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Information strategy failure: personal interaction success, in urban residential food waste segregation

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ABSTRACT

Direct measurements were taken of residential food waste sorting in a sample from over 5000 communities (5 million households) assigned to a pilot program delivered by government branches in Shanghai which relied on an information strategy for implementation. The results are compared to a population of N = 36 similar communities (36,000 households) assigned to a different program which involved considerable personal interaction. The results show that the information–based program communities did not noticeably sort their waste, whereas those given personal interaction approaches were very successful, with purity rates of 95%(8) and extra costs of about 50 RMB (8 USD) per household. This is a rare direct comparison of two different programs at such large scales, 6–36 months after launch, and suggests that personal interaction approaches should be considered by policy makers. Qualitative key informant interviews yielded data on each program's activities, which provide suggestions for further studies of the underlying behaviour change determinants involved.

1. Introduction

In this paper we would like to challenge the notion that provision of information alone in a non-personal manner has a significant effect on pro-environmental behaviour change. We compare food waste source-separation results of a sample from 5075 communities (containing circa 5 million households) in Shanghai which used a standard government information campaign to those of communities which used more personal interactions.

Governments around the world routinely use information provision as a major element of the implementation of their policies, including those relating to sustainability. A bedrock of practice in public administration is the assumption that the provision of information leads directly to public understanding and thus the embedding of the policy, albeit with varying degrees of effectiveness. Two other routine practices are the use of instruments which affect financial domains of the public (e.g. subsidies, fines, taxes), and legislation (e.g. regulations, enforcement).

The focus on finance, legislation and information stems from traditional economic models based on rational choice which assume that consumers make choices by calculating the costs and benefits to them in each situation, optimizing their own personal gains. Although the assumptions in these models have been deeply challenged in various fields (see Jackson, 2005 for an overview), rational choice approaches remain very popular due to their simplicity, their widespread use by governments, and their foundations in economics which as a subject has historically elicited a remarkable degree of credibility.

Whether concerned with pro-environmental behaviour change or other policies, the policy interventions which follow traditional rational choice models are relatively straightforward: to ensure that consumers have sufficient information to make informed choices, and to make more visible any 'social costs' and government focus areas so that those are taken into account at the same time (Jackson, 2005). In our example in Shanghai to initiate a policy on food waste source segregation, residents were reminded that it is good for the environment, and told to do it. One reason for the popularity of information strategies is how easy they are to carry out (Bator and Cialdini, 2000). However, ease of delivery does not necessarily equate to saving of money or cost-effectiveness (Pope, 1982). Most programs about sustainable behaviour in the 1970's to 1990's focused on information strategies including media advertising and the distribution of printed items (Mckenzie-Mohr, 2000) and different ways of presenting information were trialed,

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but with minimal measurable influence (Hayes and Cone, 1977; Heberlein, 1975; Kohlenberg et al., 1976; Winett and Nietzel, 1975).

Although lack of information and knowledge has been identified to be the main problem of some recycling schemes (NCC, 2003; WCC, 2003, 2004), effective ways of providing it are difficult to find, and there are many documented failures of information strategies (Bickman, 1972; Costanzo et al., 1986; Finger, 1994; Geller et al., 1983; Hirst, 1984; Hirst et al., 1981). More specifically, the most recent IPCC report presents studies that indicate that the provision of information alone, or awareness creation by itself, is unlikely to bring about significant changes in targeted sustainable behaviours (IPCC, 2014 pg 389, including Jackson, 2005; Kollmuss and Agyeman, 2002; van Houwelingen and van Raaij, 1989).

For example, Geller et al. (1983) found no impact on water consumption reduction by delivering booklets that had information about water use and energy use together with the methods of water conservation. A study of the impact of the President of the USA going on television to specifically encourage residents to turn down their thermostats to reduce energy use showed no reduction (although an increase in awareness was seen) (Luyben, 1982). In another study, Geller (1981) indicated that an information based workshop was not effective in facilitating residential energy conservation, despite both knowledge and environmental attitudes increasing.

This evidence points to a gap between rational actor theory and real life: awareness raising does not equate to changed behaviour, and this has been demonstrated by workers from different disciplines such as sociology, sustainability and social marketing (De Young, 1993; Geller et al., 1983; McKenzie-Mohr, 2000; Schultz et al., 1995; Staats et al., 1996).

A meta-analysis was more recently conducted across numerous research publications reporting results of different types of interventions, and concluded that providing information alone could not generally result in promoting behaviour change in energy conservation (Abrahamse et al., 2005). It should be noted that information campaigns have been found to be useful under certain conditions, including when there are no severe external constraints (such as lack of facilities), and when it is convenient and not costly for individuals (Steg and Vlek, 2009). If key information is missing then residents clearly need to obtain it, so it is logical that some studies find it is useful. But the effectiveness of an information campaign is not consistent with the amount of information: more information is not always better, due to it potentially causing feelings of helplessness, and even lack of control (Jackson, 2005; Kaplan, 2000). Levin (1993) proposed that more information could actually raise concerns, as well as feelings of helplessness. New work suggests that information which does not roughly match the values of the recipient can be met with increased resistance (Crompton, 2010). Thus, it is clear that information strategies are not necessarily simple or effective for behaviour change, and may actually be problematic.

It is now generally acknowledged by researchers that other factors have significant influence on such behaviours, such as personal motivation, collective practice, peer pressure, habit, subjective norm, and social context, and that these can cause policy failure if not taken into account. Policy-makers increasingly realize that they need to find policies which support behaviour change via these areas, and not use information alone (NCC, 2003, 2005) and the UK has a government-funded unit dedicated to developing evidence and expertise in this (Eppel et al., 2013).d

With such a large number of studies suggesting that strategies focusing on information are not generally effective for behaviour change, it may be puzzling why they are still used repeatedly by governments around the world. The answer may be that most of those studies focus on academic approaches and interests rather than what is needed for evidence for policy. The academic studies are usually artificial with respect to common practice. What governments need are strategies that are scalable and not difficult to implement. There is a big step from the studies carried out so far, with small samples and sometimes complex interventions showing proof of concept, to city-size demonstrations implemented through chain of command. A recent article in the journal *Science* suggested that there is a need for a swathe of intermediate-scale research, with more concerted efforts by researchers to work in tandem with policy makers and business to do the bridging work needed to translate the insights from behaviour science into scaled interventions which are effective (Allcott and Mullainathan, 2010).

In this work we contribute to that type of study called for – medium-scale and pragmatically driven research on behaviour change interventions – by studying sets of residential gated communities in Shanghai (commonly 500–4000 households each) which have been inducted into the government's food waste source separation program either through standard information strategies or through personal interaction approaches brokered by a non-governmental organization (NGO). We establish through direct measurement of the waste the level of waste separation occurring in the two approaches, and compare the types of implementation activities used in them.

2. Background

2.1. Shanghai's food waste source segregation program of 2011

Over 23 million people live in Shanghai, generating more than 20,000 tons of household waste every day, putting great pressure on waste treatment facilities. Official figures for waste in 2013 indicated that 51% is landfilled, and 23% incinerated, with only around 16% recycled or composted (Shanghai Municipal Environmental Protection Bureau, 2014). This waste generation is expected to keep growing annually due to the urbanization program in China which aims to bring more people to the cities, as well as due to high economic growth (Liu and Wu, 2011), thus resulting in more landfill and incineration facilities (Hoornweg et al., 2005). However, the composition of the household waste in the city is more than 70% food waste (Tai et al., 2011), which causes problems for both landfill and incineration (Chai et al., 2010; Zhang et al., 2008; Zhao et al., 2011). In order to reduce these problems, Shanghai Municipality in 2010 proposed a 5% annual reduction target for waste treated by incineration and landfill, and set up infrastructures such as new pilot collection systems and facilities to support the diversion of food waste from residential waste.

Significant funding was also invested at the level of residential communities. Although it is a metropolis of incredible scale, Shanghai is in fact composed of approximately 24,500 residential communities which are usually informally walled and gated, containing communal gardens and parking, and with dedicated cleaners and gatekeepers. This makes them useful as effective 'laboratories' for experimental studies of various interventions, with potentially transferable knowledge not only about improving residential recycling but also more generalizable behaviour change lessons. The timely introduction of city-wide, city-funded pilot programs across Shanghai made the city an ideal place for research studies: communities and sets of communities can be units of assessment, unlike other cities where boundaries of garbage truck routes and movements of residents and their wastes are not contained.

The number of buildings in a community can vary from just a few up to around a hundred, with modern post-2000 buildings having 30+ floors, 1980–90 buildings having 6–15 floors and the most common, pre-1990 buildings, having 6 floors, typically. The

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communities are generally classified into two types: those with 6 or less floors and no elevators, and those with elevators, up to any height. There are “waste stations” at convenient locations, usually comprising of a building about the size of a two-car garage which often includes a sink area for the cleaner to operate from. Doors along the front sometimes include hatches which are left open for residents to pass waste through to drop into bins. In larger communities there are several waste stations, and some have additional bins stationed along the road side to reduce distance for residents to walk. Residents bring their waste to the bins typically when making the journey down from the high rises for another purpose, and thus more commonly before and after work hours.

Residential communities are effectively at the level of the lowest branch of government. Each has an official Community Committee (CC) which works together to make the best decisions for the residents, in line with activities taking place at the next higher level – the formal Street Committee, which typically oversees 20–25 communities (and which thus might be most closely related to a ward level in other countries) – and which is itself answerable to the District Committee in one of the 17 districts in Shanghai. Although all districts are under the auspices of Shanghai Municipality, they are often encouraged to develop local approaches to policy implementation. Fig. 1 illustrates the tiers. As well as these government-based committees, some residents also have their own Residents' Committee. Either the CC or the Residents' Committee might have responsibility for instructing the group responsible for maintaining the grounds and premises, denoted the Housing Association, which hires the cleaners and guards and arranges waste collections.

From the end of 2010, Shanghai Municipality has focused on diversion of residential food waste. Each district invited communities to be pilots, with the numbers increased from 100 to 5000 over three years. Funding was available to reconstruct the waste stations in the communities, distribute free plastic waste bags or kitchen caddies to residents, and publish and disseminate information through the standard government channels down to the Community Committees, who would then coordinate implementation on the ground. This often involved longstanding volunteer groups of Party members who were generally available as volunteers for a variety of tasks, and block leaders who regularly acted as liaison persons between the Committee and collections of families, e.g. in a particular building or block.

Shanghai Municipality, like other government bodies in the world, mainly relied on information strategies to implement the food waste source segregation program. However, a small number of Street governments also invited non-governmental organizations (NGOs) to participate. Such organizations are only recently becoming established in China, especially for pro-environmental behaviour work. The NGO approach, in this case, was more interactive, and involved mobilizing residents besides the existing volunteer network, with an emphasis on relationships. More details are given below.

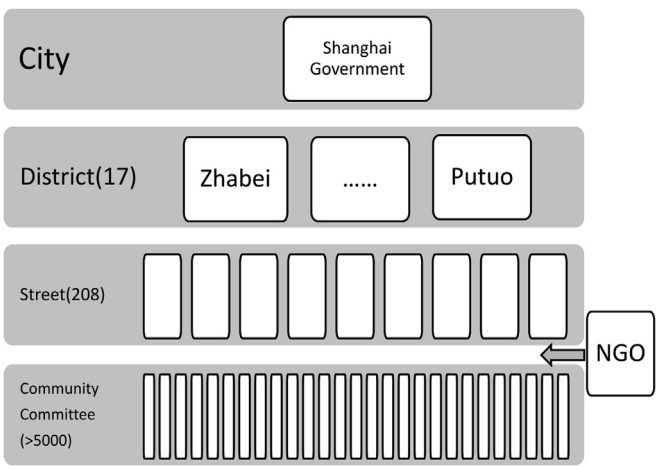

Fig. 1. A schematic of the district, D, street, S and community, C structures in Shanghai, and relative position of the NGO in this study.

3. Methodology

The approach used in this work was to consider two sets of communities – those using the standard government information strategy and those using an NGO approach – and to obtain direct measures of the success of the source segregation program on each via compositional analyses of their waste. Data would also be collected on details of the activities used in each set of programs.

3.1. Choice of indicator of recycling behaviour

There are many different methods to measure the waste recycling behaviours. Self-reported participation rate are used by some researchers (Gamba and Oskamp, 1994; Thomas, 2001), but other studies criticize their validity for practical planning due to the documented inconsistency between self-reported behaviour and actual behaviour (Perrin and Barton, 2001; Williams and Kelly, 2003). Some researchers make use of counts of residents participating compared to those who don't, known as participation rates, but these aren't practical for measuring multiple family units (Dahlen, 2005). Recycling tonnages, and recycling rates (or the source separation ratio) are both widely used (Berg, 1993; Bernstad et al., 2013; Dahlen, 2005; European Commission, 2004; Mee et al., 2004; Schultz et al., 1995). However, in Shanghai the waste collection vehicle is daily but irregular, meaning synchronized 24-h comparisons are impossible. Furthermore, recycling rates reported in other countries usually assume minimal contamination, which is often true for dry recyclables like plastic bottles and cans, whereas our preliminary studies showed that contamination rates were often 35–65% for food waste. Clearly, contamination levels are important to the success of sorting programs (Hoornweg and Bhada-Tata, 2012; Kurian, 2007) since if they are too high the food waste would be refused at the upstream processing facility. From our own preliminary studies we knew that food waste composition in unsorted residential waste in Shanghai was 65% (4) – and so it was decided that the success of the programs could be determined by analyzing the waste compositions of the sorted and unsorted waste. The measure used, $R_{FW/FW}$, is termed “purity of recyclables” (Berg, 1993; Bernstad et al., 2013; Boonrod et al., 2015; Dahlen, 2005; Timlett and Williams, 2008) and measures the percentage of food waste in the two types of bins:

$$R_{FW/FW} = \frac{FW_{ss}}{FW_{ss} + NFW} \quad (1)$$

$R_{FW/FW}$: Percentage of waste in the food waste recycling bins which is (sorted) food.
FW_{ss}: food waste source separated by residents.
NFW: Non-food waste.

In other words, each community had ‘food waste’ bins and ‘residual waste’ bins, and we could look at the amount of food waste which ended up in each. A secondary and complimentary measure could then be made, of the amount of food waste which had *not*

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been sorted correctly, and thus ended up in the residual waste bin, $R_{FW/RW}$:

$$R_{FW/RW} = \frac{FW_{unsorted}}{FW_{unsorted} + NFW} \quad (2)$$

$R_{FW/RW}$: Percentage of waste in the residual waste bins which is (unsorted) food.
$FW_{unsorted}$: Unsorted food waste.

In summary, the composition of food waste and residual waste bins were to be physically determined in each community visited, to yield pertinent information of the degree of success of the program used.

3.2. Design for representative samples

To obtain a composition analysis of the waste of a community that is representative of it is a complex task, unless large amounts of typically more than 91 kg are collected over a time period that does not cause its own bias, and on days that are not potentially anomalous such as weekends or holidays or during constructions works or house moves. In this study, however, the unit of analysis was not the community, but the *set of communities*: i.e. the sample set of those using the government information strategy (population N = 5075) and the set using NGO services (N = 37). Communities were allocated to programs through a multistage cluster random selection process, whereby each district unit randomly chose street/ward level units to then nominate randomly chosen communities from their members (Dai, 2015). This was done irregularly over a period of time between 2010 and 2013 (The exception was one community in the NGO set who volunteered for the program: they were excluded from our study, leaving us with N = 36). Of the N = 5075 communities in the full population of the government-led set, we had access to a list of n = 200 randomly chosen ones, produced using the systematic sampling method.

It was further established that all of the N = 36 and n = 200 communities had zero food waste sorting taking place before the programs began – with the exception of one community of the 200 which was then excluded from our study, leaving n = 199.

Finally, the two sets were stratified with respect to characteristics that were available which we considered to be correlated to variations in measured recycling rates. The most important of these was the time elapsed since the program launch since some researchers suggest many interventions have short-lived results (see Bernstad et al., 2013; Abrahamse et al., 2005), although we know of no rigorous studies of durability. The NGO set was more limited as it had only a subset of program start dates (e.g. none in 2010 or 2011), no semi-rural communities and no exceptionally large ones. In order to ensure that the two sets were matched and similar, government pilots were excluded in the following order: 1) all semi-rural communities; 2) those with program start dates in 2010 and 2011; 3) those with large communities over 2000 households. The remaining government pilots were then randomly culled to ensure that the proportion in the main category – program start date – was the same as for the NGO pilots. This process produced a sample of n = 42 communities, all of which we attempted to visit.

For the second set of communities, which used NGO services, the total population was N = 36 communities, and we attempted to visit every one, i.e. the full population.

As the unit of analysis was the set of communities, it was determined that each measurement in a given community did not need to be representative of that community, and thus a 'spot check' would be appropriate and expected to provide a valid distribution. From previous work we knew that the common granularity and typically bag size of residential waste meant that samples of less than 2 kg were generally unreliable for composition analysis and samples of 20 kg were, so it was decided to aim for 20 kg wherever possible but in cases where enough waste was not found on site, e.g. because the collection vehicle had recently departed, we would proceed with smaller samples but never below 2 kg.

To ensure no abnormal behaviour occurred on the sampling dates, the communities were not told that they would be sampled until after the event: they did not even know that the study was ongoing. The ethics of this were considered and agreed to be acceptable, in confidence, by the NGO director and the external researcher holding information on the government pilots.

3.3. Data collection of activities of government programs and NGO pilot programs

The two programs being studied were not designed by the researchers, but by the policy implementers. To identify the differences between implementation strategies used by government pilot communities and those used by NGO pilot communities, it was decided to carry out in-depth key informant interviews of government officers and NGO coordinators respectively, to document what elements and activities had been planned in each, and to explore their intended purpose. The interviews were recorded and transcribed for analysis, and coded for different types of activities, their personal or informational aspects, and their perceived relative contribution to the program objective. This data collection was designed to provide more detailed distinctions between the two programs, and to identify potential parameters deserving more targeted studies in further work. It was not intended to provide any detailed analysis of causal links between activities and changes in behaviour. Such analysis would require separate, in-depth, and contextual case studies to properly understand not only the intended determinants in terms of behaviour change constructs but also their actual effect in those terms. Such a study in one NGO community is in preparation, using the systematic categorisation of a theoretical domain framework (Xu, 2015).

4. Results

4.1. Composition analyses: food waste found in different bins

Of the n = 42 government scheme communities on our randomized list, we were able to visit 34: six refused us entry, and five and seven had insufficient (<2 kg) amounts of food waste and residual waste present, respectively. For the second set of communities which used NGO services, N = 36, 1 could not be located and three and six had insufficient amounts of food waste and residual waste. The data is summarized in Figs. 2–5 below.

In the government pilot communities within the food waste recycling project, the proportion of food waste (FW) in the wet waste recycling bins (WW) had a mean of 69%(17). These results are consistent with the figure of 65%(4) which we had separately established as a reference value for completely unsorted waste (from a portfolio of seventeen representative 3-day samples across five communities elsewhere, in previous studies). In the same communities, the composition in the *residual* waste (RW) bins was similar – 69%(19). In other words, the so-called recycled waste on average was not distinguishable from unsorted waste, other than being placed in a different colour bin. A two-tailed t-test shows those two distributions to not have statistically different means (see Table 1).

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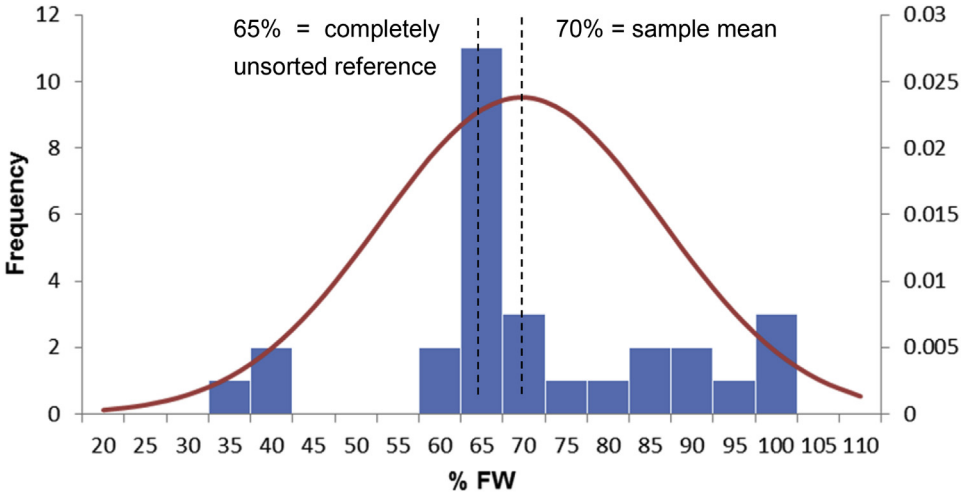

Fig. 2. Percentages of food waste in wet waste recycling bins from government pilot communities (n = 29) with a mean of 70% and standard deviation of 17%. The reference figure of 65% is what would be expected in a completely unsorted sample.

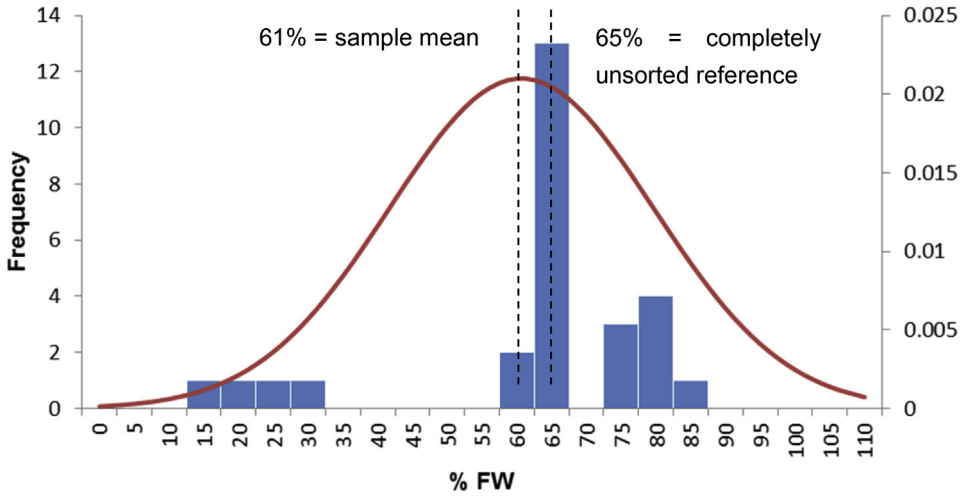

Fig. 3. Percentages of food waste in residual waste bins from government pilot communities (n = 27) with a mean of 61% and standard deviation of 19%. The reference figure of 65% is what would be expected in a completely unsorted sample.

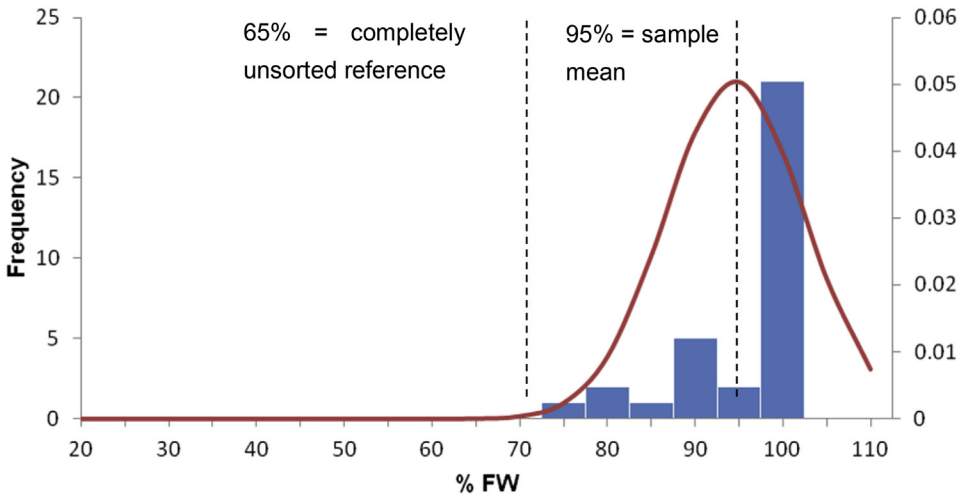

Fig. 4. Percentages of food waste in wet waste recycling bins from NGO pilot communities (n = 32) with a mean of 95% and standard deviation of 8%. The reference figure of 65% is what would be expected in a completely unsorted sample.

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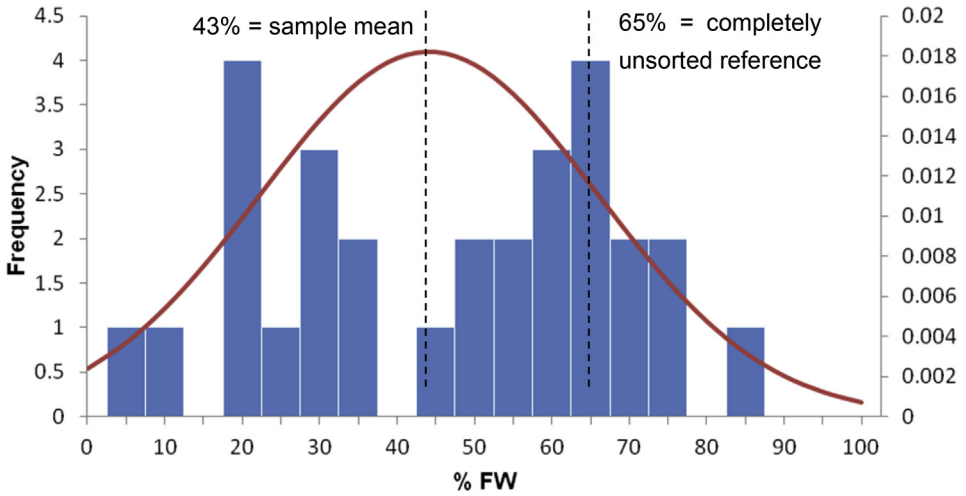

Fig. 5. Percentages of food waste in residual waste bins from NGO pilot communities (n = 29) with a mean of 44% and standard deviation of 22%. The reference figure of 65% is what would be expected in a completely unsorted sample.

Table 1
Comparison between government pilot communities and NGO pilot communities, using proportion of food waste from both wet waste recycling bins and residual waste bins.

	% FW in WW recycling bins		% FW in RW bins	
	Government pilots	NGO pilots	Government pilots	NGO pilots
N	29	32	27	29
average	70%	95%	61%	44%
SD	17%	8%	19%	22%
p-value[a]	0.019	0.000	0.000	0.093
p-value	0.000[b]		0.001[b]	

[a] Based on Shapiro–Wilk test for normality assumption.
[b] Based on Mann–Whitney U test, when either group doesn't accord with normal distribution (p-value[a] < 0.05).

In contrast, the NGO pilot communities produced recycled waste with a mean purity of 95%; there was very little contamination in it. A t-test showed the means of the distributions from the two types of programs to be strongly statistically different. Their residual waste bins still contained 44% food waste which indicated that there was room for improvement: more food could still be diverted for recycling. Again, however, a t-test showed the mean of the distribution to be statistically different to the equivalent distribution in the government program (see Table 2).

Most importantly, the waste composition data show a statistically significant difference in the results from *the two types of programs*. The government program communities have waste consistent with no sorting at all, whereas the NGO communities show clear signs of correct sorting, even if there are further amounts that can be diverted.

4.2. Data of activities: results from the interviews

The key informant interviews provided the following data about the government strategy program: standard practices for policy implementation in Shanghai were followed, with Street tiers advising Community tiers who then used their existing network of informal assistants. Thus, the data collection approach was to carry out in-depth interviews of four key informants: leading Street level government officers from two different Streets, and leading Community Committee officers from two different communities. The NGO program followed its own outline of activities, but these varied slightly depending on local contexts. It was thus deemed necessary to interview the NGO liaison officer overseeing the program, to analyse her written diary of activities, and to carry out several in-depth interviews with NGO members who led work in different clusters of communities.

Each in-depth interview lasted more than 45 min. All the interviews were then transcribed and open-coded for types of activities as described by the interviewee; personal or informational strengths of contributions.

4.2.1. Activities in the government programs

The Street Committee would first meet together with the Community Committee, Housing Association and cleaners, explain the new policy and its implementation, often using short 5 min videos, and/or a power point presentation. Local funding would be provided for the provision of a new set of brown coloured communal bins for wet waste; for the refurbishment and enlargement of the waste stations (to accommodate extra bins); for the provision of kitchen caddies for residents and in some cases plastic

Table 2
Comparison between wet waste recycling bins and residual waste bins, using proportion of food waste from both government pilot communities and NGO pilot communities.

	Government pilot communities		NGO pilot communities	
	% FW in WW bins	% FW in RW bins	% FW in WW bins	% FW in RW bins
n	29	27	32	29
average	70%	61%	95%	43%
SD	17%	19%	8%	22%
p-value[a]	0.019	0.000	0.000	0.093
p-value	0.102[b]		0.000[b]	

[a] Based on Shapiro–Wilk test for normality assumption.
[b] Based on Mann–Whitney U test, when either group doesn't accord with normal distribution (p-value[a] < 0.05).

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bags for each type of waste for a month. In addition funds were committed for extra payments to the cleaners who were now expected to correct any sorting errors of the residents: they would receive a bonus per bin of sorted wet waste. The Street Committee also made arrangements for new collection vehicles to collect the waste, and access to facilities for its processing.

The Housing Association, HA generally took responsibility for distributing the kitchen caddies and/or bags, usually by going door-to-door once and then expecting residents to visit their office to pick it up if they had missed the delivery. Government booklets with information were placed in mail boxes.

When the collection facilities and system were in place then locally placed information would be arranged such as a digital screen near the main waste station and new signs on different bin types including information of accepted waste types. Normal display areas would have information about the waste sorting displayed, such as poster cabinets and blackboards. In addition, The Community Committee, CC would arrange a publicity activity once a week for about six weeks, during which the volunteers would stand by the waste station and communicate with residents. A table was placed nearby, and a board of waste sorting information was placed in front of the table. Banners with government slogans were also used. The activity would last for 2–4 h. The volunteers involved were from the existing group in that community, which typically comprised of Party members and were dominated by the age group of retirees i.e. 50 years and over. They were trained in the usual manner of other policy implementations, by being told what information to give (which waste types went into each bin), and in the context of being assistants to the institution of the Community Committee i.e. passing on the instructions received from higher tiers.

Overall, the information from the key informants confirmed that the government programs had a heavy focus on the use of information. The underlying concept in the discussions and activities was that if the residents had enough information, they would change their behaviour. If the program was not successful, the attitude was that it needed more information to be distributed. A secondary attitude was that residents might need a financial incentive, or that their 'quality' was too low i.e. better-educated residents would do better, and so should be the focus of efforts.

4.2.2. Activities in NGO pilot communities

In the programs which involved the NGO, the Street Committee supported them to organize a meeting for all government departments with any possible link to waste sorting, including the Culture & Education Office, Urban Management Office, Women's Federation, etc. During that NGO meeting, through participation, it was clarified who would take responsibility for different aspects, and the communication mechanisms were discussed and confirmed. The NGO was considered a professional organization with specialism in waste sorting, and in this case was informally assigned by these stakeholders to plan and coordinate the overall program.

Plans for the refurbishment of the waste stations of the communities were developed in consultation with the CC, HA and residents, sometimes taking several meetings. These were then implemented, funded by the Street government.

The NGO organized an 'Open Space' workshop for a wide range of stakeholders to consult and develop ideas for bringing about behaviour change. Street government, CC, HA, representatives from Residents Association and some volunteers were invited to participate, and sub-strategies which had worked elsewhere were introduced through case studies. Participants were also encouraged to brainstorm and exchange their own ideas. By the end of the workshop, 7–8 important issues were usually agreed, and an action plan targeting these was confirmed: a plan which involved many stakeholders but within a unified plan. The NGO continued to meet with individual Community Committees every two weeks or so, and to be available whenever new issues arose.

Before any public launch of the project, the NGO raised residents' awareness by having Block Leaders deliver, and later pick up, questionnaires door-to-door. The questionnaires asked residents if they thought waste segregation was important, and whether they would be willing to do it, and whether they had suggestions about how to make the program successful. Residents were also invited to become volunteers. Approximately 60% of the questionnaires were returned, and of those 95% agreed to try to sort their waste.

The NGO then held public meetings in the communities where any residents could hear about successes in other communities. The NGO helped the CC to build and organize volunteer team inside the communities, and volunteers were then trained in several sessions, with an emphasis on positive spirit and clarification and physical demonstration to residents. After the project launch, volunteers would be on duty standing next to the communal bins for 2 h in the morning (usually 7–9 am) and 2 h in the evening (usually 6:30–8:30 pm). Many residents were touched by the efforts of the volunteers, who collectively continued these shifts for *three consecutive months*, providing a very visible face to the source separation program.

4.2.2.1. Project launch of the NGO program. Project launches took place for several hours on one day in communal open areas of the community: a table was set up to distribute kitchen caddies to passers-by and demonstrate the waste sorting procedure. There were also quizzes, posters, banners and information on the community blackboards. Local volunteers went door-to-door to give out information leaflets and stickers in a purposively friendly and chatty manner, spending 5 min with some residents when interested. It has been shown elsewhere that door-stepping activities can impact on a variety of potential determinants including some not designed in, and should thus be analysed carefully (Dai, 2015).

The NGO visited every community several times a week for troubleshooting, and held monthly workshops for the different Community Committee members to come together to collect to share problems and solutions.

During the initial three month the NGO facilitated one-off events such as sending thank you notes to residents with some positive feedback; publicizing the apartment numbers of residents that did well (and who had volunteered their numbers); a workshop on how to make fermented liquid from food waste (used as a cleaning fluid); a visit for a few people to the city landfill site; and for a short time (e.g. two weeks) offering tokens for correct sorting which could be exchanged for toothpaste and tissues.

One further aspect of the NGO approach which occurred in the same time period as the launch was that, in 10 of the 42 communities, the bins were brought down to a new area on the ground floor. Previously, they were sited on each and every floor, so this was not an insignificant change and is discussed further below.

4.2.2.2. Costs. A key question any policy implementers will ask when considering options for delivery is what the relative costs are. Both the government pilots used leaflets, booklets and variations of free kitchen caddies and/or small bags for kitchen waste, so those costs would be very similar. In addition the government pilots used block leader and volunteer time, which were highly variable and difficult to approximate. The NGO was paid approximately 50,000 RMB (8000 USD) for facilitating in each pilot community of about 1000 households for six months, or 50 RMB (8USD) per household. In each of those about 720 volunteer person-hours were needed for shifts to stand by the communal bins. Within the NGO paid costs,

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one employee coordinated several communities at the same time, including arranging and delivering the stakeholders meeting, patrolling communities weekly for troubleshooting, program launches and small scale interaction events in the community once a month. The transportation fees and meal money for the volunteers and costs for any materials needed in small activities and gifts for the residents all covered by the funds paid the NGO.

5. Discussion

5.1. Comparison of the activities carried out in both programs

The main purpose of the data analysis of the interviews was to identify major differences between the two programs. The government program was found to be heavily focused on information provision, as it had intended, including booklets, posters, blackboards and digital signs, all of which transmitted information in a neutral manner. There was also use of local volunteers to explain and model the waste sorting actions to residents, for a total of about 8–16 h each month, stationed near the waste stations (the point of action). However, these events were relatively short in duration and also likely to have been missed entirely by many residents. The fact that the information came from the HA and CC, and that the volunteers were local and known to be acting on their behalf, gave strong indications to the residents of institutional source of message, arriving via messengers known to them and similar to them – all potentially important determinants.

The NGO program was heavily focused on personal interactions and relationship building. It encouraged participation of all relevant stakeholders at most stages. It recruited pledges and thus some level of commitment from residents on an individual basis via its initial questionnaires, and recruited volunteers who were not necessarily part of the existing cadre that regularly acted on behalf of the institutions. Information and kitchen caddies were usually given to residents in person, to purposely open opportunities for conversations. And a very important and visible element was the stationing of volunteers near the waste stations, four hours every day for three months, trained to be positive. They did not only provide repeated modelling of the new behaviour, but were available for personal interactions when desired. Similarly, kitchen caddies were personally and interactively given out from a table in a public area, rather than 'available' from an office.

Since both programs delivered similar informational content, the analysis of the interview data was useful to indicate that the main differences between the two programs were the levels of interpersonal interaction, and extent of modelling the new behaviour. Operationally, the government program seemed quite generous in its resource provision, preparation and support, and it certainly provided ample opportunities in principle for residents to obtain information needed to change their behaviour. However, the NGO program converted many of those same activities into more personal ones through the use of appropriately trained volunteers, and provided much more overlap time for the residents to interact with the volunteers and embed the new information: 480 h over three months compared to 24 h over six weeks.

A summary of the main activities in the two programs is given below in Table 3, which is intended to convey the general contrasting levels of personal interaction noted in reports across the two programs Note that the interactions with cleaners and volunteers are shown as well as residents: the aspect of personal interaction was emphasized at several levels in the NGO program.

Clearly, this analysis of the different program is very basic, but it serves the purpose required for this study, which is to provide evidence of the different intentions in the minds of the implementers as they might be communicated or interpreted by other policy implementers or makers, and to identify behaviour change domains which deserve further specific study. These are given in Table 3 and the next section.

5.2. Potential links to domains of behaviour change determinants

There are tens of known determinants of recycling behaviour change mentioned in various literatures, but testing for them in such programs would require specific design for that purpose. Here we focus on why we think the general domains that are key to this project are information provision and modelling, with personal interaction as a moderator. We then briefly mention others that could be key but need further exploration. We then mention supporting results from a separate recent work.

Information strategies come in many kinds in the literature (Abrahamse et al., 2005). Some researchers consider knowledge-only strategies (Luyben, 1982; Mee et al., 2004; Staats et al., 1996; Winett et al., 1978), while others include feedback (Delmas et al., 2013; Hutton et al., 1986). Some case studies found information approaches could be effective when combined with other approaches like incentives, commitment and social or personal interactions (Gonzales et al., 1988; Hirst and Grady, 1983; McMakin et al., 2002).

In order to reduce global warming, in 1990 the Dutch government conducted a mass media campaign to provide information for all Dutch population about the nature and sources of global warming, and the potential solutions (Staats et al., 1996). However, a comparison between pre- and post-surveys indicated that the campaign failed to increase people's awareness of the problem. The researchers indicated that only people who acted pro-environmentally before the campaign were more willing to be pro-environmental after the campaign. The authors argued that people felt the responsibility was not theirs, and thus a lack of social norms or social influence might be the problem of the failure.

In our case, the government pilot communities faced similar problems. They mainly focused on delivery of information. Even though sometimes the information might be delivered door-to-door, it presented as an institutional message and was probably not considered salient to the residents. Even though volunteers were sometimes involved in the approach, they were also presented as institutional messengers, and the short frequency and duration of their appearances further limited their impact on behaviour change.

Another key difference that the NGO approach used was modelling of the new behaviour. Winett et al. (1985) used modelling through air time on cable TV, and identified an increase of knowledge levels and 10% energy use reduction in their target group. Sussman and Gifford (2012) showed that modelling was effective to encourage composting in cafeterias, and that the use of more than one modeller was extra effective. Some scholars proposed that the combination of modelling and information provision would be successful (Abrahamse et al., 2005; Lehman and Geller, 2004; Schultz et al., 2007), because descriptive norms would be involved (Steg and Vlek, 2009).

Examples of studies involving interpersonal interactions include Bernstad et al. (2013) who carried out a case study to compare the impacts of written information to oral face-to-face information on food waste recycling behaviour change in Sweden. Higher source segregation ratio of food waste and lower impurity ratios in the sorted food waste were found where face-to-face information was provided. Cobern et al. (1995) conducted phone surveys in which residents were asked if they already composted waste in their gardens. Those who indicated on the phone that they did not compost were asked if they would be interested in beginning to compost, those who expressed interest were visited by an

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Table 3
The types of information and different activities used in two food waste sorting implementation programs, with an indication of those which involved personal interactions (√) and those which did not (X).

Activities	Government program	NGO-led program
Reconstruction of Waste Station	×	×
Information: (includes)		
leaflet	×	×
posters	×	×
blackboard	×	×
banners	×	×
Kitchen caddies(from offices)	×	N/A
Kitchen caddies(from table in communal garden)	N/A	√
Waste bags	×	N/A
Information evening & Visitors from experienced volunteers	N/A	√
Launch event: (includes)	N/A	√
Children event	N/A	√
Demonstrations	N/A	√
Visibility	N/A	√
Stickers	N/A	√
Open Space Workshop (for all stakeholders)	N/A	√
Workshop for CC (troubleshooting)	N/A	√
Training for cleaners (re: mandatory sorting)	×	N/A
Training of volunteers (in terms of duty)	×	N/A
Training for cleaners (to assist households to sort)	N/A	√
Training of volunteers (for positive attitude + spirit)	N/A	√
Volunteers demonstrations: (includes)		
4–8 h once a week, for 6 weeks (24–48 h total)	×	N/A
Instruction of residents	×	N/A
Volunteers demonstrations: (includes)	N/A	√
4 h/day for 3 months (480 h total)	N/A	√
Being positive to residents	N/A	√
Naming of households who wished it	N/A	√
Thank-you notes	N/A	√
Open mini-courses about the environment	N/A	√

employee who addressed the specific barriers that were identified. 80% of those household residents were found to be composting in a follow-up several months later. Hirst and Grady (1983) reported a 2% energy saving through energy home audits, which involved personal interaction. A similar positive result of energy saving was given by Mcmakin et al. (2002) and Winett et al. (1982).

It should be noted that these studies were not focused on personal interaction as a main intervention, but more as moderator or enhancer of interventions which were targeting particular psychological or operational determinants. What is interesting is that interpersonal interaction seems to be able to make the difference between an intervention being effective or not: possibly a very strong moderating effect indeed. In a further study the relative impacts of having volunteers present was compared to a potential alternative which shared determinants of prompt and emotion: colourful bin covers. The effect of the volunteers was double that of the colourful bins (Lin, 2015).

Abrahamse and Steg (2013) argued that personal interaction could facilitate behaviour change, by making group identity and social norms more salient, and refer to a review by Postmes et al. (2005) who concluded that personal interaction was a key factor in forming group norms and identity.

In brief, the approach that NGO pilot communities used included interpersonal interactions throughout, with great frequency and duration. Standing next to the communal bins, the volunteers were able to tailor their interaction style and content to each resident, and had been trained to be positive and not overbearing. In principle such activity could – in terms of behaviour change determinants – provide modelling, increase practical skills and knowledge, and confirm new social norms and clarify the residents' required role. And all of these could have been enhanced by the interpersonal element. A parallel study of that possibility is underway.

5.3. Other potentially important determinants

Besides the key domains of determinants discussed above, there are others which our exploratory data suggest could be important to understanding the results of the two pilots sets presented here and deserve further study, such as wider social norms, and the breaking and forming habits.

Hopper and Nielsen (1991) suggested that recycling would be increased by involving social interactions, because it strengthened both social norms and personal norms. By establishing a strong norm at community level, social marketing strategies have proved to be successful to facilitate pro-environmental behaviour (Mckenzie-Mohr, 2000).

Habit is also known as one of the important challenges for behaviour change (Jackson, 2005). And similar to many psychological processes, habit formation has its own rules and dynamics (Andersen, 1982). Dahlstrand and Biel (1997) discuss the dynamic of breaking old habits and forming of new ones: it takes time, depending on the strength of the habits. In our study the NGO pilots had volunteers present for 3 months, which is enough time to form new habits.

In general, it is more difficult to alter and maintain repetitive behaviour changes than it is to bring about one-time changes in behaviour (see examples in Kempton et al. (1992), Kempton et al. (1984)). Although all the pilots involved a large change in that residents should now separate waste into two bags and two bins, it is true that in ten of the NGO communities a more drastic change was created when the bins on each floor of each building were removed to a common ground floor area: the residents would have had to significantly modify their habit, thus creating a fertile moment to form new ones. If this were a very key factor then a significant difference might be seen between those and other NGO pilots: this requires a different methodology to determine.

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Table 4
Elements of the NGO waste sorting program which were considered key, by different stakeholders in one community. Taken from the study of Xu et al. (in this issue).

Stake- holder	Elements considered key to success of the NGO waste sorting program
Community committee	1 Overlaps of responsibilities and relationships between stakeholders are complex: opportunities to address this were necessary.
	2 The NGO had relevant specialist experience in public engagement.
	3 The volunteers were an important part of the intervention due to a kind of respect for their efforts from the residents which developed.
	4 The older residents performed better than others, perceived to be due to a stronger relationship with the CC.
NGO	5 The NGO played an important brokerage role.
	6 Committed volunteers with good volunteering spirit were crucial to the project's success.
	7 Relationships between the residents and the CC or the NGO were important to success but for groups like younger people new types of relationship building were needed.
Residents	8 The residents tend to comply with the CC when they trust them.
	9 If the CC is seen to be 'serious', residents will be clear of their own role and reciprocate in effort.
	10 Volunteers can improve recycling results because of personal interactions over time

5.4. Recent supporting work

After this paper was first submitted, the results of an in-depth qualitative study in one of the NGO communities was completed. It concluded that personal interaction was an element of several key contributing factors to the success of the program, as determined via in-depth interviews with the main stakeholders and 18 residents (Xu et al., in this issue). Table 4 summarises the factors identified by each group. These results support the findings in this paper, in that the intended interpersonal aspects of the NGO program we found to be a major difference to the government program were found in that study to be key actual contributors to its success.

6. Conclusion

In summary, there are several potentially important determinants that could have contributed to the success of the NGO pilots, but one thing is clear: the government pilots did not have what was needed for success with their strategy of information delivery. The Residential Conservation Service was an early, large scale, energy conservation initiative in the US with free energy audits, low-cost loans and full information for residents, which only produced 2–3% energy savings. A review of it concluded that such efforts tend to overlook 'the rich mixture of cultural practices, social interactions, and human feelings that influence the behaviour of individuals, social groups and institutions' (Stern and Aronson, 1984). It seems that this lesson of 1984 needs to be reiterated: effective behaviour change programs need to take into account complexities of human nature. The 'personal' approach of the NGO appears to have achieved this to some extent.

Policy makers and government implementers still rely heavily on information strategies for behaviour change, notwithstanding ample academic evidence that more thoughtful strategies with respect to behaviour change determinants will have increased effectiveness. Furthermore, information-based strategies are not often challenged nor, to our knowledge, critically examined on a large scale for failure or performance against alternative large-scale strategies. Studies on such a scale which can bridge policy and academic domains have recently been called for by experts (Allcott and Mullainathan, 2010). This study showed quantitatively that a traditional information strategy was not effective in causing behaviour change for the target behaviour, i.e. residential food waste sorting, in a large scale pilot: a randomly selected sample of the 5075 pilot communities (5 million households) produced a waste composition distribution entirely consistent with zero waste sorting behaviour. We believe that this is the first time such a large scale study has been published on the failure of an information strategy program in recycling. This study also showed that an alternative strategy, describing itself as one of 'more personal interaction', produced outstanding results in similar communities. The results are strongly statistically different for a set of N = 36 communities (circa 36,000 households). Excellent source segregation of the food waste was still present 3–36 months later, and the extra cost involved was only 8 USD per household.

Neither program described or planned or considered any academic determinants of behaviour change, and their broad descriptions as 'information strategy' or 'more personal' are typical of those used by policy makers. Our qualitative data showed that the documented activities of each program were, indeed, biased towards information provision and personal interaction respectively. It also suggests certain domains of behaviour change determinants may be implied in the successful NGO program and thus be worthy of future specific study, including modelling, social influences from personal relationships, and habit formation. This exploration of the program elements perceived to be key by the implementers has thus provided a starting point for more specific research to trace underlying links between program activities and behaviour change determinants. A systematic approach to bridge theoretical domains with practice-based activities was recently used by Dai et al. (2015) to carefully analyse behaviour determinants present in different types of door-stepping practices used in recycling, and the same approach could be used here.

The results presented here are consistent with previous studies which have shown that information focused strategies are not generally effective for behaviour change, but the present work has been carried out on a much larger scale and with a real government program, rather than a small, un-scalable, academic focused set up. It is hoped that this large-scale example of the failure of a traditional approach will give impetus for policy-makers and implementers to search for alternative strategies, and perhaps to develop and test the scaling up of strategies already known by researchers to, in principle, be more effective. Shanghai Municipality has wisely paused between each phase of its rolling out of food waste sorting to assess the situation: it is hoped that these results will also be useful to other metropolises in the world trying to overcome the challenges.

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