separate to other community activities taking place.

Once a month, the residents exchange Green Points for eggs, dish washing detergent, or services like sharpening knives or repairing insect screens for windows. Three Green Points can be exchanged for one egg, with a maximum of ten eggs per month if they do the sorting every day. The residents queue to exchange their points for the eggs. While queuing, they talk a lot with each other, including about how many eggs each is getting: we heard that some residents really care about the number of eggs they get, and some who do not sort waste are interested to get eggs.

Company records showed that 32% of the residents participated more than 20 days in March, 2015. Twenty-six of the 32% did not miss any days. Contamination levels were reported at consistently less than 1%. Data also showed an average of 453 kg day<sup>-1</sup> of food waste collected that month, which scales up to 166,000 kg annually. We can gain a rough measure of the Capture Rate  $FW_{CR}$  at 30%, by using government data showing 2271 residents produced 359 kg per person of total (mixed) waste in 2014 (Nanjing MSW pollution control information notice, 2014), giving a total of 815,062 kg, and published data from elsewhere on Nanjing's average food waste ratio of 70.2% (Tai et al., 2011).

Interviews from Company A revealed that the main motivation of the company is economic benefit: government payment in exchange for meeting threshold participation rates. The company is also interested in obtaining longer-term and further contracts, and thus is willing to reflect on any improvements needed.

The company considers the residents to have low awareness of or inclination to sort food waste, and thus that incentives are needed to start and to continue. They consider that eggs are used daily by many and in demand: thus they are a good choice for the scheme, especially for low income residents. They have a unit focusing on scheme promotion, distributing leaflets to residents and occasionally organizing extra events including door-stepping for low performers for further information and persuasion.

The staff feel they provide good services to residents, reliably attending even during bad weather. They feel their incentives and services, including infrastructure, are more useful to the residents than straightforward information and indirect education which are common elsewhere.

#### *4.2. Perspectives of the Community Committee*

The Community Committee (CC) was instructed to implement a waste sorting scheme by its ward office, but already had an overlap of interest. There were previously problems from waste in the community, such as bad smells from the waste bins, waste left on the ground and leaking, and flies nearby. This situation caused residents to prefer the waste station to be moved away from them, and for related conflicts to arise. The ward office wanted to start the sorting, but they had no experience. They did not know how to make residents understand the benefits, nor have manpower to allocate.

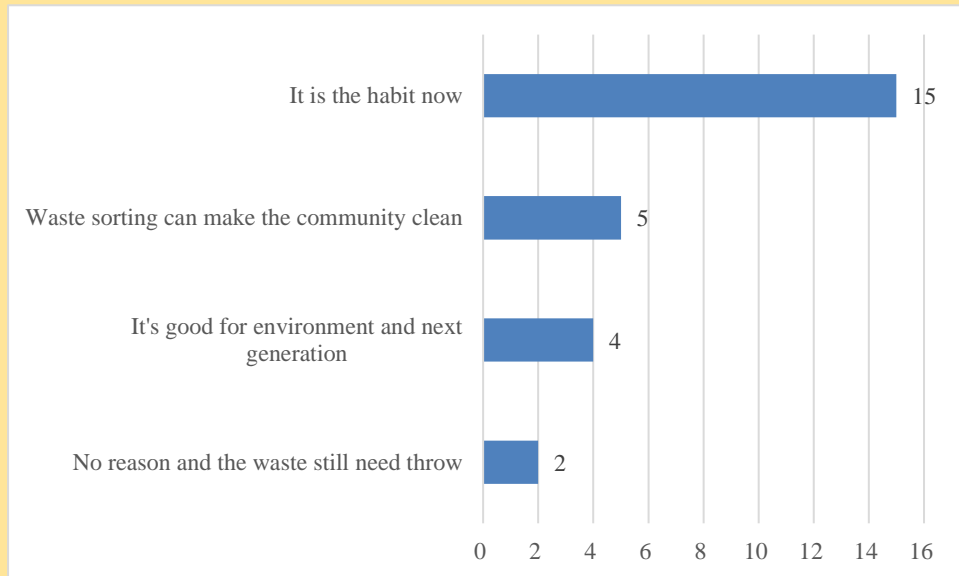
After the Green Account scheme was implemented, the CC perceived that the community became cleaner, that bad smells and leachates had abated, and the number of flies reduced. There were no conflicts between residents about the siting of the waste bins. At the start of the scheme the Community Committee informed residents through standard means –posters, blackboards and fliers in mail boxes – and got actively involved with teething problems.

#### *4.3. Responses from participants on motivation factors*

A non-representative, convenience sample of 35 participating residents were interviewed to explore motivation factors for starting and continuing to sort their food waste. Most of them (26/35) were older women with a low education level. They all thought the eggs were the best of the rewards, and ten eggs per month was reasonable.

When asked if they were likely to continue or not if the incentives were stopped, most of the residents (26/35) said they would continue, and only a few (5/35) that they would stop. The others said it depended on how much time they had, relative to the manned hours. Those who said they would likely continue, were asked why. Three reasons were given: that waste sorting had become a habit by this time (15/26), that waste sorting would keep the community clean (5/26) and that waste sorting is good for future generations and the environment (4/26) (see Figure 2).

Figure 2. Responses of participants to the question: What is the reason you say you would continue to sort food waste even if the Green Points scheme stopped? Note that the numbers are only indicative as a non-representative convenience sample was used.



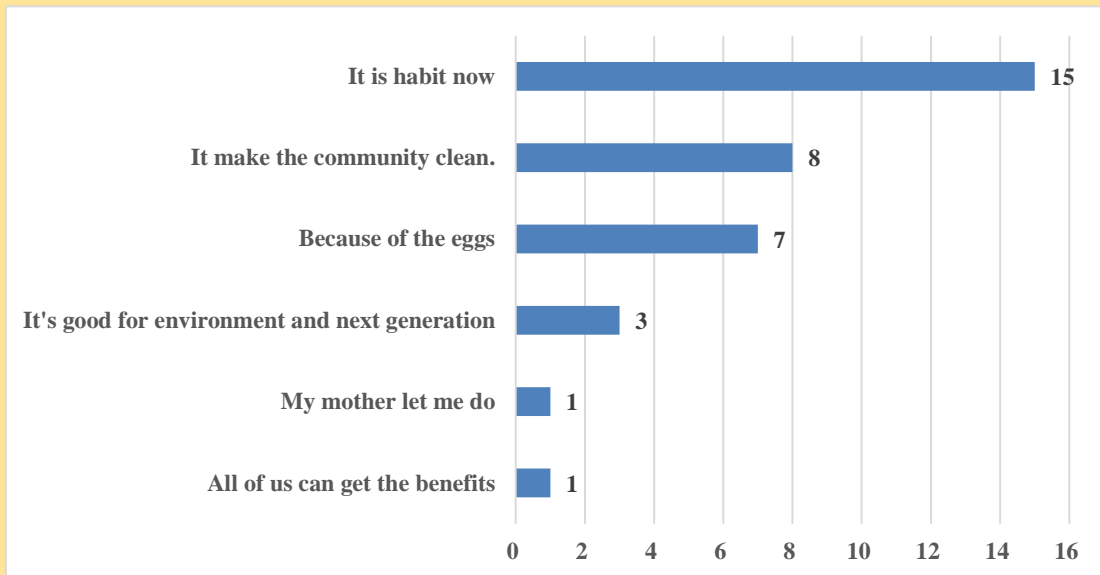
When asked what motivated them to initially begin to sort food waste, the two main responses from the convenience sample were that the eggs incentive is the main motivation (15/35); because their friends, families and neighbours were doing it, (8/35) (see Table 3).

Table 3. Responses of participants to the open question: What motivated you to initially start sorting your food waste? Note that the numbers are only indicative as this is a qualitative study and a non-representative convenience sample was used.

Result of interview	Number of residents (Percentage)
Because of the eggs incentive	<b>15</b>
Because my friends, families and neighbours do it	<b>8</b>
Don't know, or didn't answer this question	<b>5</b>
My mother makes me do it	1
I feel the waste sorting is a fresh/new thing	1
It makes the community clean	2
The waste bins are clean and pleasant	1
The leaders (community committee) expect it	2

When asked why they continue to do the food waste sorting, the main answers were that it is now a habit (15/35), it makes the community clean (8/35), and only thirdly, for the eggs incentive (7/35) (see Figure 3). Comparing this to the initial motivations, in Table 3, the eggs incentive greatly decreased to seven residents, and habit was a dominant response. This is consistent with responses to the question about whether they would continue if the scheme stopped (Figure 2), and altogether implies that although the eggs incentives got people started, habit dominated later. Secondly, the motivation of a cleaner community appeared to increase, implying that such a perception was significant to the residents.

Figure 3. Responses of participants to the open question: What motivates you to continue to sort your food waste? (Note that the numbers are only indicative as this is a qualitative study and a non-representative convenience sample was used.)



#### 4.4 Responses from non-participants on barriers to participating

Eighteen residents (male: female 4:15) who did not participate were asked what the biggest challenge was for them, and then what they company could do to motivate them more, as open questions. Thirteen cited inconvenience (waste station was too far or manned at inconvenient times): five did not believe the scheme had meaning (food would be mixed back; landfilled; could not be successful). Changes that could influence them were cited as change of manned hours and/or distance (10); if other residents did a better job (3); others (5).

## 5. Discussion

Thirty-two percent (32%) of the residents did food waste sorting at least 20 days per month, and roughly 30% of the food waste was diverted for recycling, with contamination at <1%. This capture rate is higher than obtained in Taiwan (Chang et al., 2013), USA (Levis et al., 2010) and Sweden's food waste sorting schemes (Bernstad et al., 2013; Bernstad, 2014; [www.umeva.se](http://www.umeva.se)) and with a lower contamination level. This incentive scheme has lasted for 22 months with stable participation rates and tonnages of diverted food waste - longer than all the incentive schemes found in our literature review. Thus the authors conclude that this case is a successful incentive food waste sorting scheme.



The main stakeholders were found to be the residents, community committee, ward government office, and the company. The ward office was the driver of the policy implementation and provided funds for it, but did not provide guidance on who should take what roles other than that the community committee must show compliance eventually. The community committee thus was under pressure to implement waste sorting, but did not have enough experience, time, or manpower; the company had experience and manpower and desired business growth. Although the government in China plays a dominant role in organising collecting, sorting, transporting and treating of waste (Huang et al., 2014), almost no successful food waste schemes have been reported, possibly because most rely on an information strategy alone such as the provision of mail shots, banners and posters (Dai et al., 2016).

Besides this lack of expertise, the interviews of residents and the community committee showed that the government is not perceived as consistent or persistent in implementing its waste sorting policies, but rather as tending to discontinue a scheme if it does not yield expected results quickly. This negatively affects the waste sorting enthusiasm of residents and reduces their willingness to participate: they believe the programs are only tokenistic. Building community trust has been noted in some grey literature as an important component of some community-based behaviour change approaches: Bradford Environmental Action Trust first assisted a local community to carry out environmental clean-ups to improve appearances before their main intervention to increase participation in recycling (Brook Lyndhurst & Waste Watch, 2007).

The need to recruit specialist expertise and brokers has been commented on previously (Brook Lyndhurst & Waste Watch, 2007). In Europe and North America private enterprises and non-profit organizations have taken on roles as owners and/or operators of successful residential source separation programs, bringing in specialist knowledge to develop the recycling strategies and plans, and to broker between the government and communities (McDougall et al., 2001). Xu et al (2016) reported the usefulness of a government-approved NGO broker in Shanghai which helped to co-develop new boundaries for stakeholder responsibilities to produce a large, successful, residential food waste sorting program in urban high-density housing area. In this study,

the company managing the incentives scheme and related infrastructures appears to have provided an important brokerage role between the government and residents. The resulting partnership appears to have worked because the company was able and willing to fill in various missing roles as needed, making efforts to respond to residents' sensitivities such as choices of incentives, bin cleanliness, and interest in social interaction. (It should be noted that the facilities to process any food waste were the responsibility of entirely different parties, also with complex role boundaries, but these were already established and not found to be relevant in this case study.)

Interestingly, our interviews revealed that the government and company had no confidence that residents would sort food waste without 'something in return', and were thus very comfortable with the concept of an incentives scheme. Our results confirmed that this was the highest cited reason for starting to participate in this community. However, the results also revealed social influences as important (Table 3) and we know from studies in Shanghai that non-incentivised schemes involving the use of volunteers also worked because of social influence (Xu et al., 2016; Dai et al., 2016). This then raises an interesting question for policy and implementation: is there any way to discover what proportions and type of residents are motivated to begin a new behaviour via incentives versus social influences, and can this be made predictive.

Concerning the question of what motivates continued participation after 22 months, our exploratory findings revealed that the incentives were not key (Figure 3). This is counter-intuitive to the policy makers in China, who model the residents as 'rational actors' in the economics sense of requiring tangible benefit for extra effort. But the residents said the habit is embedded now, and is not only their main reason to continue but also why they suggest they might continue if the incentives were removed (Figure 2). Habit of recycling has been noted to be a significant factor in various studies, but usually psychology-based rather than operational waste management. The residents in this case study typically sorted their waste almost every day, for 22 months: a repetition of hundreds. The authors suggest that higher levels of recycling habit would probably reduce the impact of other, intention-based factors such as social influence, personal preference, and expectation of the consequences. Further field studies separating and

quantifying these factors to make them useful in predictions and planning would be valuable.

The second reason given for continuing to sort waste is very interesting and also counter-intuitive: residents feel their environment would be cleaner. In fact, none of the contracted or related activities targeted community cleanliness, and the researchers could not ascertain any clear indication of any such change. It thus seems debatable as to whether this extra cleanliness is real or perceived: it could be more related to emotion, which is a factor in some behaviour change frameworks. The residents in this study certainly made many passing comments on their dislike of dealing with the 'dirtiness' of waste, which is consistent with that idea. We found no studies specifically examining site cleanliness with respect to recycling, but after a thorough search it two minor mentions were found. In a study of factors influencing waste separation among householders in Uganda, commitment to a clean environment was the main motivation (45%) reported for waste separation (Ekere et al., 2009). And when asked about wider benefits of recycling in the UK, some residents commented that they had noticed an improvement in street cleanliness (Phillips et al., 2011). Although our own research group has heard 'cleanliness' occasionally reported informally or anecdotally in several previous studies in the UK and China, it was always ignored because those studies used waste management frames, and emotion or perceptions were not included. This case study shows that cleanliness clearly deserves more investigation: it might be an important factor in the field regardless of its lack of connection to current waste management models.

The main reasons given for non-participation, and for company changes, were related to inconvenience – of the manned hours, and the distance. A further few mentioned no belief in the program's success. Such answers might truly represent reasons, or might be excuses made up at the time of the interview: it is very difficult to tell from an interview. However, these particular inconveniences can be specifically tested in further studies.

## **6. Conclusion**

This study shows that Nanjing Green Account is a successful incentives scheme for food waste sorting and has lasted longer than most documented before it. The high capture rate (30%), extremely low contamination level (1%) support this claim.

The main stakeholders all identified barriers between them that hindered implementation, such as low belief of serious intent or capability in each other to achieve success; of lack of appropriate expertise and pathways forward; of low concern for the principle of sorting food waste; and of uncertainty in how to motivate the residents. The use of a company as a broker between government agencies and the residents seemed to successfully resolve those concerns, and the authors feel its flexibility and willingness to reflect on local sensitivities was key.

This exploratory case study found evidence that even though the scheme was incentives-based, social influences were significant, and should not be overlooked in future planning. Habit became a significant reason to continue participating, possibly overtaking social norms and the incentives themselves, and may allow incentives to be removed or reduced. These factors have the potential to significantly affect the success, viability and practicality of future recycling schemes and should be studied further, and over time. Some of the principles are general and thus findings might be transferable to other behaviours.

A new factor of perceived site cleanliness was found to be important in this study. It is interesting both in operational terms where it could be easily implemented to improve or drive success in recycling, and in behaviour change studies to understand its psychological origin and relationship to other determinants. Similarly, specifically mentioned inconveniences of distance and manned hours of the waste station should be investigated further, and if possible relative to the other factors.

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