A framework to allow intervention design to increase food waste recycling in an urban community in Shanghai

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Abstract

China has recently surpassed the USA to become the world's largest producer of municipal solid waste (MSW). Typically more than 60% of MSW in China is food waste, the majority of which is disposed of in landfill or incinerated at great financial and environmental costs. With annual costs exceeding 12.6 billion RMB (approximately £1.26 billion) for waste treatment, alternatives are fast becoming a necessity. In 2010 the Shanghai Municipal Government introduced the Waste Minimisation Plan. The Plan outlined a 5% MSW reduction target per capita to meet the longer-term goal of 50% reduction per capita by 2020 relative to 2010. In 2011 the Shanghai municipality introduced source separation pilot programmes, focused on food waste recycling, in a bid to address the Waste Minimisation Plan. This study aims to establish a new waste management framework, which can be used to design, develop, plan, execute and assess interventions to reduce waste landfilled and incinerated by increasing food waste recycling in Shanghai.

The framework was developed from an extensive waste management literature search and also drew on selected works from behaviour change. The result of this meta-analysis was a framework consisting of 24 determinants deemed necessary for successful recycling programmes. The "Waste Management 24" (WM24) framework was used to execute and assess an intervention to increase food waste recycling in an urban residential, gated community in Shanghai. The WM24 suggested that an intervention to communicate information relating to the environmental consequences of waste disposal would be effective at improving food waste sorting behaviour. The information was disseminated using a face-to-face, doorstepping approach.

Waste quantity, composition and questionnaire survey data were collected before and after the intervention to identify any significant changes. The results indicate a statistically significant 29.1% increase in separated food waste, a 12.5% increase in the food waste capture rate and a 14.6% reduction in food waste not separated one week post-intervention. An evaluation of the results with respect to the WM24 framework suggested the most influential recycling determinants addressed by the intervention. Contrary to expectations, the questionnaire surveys indicated that knowledge, relating to the environmental consequences of waste disposal was not a significant determinant. A full explanation and discussion of the WM24 determinants and results is provided.

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Glossary

Behaviour Change – Refers to the academic discipline of behaviour change, which seeks to understand behaviour and how to affect change to encourage a particular behaviour

Capture Rate – "The quantity of target material 'captured' divided by the total quantity of that type of material present" (WRAP, 2010, 7-2)

DEFRA – Department of the Environment, Farming and Rural Affairs. DEFRA is a Governmental department in the UK

Doorstepping – Trained personally visit a target population to speak face-to-face to educate, inform and distribute promotional material usually with the aim to affect a change in behaviour

Dry waste (DW) – The Chinese terminology for residual waste

Food waste – Food waste in this study refers to: Raw and cooked food including meat and bones, vegetable peels and trimmings and small quantities of fat and cooking oil

Mixed recyclables – Mixed recyclables in this study refers to:

> Paper (paper, magazines, books, packaging paper, office paper, flyers, and cardboard)
>
> Plastics (plastic food packaging, toothbrushes, plastic cups, plastic bottles, plastic toys)
>
> Metals (drinks cans, food tins and containers)
>
> Textiles (shoes, bags, clothes, towels, face cloths, table clothes)
>
> Tetra packs

MSW – Municipal Solid Waste. "All waste originating in urban areas from residential, industrial (non-hazardous), commercial and institutional sectors" (World Bank, 2005, 8)

NGO – Nongovernmental Organisation

Participation rate – Measurement of the level of participation in a given scheme.

Recycling Determinants – Recycling determinants refer to factors that decisively affect the outcome of recycling. In this study recycling determinants refer to such factors found in the waste management literature

Recycling rate – The quantity of a waste material recycled, usually as a percentage of the total waste quantity

Residual waste – Waste not recycled

Source separation – The separation of waste materials at the point of disposal

Waste station – An area designated for waste disposal

Wet waste (WW) – The Chinese terminology for food waste

WM24 – An abbreviation for Waste Management 24 and refers to the primary recycling determinants identified from the waste management literature within this study

Ying Hua Yuan – The name of the residential community in Shanghai where this research was conducted. The name translates as Sakura Garden

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Author's Declaration

I declare that the research contained in this thesis, unless otherwise formally indicated within the text, is the original work of the author. The thesis has not been previously submitted to this or any other university for a degree, and does not incorporate any material already submitted for a degree.

Micheil Gordon

Signed

Dated

1 Introduction

Household waste management is a global issue and until recently household waste generation in many developed nations has been increasing. In Norway this has been as much as 50% over ten to fifteen years (Refsgaard and Magnussen, 2009). The situation in the UK has been similar and only since the beginning of 2000 has the UK's quantities of waste plateaued (DEFRA, 2007). In response to the vast quantities of per capita waste generation in the West, academics, governments and waste management companies have been seeking solutions to improve the management of this waste. Some improvements have been made, and since 2003 the UK has seen a year on year gradual decrease in overall household waste generation (DEFRA, 2011).

1.1 Waste Management in China

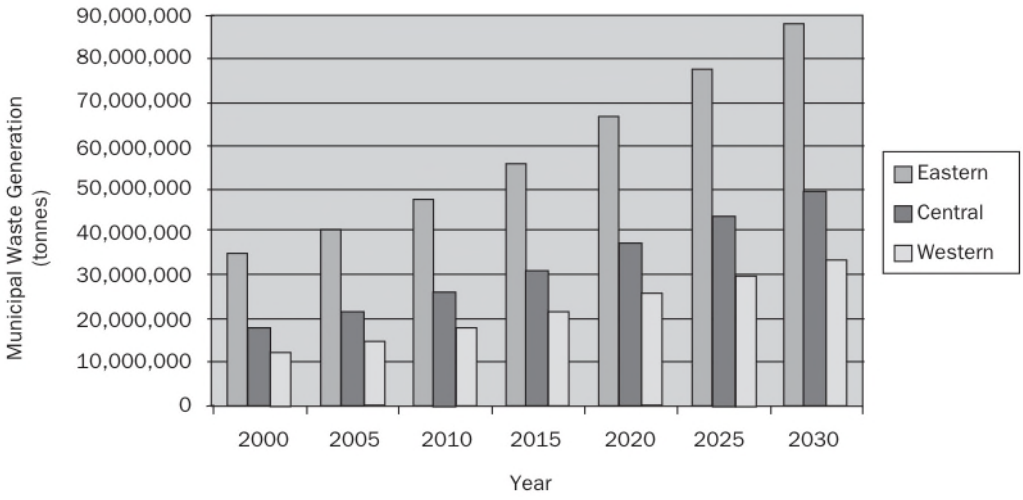
The waste situation in emerging economies has been receiving increasing attention as economic growth, urbanisation and population have led to phenomenal increases in quantities of waste and China is no exception.

During the past two decades, China has experienced unprecedented economic growth. In 2007 China's economy grew to be nine times larger than it was in 1978 (Hutton, 2008), achieving in decades what took developed nations centuries (Liu and Raven, 2010). The rapid economic growth coupled with an increasing population, urbanisation and industrialisation has caused an increase in environmental degradation (Liu and Raven, 2010), along with a considerable increase in Municipal Solid Waste (MSW) generation (Zhang et al., 2010). In 2004 China's MSW generation surpassed the USA to become the world's largest producer and with the financial waste management costs now greater than 12.6 billion RMB annually (approximately £1.26 billion), new waste management practices and policies are required (World Bank, 2005). MSW has been defined by the World Bank as, "All waste originating in urban areas from residential, industrial (non-hazardous), commercial and institutional sectors" (World Bank, 2005, 8). This definition of MSW can be applied to MSW references within this study.

According to Huang et al. (2006) there was 74.07 million tonnes of MSW generated in China in 2002 of which 89.3 per cent was landfilled, 3.72 per cent was incinerated and 6.98 per cent was composted. By 2006 the quantity of MSW

transported had almost doubled to 148 million tonnes and yet the management of the MSW had changed little; 91.4 per cent was landfilled, 6.4 per cent was incinerated and 2.1 per cent composted (Zhang et al., 2010). At present it is estimated that China produces over 150 million tonnes of MSW per year which is increasing at a rate of approximately 8% - 10% annually (Cheng and Hu, 2010).

Landfilling remains the predominant method of waste disposal, accounting for 80% of China's MSW processing (Cheng and Hu, 2010). In 2007 there were 366 landfill sites in China (Zhang et al., 2010) many of which did not satisfy the national pollution standards and are uncontrolled landfill sites or dumps (Huang *et al*., 2006). The World Bank (2005) project that by 2030 Chinese MSW output will increase to 480 million tonnes (see Figure 1); a move from primarily landfill based waste disposal methods to resource recovery is essential. The impact of such vast quantities of unregulated, poorly managed waste can have severe detrimental consequences to human health and the environment.



Based on population data from United Nations, 2002
Source: AMEC

Figure 1: Projected municipal waste generation in Urban Areas of China by region (World Bank, 2005)

Figure 1 demonstrates the projected quantities of waste for different regions in China with the greatest proportion of waste generation and increase being generated in the Eastern Provinces.

The composition of MSW in emerging Asian economies contains a significantly higher proportion of organic waste (the majority of which is food waste) than in Western countries (see Table 1).

Table 1: Composition of organic waste in Asia

Location	Findings	Study
Thailand	Food waste was found to constitute 49.3% of householders waste	(Mongkolnchaia runya, 2005)
Malaysia	Food waste was found to constitute 57% of householders waste	(Saeed et al., 2009)
Bangladesh	66% of householders waste was found to be compostable	(Sujauddin et al., 2008)
China	Food waste was found to constitute 51.8% to 70.4% of the MSW waste stream	(Chen Liu and Wu, 2011)
China	Chinese were found to dispose of roughly 64.5% organic waste	(Zhuang et al., 2008)
Chongqing, China	Food waste was found to constitute 59.2% of the MSW waste stream in Chongqing	(Hui et al., 2006)
China	Average percentage of food waste across 12 of China's major cities was found to be 52.94%	(Wang and Nie, 2001)
China	Average food waste across 8 major Chinese cities was found to be 62.5% with Shanghai 74.14% and Beijing 66.19%.	(Tai et al., 2011)
Shanghai, China	Water content from two samples of Shanghai's MSW was found to be 50% and 70%	(He et al., 2004)

In Shanghai the high moisture content of the MSW has been posing problems for incineration and as a result large waste pits have had to be installed beneath the incinerators to drain the MSW. After five days of drainage this process was found to remove 165 tonnes of water per 1000 tonnes of MSW in an investigated sample between October 2002 and September 2003 (He et al., 2004).

Recent data suggests that food waste composting in China has become increasingly unpopular and the quantities of composted food waste fell below 4% in 2006 compared with 17% in 2001 (Cheng and Hu, 2010). Cheng and Hu (2010) suggest that the growing unpopularity in composting waste treatment methods is primarily due to the lack of household source separation, low nutrient content and high heavy metal content. Zhang et al. (2008) drew similar conclusions when evaluating the heavy metal concentrations in the MSW stream in Shanghai. The study showed that there was on average >100mg kg^{-1} of Zn Cr Cu and Pb followed by Ni Cd Hg in the MSW stream. The quantities of heavy metals within the inorganic and organic waste fractions were not significantly different which the authors suggest is a result of waste blending within the MSW waste streams during disposal, collection, transport and processing. The authors suggest that a combination of source separation and separate treatment and collection of other streams such as such as organic waste, high heavy metal containing streams such as street sweepings and hazardous as well as construction wastes is required to reduce heavy metal MSW concentrations.

Organic waste sent to landfill breaks down through anaerobic digestion, and this process produces landfill gas. Zhang et al. (2010) reported of the 13 landfill sites surrounding Beijing only two were equipped to process the gas generated furthermore the composition of the gas and the consequences to human health and the environment are not reported. Typically organic waste has a high moisture content, which generates liquids under landfill conditions. These liquids can combine with hazardous substances present in landfill to create hazardous landfill leachate. Xu et al. (2006) in Zhang et al. (2010) found 10% of China's landfill leachate to be disposed of into the sewage system, 20% treated with bio-char techniques, 3% treated using membrane methods while 47% received no treatment thereby potentially polluting groundwater sources. Untreated organic waste in urban environments can pose further problems. Food waste can become breeding grounds for disease vectors such as insects and vermin and surrounding odours can become particularly unpleasant in warmer seasons (Sharholy et al., 2008).

Despite persistent problems, since the mid 1990's China's capacity and ability to manage its waste has increased dramatically as a result of continued investment in infrastructure and service delivery (Cheng and Hu, 2010). In the 1980's the

quantity of China's waste that was treated by a waste management facility was estimated to be around 5%, this figure is now estimated to have increased up to 55% (Cheng and Hu, 2010). The number of waste collection vehicles reached 66,200 in 2006, an increase of 1.6% since 1990 (Chen et al., 2010). However the Government's progress has been criticized due to decision making and operational inefficiencies and as a result commercialisation has recently taken place and in the major cities of Beijing, Shanghai, Guangzhou, and Shijiazhuang where private companies have begun managing waste collection and street sweeping services.

As previously discussed the two main waste management techniques are landfilling and incineration, with landfilling the current preferred method. However the quantity of waste incinerated has been growing and is now the second most common waste disposal treatment method in China (Cheng and Hu, 2010). Incineration is particular appealing in areas with land shortages and in high-density urban areas. Incineration typically reduces the volume of waste by 90%, requires minimal pre-processing and heat generated by the process can be used to provide district heating or generate electricity (Cheng and Hu, 2010). However disadvantages of incineration are numerous. Incineration requires highly skilled operators, a continual input of material and energy for ignition; flue gas can be highly polluted with particulates, dioxins, heavy metals, sulphur dioxide and hydrochloric acid (Cheng and Hu, 2010). The moisture content of Chinese MSW is estimated to be around 50% while MSW from American and European countries has a moisture content of 20% to 30%. Furthermore the calorific value of Chinese MSW is approximately half the calorific value of the developed countries (3,000–6,700 kJ/kg vs. 8,400–17,000 kJ/kg) (Cheng and Hu, 2010). The high moisture content and low calorific value of China's MSW creates complications for the incineration process. Towards the end of the 1980's a MSW incineration plant was installed in the Chinese southern city of Shenzhen. The MSW was subjected to extended drying and incineration times and despite the extra measures the incineration process was afflicted by grate blockages as well as significant temperature variability (Cheng and Hu, 2010).

To mitigate the problems and challenges discussed, a move from primarily landfill waste disposal methods to recovery is crucial. Source separation is regarded as an essential and effective method to recover a particular waste stream from

household waste (Zhuang et al., 2008) and essential for the future sustainability of Chinese waste management (World Bank, 2005).

The previous decades have seen developed countries focus on implementing source separation practices to increase waste management efficiency while source separation in China is still in its infancy (Chen et al., 2010). Currently dry recyclables are separated and collected by formal and informal waste collectors who earn a living from the material's market value. Medina (2000) estimates that 2% of the population of Asian and Latin American cities sustain their livelihoods through scavenging. The World Bank (2005) estimates that there are 1,300,000 people formally employed within the waste management system in China, whose main duties include waste collection and transport and recyclable materials separation for subsequent sale for income supplement. Because recyclable materials have market value many such materials are extracted from residual waste both in the public and domestic waste streams. In addition to the 1,300,000 formal waste workers the World Bank (2005) estimate there are 2,500,000 informal waste pickers who generate a livelihood by collecting recyclable materials with a market value. The informal waste collectors have a low social status and are often migrant agricultural workers who have moved to one of China's rapidly expanding urban districts in search of work.

1.2 Waste Management in Shanghai

Shanghai is a highly urbanised and industrialised large city in the east of China (see Figure 2). The city occupies an area of 6,340.5 km^2 (UNEP, 2010) and according to the 2010 Government census the population of Shanghai is more than 23 million (Bureau, 2011). Shanghai's waste management practises are advanced compared with many other Chinese cities with 7 landfill sites, 3 incineration plants and 3 biological treatment plants (Tai et al., 2011). According to the National Bureau of Statistics of China, 6.583 million tonnes of MSW was collection during 2006, 31.7% was disposed of in sanitary landfills, 17.4%, was incinerated, 8.8% was composted (Zhang et al., 2008). According to UNEP (2010) in 2008 77% of Shanghai's waste was disposed of safely, with the remainder mostly sent to unsanitary landfill sites constructed before sanitary designs became compulsory.

In Shanghai, like many other Chinese cities all MSW is managed and financed

by local government and is generally considered a public service (World Bank, 2005).

Figure 2: Map of China with Shanghai location (GoogleMaps, 2013)

Figure 2 demonstrates the map of China with Shanghai located along the eastern coast.

Pudong is a major district in Shanghai situated on the east side of the Huangpu River, which runs through the centre (see Figure 5). In a study carried out in Pudong by Minghua et al. (2009), the Authors found that between 2004 and 2005 the quantity of MSW generated in Pudong increased by 18% from 2418 to 2854 tonnes / day. By 2006 the quantity had risen further to 3,108 tonnes / day exceeding the capacities of the waste management facilities by over 1,000 tonnes daily (Minghua et al., 2009). The current trends are projected to continue into the future based on constant population increases and the cities continual development.

In 2010 the Shanghai Municipality took decisive steps to address the current waste management practices and introduced the Waste Minimisation Plan. The Plan outlined a 5% MSW reduction target per capita in order to meet the longer-term goal of a 50% reduction per capita by 2020 compared with 2010 (Zhang et al., 2012). To address the Waste Minimisation Plan the Shanghai municipality rolled

out a source separation Pilot programme in 2011. The source separation programme was focused on food waste recycling but also targeted a number of other waste streams including: paper, glass, plastic products, metals, textiles and hazardous. The scheme was initially rolled out in 100 model communities across the city. After the initial trial period the sorting programme was extended to additional communities and by the end of 2012 there were around 2,300 communities involved in a food waste focused recycling scheme with the aim to roll out the programme citywide by 2015.

The main focus of the Shanghai source separation programme is food waste for a number of reasons. Much of the recycling in China is carried out independently of government by the informal sector (Zhang et al., 2010). The informal sector generally consists of underprivileged social groups (Tai et al., 2011), the majority of which are migrant workers who sort recyclables from unsegregated MSW waste (Zhang et al., 2010). The recyclable materials are then sold for their market value. As previously stated the World Bank (2005) estimated that there are 2,500,000 informal, itinerant waste buyers in China who provide the majority of China's recycling collection services (Chen et al., 2010). As a result of the informal recycling collection system, much of the recyclables are diverted prior to disposal by citizens or removed from the waste by waste pickers or street and community cleaners. Furthermore, as previously discussed, food waste comprises the majority of Shanghai's MSW and is causing problems for incineration. The current trend in MSW composition is showing no sign of change and between 2002 and 2011 Shanghai's food waste increased at a rate of around 10% - 15% per year (An et al., 2014).

Due to the informal system in place to collect recyclable materials and due to the issue surrounding food waste in China's waste stream, previous source separation in China has been more directed towards food waste source separation (Tai et al., 2011). Figure 3 and Figure 4 have been taken from Tai et al. (2011) and demonstrate the typical MSW management in China, the first without food waste source separation and the second with food waste source separation.

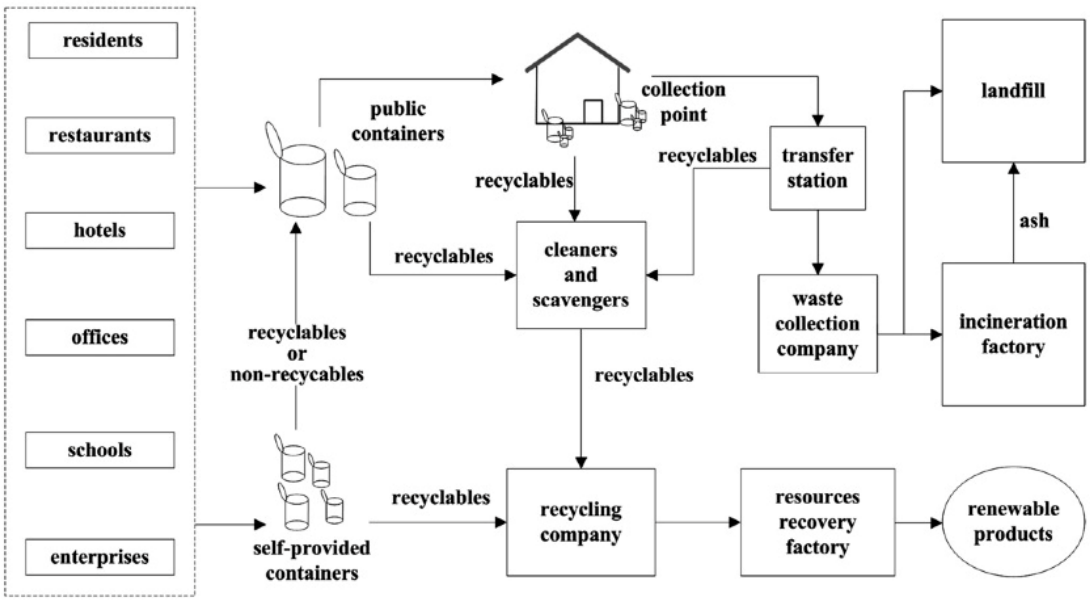


Figure 3: China's typical MSW management system without a food waste source separation scheme (Tai et al., 2011)

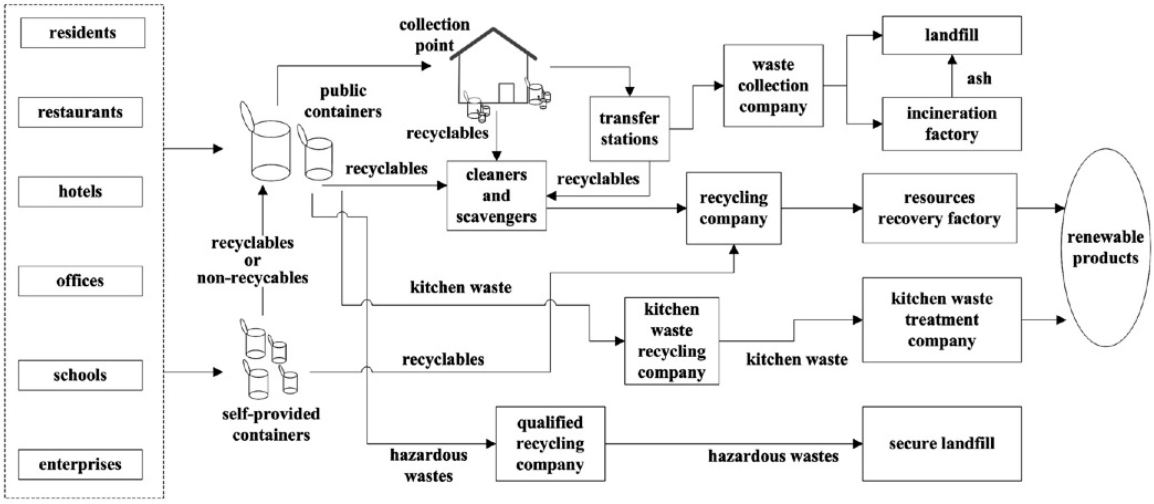


Figure 4: China's typical MSW management system with a food waste source separation scheme (Tai et al., 2011)

This study focuses on increasing the quantities of source separated food waste in Shanghai. Food waste has been targeted for the reasons already discussed such as the high food waste content in China's MSW, and for the following additional reasons. According to Adhikari et al. (2006) every kilogram of food waste disposed of via landfill generates 0.125m^3 of greenhouse gas. 60-65% of the gas generated is methane and 35-40% is carbon dioxide. Reducing food waste in the residual waste stream reduces greenhouse gas emissions (see section 7.1.8 on page 135 for more details), reduces waste to landfill, reduces transportation costs and reduces hazardous landfill leachate. Less land area is required to accommodate the growing size of landfills and consequently fewer odours affect the surrounding areas. Furthermore the food waste resource capture can be used in a variety of beneficial ways.

These include:

* Fertilizer production, naturally increasing agricultural crop yield while reducing reliance on artificial fertilisers (Hogg et al., 2007).
* Biogas fuel, heat, and power production via anaerobic digestion (Hogg et al., 2007, Bridgewater and Parfitt, 2009).

* Reduced waste disposal costs. This will have more relevance if Chinese waste management costs continue to increase and charges are forwarded on to local citizens. Currently this is not the case.
* Increased recycling, there will be less food waste in the residual waste contaminating recyclable materials; these recyclables will be easier to recover (Bridgewater and Parfitt, 2009). Furthermore it is often found that one pro-environmental behaviour leads to another, thus promoting additional recycling and conservation behaviours (Jackson, 2005).
* Used as animal feed (Zhang et al., 2012).

1.3 Recent developments

Despite the lack of waste management information in some areas, the number of published articles relating to Chinese waste management has dramatically increased over the past 15 years (Yang et al., 2013). In fact according to Yang et al. (2013) there were 730 Chinese waste management publications between 1997 and 2011 the majority of which (69%) were published between 2008 and 2011. The Authors conducted an analysis of the research titles and found that “landfill”, “incineration” and “management” are the most common topics. Table 27 found in Appendix 1 provides a list of the most recently published works on waste management in China between 2008 and 2014 as found by the Author. The purpose is to provide an indication of the current research focus.

The articles provided in Table 27 were found to fall into 5 topics including:

- Overview / Current WM Practices in China
- Articles relating to landfill
- Articles relating to incineration
- Recycling and source separation
- WM planning and improvement
- Other

The most common kind of article published describes the current situation with some statistical data on current trends and outputs. As previously mentioned landfilling is the current, predominant waste treatment method in China, this is reflected by the number of articles focusing on landfill and more specifically pollution as a consequence of landfill waste management techniques. Source

separation and waste management planning articles are less prevalent, this is expected given that source separation in China has only recently become apparent (Chen et al., 2010).

1.4 Aim and Objectives

This study was carried out in Shanghai where the Municipal Government are rolling out residential food waste collections as part of its waste management strategy. It is important to understand the impact that interventions could have on food waste recycling capture and participation to contribute to the overall goal of curbing the ever-increasing waste trend.

The aim of this study is to develop a framework from relevant literatures, which can be used to devise a suitable intervention to increase food waste recycling in an urban, gated community in Shanghai. The following objectives are outlined to fulfil the aim:

1. Identify significant determinants for successful recycling schemes from waste management and behaviour change literatures and use them to develop a framework.
2. Use the framework to plan and conduct a suitable intervention to increase food waste recycling in an urban residential community in Shanghai.
3. Obtain accurate representational waste quantity, composition and questionnaire survey data to evaluate the impact of the intervention.
4. Make recommendations on how to improve recycling schemes and suggest areas for future research.

Objective 1 is addressed in chapters 2 and 3. In chapter 2 the waste management literature is reviewed to identify the waste management recycling determinants, each determinant is discussed in turn and numerous references provided for each. Chapter 3 discusses the behaviour change literature and considers whether it can contribute to the list of recycling determinants. Behaviour change and recycling determinants are compared to ensure nothing important has been overlooked.

Objective 2 is addressed in chapter 4. In chapter 4 the determinants identified in chapter 2 are brought together into a waste management framework (WM24), this framework is then used to analyse a new food waste recycling scheme in a community in Shanghai. Any determinants that have not been addressed or

adequately addressed are identified through the analysis process and a suitable intervention is designed.

Objective 3 is discussed in the methodology, results and discussion sections. The methodological shortcomings and issues surrounding representation are presented throughout.

Objective 4 is addressed throughout the study. In the process of addressing objectives 1, 2, and 3 areas for future research have been highlighted. Recommendations are given in the conclusion.

2 Literature Review

2.1 Introduction to Recycling Determinants

Over the past couple of decades many academic and government publications have explored the variety of social and structural determinants of successful and unsuccessful waste management programmes. These publications have sought to help policy makers, practitioners and academics understand how to:

- Implement new recycling schemes
- Increase participation in new and existing waste and recycling schemes
- Reduce recycling contamination

(Suttibak and Nitivattananon, 2008)

Recently, an increasing body of work in waste management has begun seeking knowledge from social scientists working in behaviour change to apply it to waste situations. There are increasingly more articles emerging from the waste management literature that refer to behaviour theory for guidance on how to address the challenge of behaviour change for recycling, programme development, data interpretation and framework building.

Similarly behavioural psychologists working with behavioural theories have found waste management and recycling a suitable method to test, apply and develop theory in a practical capacity while also contributing to the field of waste management. As a result an increasing body of work has emerged that is behavioural and psychologically focused but which address important waste management and recycling issues (Jackson, 2005).

This interdisciplinary area has become of increasing significance as governments seek to promote more environmentally sustainable behaviours. Pro-environmental behaviour change applies theory from behavioural psychology to environmental situations. Examples include reusing unwanted products, recycling, conserving energy and water and low carbon transportation (Jackson, 2005).

Despite the advances in the field of pro-environmental behaviour change, few waste practitioners use this body of literature. Brook Lyndhurst (2007) found that few UK local authorities referred explicitly to behaviour change theory to develop

new waste approaches but do refer to more practical behaviour change frameworks such as DRFRA's 4Es (enable, engage, encourage and exemplify) see Chapter 3 on page 57 for further information. Thus far no consensus has been agreed as to the most useful, practical behaviour change determinants for applied behaviour change programmes, the areas of waste management and behaviour change will be considered in this study.

This chapter focuses on waste management publications to identify useful recycling determinants. Each determinant will be discussed with respect to the corresponding literature. Following the review of recycling determinants the behaviour change literature will be reviewed and behaviour change determinants considered with respect to the recycling determinants identified. Drawing on the work of both disciplines a framework will be developed for recycling scheme and intervention planning and development and used to plan an intervention to increase food waste recycling in Shanghai.

2.2 Recycling Determinants

The academic and grey literatures of waste management are filled with case studies of successful (high recycling rates and participation) and unsuccessful (low recycling and participation rates) recycling programmes. As a consequence waste management has grown as a discipline and there are currently a number of respected journals publishing waste articles. The number of variables present in a waste management study can be inexhaustible; therefore authors have sought to explore specific variables or sets of variables from across case studies that are relevant to various contexts. A few waste management models have also emerged from waste management literature and are discussed here.

Timlett and Williams (2011)'s ISB (infrastructure, service, behaviour) model seeks to draw attention away from the social psychological behaviour models such as those concerned with attitudes and values. The authors suggest that situational factors, which include elements relating to the local context such as size of household, availability of recycling services, spaces for storing objects and recycling scheme type (Corral-Verdugo, 2003), are often overlooked. Timlett and Williams (2011) propose that they should be given more attention when looking to understand, plan, implement and improve recycling schemes. It is suggested situational factors can contribute more towards recycling behaviour than the

intrinsic desire to act and that behaviour should be considered with respect to the situational factors.

Contrary to Timlett and Williams (2011), Barr (2007) poses a conceptual framework focusing more specifically on the social and psychological determinants of recycling behaviour. Barr (2007) sought to investigate the significant impacts that environmental values, social norms, attitudes and situational characteristics have on recycling behaviour. Barr (2007, 435) found that reduction and reuse behaviours were influenced most strongly by, “environmental values, knowledge and concern based variables” while recycling behaviour was found to be most strongly influenced by normative mechanisms (Barr, 2007). Following his investigation Barr (2007) proposes a revised list of waste situational and psychological variables, which will be considered in the waste management literature review.

The waste management models discussed are useful as starting points when looking to influence recycling behaviour but discrepancies between models are apparent and no model has been found that incorporates the wide variety of determinants that have come out of the literature. Morrissey and Browne (2004)’s waste management model review drew similar conclusions regarding the shortcomings of the waste management models. These included:

- Waste management models have not considered the complete waste management cycle
- They are often narrow in scope
- Waste management models recognise that environmental/Social/Economic factors should be considered yet no one model was found to address all three
- Models have not considered the effects of integrating the proposed strategies
- Waste management models often fail to consider the local population in the design and decision making processes
- Stakeholder integration is not considered

As a result of the lack of clarity and consistency in existing waste management models this study presents the results of a comprehensive waste management variable literature review to identify significant recycling determinants that can be

developed into a framework and used to inform future recycling scheme and intervention development, identify gaps in existing programmes and to aid the evaluation process. The waste management determinant literature review is a combined literature review and analysis. This approach has been taken to identify pitfalls of some of the determinants and to highlight their limitations.

The recycling determinants have been presented, discussed and divided into five categories:

- Structural / Technical (recycling scheme facilities, situational variables, institutional investment)
- Social / Psychological (attitudes, social norms, perceptions, beliefs)
- Institutional (including partners, stakeholders, policies, rules and legislation)
- Economic / Financial (financial incentives, socioeconomic factors)
- Demographics

A table has been drawn up for each of the determinant categories found in Appendix 2 on page 155. Each determinant has been correlated with all the identified corresponding references and as such, can be used as a resource when further information is required regarding specific determinants.

Although the five categories have been used to give structure to the literature review it should be noted that the categories are not definitive and that determinants from the categories often overlap. Therefore emphasis will not be placed on the categorisation but on the determinants themselves.

These five categories were loosely based on previous recycling determinant reviews. The categories were established to provide structure to the discussion and improve presentation; their categorisation is not the focus. Suttibak and Nitivattananon (2008) found recycling determinants to cluster into the four categories, General, Technical, Economic & Financial, and Institutional. Hornik et al. (1995) grouped recycling determinants into intrinsic incentives (attitudes, Locus of control, self-satisfaction), extrinsic incentives (rewards), internal facilitators (awareness, knowledge), and external facilitators (time, money, effort). Schultz et al. (1995) grouped them into global environmental (attitudes), specific environmental (beliefs), knowledge about recycling, demographics, and personality variables. Finally Barr (2007)’s recycling determinants grouped into

environmental values, situational characteristics and psychological characteristics.

2.3 Determinant Category 1 - Structural / Technical

Structural / Technical determinants have been found to significantly influence recycling schemes such as facilities, service type and convenience. In this chapter each of the identified determinants will be discussed in turn while the determinant table can be found in Table 28 on page 155 in Appendix 2.

2.3.1 Situational Variables

Situational variables are a broad determinant category comprised of a number of sub-category determinants. Situational variables are commonly discussed in the literature and widely regarded as “key” determinants for a successful recycling scheme. For example, without recycling facilities recycling will not take place regardless of an individual’s desire to do so. Situational determinants are known to have significant bearing on the success of a recycling scheme, exemplified by the large body of research conducted to demonstrate this. Compared with other determinant categories a number of situational variables play seemingly axiomatic roles in recycling schemes, these will be less discussed.

The subsequent section intends to describe, comment and critique the relevance of the determinants with respect to the literature.

Service - Recycling collection type (Drop-off / Kerbside collection / Community communal collection). Recycling services must be available for recycling to take place. Drop-off and Kerbside collection are most commonly used in more economically developed countries (MEDC) to recover recyclable materials. Kerbside collection is more convenient and accommodating and has been found to lead to increased materials capture by many authors. In emerging economies such as China, kerbside collections are not common and community communal collection is prevalent due to the structural layout of urban environments. This will be discussed in further detail later on.

Service - Accepted / Collected materials. Many studies have noted that the more materials accepted in the scheme the more opportunity there is to recycle and thus more materials are diverted. Thomas (2001) found this not to be the case and recorded reduced diversion of materials; one explanation is that over complicating the scheme can act as a deterrent to participants.

Service - Segregated or comingled collection. Although a seemingly evident determinant (comingled is more convenient than segregated therefore likely to result in greater success), there has been an on-going debate as to which service is more effective in promoting recycling behaviour and increasing recycling capture. This is predominantly because there is a concern that with comingled collections contamination becomes more of an issue. Noehammer and Byer (1997) found their evidence inconclusive which scheme type yields greater success while the following authors found comingled to be more favourable for success (Carlson, 2001, Oskamp et al., 1996, WYG, 2012).

Service - Collection frequency. This determinant includes alternate weekly collections, which has been found by a number of authors to increase recycling scheme success (Williams and Cole, 2013). However the relevance of collection frequency is contested and disputed. WRAP (2008) found that the importance of frequency depended on recycling attitudes and that it affected low recyclers more than high recyclers, Martin et al. (2006) found weekly collection on the same day as residual collection to be favoured while Chao (2008) and Noehammer and Byer (1997) found no strong evidence to suggest a significant relationship. Finally Carey et al. (2005) found that weekly collections to be preferred for multiple occupancy residences but also suggests fortnightly collections could work. This determinant is not applicable to China where daily waste collections are the norm.

Storage space. Another axiomatic determinant, if space is an issue then recycling participation is likely to be lowered. This is most evident in multiple occupancy buildings where lack of outside space and smaller dwellings are predominant. Some authors have discussed this determinant (see Table 28). Although useful to consider why a particular group may not be participating in recycling activity it should also be noted that perception of storage space also has a role to play (Cox, 2004). Cox (2004) found storage was listed as a barrier more commonly in low and medium recycling households regardless of accommodation type. This suggests that although physical space does have an influence, the psychological space perception is also important.

Sorting time / Time availability. This determinant is closely linked to convenience and perceptions that will be discussed later. Some authors have noted that time availability can affect willingness to participate (see references in Table 28) especially in low recycling households. However it should be

acknowledged that time availability and the perception of time availability are two different determinants. Authors such as Tonglet et al. (2004a); Barr et al. (2003); Davies et al. (2002) note that perceptions of inconvenience can inhibit recycling behaviour. To what extent time is a significant determinant is debatable and perhaps perceptions are more important than the reality of the availability of time.

Free waste receptacle / Type of receptacle. Providing extra facilities such as a free waste bin for use in the home is noted to help increase participation by some authors (see Table 28). Martin et al. (2006) suggests that it is important to provide a range of containers to suit different circumstances. In this instance there is an overlap with the localisation and convenience determinants.

Convenience / Required Effort. Convenience and required effort encompass all of the former determinants to some extent, and by addressing the above determinants the convenience can be increased and the required effort decreased. It has been listed here as a separate determinant because it has been considered as such in the literature (see Table 28). Like many situational determinants its importance for successful recycling has been debated. The majority of authors acknowledge that convenience and required effort is significant. Carlson (2001) investigated the role of social norms in recycling behaviour and found that convenience was found to be more significant for increasing and sustaining recycling behaviour than norm-strengthening techniques. Conversely, Martin et al. (2006) found evidence suggesting convenience not to be a significant factor in participation. An observation that has been discussed numerous times in the literature is for infrequent recyclers to claim they do not participate in recycling behaviour due to the lack of convenience. This will be discussed in greater detail in the Attitude section. Finally Barr (2007) notes that individual's perceptions of the convenience of recycling will affect the likelihood of recycling, therefore convenience and attitude can also be considered overlapping determinants.

It can be argued that considering convenience, as a stand-alone determinant is not useful without a more detailed definition of what is meant by "convenience". Convenience alone cannot describe the sub-determinants present in a particular study or account for the behaviour without a clear definition of which aspects of convenience the study is referring too. This is presented as a critique of the focus of many waste management studies that do not define their variables or determinants with enough depth. Considering convenience alone is unlikely to

provide any tangible transferable lessons for future waste interventions.

2.3.2 Information / Education / Knowledge

There is no doubt that to deliver successful recycling schemes information, education and knowledge must be delivered successfully (Kaplowitz et al., 2009, Iyer and Kashyap, 2007). The focus of the information will depend on the focus of the recycling scheme, the context in which it is carried out and which determinants need reinforcing or addressing.

2.3.3 Method of Communication

Participation in recycling schemes requires some degree of knowledge and basic skills that often need to be taught and communicated for success (Read, 1999). These are delivered via a variety of education and communication techniques; the following examples are taken from Read (1999):

- Media campaigns
- Household leaflets
- Radio advertising
- Public meetings
- Seasonal promotions
- Celebrity lunches
- Reminder cards
- Conference presentations
- Mobile advertising
- Recycling toys
- Telephone hotlines
- School presentations
- Surveys
- Promotional videos

(Read, 1999)

What is of interest and of importance to recycling organisations and authorities is which methods and combinations have shown positive results in implementing new schemes especially in light of the mounting evidence that information-only campaigns are often insufficient for long term behaviour change (Jackson, 2005,

Steg and Vlek, 2009).

De Young (1990) reviewed varying education programmes to understand how they could target recycling motivation, knowledge, recycling attitudes and social norms. De Young (1990, 253) found that educational programmes that focus on the “how to recycle” were most effective. Kaplowitz et al. (2009, 618) drew similar conclusions and suggested communication strategies should focus on the “what, how and where” to recycle rather than the “whys”. Iyer and Kashyap (2007) investigated the effects of information and incentives on recycling schemes and found both were useful for increasing recycling behaviour however the authors suggest incentive’s strengths lie in short term gains and information in long-term and sustained gains. The authors did not detail what types of communications were most effective and which lead to assimilated knowledge. Despite the many methods of communication it is likely that different contexts will respond differently to different communication interventions. Kaplowitz et al. (2009) noted that university student populations responded well to promotions and incentives while the academic staff preferred personal contact. There are other studies looking at personal contact in the relevant literature usually in terms of a doorstepping intervention.

Doorstepping studies to increase recycling participation have generally been found to be successful in examples from the literature and have proved highly successful tool during election campaigns (Cotterill et al., 2009). Doorstepping has been used as a method to address many recycling related issues such as:

- Raise awareness of recycling and encourage action
- Provide details about recycling collections from home
- Increase capture rates (the range of materials a householder recycles)
- Decrease contamination (materials that should not be put in their bag/box)
- Improve set-out (the frequency with which a householder recycles)
- Improve participation (the number of households recycling)
- Provide targeted information with a personal approach
- Collect attitudinal data on recycling
- Obtain feedback from residents on current services

(WasteWatch, 2006)

In a recent study by Cotterill et al. (2009), doorstepping was found to increase recycling participation in a UK kerbside collection scheme (measured by set-out rates) by 5.4% when compared with the control. The effect was found to reduce over time and three months after the intervention it was at just 1.7%. Although Cotterill et al. (2009) state that their results were controlled for ethnicity, deprivation and baseline no weight data were collected and therefore to what extent the intervention influenced recycling capture and waste diversion is unclear. Timlett and Williams (2008) investigated the impacts of three different interventions to increase UK kerbside recycling participation. Doorstepping was found to be the least effective at reducing contamination levels and most costly method for changing behaviour when compared with personalised incentives and feedback interventions. It is suggested that this could be due to the initial high baseline participation rate. Despite the disappointing results of the doorstepping intervention they found a 13% increase in households recycling all four of the target materials while the incentives project showed a 3% decrease. The Authors suggest that the other interventions were more successful due to the more intensive communication techniques used and suggest that doorstepping might be more successful when designed to address specific aims, for flats using communal bins or where additional quality is required. WasteWatch (2006)'s "Recycling for Flats" reported the results of doorstepping campaigns in a number of different locations in the UK. The results of the interventions were very successful in increasing the tonnage or recyclate by up to 35% in some cases and recycling scheme participation up to 80%. The report suggests that the merits of a doorstepping intervention lie in its ability to deliver specific and directed information, this is in accordance with suggestions from Timlett and Williams (2008). Grodzińska-Jurczak et al. (2006) conducted a doorstepping intervention in Poland to increase the quality and quantity of segregated household recyclables. 687 households were visited over 24 months, by young enthusiastic doorsteppers in uniform who promoted recycling and reuse behaviours, communicated technical details about the recycling services and carried out a 4 minute survey pertaining to householder's waste and recycling attitudes. The doorstepping intervention resulted in 11.5 tonnes per month increase in recyclate and a 55% increase in participation over 15 months. Feedback indicated the method of using young encouraging volunteers and the face-to-face approach was well received. Read (1999) found similar results with average recycling tonnages increasing from 107

tonnes pre-intervention to 132 tonnes post doorstepping intervention.

Bernstad et al. (2013) carried out a doorstepping intervention to determine the impacts of written and oral face-to-face communications on food waste recycling behaviour in multiple occupancy apartment blocks in Sweden. The authors divided the sample area into two and used a doorstepping and written communication on half (group1) and a written only communication on the other half (group 2). The interventions demonstrated a significant decrease in the overall levels of residual waste post intervention in both groups 1 and 2 and significantly less food waste in the residual waste in group 1 when compared with group 2 as well as initially higher food waste capture rate in group one. However over time the ratio of separated food waste between the treatment groups reduced and when averaged out over the entire study period of 104 weeks the difference was not significant. The Authors conclude that the doorstepping intervention did not contribute to long-term increases in food waste sorting behaviour.

The block leader approach is another face-to-face communication technique and uses local citizen volunteers to communicate with other citizens. An individual is approached or can be nominated and asked to represent their block, street or area. That individual is then responsible for delivering communications and in the case of waste recycling provides extra support and encouragement on a one-to-one, level. The block leader approach is discussed in further detail in the Norms section on page 43.

The merit of the block leader and doorstepping communication techniques is that the level of communication delivery can be ensured as a result of the face-to-face contact. While a banner, poster, leaflet, TV and radio communication can be ignored a face-to-face interaction is much harder to overlook. The block leader approach and doorstepping techniques will offer a suitable intervention strategy when information must be delivered to a population and in a short period of time.

It is clear that communication strategies are integral to any new recycling scheme and a few methods have been discussed and many more approaches have been mentioned. Although it is still unclear which methods are best able to satisfy the communicative aims it is clear that without communication strategies schemes are unlikely to be successful. Like with many of the recycling determinants the most successful strategies will involve a combination of methods, which have been

localised to the specific contexts. However as Kaplowitz et al. (2009) note it is more probable that strategies will be developed with respect to available resources and finances rather than by what has been found to be most effective.

2.3.4 Localisation of the Programme and Community Involvement

A select few authors have acknowledged the localisation of a recycling programme as being of importance with regard to new and existing recycling schemes. This determinant overlaps with attitudes as the way in which the programme is introduced can affect the way in which participants view the recycling programme. As discussed in the attitudes section (2.4.2) Brook Lyndhurst (2007) found that attitudes towards local government could influence participation and that by localising the programme and developing it as a community initiative the negative attitudes can be mitigated. Chao (2008) suggest that techniques should be tailored to the facilities and the context in which they operate to increase recycling participation. Folz and Hazlett (1991) suggest citizen involvement in the planning stages of a programme along with local meetings and tailored information could help increase environmental citizenship and personal responsibility towards recycling. Zhang et al. (2008) suggest that by tailoring the source separated materials certain local problems can be addressed. Finally Maria Muller (2001) found localisation of a programme is more likely to meet the demands of the local population, increase ownership for the programme and also increase appreciation for the local governing authority.

2.3.5 Number of Operatives

The number of skilled and trained operatives working within the context of the recycling programme has been documented by a few authors as important for programme success (Mongkolnchaiarunya, 2005, Suttibak and Nitivattananon, 2008, Refsgaard and Magnussen, 2009). This is another axiomatic determinant and often constrained by the resources available. Volunteers are a proven way to increase operative presence without putting pressure on financial resources (Cox et al., 2010).

2.4 Determinant Category 2 - Social / Psychological

Social / Psychological determinants are more complex because they often involve an understanding of human behaviour and behavioural motivators, which is

regarded as highly complex (Jackson, 2005). However, as previously discussed, psychologists and sociologists have increasingly used waste management and recycling as a means to test and investigate behavioural theory. As a consequence an increasing body of literature has emerged that looks specifically at the Social / Psychological determinants of recycling programmes. A consequence of the complexities of behavioural determinants is that their isolation is notoriously difficult and they often overlap. For example Perceptions overlap with Norms and Attitudes, Locus of Control and with Self-Efficacy, Feedback / Commitment / Goals / Prompting and reminders with Norms, and Habit with Previous experience. Overlap can also be seen between some Social / Psychological determinants and Structural / Technical determinants. Despite the overlaps the determinants can also be considered separately depending on their defining factors and which specific aspects they encompass.

In this chapter each of the Social / Psychological determinants will be discussed in turn while the Social / Psychological determinant table can be found in Table 29 on page 158 in Appendix 2. The Social / Psychological recycling variables were identifies from a wide variety of literature, including waste management and psychological and sociological behavioural studies.

2.4.1 Perceptions / Beliefs

Perceptions of the waste system, the local management authorities and the environment have been found to affect recycling behaviour in a number of studies. Suttibak and Nitivattananon (2008) found the perceived awareness of waste issues by the programme administrative authority was a significant factor in the level of success of a recycling scheme in Thailand. Similar findings have been observed in the west, specifically that attitudes towards and perceptions of a local authority effect the outcomes of a recycling programme (Williams and Kelly, 2003, Brook Lyndhurst, 2007, Martin et al., 2006, McDonald and Oates, 2003). Perceptions can also affect the outcome of the programme in other ways, as previously noted. Barr (2007); Tonglet et al. (2004a); Cox et al. (2010) suggest that perception of recycling convenience is a consideration, especially in the case of infrequent recyclers or non-recyclers. It should also be noted that perceived and actual norms have also been considered and will be discussed further in the norms section.

2.4.2 Attitudes

Many studies have shown a correlation between attitudes, specifically concern for the environment and recycling behaviour. Investigations have made use of the New Environmental Paradigm (NEP) cf. (Dunlap et al., 2000). NEP is a method used to quantify and measure environmental attitudes and which can then be used to investigate their relationships to recycling (Chung and Poon, 2001, Do Valle et al., 2004, Schultz and Oskamp, 1996). Chung and Poon (2001) found a lower NEP score to be associated with a lower recycling disposition; Schultz and Oskamp (1996) noted that NEP was a good predictor of recycling behaviour only when the behaviour involved significant effort and Do Valle et al. (2004) found no relationship between NEP score and recycling behaviour.

Carlson (2001) discusses the effects of attitudes on recycling behaviour and makes three observations; the first is consistent with Schultz and Oskamp (1996) and states that a negative attitude towards recycling is reduced if recycling is made highly convenient (low-cost behaviour). Andersson and von Borgstede (2010) have observed this phenomenon in other studies by Diekmann and Preisendörfer (2003) and Harland et al. (2007). The second is that attitudes can predict the extent of the recycling behaviour and even in highly convenient schemes pro-recycling and pro-environmental attitudes have been found to lead to greater recycling capture. The third observation noted by Carlson has also been observed in numerous other studies and suggests that infrequent recyclers recycle less due to inconvenience factors (Vining and Ebreo, 1992, Ebreo and Vining, 2001, Schultz et al., 1995, Gamba and Oskamp, 1994).

Tonglet et al. (2004b) and Steg and Vlek (2009) suggest that the establishment of new recycling facilities can lead to increased positive attitudes towards recycling and as a consequence may lead to an increase in recycling materials capture. Finally Brook Lyndhurst (2007) found that attitudes towards the local governing authority can affect the success of a recycling scheme. If a negative attitude prevails, a certain percentage of householders will be against the scheme. However this can be mitigated if the scheme is presented as a community initiative and not exclusively government driven (Brook Lyndhurst, 2007).

Although attitudes sit within the psychological / social determinant category they have been shown to have many connections with structural / technical

determinants. This highlights the interrelated nature of the recycling determinants and that a specific definition of what is meant by a determinant needs establishing before its relevance and impact can be investigated and evaluated. It should be noted that attitudes need further defining and breaking down into more specific definitions in order to understand how attitudes shape the waste management situation (Mosler et al., 2008).

2.4.3 Norms

Social norms both actual and subjective or perceived have been considered in recycling investigations as a method to understand behavioural patterns in specific contexts and also as a method to elicit behaviour change through norm-strengthening techniques. Often normative mechanisms are discussed to help explain a specific phenomenon. Chao (2008) and Mongkolnchaiarunya (2005) did not carry out statistical tests to measure the impacts of norms but in their investigations of new and relatively successful recycling schemes they used various norm-strengthening techniques. However like many other of the determinants the literature yields mixed results when looking for significant predictors of recycling behaviour. Bratt (1999) investigated the effects of both personal and social norms on recycling behaviour to find no relationship between the social norm and behaviour. Carlson (2001) also found norms to have little effect on behaviour when the convenience factor was high (as mentioned earlier) and concludes that norm management and regulation is not that significant for sustaining or increasing recycling behaviour. Chan (1998) found subjective norms, attitudes and perceived control to account for 44% of the variance of self-reported behavioural intention and was a statistically significant factor for predicting behavioural intention.

The Block Leader approach has been listed under the “Method of Communication” determinant, however depending on the block leader this approach can also have an effect on social norms and perceptions of norms. Schultz et al. (1995) notes that the block leader approach can deliver two distinct outcomes, to educate and disseminate information and to increase personal contact and Carlson (2001) suggests it is a way to “internalise a recycling norm”. Burn (1991) used a block leader intervention to increase recycling participation in the USA. Block leaders delivered face-to-face, persuasive information and special recycling bags to the treatment group and information and bags were distributed and left at the front

doors of the control group. Burn found the block leader treatment group to recycle significantly more than the control group. Hopper and Nielsen (1991) obtained similar results.

In the discipline of behaviour change norms have been extensively studied and have numerous examples of norms influence on behaviour. Cialdini et al. (1991) (focus theory of normative behaviour) found the influence of norms to be greater for low cost / effort behaviours such as changing temperature gauges than other higher cost / effort behaviours. This conclusion appears to be consistent with the waste management literature on norms and attitudes, which find norms and attitudes to be more predictive of recycling behaviour when such behaviour requires relatively low effort. Schwartz (1970) cited in Burn (1991) found that for a norm to predict behaviour a belief about the negative consequences for norm rejection must be held.

2.4.4 Belief in one's Ability (Locus of Control)

Kollmuss and Agyeman (2002, 243) have defined locus of control as, "An individual's perception of whether he or she has the ability to bring about change through his or her own behaviour". Few waste management studies have investigated this determinant due to its intangible nature and a lack of understanding on how to increase recycling behaviour through targeting an individual's locus of control. Schultz et al. (1995) found that recyclers are more likely to have an "internal" locus of control, believing that they are able to affect change rather than change being outside their control (external locus of control).

This determinant can be considered as a descriptive determinant for interpreting rather than for predicting an effect. Its merit lies in its ability to understand behaviour rather than to use it to predict or plan change.

2.4.5 Self-Efficacy

Self-efficacy is the belief in ones capabilities and abilities to execute an action or behaviour and as such has been extensively considered in the behaviour change literature. Some authors in the waste management domain have discussed the role of self-efficacy as a potential barrier to recycling behaviour. If an individual believes that their contribution to the wider problem is minor or insignificant and lacks a belief in their abilities to execute the behaviour this can be a barrier to

recycling (Cox et al., 2010). Barr et al. (2003) and Barr (2007) found self-efficacy to be significant regarding an individual's ability to act and Chan (1998) and Tang et al. (2011) both found strong correlations between self-efficacy and recycling behaviour. Self-efficacy has both descriptive and predictive uses as a recycling determinant. Just as self-efficacy can contribute to an understanding of a lack of recycling behaviour it can also be targeted with an intervention designed to increase the self-efficacy of the participants. Some suggested techniques might include norm-strengthening techniques, increasing convenience or specific communications to increase awareness of the individual and collective impact of recycling.

2.4.6 Belief / Perceptions of Recycling Consequences

This determinant shares many similarities with the previous determinant and can also be considered both a descriptive and predictive determinant. Belief of consequences has been acknowledged in behavioural studies as a determinant for behaviour change (Strathman et al., 1994, Michie et al., 2005, Joireman et al., 2012). Strathman et al. (1994) pose a *"Consideration of Future Consequences (CFC)"* scale which has been used a number of times to investigate the relationship between CFC and behaviour and recently the construct has been re-evaluated and updated see Joireman et al. (2012).

Since 1994 many authors, mainly in the field of health, have used the original CFC scale to investigate the relationship between CFC and heath related issues such as smoking, drinking, exercising, healthy eating and other general issues of health and safety (Joireman et al., 2012). The updated CFC construct was introduced to address various criticisms of the earlier construct, which did not distinguish between immediate and future consequences, which was found to explain various behavioural decisions (Joireman et al., 2012).

Joireman et al. (2001) used the CFC on a sample of college students and found a strong positive correlation between their belief of social consequences and pro-environmental behavioural intentions. Ebreo and Vining (2001) also used the CFC and found altruistic subjects and those who consider the future consequences of their actions to be more likely to recycling than others.

Other studies include Tonglet et al. (2004a) who found a statistically significant relationship between attitude, consequences of recycling, community concern and

recycling intentions. Lindsay and Strathman (1997) found a correlation between belief of health consequences and recycling behaviour while Bratt (1999) found only a loose connection between belief of environmental consequences and reported behaviour. The focus of Bernstad et al. (2013)'s longitudinal doorstepping investigation aimed at increasing food waste recycling delivered information on "how" to recycle as well as "why". The printed leaflet and oral communication delivered information on the environmental benefits of food waste sorting including the benefits of anaerobic treatment of food waste as well as the ability to generate biogas. The householders were made aware of the quantity of biogas produced per kg food waste recycled. Although Bernstad et al. (2013) conclude that the doorstepping was not significantly effective at increasing food waste recycling on a long-term basis, their questionnaire survey found that 75% of respondents reported that it is important to know the environmental consequences of waste disposal.

Despite the studies listed above there have been no studies (to the authors knowledge) that have used belief of environmental consequences of waste disposal as a method to improve recycling; in other disciplines there are examples cf. Joireman et al. (2012). Using belief of environmental consequences of waste disposal as a method to improve recycling schemes is suggested as an area for future research.

2.4.7 Attachment to or Concern for the Community

This determinant is predominantly a descriptive determinant used to understand why an effect has taken place rather than to change or influence it. This determinant has been discussed in only a very few studies known to the author. Shaw and Maynard (2008) found that a concern for the community was generally more effective at motivating participation in recycling schemes than personal gain. They went on to suggest that this determinant is driven by altruism, encouraging actions, actions that benefit the group rather than individuals and actions which have positive influences on recycling behaviour. Tonglet et al. (2004a) came to similar conclusions, which is that concern for the community is a significant predictor of recycling behaviour. More specifically the authors looked at "concern with maintaining a good place to live" and "interest in the health and well-being of the community" (Tonglet et al., 2004a, 35). It is worth noting that although acting on behalf of the community is possibly altruistic, improving the community

environment will usually improve the personal environment as well. Finally Mongkolnchaiarunya (2005) suggest that communities with a high resident turnover may have a lower sense of community and therefore be less inclined to engage in new waste programmes. An area for future investigations that look at the role of community and specifically a “sense of community” and its influence on recycling behaviour is suggested.

2.4.8 Feedback / Commitment / Goals / Prompting and Reminders

Feedback has been used in the waste literature as a means to increase recycling participation, diversion and material quality. It has been used as a stand-alone intervention with promising results (Kim et al., 2005, Timlett and Williams, 2008), in conjunction with other interventions (Timlett and Williams, 2008, Perrin and Barton, 2001, Harder and Woodard, 2007) and it has been used as norm strengthening method to increase recycling behaviour (Carlson, 2001, Schultz, 1999).

Feedback and goal setting have been studied in other areas such as energy conservation. Abrahamse et al. (2005)’s feedback literature meta-analysis found feedback to be a significant energy reduction strategy with few exceptions. Results from the feedback studies found feedback frequency, type of feedback (whether the feedback causes cognitive dissonance or not) and whether feedback was combined with other interventions such as goal setting offer varying degrees of success. Following their meta-analysis Abrahamse et al. (2007) conducted their own tailored information, feedback and goal setting investigation. The results showed a 5.1% energy reduction in the treatment group when compared to the control.

Similar results have been presented in the waste literature. Kim et al. (2005) found a statistically significant increase in recycling when written feedback was provided and an increase (but not statistically significant) in recycling with graphic feedback and all recycling, except paper cup recycling, decreased when the feedback was removed. Perrin and Barton (2001) found information feedback provided to households increased the recycling rate by up to 48%, scheme participation up to 93% and the weekly set out rates up to 84%. Similarly Katzev and Mishima (1992) report that two week posted feedback increased paper recycling by 76.7% over the baseline which was still 48.3% above the baseline one week post intervention. Timlett and Williams (2008) carried out two feedback interventions; one was

concerned with feedback only while the other was used in conjunction with an incentives intervention. The authors state that the feedback intervention increased recycling set out rates but was not statistically significant, however there was a statistically significant decrease in recycling contamination levels. Interestingly, when evaluating the impact of the combined feedback and incentives intervention just 13% of respondents stated the reward as their main motivation.

Goal setting and commitment pledges are other methods used to affect recycling behaviour and have been used to good effect in a few studies (Folz and Hazlett, 1991, Schultz et al., 1995, Wang and Katzev, 1990).

Prompting and reminders are difficult determinants to discuss on their own because all the above and many other determinants can be regarded as prompting and reminders to recycle. Facilities provided, publicity and gifts disseminated, communication method, the education delivered or the service given. For this reason there is little research into the effects of “prompting” as a lone determinant because within the context of waste management most interventions serve as prompts. Read (1999) discusses prompts and reminders with regard to the communication techniques used, Schultz et al. (1995) studied prompting and concluded that prompting along with other determinants is able to produce significant increases in recycling behaviour, Burn (1991) mentions prompts in the context of his doorstepping intervention and Harder and Woodard (2007) found reminders and feedback to have an effect on recycling participation.

This determinant category has demonstrated consistent promising results in the literature, furthermore such intervention techniques are often more cost effective when compared to other alternatives (Timlett and Williams, 2008). However the intervention’s long-term effects have been less reported and the sustainment of the behaviour post intervention is an area for future research.

2.4.9 Habit

Triandis (1979) cited in Davies et al. (2002, 31) defined habit as “situation-specific sequences that are or have become automatic, so that they occur without self-instruction”. Habits are formed to minimise cognitive effort in behavioural choices and decision-making processes (Jackson, 2005). Cox et al. (2010) notes that habits can have both negative and positive consequences for recycling programmes. If a strong habit is formed regarding waste disposal prior to a new

recycling scheme then old habits will require breaking before new habits can be formed (Cox et al., 2010). Although habitual behaviours are difficult to change (DEFRA, 2008) if new recycling habits are created then it is possible that the desired recycling behaviour will be sustained into the future and the need for continued interventions will be reduced (Cotterill et al., 2009).

According to Cox et al. (2010) habits can be formed through continued communication and hands on approaches and similarly Sharp et al. (2010, 259) found “drip-feeding” information regularly rather than sporadically and providing specific advice on how to carry out the behaviour to be useful in forming new recycling habits.

2.4.10 Previous Experience

Previous or past experience has been discussed both in the waste management and behavioural literatures. Tonglet et al. (2004a) notes that a number of recycling studies have indicated that previous experience is a good predictor of recycling behaviour. In the behavioural domain Ajzen (1991) believes past experience can be explained by other behavioural determinants and does not need to be considered separately. Discrepancies in the literature review have been consistently highlighted as a limitation to such type of study and clear determinant definitions are required to reduce ambiguity.

2.5 Determinant Category 3 – Institutional

Institutional determinants can be subdivided into two categories. The first: Stakeholder involvement and cooperation and the second: policies, rules and legislation. The former has been given less consideration than the other categories of determinants until fairly recently. In this chapter the two categories will be discussed in turn while the determinant tables can be found in Appendix 2 in Table 30 and Table 31 on page 160 and 160 respectively.

2.5.1 Stakeholder Involvement and Cooperation

Two recent editorials in the journal of Waste Management have emerged in the past year discussing the importance of considering different partners / stakeholders for successful recycling schemes and the contributions that they can make (Alamgir et al., 2012, Williams et al., 2012). Suttibak and Nitivattananon (2008) found that the successful involvement of a variety of different partners is

essential and that each partner can execute different essential roles within the context of a recycling scheme. Ahmed and Ali (2004, 478), Ahmed and Ali (2006, 782) looked at the roles different partners play in recycling schemes and called for a new approach to improve the relationships between public and private partners, suggesting a “facilitating agent” might be required to act as a broker between various partners to facilitate communication, the transfer of information and skills and to develop public and private partner relationships. Other authors have suggested a similar need for a “brokerage” to dismantle barriers and facilitate knowledge sharing and transfer (Zurbrügg et al., 2012, 2127, Cox et al., 2010).

Suttibak and Nitivattananon (2008) have discussed the role of international cooperation as being a useful consideration for waste recycling programme success. Although they didn't find the determinant to be statistically significant they did find it was important for investment, promotion and technology transfer.

Finally Martin et al. (2006) and Brook Lyndhurst (2007) discuss that animosity towards a delivery partner can result in a lack of participation and engagement of a certain percentage of participants. Therefore good relationship development is considered important for successful schemes.

2.5.2 Policies, Rules and Legislation

The waste management literature surrounding policies, rules and legislation is predominantly inconclusive, with the majority of debate surrounding mandatory or voluntary recycling participation. There is still ongoing debates and to what extent this category of determinants is important is still uncertain. The most common waste policies identified from the literature are “mandatory recycling participation” and “unit pricing”, these are discussed in the following section.

2.5.3 Mandatory Recycling Participation

Noehammer and Byer (1997, 423) concluded that mandatory recycling programmes generally yield higher participation rates than voluntary. However “well-designed” voluntary programmes have the potential to achieve similar participation rates. Folz and Hazlett (1991) investigated the impact of policies, including mandatory recycling, on recycling success (participation and diversion) and concluded that being democratic and open during planning is more conducive to success than pre-prescribed sets of policies. Yang and Innes (2007) found that

a mandatory recycling policy did increase participation and diversion when implemented with a strict enforcement. While Jenkins et al. (2003) found that mandatory recycling programmes had no effect on the quantity of materials diverted. Finally Shaw and Maynard (2008) found the evidence for mandatory vs. voluntary recycling policy inconclusive.

2.5.4 Unit Pricing

Unit pricing for waste disposal is a controversial policy that charges per unit of waste disposed, and like the mandatory policy has yielded mixed results. Chao (2008) and Yang and Innes (2007) looked at the effect of a per waste bag collection charge policy implemented in Taipei city, in 2000. The results of the policy as reported by the authors were successful, increasing the quantity of recyclables significantly, which for paper recycling was 78.6% (Yang and Innes, 2007). However it was noted that for glass, the policy appeared to reduce diversion. Carlson (2001) found inconclusive evidence to suggest that unit pricing increases recycling rates and Kinnaman and Fullerton (2000) found that a $1 charge per unit of residual waste disposed, reduced individual waste disposal by 44% per year and increased recycling by 13.5kg per person per year. The criticism of unit pricing is that it leads to illegal dumping, burning or disposing in public waste bins to avoid the charges, this was found by Miranda and Aldy (1998); van den Bergh (2008) and Zhang et al. (2010).

2.6 Determinant Category 4 - Economic / Financial

The Economic / Financial category includes the rewards / financial incentives determinant only. In this chapter “rewards / financial incentives” will be discussed while the references corresponding to this determinant can be found in Table 32 on page 161 in Appendix 2.

2.6.1 Rewards / Financial Incentives

Incentives have been suggested as an efficient method to increase participation and recycling rates while other studies dismiss the use of incentives or propose their use with caution. Shaw and Maynard (2008) investigated recycling participants attitudes towards financial incentives and concluded that programme enhancement is preferable to the use of incentives. Suttibak and Nitivattananon (2008) suggest that the use of economic incentives have the potential to increase

recycling participation, however the long-term implications were not investigated. Noehammer and Byer (1997) drew similar conclusions and found participation rates correlated positively to economic incentives, however to what extent, the authors are uncertain. Timlett and Williams (2008) found their incentives intervention affected recycling participation, however the authors claim it was not possible to isolate the variable to determine its significance. They conclude that the intensive communication, engagement and feedback that accompanied the incentive scheme could have produced similar effects regardless of the incentive. This was confirmed by their qualitative data, which suggested that only 13% of participants were motivated to recycle as a result of the economic incentive. Harder and Woodard (2007) investigated the impact of a range of economic incentives on recycling behaviour and found the most effective incentive had a value greater than £1. Finally, a UK nationwide DEFRA funded incentives project established that 30 out of 53 trials or 57% were considered effective at increasing quantities of recycled material however like many of the other examples previously discussed the extent to the success is unclear (ATEA, 2006).

A problem that's emerged with economic incentives has been that once the incentive is removed the desired behaviour soon returns to pre-intervention levels (Wang and Katzev, 1990, Burn, 1991, Geller, 2002). Others have found monetary incentives to have negative consequences for altruistic recyclers who do so for the communal benefits rather than individual gains (Tonglet et al., 2004a, Barr et al., 2001).

2.7 Determinant Category 5 – Demographics

In this chapter demographics will be discussed while all the references identified by the literature review can be found in Table 33 on page 161 in Appendix 1Appendix 2.

2.7.1 Demographics

Many authors have investigated demographic determinants of recycling behaviour, yet despite the countless examples; many studies have found that they do not yield useful information. According to Domina and Koch (2002, 218)'s literature search the traditional recycler is "White, younger, better educated, middle / upper class citizens, and politically liberal". While according to Tonglet et al. (2004a) and Belton et al. (1994) the most likely individuals to participate in waste minimisation

were from older demographic groups. Schultz et al. (1995) and Carlson (2001) found income to be a good predictor of recycling behaviour but not age or gender while Lee and Paik (2011) and Chan (1998) found both age and gender to be both significant predictors of recycling behaviour. Iyer and Kashyap (2007) state with certainty that females are more environmentally inclined than males and as a result recycling schemes should target the female population.

Many further examples can be observed in the literature where demographic variables have demonstrated statistically significant conflicting results and generalisations regarding recycling behaviour. However significant relationships are not always determined and there are equally numerous academic papers that have failed to determine any relationships. Martin et al. (2006) established a weak, non-significant relationship between age and income and Folz and Hazlett (1991); Domina and Koch (2002); Corral-Verdugo (2003); Scott (1999); Barr (2007) and Chan (1998) all indicated that demographics are of low importance if not, insignificant and have little or no bearing on recycling behaviour.

Hansmann et al. (2006) and Matsumoto (2011) carried out a similar review of the role of demographics in recycling studies and drew similar conclusions that the results are inconsistent. Further evidence is provided in Table 34 on page 161 in Appendix 2.

The evidence from the literature suggests that concentrating on the specifics of demographics with the aim to increase recycling behaviour is limited in scope. The inconsistencies in the literature provide a weak case for focusing on demographics. However basic demographic information can help to localise a new or existing programme or intervention. For example if there is an unusually high retired population or family population an intervention or service will need to be tailored accordingly. In these cases demographic information can help plan tailored interventions and interpret intervention results. This study will collect basic demographic information for these purposes.

2.8 Concluding Comments

The literature review was undertaken to identify recycling determinants from the relevant literatures and to present and discuss them. The determinants were grouped into five categories to give clarity to the discussion; it was not the intention to create new determinant clusters. The literature review is also intended

as a determinant resource library where information regarding specific determinants can be located when looking to work with existing or new recycling schemes. In the following chapter the identified determinants will be grouped together and used to analyse a current recycling scheme and to design and plan an intervention to increase food waste recycling in Shanghai.

2.9 Waste Management 24 (WM24) Determinants

So far the waste management literature has been reviewed and 31 determinants of successful recycling schemes have been identified. The initial 31 determinants have been reduced to 24 because “service” and “stakeholder involvement and cooperation” can account for a number of determinants and make the list more manageable. All the 24 determinants have been discussed in waste management studies as being of importance to recycling programmes in various capacities. The 24 determinants have been identified from waste management literature and have been named the “Waste Management 24 (WM24)” and is referred to as the WM24 throughout this investigation. The 24 determinants are listed below in Table 2.

Table 2: Waste Management 24 (WM24) Determinants

No.	Determinant
1	**Service – a)** recycling collection type (drop-off / kerbside collection / communal community collection) **b)** Recycling disposal method (segregated or comingled collection) **c)** Accepted / collected materials, **d)** Collection frequency
2	**Storage space**
3	**Sorting time / time availability**
4	**Free waste receptacle / type of receptacle**
5	**Convenience / Required Effort**
6	**Demographics**
7	**Information / education / knowledge**
8	**Method of communication** (including research into the block leader approach, study tours and doorstepping)
9	**Localisation of the programme and community involvement**
10	**Number of operatives**
11	**Perceptions / Beliefs -** management competence, awareness, waste, waste sorting, environmental problems, convenience
12	**Attitudes -** towards recycling / environment, waste management service provider, local government, includes work using NEP
13	**Norms -** Personal norms, social norms and subjective norms. Also includes research into the block leader approach
14	**Belief in one's ability -** locus of control, responsibility, response-efficacy which is a belief that the individual can make a difference
15	**Self-efficacy -** belief about self-capability or perceived behavioural control
16	**Belief / Perceptions of recycling consequences**
17	**Attachment to or concern for the community**
18	**Feedback / Commitment / Goals / Prompting and Reminders**
19	**Habit**
20	**Previous experience**
21	**Stakeholder involvement and cooperation -** NGO involvement, private sector cooperation, local government involvement, community based partner involvement and international cooperation

No.	Determinant
22	**Mandatory recycling participation**
23	**Unit / Per bag pricing**
24	**Rewards / Financial incentives**

The 24 determinants presented in Table 2 have been gathered from a wide body of literature including waste management case studies, waste management models, behaviour change waste management focused studies and government reports. The case studies were useful for identifying the significance of some recycling determinants and variables however the specific nature of the case studies often struggled to generate transferable lessons, furthermore there was found to be lacking precise waste management determinant definitions which can lead to ambiguity. Some determinants were found to have little relevance to the overall goal of improving the waste management situation such was the case with the demographic determinants. Finally the behaviour change in waste management studies are useful for understanding the complexities of the social variables within the waste management context but are sometime too theoretical and complex for direct use in the field (Smallbone, 2005).

The following section considers works from the academic area of behaviour change. Behaviour change theory has been touched upon in some waste management studies; it will now be discussed in further detail. Behaviour change will be used to validate the WM24 and to verify that the WM24 has not overlooked any determinants intrinsic to behaviour change. An introduction to behaviour change can be found in Appendix 3Appendix 1.

3 Behaviour Change Literature Discussion

Despite waste management studies drawing upon works from behaviour change (BC) and behaviour change theories, there is still a reluctance to do so. This section will explore some ideas why this is the case and how behaviour change can contribute practically in a waste management context.

Brook Lyndhurst (2007) found few recycling projects in the UK referred explicitly to behaviour change theories and policies during programme development. Those stating they felt informed regarding behaviour change theory commonly referred to DEFRA's 4Es (enable, engage, encourage and exemplify) behaviour change framework (Brook Lyndhurst, 2007) see DEFRA (2008) for the 4Es framework. Incidentally, the DEFRA 4Es framework was not derived from behaviour theory and literature but from a public survey of attitudes. The framework identifies behavioural goals and segments the population to identify a number of behavioural groups and the likelihood of the group taking up the desired behaviour. Despite this the DEFRA framework has been referred to by many local authorities (Brook Lyndhurst, 2007) and has been referenced in a number of academic publications (Cox et al., 2010, Sharp et al., 2010, Timlett and Williams, 2008, Timlett and Williams, 2011).

This study has reviewed a small number of behaviour change theories and models and in the coming paragraphs some of their limitations highlighted. It is interesting to note that parallels can be found between the shortcomings of the waste management and BC models. Jackson (2005, 23) comments that for a BC model to be "useful" it must not be overly complex and must therefore limit the number of BC determinants and their interrelationships. However by limiting the determinants there is a danger of overlooking other determinants (Jackson, 2005). Simpler models demonstrate more examples of empirical testing in the literature however they offer only limited ability to generate sound explanations and predictions of the behaviour. Jackson supports these statements by referring to Stern's Value Belief Norm (VBN) theory (see Appendix 3), which was able to account for only 35% of the behavioural variance in empirical studies (Jackson, 2005).

Steg and Vlek (2009) suggest that behaviour change theory, specifically the three areas concerned with cost and benefit, moral and normative concerns and affect, found that there is no clear indication pertaining to which aspects are of use in

which situation. Furthermore research carried out on the practical application of the three perspectives was found to be lacking (Steg and Vlek, 2009).

Michie et al. (2005) identified a gap between theory and practice and sought to address this gap and offer theoretically substantiated practical determinants for behaviour change in public health. Michie et al. (2005) acknowledge that often intervention strategies are not theoretically supported due to the variety, complexity and overlapping of many BC theories. Michie et al. (2005) identified 230 studies where methodology has been derived intuitively; such studies have used methods such as printed materials, feedback, prompts, and educational outreach. However the lack of theoretical underpinning of such intervention strategies is acknowledged as disadvantageous as it is not clear which methods have had the most impact or are of real significance and which interventions are suited to which contexts. Therefore few studies of this nature are able to generate transferable lessons (Michie et al., 2005). Michie et al. (2005) argues further that the abundance of BC theories are impossible to incorporate into a single model and that by drawing upon such a vast body of material, construct selection cannot be well-informed and creates such a complex array of constructs that they cannot be practically applied.

Parallels can be drawn between Michie et al. (2005)'s finding in behaviour change for public health strategies and the behaviour change for waste management strategies where theory is also often neglected for intuition or trial and error techniques. As a consequence waste management generated behaviour change theory has been slowly developed as a result of the combined results of case studies, (see Timlett and Williams (2011) and DEFRA (2008)) and culminated in a number of waste management models and theories. Throughout the waste management literature review, determinant overlaps have been highlighted and discussed as a limitation and as a result further clarification and specificity have been suggested as a means to mitigate ambiguity. Similar observations have come out of the BC determinant literature where many behaviour change theories contain overlapping constructs and non-specific definitions leave constructs open to manipulation (Michie et al., 2005).

The evidence suggests that both waste management and BC determinants share similar limitations when looking to use theory to affect behaviour change and the vast number of different theories makes it hard to select which to use (Michie et al.,

2005). It is clear that frameworks such as DEFRA's 4Es are valuable to waste practitioners, and policy makers and are more practically applicable than some of the behaviour change theories despite the 4Es lack of theoretical underpinning. What is required in this situation is a behaviour change framework based on behaviour change theory but also highly practical and versatile and not overly complex (like the 4Es). Michie et al. (2005) attempted to contribute in this area and their construct will be discussed further in the following section.

3.1 Behaviour Change Constructs

Michie et al. (2005) used a consensus approach to develop a behaviour change framework grounded in behaviour change theory but for direct practical use in the field of public health. Although developed specifically for public health the authors suggest that it can also be used in other contexts and disciplines. This is the first such practical framework developed using a consensus approach that exists, to the Author's knowledge. This framework will be explored further in this study and used to corroborate the recycling determinants taken from the waste management literature and to identify any overlooked determinants.

Michie et al. (2005) used a distinctive methodology to arrive at their behaviour change constructs, which involved convening three expert groups including health psychology theorists, health service researchers and health psychologists. Their aim was to collectively identify a number of behavioural theories and draw out the most useful, practical behavioural constructs for use in behavioural studies, specifically for public health. The outcome of the study is a list of 12 behavioural constructs condensed from an initial 128 and drawing on 33 psychological theories. Each of the 12 constructs contains a number of behavioural determinants. The 12 constructs were collected and corroborated by experts and practitioners working in the field.

3.1.1 Michie et al. (2005)'s 12 Behaviour Change Constructs

1. Knowledge
2. Skills
3. Social / professional roles and identity
4. Belief about capabilities (self-efficacy)
5. Beliefs about consequences (anticipated outcomes, attitudes, incentives, rewards)
6. Motivation and goals (intention, target setting, commitment)
7. Memory, attention and decision processes
8. Environmental context and resources (environmental constraints)
9. Social influences (norms, social pressure, feedback)
10. Emotion
11. Behavioural regulation (feedback, action planning)
12. Nature of the behaviour (habit, past behaviour, stages of change)

For further details on the specific methodology and the determinants contained within the 12 constructs please refer to the original study by Michie et al. (2005).

In the following section the 24 recycling determinants identified within this study will be analysed and discussed with respect to Michie et al. (2005)'s 12 BC determinants.

3.2 Validating the WM24 Using Behaviour Change Determinants

The WM24 is given in Table 3 and Table 4 and each of the determinants has been linked to one or more of Michie et al. (2005)'s behaviour change constructs. The purpose is to try and demonstrate that the WM24 determinants derived from the waste management and selected by the Author are able to cover the different behavioural determinants derived from behavioural theory, and thus limit bias. The implications are that the WM24 has not overlooked any major behaviour change determinants and therefore demonstrate its worthiness as a usable framework.

Tables 9 and 10 demonstrate the determinant linking, Michie et al. (2005)'s behaviour change determinants are represented by the numbers 1- 12 along the top and the WM24 determinants are given in the left hand column.

Table 3: Validating the WM24 using Behaviour Change Determinants – Part 1

		1	2	3	4	5	6	7	8	9	10	11	12
1	**Service**								✓				
2	**Storage space**								✓				
3	**Sorting time / time availability**				✓				✓				
4	**Free waste receptacle / type of receptacle**								✓				
5	**Convenience / Required Effort**								✓				
6	**Demographics**								✓				
7	**Information / education / knowledge**	✓											
8	**Method of Communication**	✓								✓	✓		
9	**Localisation of the programme and community involvement**						✓	✓		✓	✓		
10	**Number of operatives**								✓				
11	**Perceptions / beliefs**				✓	✓							
12	**Attitudes**					✓			✓		✓		

Table 4: Validating the WM24 using Behaviour Change Determinants – Part 2

		1	2	3	4	5	6	7	8	9	10	11	12
13	**Norms**									✓			
14	**Belief in one's ability**				✓								
15	**Self-efficacy**				✓								
16	**Belief / perceptions of recycling consequences**					✓							
17	**Attachment to or concern for the community**									✓	✓		
18	**Feedback / Commitment / Goals / Prompting and Reminders**						✓	✓		✓		✓	
19	**Habit**												✓
20	**Previous experience**		✓										✓
21	**Stakeholder involvement and cooperation**			✓									
22	**Mandatory recycling participation**						✓						
23	**Unit / per bag pricing**						✓						
24	**Rewards / financial incentives**						✓						

The linking of the two frameworks is to some extent open to subjective interpretation therefore the following section will discuss the rationale behind the linking of the determinants to reduce ambiguity for the reader. Not all the determinants will be discussed because some determinants are less open to subjective interpretation than others. The excluded determinants from the discussion include:

- Service
- Storage Space
- Free waste receptacle / type of receptacle
- Convenience / Required Effort
- Information / education / knowledge
- Number of operatives
- Perceptions / beliefs - management competence, awareness, waste, waste sorting, environmental problems, convenience
- Norms - Personal norms, social norms and subjective norms. Also includes research into the block leader approach
- Belief in one's ability - locus of control, responsibility, response-efficacy which is a belief that the individual can make a difference
- Self-efficacy - belief about self-capability or perceived behavioural control
- Belief / perceptions of recycling consequences
- Habit
- Stakeholder involvement and cooperation
- Mandatory recycling participation
- Unit / per bag pricing
- Rewards / financial incentives

The determinants not displayed in the above list will be discussed in further detail in the following section.

3.3 Linking Waste Management and Behaviour Change Determinants Discussion

3.3.1 Sorting Time / Time Availability

This determinant has been linked with Michie et al. (2005)'s number **4.** Belief about capabilities and **8.** Environmental context and resources. This is because as

previously discussed the perception or belief of time availability has been indicated as an important factor with respect to recycling (Tonglet et al., 2004a, Barr et al., 2003, Davies et al., 2002) as well as actual time availability. Thus encompassing Michie et al. (2005)'s number **4** and **8**.

3.3.2 Demographics

The demographics determinant has been discussed so far in relationship to its relevance for waste management recycling studies. The prevailing conclusion is that in the majority of case studies considering demographics are not so useful. Demographics have been included in the WM24 because of their prevalence in the waste management literature and their potential importance for intervention outcome comprehension. Where a particular demographic class prevails their consideration will likely need addressing. The determinant does not feature predominantly in Michie et al. (2005)'s BC determinant list, which further indicates its lack of importance, however they can be loosely correlated with "**8.** Environmental contexts and resources" because it is in the environmental context wherein a particular demographic group exists.

3.3.3 Method of Communication

Method of communication has been linked to two of Michie et al. (2005)'s determinants. **1.** Knowledge, because the method of communication has been shown to influence the level of knowledge transfer to householders within a recycling scheme (Kaplowitz et al., 2009). **9.** Social influences because the communication method can affect aspects like norms if it is delivered in a social capacity such as doorstepping (Timlett and Williams, 2008). Finally **10.** Emotion because the nature of the communication (positive or negative) may have the potential to evoke different emotional reactions to the communication however this needs further exploration to be considered conclusive.

3.3.4 Localisation of the Programme and Community Involvement

This determinant correlates to four of Michie et al. (2005)'s determinants. **6.** Motivation and Goals because the waste management literature suggests that localisation can have a motivational effect on the local population (Maria Muller, 2001). **7.** Memory, attention and decision processes because a couple of waste management authors found that involving local citizens in the decision making

process had a positive effect on the recycling programme (Folz and Hazlett, 1991). **9.** Social influences and **10.** Emotion can affect the social interactions between the local population and the local authority in a positive or negative way (Maria Muller, 2001).

3.3.5 Attitudes

Attitudes do not feature prominently within Michie et al. (2005)'s 12 constructs however they do fall under beliefs about consequences. While in the waste management literature, numerous references to attitudes are found. One explanation is that attitudes on their own are not useful without a specific definition relating to the attitude being referred to; this has already been discussed as a limitation in the literature review. By including attitudes in belief of consequences it is clearer which type of attitudes the determinant is referring to. However in the waste management literature attitudes must be carefully broken down and defined to avoid ambiguity and to make the attitudes determinant useful. For this reason Attitudes have been correlated with a number of Michie et al. (2005)'s determinants including **5.** Belief of consequences, **8.** Environmental context and resources (attitudes towards the facilities) and finally **10.** Emotion. For example attitudes towards the local authority or waste management company can be emotional in a positive or negative way and affect recycling participation (Brook Lyndhurst, 2007).

3.3.6 Attachment to or Concern for the Community

This determinant is not found extensively in the waste management literature but from the limited references found it clearly has social implications. Therefore it has been linked to **9.** Social influences and **10.** Emotion.

3.3.7 Feedback / Commitment / Goals / Prompting and Reminders

This construct encompasses four related determinants and has been linked to **6.** Motivation and goals**, 7.** Memory, attention and decision processes, **9.** Social influences and **11.** Behavioural regulation. Feedback is part of social influences and behavioural regulation according to Michie et al. (2005). Feedback has also been discussed in terms of social influences in the waste management literature particularly with regard to social norms (Carlson, 2001, Schultz, 1999). The behavioural regulation construct encompasses many determinants, which aim to

mediate and sustain the desired behaviour (cf. Michie et al. (2005)) one of which is feedback. Commitment and Goals are directly comparable to the Michie et al. (2005)'s Motivation and Goals determinant and prompting is related to Memory, attention and decision processes because prompting and reminders have been used in waste management studies to remind participation in recycling schemes.

3.3.8 Previous Experience

Previous experience is directly related to Michie et al. (2005)'s **12.** Nature of the Behaviour and is listed within the construct. Previous experience has also been linked to **2.** Skills and although skills are not necessarily obvious in previous experience, previous experience would imply that a previous action has been undertaken thus increasing a skill. The Skills construct appears under represented by the waste management literature review and few studies refer specifically to skills as a determinant for recycling. One explanation is that in waste management, the skill is not of great complexity and it is inferred that the skill of placing different waste streams into different receptacles or locations does not require a great deal of attention. However in other disciplines of behaviour change, where the skill required is more complex then skills will require greater consideration than they receive in the waste management literature.

3.4 Concluding Remarks

Both of the two frameworks presented and discussed in this chapter appear to be useful for understanding what needs considering for successful waste management recycling programmes. Michie et al. (2005)'s framework appears to account for all the determinants extracted from the waste management literature and the WM24 developed out of the waste management literature seems to account for all the behaviour change determinants as outlined by Michie et al. (2005). However the comparisons of the two frameworks have required a number of fundamental assumptions to be made, these will be discussed in greater detail in chapter 7.5.1 on page 143.

The WM24 will now be carried forward into the following chapters and used as a tool to plan and evaluate a food waste recycling intervention in Shanghai. Using Michie et al. (2005)'s 12 BC constructs in a waste management context is suggested as a future area for research.

4 Ying Hua Yuen Community, Shanghai

The preceding chapters have sought to address the first objective, which is to develop a framework from significant determinants of successful recycling schemes. The purpose of developing the framework is to apply it to a localised situation in Shanghai to guide and inform the methods employed to improve the local waste situation.

The research was based in Shanghai due to its proximity to the Fudan University where the Author was located. Furthermore Shanghai presents a unique opportunity to conduct recycling research in communities where food waste recycling schemes are constantly being introduced. Finally, Shanghai has a history of leading new waste management initiatives (Zhang et al., 2012) and according to An et al. (2014), Shanghai is currently leading the country in this area.

This chapter explores the current waste management situation in a specifically selected Shanghai residential community. The community is called “Ying Hua Yuan" and is the investigation site for this study.

4.1 Identification and Description of Ying Hua Yuan Community

To locate a suitable community where a study of this nature could be conducted was a complicated procedure and it was discovered that the community had to fulfil all the following requirements:

- The community will shortly introduce a new food waste recycling scheme (allowing enough time for baseline data to be collected)
- The possibility to collect accurate waste composition and quantity data (the waste is stored in manageable sized receptacles able to fit onto a portable set of scales, the waste is not emptied sporadically or continually throughout the day, or at very unsociable hours)
- The Community Committee supports the research and grants permission for the data to be collected
- The residential cleaners are cooperative and understand that accurate data collection is imperative

- Community is not too big (unmanageable quantities of waste generated) or too small (not enough waste generated)

To locate such a community took a long time, and required numerous site visits, meetings and pilot data collections. Before finding an appropriate community approximately 15 alternative communities were visited and assessed for their suitability. To assist in this process the help of a local Environmental NGO was sought. The NGO had been actively involved in the introduction of a number of very successful food waste recycling schemes in Shanghai and was experienced in offering guidance and support to communities beginning the new schemes. The NGO was able to provide the Research Group with information concerning communities rolling out new food waste recycling programmes which helped the selection process significantly. The local NGO also assisted with community introductions and greatly accelerated the building of trust and confidence in the Research Group and the research intensions.

The chosen community for this study was a typical Shanghaies community called Ying Hua Yuan. Ying Hua Yuan community, which translated means Sakura Garden, is located in Shanghai's Putuo district on Beshi Road close to Tongchuan Road and the Middle Ring Highway. Putuo district is located west of the Huangpu River and is one of the older Shanghai urban districts (see Figure 5 for map). Putuo encompasses an area of 54.83km^2 and according to the 2010 census has a population of 1,288,881 (Bureau, 2011).

Ying Hua Yuan community was selected as the unit of analysis because it was able to meet all the above parameters allowing this study to go ahead.

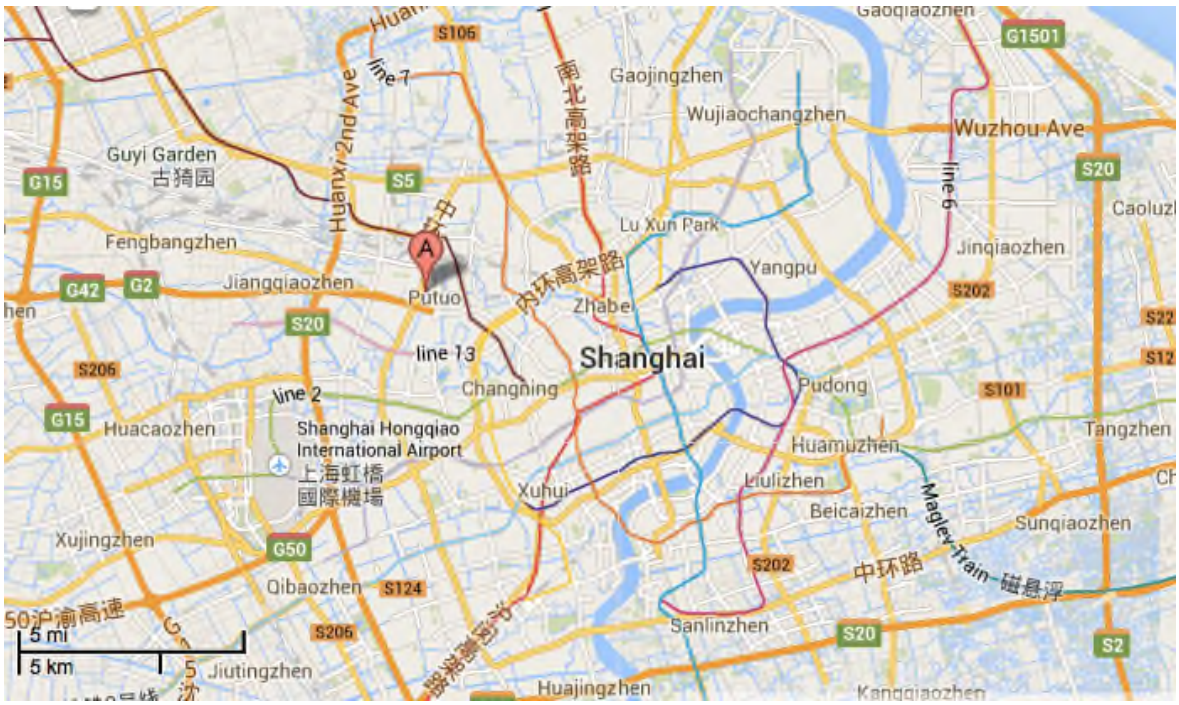


Figure 5: Map of Shanghai with the location of Ying Hua Yuan community represented by letter A. Putuo district can be located to the West and Pudong to the East (GoogleMaps, 2013)

Ying Hua Yuan community was constructed in 1988 and consists of 75 apartment blocks with 996 apartments. The official number of residents is 2,700 however many residents live elsewhere keeping their apartments empty, therefore a more realistic figure is estimated at between 2,400 – 2,500 by the Community Committee.

The age distribution in 2012 is displayed in Table 5.

Table 5: Age distribution data for Ying Hua Yuan. * Data obtained from the Community Committee statistics book for 2012. ** Data calculated from the official total (2700)

Age	Number	%
0-14	126*	4.7
15-59	1878**	69.6
60+	696*	25.8

The age statistics demonstrates quite a high elderly population percentage at roughly 25% this figure would be higher if the unofficial total were to be used in the

calculation. This is something to take into consideration later on when analysing the results.

Ying Hua Yuan community is a comparatively old community for Shanghai with "old style" 6 floor apartment buildings arranged around a communal garden area with benches, flowerbeds, trees and exercise equipment (see Figure 15 for an impression of the community). The rear of the community backs onto a river and there is no access across the river. Access to the community is via 3 gates, one main gate in the middle for all traffic and two smaller pedestrian only gates at either end (see Figure 6 for layout). Ying Hua Yuan is not a unique residential community and the layout, apartment type and number of residents is typical for Shanghai, especially in the older Shanghai districts like Putuo.

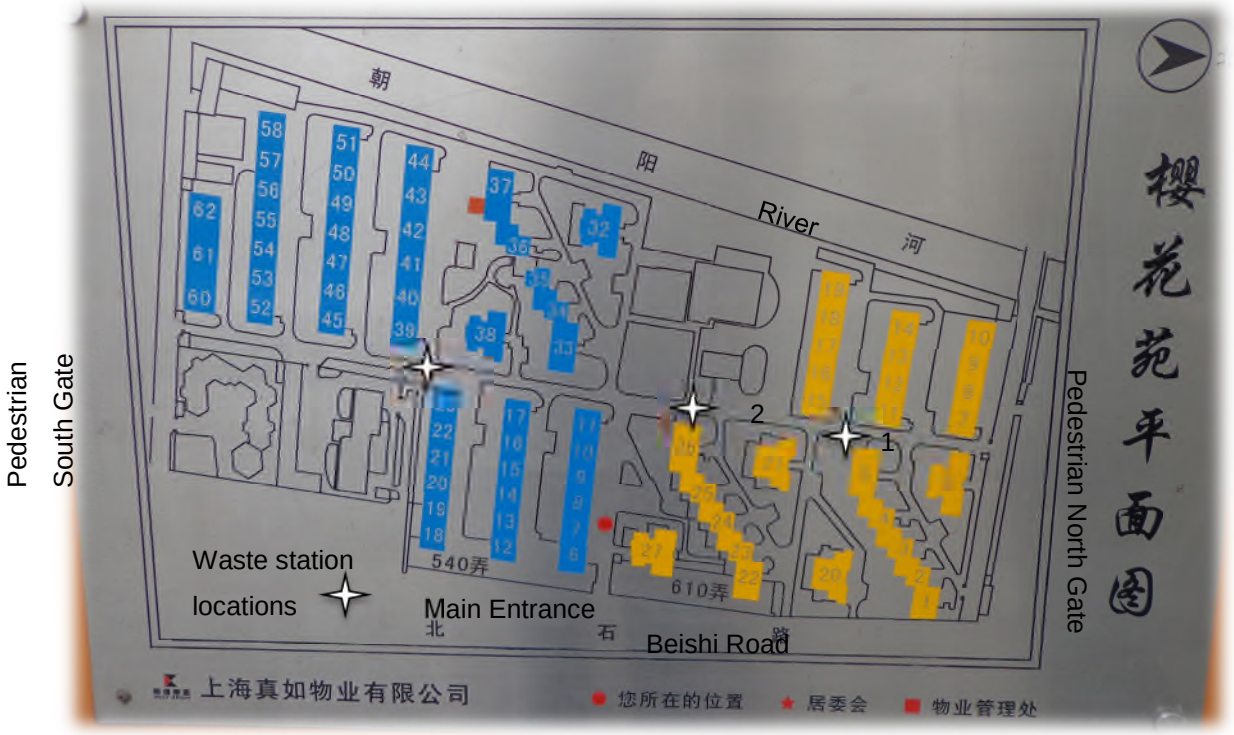


Figure 6: Ying Hua Yuan community layout

The Community Committee and the housing association manage the community. The Community Committee is affiliated with the street government (local area government) and are the lowest level of local government, communicating local policy, publicity, community events and is responsible for community decision-making. The Community Committee also manage a team of resident volunteers, most of which are retired residents, to offer help with community affairs. The housing association is a private company contracted by the Community

Committee to manage various aspects of the community such as sanitation, maintenance and security. The residents are responsible for transporting their wastes to one of three waste stations located on the central road running through the community. There are two fulltime residential cleaners whose jobs are street sweeping and waste management. The cleaners are responsible for transporting the waste from the community waste stations to a local transfer station approximately 200m away.

4.2 Current Waste Management Practices in Ying Hua Yuan Community

The residual waste is managed by the two cleaners and periodically emptied into a three wheeled, electric cart (see Figure 7) throughout the day at 6am, 9:30am and 5pm, 7 days per week. Before 6th May 2013, unsegregated waste was disposed into 240L wheelie bins situated throughout the community. Only marginal sorting took place by keen residents to assist the cleaner or to sell some high value recyclables. There was no formal sorting scheme or facilities to accommodate sorting.

On the 6th May 2013 a new food waste separation programme was introduced, although it was aimed at food waste recycling the separation of additional waste streams were also accommodated. Table 6 demonstrates the recyclable materials accepted for recycling in Ying Hua Yuan, the information was provided by the Community Committee.

Table 6: Waste separation categories in Ying Hua Yuan recycling programme

Waste category		Includes
Mixed recyclables same bin disposal	Paper	Paper, magazines, books, packaging paper, office paper, flyers, and cardboard
	Plastic	Plastic food packaging, toothbrushes, plastic cups, plastic bottles, plastic toys
	Metals	Drinks cans, food tins and containers
	Textiles	Shoes, bags, clothes, towels, face cloths, table clothes
	Tetra packs	Tetra pack packaging
Glass		All glass bottles, broken glass, glasses (eye), light bulbs, thermos flasks
Hazardous		Batteries, fluorescent light bulbs, unused medicines, thermometers.
Food waste		Raw and cooked food including meat and bones, vegetable peels and trimmings and small quantities of fat and cooking oil
Residual waste		All other wastes

The new scheme was introduced as part of the Shanghai Municipal Government's drive to meet the Waste Minimisation Plan. The community received financial support from the Sanitation Bureau and guidance from an environmental NGO. Despite the help the majority of the programme implementation was undertaken by the Community Committee who elected to carry out the sorting programme in their community.

The introduction of the scheme brought about changes in the way the community's waste was managed. The 240L mixed waste wheelie bins were removed from around the community so that only the three waste disposal points remained. These are marked on the map in Figure 6 as waste stations 1-3. At each of the three waste stations there are a number of different coloured wheelie bins for the different waste streams. Mixed recyclables can be disposed of into a blue 240L wheelie bin, glass into a green 240L wheelie bin, hazardous into a red 240L wheelie bin, residual waste into black 240L wheelie bins and food waste into 120L

brown wheelie bins. Despite the variety of bins the majority of waste was disposed of into the residual waste or food waste bins. From continual visual examinations of the mixed recyclable, glass and hazardous waste bins it was estimated that the residual and food waste bins account for >90% of the community's waste. It should be noted that in China food waste is referred to as "wet waste" (WW) and residual waste is referred to as "dry waste" (DW). The Chinese terminology has been used for the data recording sheet and questionnaire survey found in appendices 4 and 10 respectively.

The cleaners transport the residual waste to a nearby waste transfer station where it is roughly sorted by the waste management staff for any further valuable recyclables and then compressed ready for disposal via landfill or incineration.

The cleaners manage the dry recyclables and glass categories. They sort and store the recyclables until adequate quantities have accumulated then they are transported to a local recycling company and sold. The market value of the materials determines to what extend the cleaners are involved in the sorting and management of the recyclables. The hazardous waste is managed by the Sanitation Bureau and emptied when required (refer to Figure 4 on page 25 for the waste flow diagram).

Figure 7 demonstrates waste station 3 in Ying Hua Yuan community and the cleaner's residual waste electric cart. This type of waste station is typical in communities involved in the waste sorting programmes.

Figure 7: Waste station 3 in Ying Hua Yuan community

4.3 Food Waste Management in Ying Hua Yuan

The government Sanitation Bureau manages the food waste collection. The food waste bins (left hand brown bins in Figure 7) are emptied daily at 6:30am by the food waste collection crew and transported directly to the food waste processing plant approximately 2km away.

The food waste processing plant which processes food waste from Ying Hua Yuan was visited by the Author to determine how the food waste is being processed. A summary of the process is presented below and more detailed information can be found in Appendix 4.

1. Food waste arrives at the processing plant directly from the community
2. It is weighed
3. It is emptied onto a concrete surface and contamination is removed by hand
4. The food waste is ground into a homogeneous material (see Figure 8 and Figure 9)
5. The material is compressed and much of the water extracted (see Figure 9)

6. The material is then put into the anaerobic digester with chicken manure and wood chips to increase the volume and to decrease its density and for better fermentation
7. After 8 hours the material is bagged (see Figure 10) and left for 45 days to ferment on its own
8. Product ready for use

The finished product is used to plant trees and create parkland on top of Shanghai's Laogang landfill site. Figure 8, Figure 9 and Figure 10 were taken during the food waste processing plant site visit.

Figure 8: Food waste processing plant

Figure 8 demonstrates the food waste processing plant what accepts Ying Hua Yuan's food waste. Ahead are the two large grinders and to the right can be seen the biological digesters.

Figure 9: Ground food waste being placed into the compressor for water extraction

Figure 10: The finished product after 8 hours in the biological digester

4.4 Waste Sorting Programme in Ying Hua Yuan

To successfully achieve the research objectives it was imperative to gain a comprehensive understanding of the local environment in which this study was to be carried out and to understand in as much depth as possible the waste related affairs of the community. It was established, through experience, that the most effective method to obtain such information was via regular communications between the Fudan University Research Group and the "key informants" which included the Community Committee the community cleaners and the Environmental NGO. It was thus necessary for a member of the Fudan Research Group to initiate contact with the key informants as frequent as possible, usually weekly. The information was recorded in note form from conversations in Chinese by Fudan PhD and Masters Students and then translated with the help of the Author and archived in a diary format.

The diary was able to offer an insight into the complex structure of stakeholder and partner involvement and how they interact to deliver the numerous interventions required to initiate a new waste recycling programme. The following section will look at the how some of these partners have been involved and what types of interventions have been carried out since the programmes conceptualisation.

4.4.1 Ying Hua Yuan's Food Waste Recycling Scheme Diary

2012: Introduction to food waste sorting

Members of the Community Committee attend an open space event in another local community that is already involved in the food waste recycling programme. Here they learn about waste sorting and realise the benefits. After the event they are approached by an environmental NGO involved in the food waste sorting programme's execution and asked if the Community Committee would like to carry out such a programme in their community. They begin to think about it.

8th March 2013: Woman's festival

The Community Committee place blackboards near the community entrance with information about the new waste sorting programme (see Figure 11). The blackboards have been used throughout the programme to communicate information and feedback about the food waste sorting programme typically being updated every 2-3 weeks.

28th March 2013: Sakura festival

A festival to mark the blossoming of the cherry trees around the community and an ideal time to promote the new recycling programme and the planned start date of 6th May. Speeches, interactive games were used in creative ways to educate participants about how to participate in the waste sorting programme (see Figure 15).

28th March 2013

Signatures collected from residents and displayed on a large corrugated plastic board tree called the “hope tree” as a pledge to carry out the food waste sorting (see Figure 14).

17th April 2013

240 Litre mixed waste bins removed from around the community leaving only the three waste stations for waste disposal.

16th – 18th April 2013: Waste data collection

Pre-food waste recycling scheme data collected: Waste quantity and composition collected from waste stations 1, 2 and 3.

22th April 2013

A count down to the start of the waste sorting programme is displayed on the community blackboards.

3rd May 2013: Volunteer training

The NGO organises training sessions for the resident volunteers on how to carry out correct sorting and establish their role in the programme. The volunteer meetings are subsequently held every two weeks.

4th – 5th May 2013

Kitchen food waste caddies distributed outside the Community Committee office. The distribution activity involved the Community Committee and the NGO accompanied by some high school student volunteers.

6th May 2013: Waste sorting programme begins

Volunteers stand at the bins during the morning and evening rush hours to help residents and demonstrate how to do the correct food waste sorting. They remove plastic bags from the food waste bin if residents do not.

Small reward cards are given out to residents demonstrating correct sorting behaviour (see Figure 12). The reward cards can be exchanged for small gifts when 30 or more have been collected.

29th May 2013

The Community Committee put up many photos on the notice board depicting residents doing correct sorting, the recent open space event and of the volunteers to praise the volunteers and residents.

31st May 2013: Volunteer meeting

The second meeting for the volunteers with the NGO and Community Committee. Programme discussion and further training given.

31st May 2013

District journalist interviews the Community Committee about the sorting programme.

6th – 31st May 2013

The Community Committee broadcast on the community radio daily for 30 minutes with 15 minutes of news repeated. The Community Committee discuss the sorting programme, how to do it, problems of significance, and who has been doing well and any other related issues worthy of discussion.

1st June 2013

Radio broadcasts reduce from daily to weekly.

5th June 2013

Community newsletter distributed to all residents with a large section devoted to the sorting programme, how it is going and where improvements need to be made i.e. contamination issues etc.

6th June 2013

Local TV station films residents sorting their food waste during the morning rush hour.

6th – 30th June 2013: Volunteer period 2

The morning volunteer slot is cancelled leaving volunteers at the bins in the evening only. Instead of removing food bags for the residents they ask the residents to remove the bags themselves. If the residents refuse the volunteer will put the whole full bag of food waste into the residual waste bin. During this time

the volunteers update the blackboards daily with new information, any problems they encountered with the programmes progress and with new information such as the number of apartments recently joining the programme. They continue to distribute reward cards.

18th June 2013 – Showcasing

Approximately 30 Community Committee members from other communities in the district and 10 Government officials visit the community to see their food waste sorting programme in operation.

18th – 20th June 2013: Waste data collection

Waste quantity and composition collected from waste stations 1, 2 and 3 to determine how well the scheme is performing since its introduction and to determine the levels of recycling before the planned intervention.

24th June 2013

Letter given out to all China Communist Party (CCP) members living in the community. The letter details the progress made by the waste sorting programme and the issues it is facing such as cigarette butts and plastic bags in the food waste bins. The letter goes on to encourage the CCP members to lead by example, to encourage their families to participate and reminds them of the waste categories.

25th June 2013

Letter given out to all residents to raise awareness about contamination of the food waste bins and ask for increased care when disposing of food waste.

26th June 2013

A notice placed on the food waste bins asking the residents to remove their bags before disposing of food waste and not to place cigarette butts or tissues, the common contaminating items, into the food waste bins (see Figure 13).

30th June 2013

Volunteer programme ends and volunteers no longer stand at the food waste bins during the evening rush hours. Instead the volunteers parole the entire community from 7am – 9am and 5:30pm – 7:30pm. Their new role is to provide general assistance and security within the community including assistance for the sorting programme when and if it is required.

11th – 12th July 2013

Residents can exchange their reward cards for gifts, more than 30 cards qualify for a gift set which includes soap and washing up liquid. 60 reward cards qualifies for 2 sets. The Community Committee encourage the volunteers to claim their gifts despite knowing the volunteers are faultless in their sorting behaviour, however they don't want the volunteers to be tempted to hand over their cards to other residents.

Figure 11: Community blackboards

Figure 12: Correct sorting reward card

Figure 13: Contamination notice placed on the food waste bins

Figure 14 and Figure 15 were taken during the Sakura festival. Figure 14 demonstrates the hope tree and how it was used. At the rear of Figure 15 the typical old style 6 story Shanghaies apartment buildings can be seen. The

apartment blocks depicted in this figure are representational of all apartment blocks in Ying Hua Yuan.

Figure 14: Hope tree

Original in Colour

Figure 15: Ying Hua Yuan community and communal gardens during the Sakura Festival

5 Methodology

In this chapter the methodologies used to fulfil the research objectives two and three are considered, that is to use the WM24 framework to identify a suitable intervention to increase recycling in a Shanghai community and subsequently carry out the intervention and monitor and evaluate its outcomes.

To achieve these objectives this study has used a number of methodologies. To determine a suitable localised intervention the community diary has been analysed with respect to the WM24. To monitor and evaluate the intervention a combination of questionnaire surveys and waste quantity and composition data were collected. A diagram of the methodologies employed can be found at the end of this chapter in Figure 19.

5.1 The Diary Approach

The diary approach methodology was used to gain an understanding of the local community and in particular to:

* Identify previous and planned waste recycling interventions
* Gain an rough understanding of the community's traditions, customs and culture which can help with the localisation process
* Build and maintain a relationship with the community by taking an interest in community affairs and attending community events
* Use the diary information to localise and contextualise the WM24
* Analyse the diary with respect to the WM24 determinants to identify to what extent the WM24 determinants have been addressed, not addressed and in what capacity

For this research project it was not necessary to collect diary information with significant depth, however it was imperative to gather information on a regular basis. The diary approach made this possible by using telephone conversations, chance meetings with the NGO and Community Committee as well as scheduled meetings. The aim was to build up a detailed picture of the activities taking place in the community regarding the waste programme not to gather in depth qualitative interviews for analysis. The diary method was able to provide this and succeeded in establishing the current situation in the community under investigation. It was

also imperative that this research project did not become perceived as a nuisance and become too demanding on the key informant's time which might jeopardise the entire project and the future prospects of working with the community.

5.2 Using the WM24 to Identify a Suitable Intervention in Ying Hua Yuan Community

The WM24 framework of recycling determinants has been generated from international literature and in order for the framework to be used in the current context of a community in Shanghai it must be localised. It is therefore necessary to understand local context in which the WM24 will be used.

This study has been able to achieve a comprehensive analysis of the local situation through the diary approach presented in section 4.4 and 5.1.

To localise the WM24 and identify to what extent the WM24 has been previously addressed a cross-examination was carried out between the WM24 and the diary information. From the diary information 22 interventions have been identified, these are presented in Table 7.

The matrix presented in Table 8 is an analysis of the 22 interventions identified by the diary with respect to the WM24. The purpose of the matrix is twofold, firstly to help localise the WM24 to Ying Hua Yuan community and secondly to identify any WM24 determinants that have not been adequately address or are lacking in the current recycling programme. The 22 interventions are represented by the numbers from 1 to 22 on the first row of the matrix while the numbers 1 to 24 in the left-hand column of the matrix represents the WM24 determinants. Highlighted rows indicated that a WM24 determinant has not been addressed. A key to the 22 attributes relating to the food waste recycling scheme is provided in Table 7 and a key to the WM24 determinants is provided in Table 2, in section 2.9 on page 54.

Table 7: Food waste recycling interventions

No.	Food waste recycling scheme interventions
1	Mixed waste bins removed from other parts of the community
2	Communal community collection waste management system
3	Segregated and comingled services provided
4	Kitchen caddies distributed
5	Volunteers help at the food waste bins morning and / or evening
6	Woman's festival
7	Sakura Festival (games for children, many retired people present)
8	Blackboards placed on display with information about the sorting programme
9	Community event to promote the sorting programme
10	Volunteer training
11	Volunteer meetings
12	Media attention (TV and newspapers)
13	Notice placed on food waste bins
14	Photos displayed depicting residents sorting correctly
15	Letters distributed to residents via block leaders
16	Showcasing
17	Signatures collected and publically displayed to demonstrate residents commitment to the sorting programme
18	Countdown to the start of the programme
19	Community committee attends other community's open space event
20	International Research Group involved in monitoring the scheme's progress
21	Reward cards given out to reward correct participation
22	Community radio broadcasts

Table 8: WM24 determinants addressed by previous interventions in Ying Hua Yuan community

	Ying Hua Yuan's food waste recycling scheme diary entries																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
WM24 1	✓	✓	✓	✓																		
2		✓																				
3					✓																	
4				✓																		
5	✓			✓	✓																	
6						✓	✓															
7					✓			✓	✓	✓	✓	✓	✓		✓							✓
8					✓			✓			✓	✓	✓	✓	✓							✓
9					✓				✓	✓	✓			✓		✓						✓
10					✓						✓											
11					✓				✓		✓	✓			✓	✓						✓
12					✓						✓	✓		✓	✓	✓						✓
13	✓				✓						✓	✓		✓		✓						✓
14									✓		✓	✓		✓			✓					
15					✓						✓	✓										
16																						
17					✓						✓											✓
18					✓						✓		✓	✓	✓	✓	✓	✓				✓
19					✓									✓			✓					
20																			✓			
21					✓						✓					✓			✓	✓		
22																						
23																						
24																✓					✓	

The information presented in Table 8 can begin to offer a method to localise the WM24 to Ying Hua Yuan community. The purpose of localising the WM24 using the diary information is to determine the relevance of the WM24 for the local environment and to understand what each WM24 determinant looks like in the local context. For example “Service” (determinant 1) can easily be identified as “*Mixed waste bins removed from other parts of the community, communal community collection waste management system* and s*egregated and comingled services provided*”.

The purpose of the cross-examination presented in Table 8 is to be able to demonstrate the degree to which the WM24 determinants are absent or have been addressed to a greater or lesser extent. This study will now consider the WM24 determinants, which according to Table 8, are absent or have been addressed to a lesser extent than others. The wide body of international literature used to generate the WM24 suggests that perhaps some WM24 determinants will not apply to the local environment and context of Ying Hua Yuan. It is therefore vital that the WM24 is used alongside the diary information to determine their relevance.

5.2.1 Weakly Addressed Determinants

Storage space (determinant 2), sorting time / time availability (determinant 3), demographics (determinant 6) and previous experience (determinant 20) all appear to be weak determinants according to Table 8. On closer inspection it can be observed that these determinants are of a different nature to other determinants given that they cannot be easily addressed. Rather, their merits lie in their ability to ensure intervention suitability during the planning stages. In the case of demographics the Community Committee are conscious of the demographic situation in the community and will likely have taken it into consideration. This is exemplified by the nature of the Sakura festival, which took place during the week, those that attended were mostly young children and grandparents, and the activities reflected this. In the case of sorting time / time availability the volunteers can assist residents at the bins to carry out their food waste recycling reducing the required time, however this is not a long term solution and residents will have to find enough time if they are to participate into the future. Storage space is difficult to increase within individual apartments however providing daily waste collections ensures waste need not build up within homes, storage space can also be considered as a reason for non-participation. Finally previous experience is

another determinant that can predict the outcomes of a sorting programme. If the majority of the target population have all experienced similar recycling schemes elsewhere their baseline knowledge and experience will be higher, however addressing it through interventions is difficult and this is reflected by the analysis in Table 8. Table 8 has highlighted weak determinants and reasons why they appear weak have been discussed. The weak determinants do not offer suitable areas for future intervention design and development. The absent determinants will now be considered

5.2.2 Absent Determinates

According to Table 8 belief / perceptions of recycling consequences (determinants 16), mandatory recycling participation (determinants 22), and unit / per bag pricing (determinants 23) determinants have not been addressed. The latter two determinants are not applicable in the context of Ying Hua Yuan community due to the communal systems in place for waste disposal. The former, belief / perceptions of recycling consequences has been identified as a lacking determinant and will be explored further as a possible area for intervention development.

Belief / perceptions of recycling consequences is a determinant which has come out of the waste management literature and the BC literature and according to the WM24 and diary analysis appears to be lacking. Furthermore this determinant has been a suggested area for future research by the current study and identified in the literature as an under-addressed determinant in China in general. Harris (2006) states that environmental knowledge among Chinese citizens is generally low and that awareness extends to sanitation, health and possibly the surrounding area. Harris (2006) further highlights the Chinese are rarely aware that their actions can have a harmful effect on the environment. Bernstad et al. (2013) investigated the importance of knowledge relating to environmental consequences of waste disposal in their food waste doorstepping study in Sweden and found that 75% of the questionnaire respondents stated that it is important to be informed about what happens to food waste after it is collected. The analysis of the diary and previous findings from the literature suggest that knowledge relating to the environmental consequences of waste disposal is lacking in Ying Hua Yuan community, and is of significance for successful recycling schemes.

With respect to the WM24 analysis this study now focuses on designing an intervention to address the belief / perceptions of recycling consequences determinant.

5.2.3 Designing an Intervention to Address the Belief / Perceptions of Recycling Consequences

The type of intervention required to address the belief / perceptions of recycling consequences determinant will involve a communication technique. A variety of communication methods have already been discussed in section 2.3.3 on page 36. Many of the communication techniques documented in the literature cannot ensure information assimilation by the target population making the intervention evaluation difficult to carry out. However the doorstepping and block leader approach both involve face-to-face contact maximising information assimilation and establishing the intervention contact rate.

After considering the numerous communicative techniques doorstepping was chosen as the delivery method to address the belief / perceptions of recycling consequences determinant. There are several reasons why doorstepping was selected as the communication technique for this context, some of which are bulleted below.

- Ensure the information is delivered to the local population
- Maximise information assimilation
- Can be carried out intensively over a short period of time
- Can be used to deliver other communicative techniques simultaneously such as leaflets, posters and stickers.
- A doorstepping contact rate can be established
- Suited to multiple occupancy dwellings (Timlett and Williams, 2008, WasteWatch, 2006)
- Suited intervention to deliver tailored information (Timlett and Williams, 2008, WasteWatch, 2006)
- New contribution to knowledge (see below)

There is an absence of information on the impacts of doorstepping in China and, to the author’s knowledge; no such studies have been conducted to date. A doorstepping intervention would offer a new communicative, motivational and

educational approach to recycling interventions in China and offer insights into the effectiveness of a doorstepping approach in China.

Timlett and Williams (2008) suggest that a doorstepping approach is best suited to investigations with very specific aims, for apartments and for areas providing communal waste bins such as the present study. Bernstad et al. (2013, 101) suggest in their doorstepping communication intervention study that a reasons for a communication intervention not working could be because of “over-information” where householders in the treatment group are no longer responding to information because of the frequency and persistency of information. In the Chinese context this does not appear to be an issue, no doorstepping campaign or individual face-to-face communication has been delivered and an emphasis has not been placed on the environmental consequences of participating in the food waste recycling scheme.

The WM24, together with the diary, have been used to analyse the current food waste recycling scheme in Ying Hua Yuan and succeeded in identifying a weak determinant. Furthermore the analysis of the WM24 has provided a suitable method to strengthen the weak determinant. Thus the intervention to increase food waste recycling rated in Ying Hua Yuan will involve a belief / perceptions of recycling consequences communication delivered using a doorstepping technique. It should be noted that although the intervention is focused on delivering the belief / perceptions of recycling consequences communication; the nature of the doorstepping approach will also address a number of other WM24 determinants. It is imperative to know which determinates the intervention will be addressing for the intervention evaluation and data analysis phases. These will be looked at in further detail in section 7.4 on page 139.

To assess the outcomes of the intervention the following data were collected:

- Pre-scheme waste quantity and composition data
- Pre-intervention waste quantity and composition data
- Pre-intervention questionnaires to evaluate the levels of knowledge relating to the environmental consequences of waste disposal
- Post-intervention waste quantity and composition data
- Post-intervention questionnaires to evaluate changes in the levels of knowledge relating to the environmental consequences of waste disposal

A summary of the research activities and the author's role in undertaking the research are presented in Table 35 in Appendix 12 on page 185. It should be noted that the execution of this research was carried out under time pressure due to the food waste recycling scheme's operational timeframes and visa expiry timeframes.

The research timeline is displayed in Table 9.

Table 9: Research timeline

Date	Research activity
16th – 18th April 2013	Pre-scheme (no waste sorting) waste quantity and composition data collection.
6th May 2013	Scheme introduced by the Community Committee and the environmental NGO (No research involvement).
18th – 20th June 2013	Post-scheme pre-intervention waste quantity and composition data collection.
1st – 2nd July 2013	Pre-intervention questionnaires distributed to half the community.
6th July 2013	Doorstepping Intervention carried out in the whole community from 8am – 5pm. Pre-intervention questionnaires collected.
11th – 12th July 2013	Post-intervention questionnaires distributed in the other half of the community.
17th July 2013	Post-intervention questionnaires collected.

The month and a half gap between the introduction of the food waste recycling scheme and the pre-intervention data collection period and subsequent intervention was to allow recycling rates to settle so any changes would be more obvious. It is usual for recycling rates to peak after the introduction of a new recycling scheme.

The doorstepping intervention was proposed and explained to the Community Committee 10 days prior to it taking place. The Community Committee was shown examples of the type of material that could be distributed during the doorstepping and explained the content of the communication. The Community Committee granted consent for the doorstepping to be conducted on Saturday 6th July and 7th July if two days was required.

5.3 Waste Quantity Data

This used a bin weighing methodology to collect the waste quantity and composition data. The methodology was guided and informed by WRAP (2010)'s "Improving the Performance of Waste Diversion Schemes: A Good Practice Guide to Monitoring and Evaluation". Chapter 6 in this document details specific methodologies for waste quantity data collection and where caution needs executing.

Ying Hua Yuan has a total of three waste stations each with a variety of wheelie bins for communal use. As previously mentioned there are blue bins for mixed recyclables, green bins for glass, red bins for hazardous, black bins for residual waste and brown bins for food waste. This study focuses on the residual waste and food waste streams only. The primary reason for not considering the entire waste stream of Ying Hua Yuan is due to logistical constraints. The other waste streams including dry recyclables, glass and hazardous are emptied on an ad hoc basis. The irregular collections of these waste streams cannot ensure rigorous data collection and the coordination with the cleaners too resource intensive furthermore it was estimated that the other waste streams accounted for only a small proportion of the waste (<10%).

The residual waste quantity data were collected over three days during the working week. Weekends were excluded because of the increase in inconsistent waste disposal behavioural patterns due to special ceremonies, family visits, or out of town holidays, all of which are likely to fluctuate and create inconsistent waste data. Therefore the weekday waste samples were chosen because of their increased representation of the community's waste. Monday's waste sample was also excluded because of the overlap with Sunday's waste sample. In China it is common for householders to dispose of their household waste daily at the waste stations, this helps to reduce daily variability in the community's waste outputs.

This study collected data for three consecutive days during each data collection period. Three days of data increased data representation and reduced the sample standard deviation. More than three days would have been too resource and time intensive and the relative consistency in the data did not provide adequate evidence to make greater investment. Preliminary data analysis and research experience demonstrated that three days waste data quantity collection was acceptable for the purposes of this study and provided comparable data.

Data collection was pre-arranged in advance with the Community Committee and the residential cleaners to obtain consent and to ensure no waste was removed from the community before it was recorded. Researchers arrived at the community 15 minutes prior to the first waste collection at 6am and weighed all residual bins before the cleaner emptied the bins into his waste cart. The scales used to carry out the measurements were accurate to 1g with a maximum load capacity 150kg. The weight data were recorded on a predesigned data-recording sheet (see Appendix 5). Other information recorded included: time, date, researchers names, weather, approximate volume, bin size and number, bin contents, waste station number, empty bin weight and further comments and observations. The residual waste bins were numbered at each waste station if there was more than one so each bin could be corresponded to the weight recorded. This was important when subtracting the empty bin weight from the total weight. The empty bin weight was recorded once daily and the three-day average was calculated and subtracted from each corresponding bin weight total. This process was repeated for all waste stations three times per day just before the waste collection times (6am, 9:30am and 5pm).

After data recording the researchers helped the cleaners and waited with them until the waste had left the community to ensure any extra bags arriving at the bins were weighed before entering the cleaner’s waste cart. The food waste data were collected using the same methodology. Researchers waited until the food waste collection cart arrived and weighed all food waste bins before they were loaded onto the cart and removed. There was a slight difference in the two methodologies, for the residual waste data collection the corresponding empty bin weights were measured while for the food waste data collection this was not feasible. The empty bin weights could not be recorded and corresponded due to the method of waste removal. The food waste collection company removed the full food waste bins

daily and replaced the bins with empties. Thus the empty corresponding bin weights could not be recorded. The food waste bins were all 120L wheelie bins of a similar design and the new empty bins delivered were weighed to obtain a 120L food waste bin average. This average was used across the data to calculate the waste only figures for the food waste.

Figure 16 and Figure 17 depict the food waste collection cart, the scales used to weigh the bins and the bin weighing process used in Ying Hua Yuan.

Figure 16: Food waste collection and weighing

Figure 17: Bin weighing processed used in Ying Hua Yuan

5.4 Waste Compositional Analysis

The waste compositional analysis was undertaken on the residual waste stream for the specific purpose of determining the quantity of food waste present. The methodology was not as complex as other household waste composition studies because of this study's specific aims and the waste management system in place in Ying Hua Yuan. To inform the methodology and to minimise possible errors Dahlén and Lagerkvist (2008) paper was referred to for guidance.

The environment in which the compositional analysis data were gathered did not allow for samples to be collected and stored for analysis at a later date. Subsequently the analysis had to be conducted in accordance with the community and the existing waste collection system. Ying Hua Yuan's residual waste is collected three times daily at 6am, 9:30am and 5pm thus limiting the available time in which to conduct the compositional analysis. Due to logistical constraints the only time suitable to conduct the compositional analysis was approximately 3:30pm. By 3:30pm a sufficient waste sample had been deposited and adequate time remained to carry out the research prior to the 5pm waste collection. At

3:30pm the entire waste sample that had been generated since the 9am collection was analysed. By analysing the entire available waste sample the need for a scientifically rigorous sampling strategy was mitigated. One compositional analysis was undertaken at each waste station per day. It should be noted that the 3:30pm waste sample is waste deposited during daytime working hours by perhaps a certain demographic group, thus the samples representation is brought into question. Despite the possible bias, the composition analysis sample was collected and analysed consistently throughout the research and does not bring the comparability of the samples into question.

There is great variability in the literature regarding sample sizes for compositional analyses and no consensus has yet been reached (Dahlén and Lagerkvist, 2008). Nordtest (1995) suggests no less than 5% of the entire sample should be analysed, SWA-tool (Commission, 2004) suggest that no less than a $45m^3$ bin of waste should be analysed and Sfeir et al. (1999) investigated the effect of sample size on variability and concluded that 91kg was a sufficient sample size provided that the waste categories under investigation were below ten. This study investigated fewer than ten waste categories and the samples were designed to be above the 91kg threshold as outlined by Sfeir et al. (1999).

The residual waste 3 day sample sizes, the compositional analyses sample sizes and the percentage of the residual waste analysed is given in Table 10. Roughly 7% of the entire residual waste sample was analysed on each data collection occasion.

Table 10: Waste compositional analysis data sample sizes

Date	Residual waste (kg)	Compositional analysis sample analysed (kg)	% of the residual waste analysed
16th – 18th April 2013 (baseline)	2245.8	177.4	7.9%
18th – 20th June 2013 (pre-intervention)	1702.4	120.7	7.1%
16th – 18th July 2013 (post-intervention)	1631.4	116.3	7.1%

A sample of residual waste between 30kg and 45kg was analysed at each of the three waste stations. Although this sample size does not fall above the minimum threshold of 91kg the three samples were combined and the combination always exceeded 91kg. The combination of the three compositional analyses provided the best possible indication of the quantity of food waste being deposited into the residual waste in Ying Hua Yuan.

Categorisation was determined from a combination of previous similar studies (Wang et al., 2008, Zhuang et al., 2008, Dahlén and Lagerkvist, 2008, Sfeir et al., 1999) and through preliminary data analysis of the waste samples. The focus was on food waste but a variety of other categories were also observed to ensure any inconsistencies were not missed. The data presented in the following section uses the composition analysis to determine the percentage of food waste in the residual waste and does not discuss the other waste categories in this study.

The categories analysed were:

- Mixed recyclables (as defined in Table 6)
- Glass
- Nappies
- Textiles
- Food waste
- Hazardous
- WEEE (waste electrical and electronic equipment)
- Wood
- Non-recyclables (any material not encompassed by the above and included materials such as: fines, wet paper, card and tissues, dense plastics, sanitary waste)

The entire waste sample was analysed on a disposable plastic sheet and separated by hand into the various categories (see Figure 18). The non-recyclables and food categories are largest in the waste sample and 120L wheelie bins were used to sort the waste into. The 120L bin was always weighed beforehand and the empty bin weight subtracted. The remaining categories were sorted into plastic bags or piles depending on the quantities. Weighing took place after the entire sample had been sorted using two sets of scales. The 120L bins containing the food and non-recyclable waste streams were weighed using the same scales used for the waste quantity data collection while the smaller categories were weighed with a smaller scale set accurate to 0.01g with a maximum load capacity of 30kg.

Before data collection took place all researchers completed risk assessments for each research activity (see Appendix 6). Protective equipment was provided including needle proof gloves for the compositional analysis, overalls, disposable gloves for handling the bins, hand sanitizer and facemasks. After data collection researchers ensured that community equipment was cleaned (if required) and replaced and work area cleaned and returned to its original condition. Figure 18 depicts a waste compositional analysis in process.

Figure 18: Waste compositional analysis being undertaken in Ying Hua Yuan

5.5 Belief of Environmental Consequences Communication

The aim of the belief of environmental consequences communication was to strengthen the WM24 belief of environmental consequences determinant. The required information to address the belief of environmental consequences of waste disposal determinant included:

1. Information related to the quantities of waste produced by Shanghai and by the community
2. How the waste is treated in Shanghai
3. Consequences of source separating food waste and the consequences of not source separating food waste.

A colour printed leaflet was specifically produced for the community with localised information and pictures with information relating to numbers 1 to 3 from the list above. The leaflet was developed and designed in English and translated into Chinese, English and Chinese versions can be found in Appendix 7. To supplement the leaflet and to assist the doorsteppers, two A3 colour posters were produced with pictures relating to numbers 2 and 3 from the list above, (see Appendix 8). The posters used localised pictures to demonstrate what happens to waste in Shanghai. Finally a choice of A6 size bin stickers was offered to residents. The stickers were designed with pictures depicting positive outcomes of food waste sorting and intended for sticking onto resident's food waste kitchen caddies; the stickers are discussed further in section 5.6 on page 104.

The intervention was specifically designed to address the belief of environmental consequences WM24 determinant, however the intervention will simultaneously address a number of other WM24 determinants. To isolate the impact of the target determinant from other interacting determinants and to evaluate the change in the level of environmental consequences waste disposal knowledge questionnaire surveys were employed (see below for details). It is also important to be aware of the other determinants addressed and their potential to influence the results. Table 11 analyses the intervention with respect to the WM24 framework to identify the other determinates involved. A brief explanation on how the WM24 determinant was addressed by the communicative materials is provided in brackets next to the WM24 determinants addressed.

It should be noted that the leaflet is analysed with the assumption that it is read, this cannot be guaranteed. Similarly the stickers will act as a prompt only if the stickers are used as intended. All supplementary materials can be found in the appendices section.

Table 11: WM24 determinants addressed by the communication materials

Belief of environmental consequences of waste disposal – materials used to deliver the intervention	**The WM24 addressed by the communication materials**
Pictorial posters demonstrating the waste flows (residual waste and food waste)	• **7.** Information / education / knowledge (What happens to the waste in Shanghai) • **8.** Method of communication (visual) • **9.** Localisation of the programme and community involvement (localised pictures used) • **11.** Perceptions / beliefs (perceptions of sorting and recycling targeted) • **12.** Attitudes (Positive attitudes towards food waste recycling encouraged) • **16.** Belief / Perceptions of recycling consequences (what happens to sorted and not sorted waste in Shanghai pictures)
Leaflet (provided that the leaflet is read)	• **7.** Information / education / knowledge (What happens to the waste in Shanghai) • **8.** Method of communication (leaflet) • **9.** Localisation of the programme and community involvement (localised pictures and information) • **11.** Perceptions / beliefs (perceptions of sorting and recycling and waste disposal in Shanghai) • **12.** Attitudes (positive attitudes towards food waste recycling encouraged) • **15.** Self-efficacy (Waste sorting described as

Belief of environmental consequences of waste disposal – materials used to deliver the intervention	The WM24 addressed by the communication materials
	easy) • **16.** Belief / Perceptions of recycling consequences (what happens to sorted and not sorted waste in Shanghai pictures)
Stickers	• **8.** Method of communication (eye catching pictures - visual) • **16.** Belief / Perceptions of recycling consequences (pictures relating to the outcomes of food waste recycling) • **18.** Feedback / commitment / goals / prompting and reminders (Prompting and reminders) • **24.** Rewards / financial incentives (reward)

5.6 Doorstepping

The doorstepping design drew upon doorstepping literature and best practice guides. Previous research suggest the following factors should be considered when preparing to carry out a doorstepping intervention:

- Use of young volunteers (Grodzińska-Jurczak et al., 2006)
- Weight data rather than set out rates offer more accurate assessment of the intervention (Cotterill et al., 2009)
- More successful when designed to address specific aims (Timlett and Williams, 2008, WasteWatch, 2006)
- Useful for flats using communal bins or where additional quality is required (Timlett and Williams, 2008, WasteWatch, 2006)
- Doorsteppers should wear a uniform (Grodzińska-Jurczak et al., 2006, Read, 1999)
- Doorsteppers carry ID badges (Grodzińska-Jurczak et al., 2006)

- Provide training to the doorsteppers (Coates Anna et al., 2004, Cotterill et al., 2009, Grodzińska-Jurczak et al., 2006)
- Use a positive and encouraging approach (Grodzińska-Jurczak et al., 2006, Cotterill et al., 2009)
- Possible doorstepping materials (Coates Anna et al., 2004, Read, 1999):
    - A service information leaflet
    - A campaign specific leaflet
    - 'No Junk Mail' letterbox stickers
    - Pencils made from recycled vending cups
    - Fridge magnets
    - Recycled note pads
    - Cloth shopping bags
    - Stickers
    - Badges

Referring to the above the doorstepping intervention was designed taking into consideration local norms and customs.

The doorstepping was carried out by 13 Fudan undergraduate, Masters and PhD students, 6 members of the Fudan Sustainable Behaviour Research Group (including the Author) and 6 from the local environmental NGO. All participants wore branded tabards and ID badges round the neck on lanyards. They were grouped into pairs and each group carried a university branded bag containing a choice of bin stickers, leaflets in English and Chinese, apartment tick sheet to record apartments visited and a large pictorial posters depicting Shanghai's waste flow. The bin stickers were designed to be placed on the side of resident's food waste kitchen caddies to encourage sorting and act as a prompt when disposing of waste. The choice of stickers offered, helped engage the residents in the doorstepping and increase concentration; they also acted as a reward for participation in the intervention. The pictures on the stickers were chosen to represent the positive outcomes of food waste sorting and included a bright sunflower (also featured on the leaflet and poster), a colourful selection of fruit and vegetables (featured on the poster) and piglets (see Appendix 9). The doorsteppers highlighted that correct sorting can be used to grow healthy fruit and vegetables, sunflowers or can be fed directly to pigs to produce pork, the most popular meat in China.

Prior to the doorstepping the students attended an afternoon training and discussion session and a pre-doorstepping preparation talk. The afternoon training session consisted of two parts, a discussion followed by training. A Fudan professor of sustainability chaired the training and discussion session and every one was encouraged to participate. The discussion was particularly important to finalise a suitable, culturally sensitive structure to the doorstepping method and communication script. This gave the group the opportunity to contribute and collectively arrive at a consensus regarding the delivery methodology. The discussion was followed by role-play and each student had a chance to practice the doorstepping technique. The doorstepping guidelines and prompts are given in Appendix 10 and were provided to all doorsteppers.

The Community Committee provided block leaders to introduce the doorstepping teams to residents. The Community Committee suggested an introduction by a local representative is the culturally acceptable approach to the doorstepping intervention; furthermore it helped gain the residents trust and attention. The block leaders were also aware of empty apartments and apartments which should not be doorstepped increasing the doorsteppers security and saving time. The Community Committee provided tick sheets of block and apartment numbers making it easy to monitor where doorstepping had taken place.

Throughout the doorstepping there was always someone present from Fudan and the Community Committee to assist the doorsteppers with any problems. There was a common room with refreshments and extra leaflets, stickers and tick sheets if needed.

The doorstepping intervention was elected as the most suitable method to ensure the communication of the WM24 Belief / Perceptions of recycling consequences determinant. However in the process of undertaking the doorstepping intervention other determinants were subsequently addressed. Table 12 indicates the other determinants that the doorstepping intervention addresses. It is important to be aware of all the WM24 determinants affected for analysis and interpretation of the results.

The method with which the doorstepping has been conducted will favour some determinants over others. These are highlighted in bold and will be further discussed with respect to the results in the discussion section.

Table 12: WM24 determinants addressed by the doorstepping intervention

The WM24 addressed by the doorstepping intervention
• **7. Information / Education / Knowledge** (What happens to the waste in Shanghai, any questions answered, how to carry out the sorting, number of categories that can be recycled) • **8. Method of communication** (face to face, leaflet, poster) • **9.** Localisation of the programme and community involvement (block leaders present, localised materials used) • **11.** Perceptions / beliefs (perceptions of sorting and recycling, the recycling programme) • **12.** Attitudes (Positive attitudes towards food waste recycling and the sorting programme encouraged) • **13. Norms** (visiting each household reinforces recycling as a norm) • **15.** Self-efficacy (sorting is easy iterated) • **16. Belief / Perceptions of recycling consequences** (see Table 11) • **18.** Feedback / commitment / goals / prompting and reminders (householders informed of their excellent progress so far, stickers for food waste bins) • **21.** Stakeholder involvement and cooperation (Community Committee, NGO, block leaders, Fudan University students and international researchers and volunteers all working together) • **24.** Rewards / financial incentives (stickers distributed)

5.7 Questionnaires

The questionnaires considered the extent residents knew about the environmental consequences of recycling and not recycling before and after the doorstepping intervention. The context in which this research was carried out did not allow for multiple surveys to be conducted on the sample population. The Community Committee would only permit one survey per resident for the purpose of this research; therefore questionnaires were distributed before the intervention in one half of the community and after the intervention in the other half. This method ensured residents were not troubled more than once and ensured local protocol was maintained.

The community is naturally divided into two sections the right side is in the 610 group and depicted in yellow on the community map and the left side of the community is in the 540 group and depicted in blue on the map (for map see Figure 6 on page 70). An assumption was made that the two halves were equally representative of the whole community, the Community Committee did not indicate any reason why this should not be the case.

It is customary in China to provide a small reward for completed questionnaires in such circumstances furthermore a reward acted as a time incentive. The first 100 completed pre-intervention questionnaires could be exchanged for a Fudan University branded pen, diary or carrier bag. The first 100 completed post-intervention questionnaires could be exchanged for a Fudan University branded pen only for logistical reasons. On completion of the questionnaire residents were instructed to hand it in to the Community Committee who consented to collecting the completed questionnaires and distributing the gifts. The nature of the reward was not indicated on the questionnaire sheets.

A self-completion questionnaire methodology was used to reduce the questionnaire dissemination time. Community block leaders were convened to carry out the distribution at the suggestion of the Community Committee. The block leaders were given the precise number of questionnaires depending on the number of households within their block, this was to avoid duplication. The pre-intervention questionnaires were distributed to the right side of the community over the 1st and 2nd July, 4 days before the doorstepping intervention. The block leaders distributed the questionnaires directly to the residents or placed them in their mailboxes if there was no answer. The post-intervention questionnaires were distributed to the left side of the community on the 11th and 12th July 5 days after the intervention using the same methodology. The questionnaires distributed before and after were identical except for the colour of paper they were printed on. Different colour paper was used to ensure before and after questionnaires could not be confused and to prevent questionnaire fabrication.

The unique environment in which this study was conducted meant that many of the methods had to be tailored to the local environment and resources available however the doorstepping study by Bernstad et al. (2013) and Davies (2007)'s research methodology textbook were used as a resource. The questionnaire was an anonymous, simple five-question questionnaire with three open ended

questions and two relating to the demographics of the respondents. Open-ended questions were used because they do not force respondents to adopt preconceived answers and help to mitigate bias (Davies, 2007). The questions are presented below and the actual questionnaire used can be found in English and Chinese in Appendix 11.

1. If you recycle your food waste at the moment what are the main reasons?
2. (a) What happens to the dry waste (residual waste) when it leaves the community?

2. (b) What happens to the wet waste (food waste) when it leaves the community?

3. (a) Does waste disposal have any effects on the environment?

Yes No Not sure

(b) If you answered YES what are they?

4. Approximate age?
5. Gender? M F

5.8 Summary of Methodologies

The methodologies used in this research project were chosen to provide maximum rigour within the scope of the project while also achieving the research objectives. Figure 20 demonstrates the variety of methodologies used in this research project and their inter-relationships.

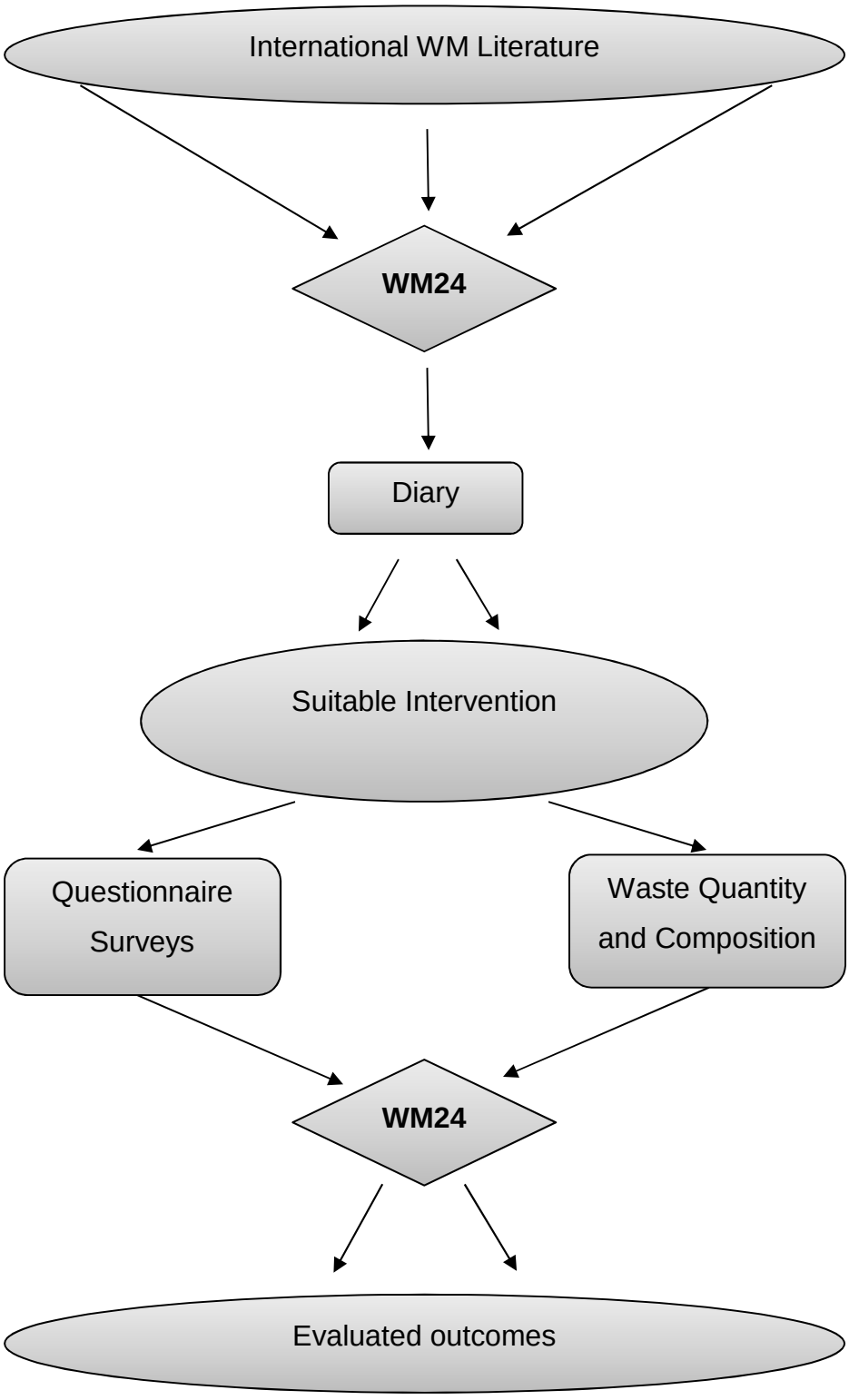


Figure 20: Summary of methodologies

The numerous research activities carried out as part of this investigation required

the participation of a number of different researchers and students. A list of the research activities carried out and the corresponding individuals associated with them can be found in Appendix 12 on page 185.

6 Results

6.1 Doorstepping

The doorstepping was carried over one day only; the second day was not required due to the high contact rate achieved over the first day. The Community Committee and resident volunteers recorded the number of blocks and apartments doorstepped. Out of a possible 996 apartments 45 were excluded due to inhabitation bringing the achievable total to 951 apartments. In total, 633 apartments were successfully doorstepped, a contact rate of 66.6%. The number of apartments that were successfully doorstepped on the left side (group 540) was 375 out of a possible 374 or 65.3% and the number of apartments that were successfully doorstepped on the right side (group 610) was 258 out of a possible 377 or 68.4%. Compared with previous doorstepping studies this is a reasonably high contact rate (Coates Anna et al., 2004) possibly as a result of conducting the doorstepping on the weekend when there is likely to be more residents at home.

6.2 Questionnaires

The questionnaires were carried out to determine the level of knowledge relating to the environmental consequences of waste disposal before and after the intervention. It was hypothesised that the level of knowledge relating to the environmental consequences of waste disposal will be lower before the intervention and will increase after the intervention.

The pre-intervention questionnaires were distributed to 439 households on the right side of the community and total of a 129 questionnaires were returned, a completion rate of 29%. However despite the many methods put in place to prevent duplication, the data analysis revealed that 36 of the returned questionnaires were duplications (28%). The duplications were easily identified from the Chinese handwriting, and the content. The duplicates were discarded taking the usable questionnaire sample size to 93 (21%).

The post-questionnaires were distributed to 425 households on the left side of the community and a total of 191 were returned, a completion rate of 45%. This sample also suffered from 21 duplications or 11%. Likewise the duplications were discarded taking the usable sample size to 170 or 40%. It is likely the high number

of duplicates is a result completed questionnaire rewards and residents desire to obtain more than one gift.

The pre-intervention and post-intervention questionnaires were analysed using the same methodology. The questionnaires were translated from Chinese and coded using an open coding approach to categorise the respondent's answers (Davies, 2007). The responses followed similar patterns and answers which made coding easy and every time a category was mentioned it was recorded in a spreadsheet. It should be noted that more than one category could be coded in one response so the total number of categories mentioned exceeds the response sample size. The results are presented in the following tables and the number of respondents mentioning a particular response is given in percentages. The pre and post intervention data is included for comparison.

Question 1: If you recycle your food waste at the moment what are the main reasons?

Table 13: Results from questionnaire survey - Question 1

Response	**Respondents mentioning (%)**	
	Pre %	**Post %**
For a cleaner community, city, country or living environment	23.7	19.4
For the next generation	21.5	21.2
Waste sorted becomes a resource	12.9	11.8
Environmental protection / reduce pollution	41.9	44.7
Better air quality	6.5	1.8
Motivated by work of the Community Committee / Volunteers	2.2	1.2
Publicity	6.5	3.5
It's our responsibility	2.2	7.6
Human health	8.6	8.8
To reduce waste	11.8	4.1
Other	7.5	7.6
Unanswered	3.2	1.2
For society / world	0	10.0
For myself	0	3.5
Learned from foreigner / foreign countries	0	2.4

Question 2 (a): What happens to the dry waste (residual waste) when it leaves the community?

Table 14: Results from questionnaire survey - Question 2 (a)

Response	Respondents mentioning (%)	
	Pre %	Post %
Landfill or Incineration	36.6	15.3
Landfill	8.6	9.4
Incineration	8.6	21.2
Waste Factory	3.2	0.0
Recycled	11.8	13.5
Composted	1.1	3.5
Sorted	3.2	4.1
Not sure	30.1	35.3
Unanswered	2.2	4.1

Question 2 (b): What happens the wet waste (food waste) when it leaves the community?

Table 15: Results from questionnaire survey - Question 2 (b)

Response	Respondents mentioning (%)	
	Pre %	Post %
Composted	48.4	54.1
Wet waste factory	9.7	1.2
Recycle	4.3	1.8
Bio-gas	1.1	0.0
Sorted	1.1	0.6
Pig-feed	3.2	4.7
Incineration	1.1	3.5
Landfill	1.1	2.4
Other	5.4	0.6
Not sure	25.8	31.2
Unanswered	2.2	1.8

Question 3 (a): Does waste disposal have any effects on the environment?

Table 16: Results from questionnaire survey - Question 3 (a)

Response	Respondents mentioning (%)	
	Pre %	Post %
Yes	68.5	71.2
No	20.7	11.2
Not sure	10.9	17.6

Question 3 (b): If you answered YES what are they?

Table 17: Results from questionnaire survey - Question 3 (b)

Response	Respondents mentioning (%)	
	Pre %	Post %
Landfill takes up space	19.4	5.9
Air pollution	44.1	37.1
Soil pollution	15.1	8.2
Water pollution	4.3	10.6
Heavy metals	2.2	0.0
Unsorted waste is a waste of resources	4.3	0.0
Will have an effect on the environment (unspecified)	18.3	17.6
Human health	9.7	11.8
Global warming / greenhouse gas / greenhouse effect	1.1	5.3
Unanswered	2.2	8.2
Other	1.1	7.1

Question 4: Approximate age?

Table 18: Results from questionnaire survey - Question 4

Response	Respondents mentioning (%)	
	Pre %	Post %
0-19	3.2	0.0
20-29	8.6	2.4
30-39	6.5	5.9
40-49	10.8	11.2
50-59	24.7	25.9
60-69	24.7	32.4
70+	15.1	18.8
Undisclosed	6.5	3.5

Question 5: Gender?

Table 19: Results from questionnaire survey - Question 5

Response	Respondents mentioning (%)	
	Pre %	Post %
Male	29.0	37.1
Female	65.6	60.0
Undisclosed	5.4	2.9

The results from the questionnaire demonstrate little change before and after the intervention contrary to the hypothesis. In response to the question “what happens to the dry waste (residual waste) when it leaves the community”, 53.8% knew it was landfilled or incinerated before the intervention and 45.9% knew after the intervention. Similarly in response to the question “what happens to the wet waste (food waste) when it leaves the community”, 48.4% knew it was composted and 9.7% stated it was processed in the food waste plant before the intervention, a total of 58.1%. After the intervention the results are similar, 54.1% stated the food waste was composted and 1.2% stated it was processed in the food waste plant, a combined total of 55.3%.

In response to the question “does waste disposal have any effects on the environment” 68.5% replied yes before and 71.2% replied yes after, 20.7% replied no before and 11.2% replied no after. Although there has been a drop in the number of people stating that waste disposal does not have an effect on the environment no conclusions can be made from this result alone. The knowledge relating to the nature of the effect on the environment was investigated in further detail and the results demonstrate no discernable trends in increasing awareness of the environmental consequences of waste disposal after the intervention.

The two questions relating to the demographics of the respondent demonstrate some biases in the data. The majority of respondents were female and over 60 years of age in both the before and after respondent samples. 46.3% of respondents were over the age of 60 and 65.6% were female in the pre-intervention sample and 54.7% were over the age of 60 and 60% were female in the post-intervention sample. The age and gender distribution in the questionnaire respondents is not representative of the whole community. The data indicates that it was the retired females who were most willing to complete the questionnaires. Despite the biases, the demographic group was consistent in the respondent sample before and after the intervention and therefore does not bring the comparability of the two samples into question.

The questionnaires demonstrate that the intervention had no obvious effect on the level of knowledge of the environmental consequences of waste disposal. The questionnaires did however demonstrate that the baseline knowledge level of the environmental consequences of waste disposal was higher than expected making any changes harder to observe. The intervention was designed on the premise that this type of communication had so far not been carried out in the community. The initial questionnaire results would suggest that this is not true. On the basis of the questionnaire results further investigation into the community diary was carried out, and the results can be found in the discussion section.

6.3 Waste Quantity and Composition Data with Percentages and Percentage Differences

In this section the results from the waste quantity and compositional analysis data collection are presented. The data were collected on three occasions between April and July 2013 in Ying Hua Yuan community; each data collection comprises three days of waste data. Table 20 presents the waste quantity and composition results and the relevant percentages and percentage increases and decreases.

Table 20: Residual waste and quantities of separated food waste with relevant percentages

Data collection period	**Three-day residual waste and food waste separated data with percentage increases and decreases**			**Percentages of residual waste and food waste separated**	
Date	Residual waste	Food waste separated	Total	Residual waste	Food waste separated
16th – 18th April 2013 (baseline)	2245.8kg	0kg	2245.8kg	100.0%	0.0%
18th – 20th June 2013 (pre-intervention)	1702.4kg	862.5kg	2564.9kg	66.4%	33.6%
% Increase (+) / decrease (-)	-24.2%	n/a	+12.4%	n/a	n/a
16th – 18th July 2013 (post-intervention)	1631.4kg	1216.12kg	2847.5kg	57.3%	42.7%
% Increase (+) / decrease (-)	-4.2%	+29.1%	+9.9%	-9.1%	+9.1%

6.3.1 Variability

Table 20 demonstrates the variability of the residual waste and food waste separated sample sizes over the data collection periods; some variability might be partially explained by seasonal variation, seasonal variation was found to be an influencing factor by WRAP (2010). The variation in compositional analysis sample sizes is due to sample availability. The sampling strategy for the compositional analysis was to analyse the entire available sample at a given time, therefore the variation in compositional analysis sample sizes is due to normal fluctuations. Other possible reasons for the changes in the sample sizes will be discussed in the discussion section.

This study is concerned with the impact of the designed intervention on food waste separation in Ying Hua Yuan community. The data demonstrates an increase in separated food waste after the intervention and a slight decrease in the quantity of residual waste, there has also been an overall increase in the total quantity waste output (see Table 20). This indicates that food waste separated has increased while the quantity of residual waste has not reduced accordingly, resulting in an overall increase in total waste output. If the intervention has had a positive influence on the quantity of food waste separated, an approximately equal decrease in residual waste and increase in separated food waste would be expected. It appears that there has been an increase in separated food waste and a decrease in residual waste however the decrease does not appear equal. From Table 20 it cannot be determined whether these observations are statistically significant or not. Statistical tests on the can be found in section 6.6 on page 124.

6.3.2 Percentages and Percentage Differences

In this section the different percentages and percentage changes are considered.

The percentages of residual waste and food waste separated given in Table 20 demonstrate the percentages for the three waste samples for the three data collection periods. When the pre-intervention food waste percentage is compared with the post-intervention food waste percentage a 9.1% increase in food waste separated can be observed. Because total samples are being compared a 9.1% decrease in the residual waste must also be observed. From the kg sample size data already discussed it has been established that the increase in food waste separated does not equally correlate to a decrease in residual waste. To

investigate this relationship further the percentage difference between the separate waste streams kg data will be considered.

The percentage differences between the baseline, pre-intervention and post-intervention kg data are provided in Table 20 to give an indication of the level of change. This study is primarily interested in the increases and decreases between the pre and post intervention data as a method to evaluate the impacts of the intervention. The data suggests an increase in food waste separation of 29.1% and a decrease in residual waste of 4.2%. As previously mentioned, this might suggest an increase in food waste generation rather than an increase in food waste separation from the residual waste, further support is provided by the 9.9% overall increase in waste. If increased separation had occurred there would be an expected decrease in the residual waste similar to the increase in the separated food waste. The percentage increases and decreases between the kg data values appear to provide a more accurate representation of the situation than the 9.1% increase and decrease previously discussed. However the quantity of food waste in the residual waste has not yet been investigated. The following section considers the quantity of food being disposed of in the residual waste for the pre and post intervention data samples.

6.4 Food Waste in the Residual Waste

Table 21 and Figure 21 demonstrate the changes in the quantity and composition of the waste in Ying Hua Yuan for the three data collection periods taking into account the food waste present in the residual waste. The figures given are the sum in kg of the waste over three days. The “food waste in the residual waste” values have been calculated from the percentage of food waste found in the compositional analyses sample, this percentage has been applied to the residual waste totals to give an estimation for the quantity of food waste in the entire residual waste samples. Data is displayed in a table and in a figure for visual clarity. The residual waste refers to the residual waste minus the food waste in the residual waste in the following figures. The food waste in the residual waste, values were included as residual waste in the previous tables and figures.

Table 21: Waste data including food waste in the residual waste data and percentage differences

	Food waste in the residual waste	**Food Waste Separated**	**Residual Waste**	**Total**
16-18 April (Baseline)	**1444.3kg**	**0.0kg**	**801.5kg**	**2245.8kg**
18-20 June - (Pre-intervention)	**1043.2kg**	**862.5kg**	**659.1kg**	**2564.9kg**
% Increase (+) / decrease (-)	-27.8%	n/a	-17.8%	+12.4%
16-18 July - (Post-intervention)	**891.1kg**	**1216.1kg**	**740.3kg**	**2847.5kg**
% Increase (+) / decrease (-)	-14.6%	+29.1%	+11.0%	+9.9%

Table 21 highlights a number of possible trends. It was hypothesised that the data would demonstrate a downward trend in the quantity of food waste in the residual waste after the introduction of the food waste sorting programme and the subsequent designed intervention, this trend can be observed. The food waste in the residual waste has decreased from the baseline to the post intervention data from 1444.3kg to 891.1kg a decrease of 38.3%. The decrease in food waste in the residual waste between pre and post intervention data samples is 152.1kg, a decrease of 14.6%. It was further hypothesized that the food waste separated would increase during the course of the research. An increase of 862kg can be observed after the introduction of the programme and a further increase of 353.6kg (29.1%) can be observed after the designed intervention. The quantities of total residual waste are fairly consistent decreasing by 17.8% between the baseline and the first data collection and then increasing after the intervention by 11%. The fluctuations in residual waste do not appear to follow any trends however with only three data collection periods it is difficult to make any conclusions. The small change in the residual waste quantities and the increasing overall food waste could be due to seasonal variations. The statistical significance

of the changes in the data are explored in section 6.6. Figure 21 demonstrates data from Table 21 as percentages.

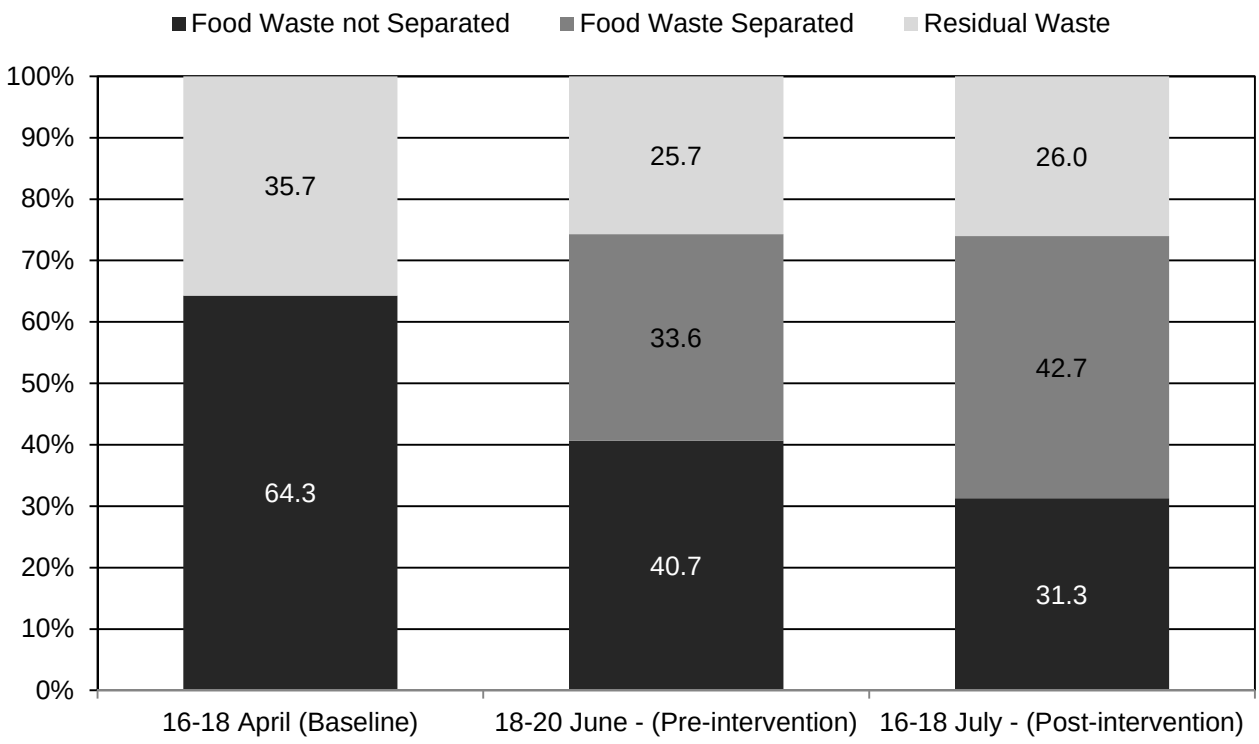


Figure 21: Residual waste vs. food waste separated and not separated (%)

Figure 21 demonstrates the changes in percentages in the waste composition. Figure 21 has been included because it is easier to observe the trends in the pre-intervention and post-intervention data discussed above. The decrease in food waste in the residual waste, the increase in food waste separated and the similar percentage of residual waste can be observed. To understand the increase in food waste capture the food waste data needs examining separately in further detail.

6.5 Food Waste Capture Rate

The hypothesis established before the execution of the intervention was that the food waste capture rate would increase as a result of the intervention and that the food waste not diverted would decrease. The percentage of food waste separated out of the total food waste is known as the food waste capture rate (given in the right hand column of Table 22). A capture rate has been defined by WRAP (2010) as “the quantity of target material ‘captured’ divided by the total quantity of that type of material present”. The food waste capture rate is used in this study as an assessment of the impact of the intervention.

Table 22 demonstrates the food waste capture rate, the food waste not diverted rate and the percentage change in these percentages between data collection periods.

Table 22: Food waste capture rate with the percentage difference

	Food Waste not diverted (%)	**Food Waste capture rate (%)**
16-18 April (Baseline)	**100.0**	**0.0**
18-20 June - (Pre-intervention)	**54.7**	**45.3**
% increase (+) / decrease (-)	-45.3	+45.3
16-18 July - (Post-intervention)	**42.3**	**57.7**
% increase (+) / decrease (-)	-12.5	+12.5

The data confirms the initial hypothesis and a decrease in food waste not separated and an increase in the food waste capture rate can be observed. The percentage difference between the pre-intervention and post-intervention food waste capture rate is 12.5%. The results in Table 22 indicate an increase in the food waste capture rate of 12.5% after the execution of the designed intervention and a decrease of 12.5% in the quantity of food waste not captured. The food waste capture rate will be discussed further in the discussion section.

6.6 Statistical Testing

Two statistical tests were conducted on the pre-intervention and post-intervention data sets. The first was carried out on the pre-intervention and post-intervention residual waste data sets and the second statistical test was carried out with the pre-intervention and post-intervention food waste separated data sets. The statistical tests were intended to determine whether the intervention resulted in statistically significant changes in the quantities of residual waste and food waste separated. No statistical tests were carried out on the baseline data, as they would not have provided any assessment regarding the outcomes of the intervention. Furthermore no statistical tests were conducted on the food waste in the residual waste data because of the data type. The food waste in the residual waste data were calculated from the percentage of food waste found in the residual waste compositional analysis sample and is therefore not suitable data for statistical testing.

6.6.1 Tests for Normal Distribution

To determine the type of statistical tests to use on the data it is first necessary to determine whether the data is normally distributed or not. Four normal probability plots were generated using the Minitab software package for the four data sets, the results are given in Table 23. For the data sample to be considered normal, the p-value must be greater than 0.05. The normality tests are necessary to determine the type of statistical tests that can be performed on the data.

Table 23: Test for normally distributed data

Data sample	p-value	Normally distributed?
Pre-intervention residual waste	0.167	✓
Post-intervention residual waste	0.356	✓
Pre-intervention food waste	0.032	✗
Post-intervention food waste	0.434	✓

The output plots can be found in Appendix 13: 9.1.1.

6.6.2 Descriptive Statistics

Descriptive statistics on the data sets used for the statistical analysis can be found in Table 36 on page 190 in Appendix 13. The quantity of data points (N) varies on the different data collection occasions therefore the data cannot be paired. For the residual waste a two sample t-test will be used because the data sets have been established as normal. This is the most powerful statistical test available for this type of data. A two sample-test could not be carried out on the food waste data set because normal data distribution could not be assumed for all the data sets. A Mann-Whitney U-test was carried out on the food waste data.

6.6.3 Two Sample T-Test – Residual Waste Data

The two sample t-test was carried out to investigate if there is a statistically significant difference between the quantity of pre-intervention residual waste and the quantity of post-intervention residual waste. The Null Hypothesis is:

The mean of the pre-intervention residual waste data is equal to the mean of the post-intervention residual waste data.

To reject the Null Hypothesis the p-value must be < 0.05.

According to the Minitab output for the two sample t-test is, the p-value = 0.122 and is greater than 0.05 therefore there appears to be insufficient evidence to reject the Null Hypothesis. There is no statistically significant difference between the quantity of pre-intervention residual waste and the quantity of post-intervention residual waste.

6.6.4 Mann-Whitney U-Test – Food Separated Waste Data

The Mann-Whitney U-test was carried out to investigate if there is a statistically significant difference between the quantity of pre-intervention food waste separated and the quantity of post-intervention food waste separated. The Null Hypothesis is:

The median of the pre-intervention food waste separated data is equal to the median of the post-intervention food waste separated data.

To reject the Null Hypothesis the p-value must be < 0.05.

According to the Minitab output for the Mann-Whitney U-test the p-value = 0.0052 and is less than 0.05 therefore there appears to be sufficient evidence to reject the Null Hypothesis. There is a statistically significant difference between the quantity of pre-intervention food waste separated and the quantity of post-intervention food waste separated.

Table 24: Summary of Results from the Data Analysis

	% Increase / decrease from Pre-intervention to Post-intervention	**p-value**	**Change Statistically significant ?**
Residual Waste (inc. food waste not separated)	4.2% decrease	0.122	No
Food Waste Separated	29.1% increase	0.0052	Yes
Residual Waste (minus food waste in the residual waste)	11.0% decrease	n/a	?
Food waste in the residual waste	14.6% decrease	n/a	?
Total waste	9.9% increase	n/a	?

Table 24 summarises the results of the data analysis. The implications of these finding will be further discussed in the discussion section.

7 Discussion

The aim of this study was to develop a framework from relevant literatures, which can be used to devise a suitable intervention to increase food waste recycling in an urban, gated community in Shanghai. So far the study has carried out a comprehensive literature review and discussion, has identified a number of waste management recycling determinants, has developed a framework from the identified determinants and used the framework to design and develop an intervention to increase food waste recycling in Shanghai. In this chapter the approach used and results obtained will be discussed in further detail and the merits and limitations of the approach evaluated. During the course of this study a number of areas for possible future research were identified, these will also be presented.

7.1 Results

In this section the results from this study will be discussed in greater detail.

7.1.1 Questionnaires

The questionnaire results demonstrated no discernable change in the level of environmental consequences of waste disposal knowledge before and after the intervention, contrary to the hypothesis. To understand the data further an additional investigation was carried out with the Community Committee post-intervention. The leader of the Community Committee was interviewed with the intention to establish how the residents had known about the environmental consequences of waste disposal and to try and understand the questionnaire results further. During the course of the interview it became apparent that a number of previous interventions had been conducted which this study had not been aware of. Furthermore, a number of the interventions communicated the environmental consequences of waste disposal. The following diary entries have been translated from the Chinese interview with the Community Committee and include instances where a communication of the environmental consequences of waste disposal took place.

24th April 2013: Open space

Between 50-60 residents, Community Committee members and volunteers from Ying Hua Yuan attended an open space event in the local library. Some local

government officials also attended the event. The event host introduced the sorting programme and encouraged opinions to be voiced. A specialist in the waste and recycling field presented the contemporary condition of waste in China with pictures and videos. The harmful consequences of unsegregated waste disposal were iterated.

May 2013: Community Blackboards

Information regarding the sorting programme such as who is doing well and how to participate was displayed on communal community blackboards. In addition another blackboard read (translated from Chinese): "Why we are doing the sorting. Waste is usually taken to a landfill site, which costs a lot on money. Every 16 days the equivalent mass of the tallest building in Shanghai is produced is waste. The other waste disposal method is incineration but incineration also costs a lot of money and causes pollution. Sorting separates waste out at the source and through sorting and recycling we can use some of the waste as a resource. After the sorting some waste will go to a factory and not go to landfill. This will reduce pollution from landfill and incineration. When waste is mixed its only waste when it's sorted it becomes a resource".

May 2013: Community food waste sorting leaflet

The leaflet can be found in Appendix 7. The leaflet distributed to the residents has a small section related to what happens to the waste when it leaves the community and the consequences of waste disposal, it reads, "food waste is composted, residual waste is sent to landfill or incineration. After sorting 90% can be recycled and only 10% should go to landfill or incineration".

Regrettably the above information became apparent after the intervention had been designed and carried out. The questionnaires indicated a possible intervention design miscalculation and on closer inspection it was found that a number of previous interventions had been overlooked. The consequences of overlooking the above information resulted in the designed intervention to be unsuccessful at increasing the level of knowledge relating the consequences of waste disposal due to the already high levels of awareness. The above information provides evidence for the results of the pre and post intervention questionnaires and further discussion of the research methodology is provided in the coming sections.

Question 1 from the questionnaire surveys, “If you recycle your food waste at the moment what are the main reasons?” was not intended to gather specific information relating to the intervention but was included as an exploratory question to determine motivations for recycling behaviour. Similar surveys addressing this question have been carried out. Belton et al 1994 found 64% of respondents stated environmental concern as the main motivator to recycle in a study from Glasgow, UK and a focus group in Massachusetts, USA found the main motivators for recycling were concern for the environment and social pressure (Arlington, 2002). This study found 42-45% of respondent’s stated environmental protection as the main motivator for recycling which is in accordance with the two studies mentioned above. However, 19-24% stated for a cleaner community, city, country or living environment and 21% stated for the next generation. It appears that citizens from Ying Hua Yuan were making a psychological link between recycling and the sanitation of their immediate environment, when in fact there is no relationship. This phenomenon has not been previously observed in the literature, to the Authors knowledge. Furthermore, recycling for the next generation as a stated, major motivator for recycling did not appear to feature prominently in the recycling literature. This study proposes two new areas for further investigation. Firstly, is there a relationship between the perception of the local environment’s sanitation level and with recycling and secondly what are the culturally different motivators for recycling and where do they come from. The former study may lead to a new recycling determinant and the latter study will help contribute to a greater understanding of recycling motivations in different contexts and cultures and could aid the localisation process.

7.1.2 Waste Sample Size Variability

The entire waste sample sizes are not consistent. The baseline waste sample totalled 2,245.8kg, the June sample 2,564.9kg and the July sample weighed a total of 2,847.5kg. Between the baseline data collection in April to the post-intervention data collection in July there has been a 601.7kg increase in waste output over the 3-day monitoring period. The majority of the increase can be attributed to food waste, as illustrated in Table 20, and after speaking to local residents and the community cleaners there are a number of suggested reasons for the increase. April is still a relatively cold month in Shanghai and the availability of fresh fruit is not as apparent as in the warmer months, this might lead to less

food waste output. The diet in Shanghai is also very seasonal and the June data collection period coincided with Shanghai's broad bean season. During the June site visits this was evident and the food waste bins were often filled with broad bean skins. The resident cleaner commented on the seasonal variation, and stated that broad bean season always results in an increase in overall waste output in the community. The July data were collected in the middle of the watermelon season, although the broad bean season had ended, watermelon skin was a common sight in the food waste bins. In addition to the seasonal variation the July data collection coincided with the end of the school summer term. It is possible that more family meals were being prepared during the day leading to the increased waste output. No definitive data were collected to corroborate these hypothesis and further investigation would be required to determine the cause of the increase. The execution of a number of in-depth interviews with key informants and householders would contribute to the intervention's evaluation and would provide deeper explanations. Time and resources constraints prevented the collection of in depth interviews for this study, however it is suggested that in-depth interviews could be considered for evaluation of future similar studies.

7.1.3 Food Waste

To achieve a more detailed evaluation of the intervention, waste compositional analyses were conducted to determine the quantity of food waste not being separated (food waste in the residual waste). The data indicates an increase in separated food waste of 29.1% after the intervention, supporting the hypothesis that the intervention succeeded in increasing food waste recycling behaviour. However to what extent this is a result of food waste diverted from the residual waste requires further consideration. The data suggests a 14.6% decrease in food waste in the residual waste, which could account for approximately half of the increase in food waste separated. Thus the data can be interpreted as a 29.1% increase in separated food waste of which 14.6% has come from within the residual waste and a further 14.5% is attributable to seasonal fluctuations in diet and produce availability. The fluctuations in the quantity of residual waste demonstrate no trend and without a larger data set over a longer time period no conclusions can be made. The longer-term impacts of doorstepping have been investigated in a few studies from the literature. Bernstad et al. (2013) monitored the impacts of their doorstepping intervention on food waste capture rates over a

24-month period. They found that the doorstepping resulted in an initial increase in food waste recycling but over time reduced to similar levels to the control group. Conversely Grodzińska-Jurczak et al. (2006) found that although recycling rates gradually decreased after their doorstepping intervention had ended, they remained well above baseline rates. A larger data set would improve seasonal variation accountability and help determine the longer-term impacts of the intervention.

No compositional analysis was conducted on the food waste separated waste stream and as a consequence food waste contamination levels was not established. The food waste compositional analysis was not carried out due to logistical and time constraints. On every data collection occasion the food waste bins were visually inspected for contamination, on some occasion's minor contamination, mainly due to plastic bags, was found. The majority of contamination observed came from plastic bags containing food waste, cigarette butts and tissue paper. The Community Committee also observed this phenomenon and in response issued a notice to all residents and placed a notice on the bins asking residents to take further care when disposing of their food waste. Furthermore the residential cleaners and volunteers were instructed to remove any contamination observed helping to ensure contamination levels were reduced. However it is still likely that a small amount of contamination entered the food waste stream and caused inaccuracies in the data used in this study by overestimating the food waste and not accounting for contamination. The level of inaccuracy is likely to be small due to the methods put in place to reduce contamination and the relative density of food waste compared to the major contaminating materials such as tissue, plastic bags and cigarette butts. To determine the precise food waste contamination levels a food waste composition analysis would be required. Due to time constraints more data collection was not possible and as a result the level of food waste contamination and the longer-term impacts of the intervention could not be determined within the scope of this study. Despite the uncertainties the data suggests a significant increase in separated food waste and a decrease in food waste in the residual waste.

7.1.4 Food Waste Capture Rate

The food waste capture rate is, "the quantity of target material 'captured' divided by the total quantity of that type of material present" (WRAP, 2010, 7-2). The food

waste capture rate provides a clear indication of the quantity of food waste separated as a percentage of the total food waste stream (food waste separated and food waste not separated). The data suggests an initial pre-intervention food waste capture rate of 43.5%. Bridgewater and Parfitt (2009)'s food waste trials in the UK achieved food capture rates between 43% and 77% across the food waste trial locations. The pre-intervention food waste capture rate is comparatively low in comparison to some of the results from the UK food waste trials, and demonstrates that there is room for improvement. Post-intervention the food waste capture rate increased by 12.5% to 57.7%, which is comparable to the higher scoring UK food waste trials. The food waste capture rate accounts for the food waste not separated and is therefore a good indication of the effects of the intervention, thus the data suggests that the intervention led to an increase in the food waste capture rate of 12.5%.

7.1.5 Statistics

Statistical tests were conducted on the raw data sets only. These include the food waste separated data set and the residual waste data set (food waste in the residual waste is included in the residual waste raw data set). The statistical test confirmed the hypotheses inferred from the data charts. Firstly there has not been a significant change in the quantities of residual waste between the pre and post intervention waste monitoring periods. Secondly that there has been a significant increase in the quantity of separated food waste after the execution of the intervention. The food waste in the residual waste data were generated from the residual waste raw data and the composition analysis data. The percentage of food waste in the residual waste was determined by applying the percentage of food waste found in the compositional analysis sample. Therefore the food waste in the residual waste is not a raw data set on which a statistical test can be conducted. In conclusion the statistical tests demonstrate no statistical change in residual waste quantities and a statistically significant increase in separated food waste after the execution of the designed intervention.

7.1.6 Compositional Analysis

The reliability of the method used to determine the food waste in the residual waste data is determined by the reliability of the compositional analysis and to what extent it is representative. The representation of the compositional analysis

sample used in this study has not been verified and would have benefited from a sample representation test. There are two possible areas of possible representation dispute, the time of day the compositional analysis was conducted and the sample size. The time of day could not be altered due to the logistical constraints previously discussed; however consistency ensured the samples comparability. The sample size analysed was the entire available sample at the time of sample collection. Over three days a minimum of 7% of the three-day residual waste sample was analysed during each data collection period. Nordtest (1995) suggest that a minimum of 5% of the population should be represented in the sample and Sfeir et al. (1999) suggested samples should be no smaller than 91kg. The samples used in this study were above the 91kg threshold suggested by Sfeir et al. (1999) and greater than 5% of the sample population. Despite the reassurances, the genuine level of representation provided by the samples used in this study cannot be determined without further investigation. It is suggested that a one off comparison between a waste sample large enough to exhaust percentage of food waste in the residual waste variability, and the smaller samples would give an indication to the representation of the samples used. However, this is time and resource intensive and the situation in Ying Hua Yuan did not facilitate large quantities of waste storage and analysis. Additional potential errors in the compositional analysis data include errors due to fines and moisture (Dahlén and Lagerkvist, 2008). Fines are the small particles left behind after conducting a compositional analysis and can include wastes such as soil, vacuum cleaner dusts and cat litter. The fines are time intensive to sort and often require sieving (Dahlén and Lagerkvist, 2008). The compositional analysis undertaken in this study classified such material as non-recyclable thus eliminating the need for detailed categorisation. The non-recyclable category included materials that were not encompassed by a pre-determined category and which were currently not being recycled by the scheme. The non-recyclable category accounted for soiled paper and card, dense plastics, fines, plastic film and sanitary wastes and therefore mitigated any issues concerning “left over” ambiguous wastes. Errors in the composition data can also occur due to moisture. This is especially apparent in waste with high moisture content such as the wastes used in this study. Some waste categories are more susceptible than others and Dahlén and Lagerkvist (2008) found that up to 55% of paper could be attributed to moisture. Classifying heavy moisture-contaminated materials such as wet paper and card into the non-

recyclables category helped to mitigate this. Despite efforts to reduce errors there was still incidents where slightly contaminated materials were classified resulting in slight overestimations of that waste stream. The data were not adjusted for these errors.

7.1.7 Baseline Data

The baseline data collected in April was included in the results to provide more detailed information concerning the waste trends such as the food waste in the residual waste and overall waste output. The baseline residual waste data demonstrated a food waste content of 64.3%. This figure is consistent with the findings from the literature regarding the quantities of organic waste found in MSW in Asian countries including China (see chapter 1.1 on page 16). The baseline data were also collected to determine whether the introduction of the sorting programme would result is an overall change in the waste output or whether it would remain consistent. Other studies have found new recycling schemes to result in overall waste decreases (Read et al., 2009), however this was not the finding from this study which found the overall waste generation to rise throughout. Possible reasons for the increase have already been discussed. Without the Baseline data set this increasing trend would not have been apparent.

7.1.8 Greenhouse Gas Emissions from Food Waste

The motivations for this study were discussed in chapter 1.2 on page21; one of which was to reduce greenhouse gasses produced by food waste sent to landfill. In this section the results from this study are considered to investigate to what extend the intervention can contribute towards greenhouse gas emissions reduction. In section 1.2 on page21 it was noted that for every kilogram of food waste disposed of via landfill, 0.125m^3 of greenhouse gas is generated of which 60-65% is methane and 35-40% is carbon dioxide (Adhikari et al., 2006). These data can be used to estimate the reduction in greenhouse emissions as a consequence of the planned intervention carried out in this study. Table 25 presents the greenhouse gas emissions scenario if all of Ying Hua Yuan's residual waste was disposed of via landfill. The data were generated using Adhikari et al. (2006) greenhouse gas data.

Table 25: Greenhouse gas emissions from food waste

	Food waste in the residual waste (kg/3 days)	Greenhouse gas produced under landfill conditions	Food Waste Separated (kg/3 days)	Reduction in greenhouse gas emissions
16-18 April (Baseline)	1444.3kg	180.5m^3	0.0kg	0.0 m^3
18-20 June - (Pre-intervention)	1043.2kg	130.4 m^3	862.5kg	107.8 m^3
16-18 July - (Post-intervention)	891.1kg	111.4 m^3	1216.1kg	152.0 m^3

According to Table 25 the intervention potentially prevented up to 19m^3 of greenhouse gas emissions from being released into the atmosphere every 3 days assuming landfill waste disposal methods are used.

7.2 Methodology

This study used a unique methodology that has not been previously used in waste management recycling studies. The WM24 framework was developed from literature and used as the basis for planning an intervention to increase food waste in an urban-gated community in Shanghai. The WM24 provided a pool of waste management resources to inform the intervention and aid the planning process. The type of intervention to conduct was informed from an analysis of the community diary, and the assumption was made that by focusing on weak or absent areas within WM24 the food waste-recycling situation could be improved. This approach was successful, weak areas were identified and an intervention designed and executed; however there were shortcomings in the approach. The shortcomings were a result of incomplete diary information. Focus was drawn towards the “belief of environmental consequences of waste disposal” determinant that had been previously addressed but which appeared to be lacking. The results from the questionnaire surveys, which were designed to measure the change in the levels of knowledge regarding belief of environmental consequences of waste disposal, demonstrated no change had taken place as a result of the intervention.

The incomplete diary on which the WM24 analysis was carried out was a result of a number of factors. Due to the language barrier the Author was unable to verify or collect the diary information first hand and this responsibility had to be delegated. The diary information was gleaned from conversations between Chinese university Masters and PhD students and the Community Committee and the community cleaners. It is now clear that for this approach to be effective a constant rapport must be established between the Community Committee and the Research Group. It is now known that it is not sufficient to initiate telephone communications or ad hoc “chats” when present in the community for other purposes, to acquire adequate depth of diary information. It must be stressed that to gain the level of detail required weekly formal meetings are suggested as the best method of obtaining the necessary levels of information. This however is not easy to achieve and it is likely that in this situation the key informants would not have been willing to agree to such involved meetings. As previously mentioned it was imperative that the diary communications did not become regarded as a nuisance, therefore a tactful approach was adopted and perhaps fewer than adequate communications were had. It is also plausible that the Community Committee did not fully understand the basis for the consistent communication regarding the diary and therefore did not comprehend the importance of the fine detail that was required. The ramifications were that fundamental pieces of information were missed leading to errors in the planning of the intervention.

As previously mentioned the research was carried out under time pressure and as a result there was relatively short periods between the data collection activities and the intervention. This resulted in the analysis of pre-questionnaire data after the intervention took place. If time had not been an issue the questionnaires would have indicated that the belief of environmental consequences of waste disposal knowledge was already present and there would have been enough time to re-visit the WM24 and alter the intervention. It is likely that a doorstepping intervention would have been conducted regardless of the missing diary information due to the number of other justifications. However the focus would not have been directed towards the belief of environmental consequences of waste disposal determinant.

The extent to which addressing the belief / perceptions of environmental consequences determinant can affect recycling scheme success was not established within this study due to the shortcoming in the methodological

approach taken, and remains an area for future research. The WM24 has not sought to rank the determinants in terms of their importance to a scheme and effectiveness at increasing recycling rates and behaviour. It is suggested as an area for further WM24 development, however caution is urged when indicating a determinant to be of greater significance to another, as the context in which this is established is likely to have influence.

7.3 Waste Management Literature Review

The literature search drew upon a vast body of published academic and grey literatures to identify the recycling determinants. The review drew attention to a number of observed shortcomings that have been alluded to throughout the study. It was found that investigations seeking statistically significant determinants in recycling schemes often prove useful for localised contexts and many interesting findings have emerged, new recycling determinants discovered, and theories and frameworks developed. However there was also a lack of consistency in the published results. As a consequence there has arisen a level of ambiguity surrounding recycling determinants resulting in few reliable transferable lessons for use in other contexts. This proved an issue within this study when attempting to evaluate the importance and relevance of determinants from the published results for the local Shanghai context.

Other authors have observed this phenomenon. Jackson (2005) commends the recycling literature for taking a more holistic approach to recycling investigations, however, Jackson comments that the approaches used are not always clear and well structured. Jackson comments further that; “In particular, this literature often does not explore the relationships between internal factors and external constraints in any depth.” (Jackson, 2005, 89).

The second shortcoming identified was relating to specific definitions and interpretations. For example “convenience” is identified as a recycling determinant by a number of studies, yet its definition is not clearly outlined and may or may not include any number of determinants within it. Mosler et al. (2008) also observed this phenomenon and called for further specificity within definitions. Throughout the literature search examples of determinant overlap have been highlighted which depend on definition and interpretation and consideration has been given to examples where ambiguity has arisen from poorly defined determinants.

One explanation for the discrepancies is that each waste management study has been undertaken at different times and in different contexts, therefore it is expected that different determinants will produce varied results. To address the discrepancies this study chose to include as many of the recycling determinants in the WM24 framework as possible. The variety of sources and the number of determinants offers greater choice to waste management practitioners looking to develop or improve recycling schemes. Furthermore the detailed determinant discussion allows practitioners to make an assessment of the merit of addressing a determinant with respect to the published literature and the local context. If further information is required regarding a specific determinant, the reader can find a wide selection of publications referenced in the determinant tables.

7.4 Intervention Evaluation

The doorstepping intervention was selected as the medium to communicate the environmental consequences of waste disposal to the householders of Ying Hua Yuan. Regrettably the primarily objective was not satisfied which raises the question of what aspects of the intervention did have an effect? The WM24 framework can be revisited for further analysis of the additionally addressed relevant determinants.

In chapter 5.2 the WM24 determinants were correlated with the interventions carried out. The type of intervention conducted will naturally favour some determinants over others; the intervention biases are discussed here. The determinants highlighted in bold are thought to be of even greater relevance.

Table 26 presents the determinants identified by the WM24, which were present within the intervention. According to the WM24 the intervention addressed 12 determinants, of which belief / perceptions of recycling consequences had no effect. The WM24 has identified a further 11 possible reasons why the intervention had an effect.

Table 26: WM24 determinants addressed by the doorstepping intervention

The WM24 addressed by the doorstepping intervention
• **7. Information / Education / Knowledge** (What happens to the waste in Shanghai, any questions answered, how to carry out the sorting, number of categories that can be recycled) • **8. Method of communication** (face to face, leaflet, poster) • **9.** Localisation of the programme and community involvement (block leaders present, localised materials used) • **11.** Perceptions / beliefs (perceptions of sorting and recycling, the recycling programme) • **12.** Attitudes (Positive attitudes towards food waste recycling and the sorting programme encouraged) • **13. Norms** (visiting each household reinforces recycling as a norm) • **15.** Self-efficacy (sorting described as an easy activity) • **16. Belief / Perceptions of recycling consequences** (doorsteppers communication, posters, leaflets, stickers) • **18.** Feedback / commitment / goals / prompting and reminders (householders informed of their excellent progress so far, stickers for food waste bins) • **21.** Stakeholder involvement and cooperation (Community Committee, NGO, block leaders, Fudan University students and international researchers and volunteers all working together) • **24.** Rewards / financial incentives (stickers distributed)

Information / Education / Knowledge: The intervention was designed around the delivery of information via multiple mediums. The purpose of the doorstepping, leaflet, poster, and face-to-face communication was to deliver information therefore addressing this determinant in multiple ways. Aside from the belief / Perceptions of recycling consequences information the doorstoppers were trained to communicate basic information about the scheme, the various waste categories accepted along with any questions or concerns the householders may have had.

Method of communication: Method of communication delivered face-to-face communication, an intervention not previously carried out in Ying Hua Yuan. Residents received a personal interaction and reassurance and encouragement about the programme.

Attitudes: Attitudes were positive and optimistic and encouraging throughout, this might have influenced the householders, however the brief nature of the interaction is unlikely to result in lasting attitude change.

Norms: The intervention will have influenced social norms. The literature suggests that doorstepping and block leaders can both increase social norms through the delivery of information and personal contact (Burn, 1991, Schultz et al., 1995, Carlson, 2001). Burn (1991) reinforced recycling as a norm through the distribution of information using a personal contact approach. The information was focused on informing participants that others in their neighbourhood were recycling. The current study did not emulate Burn (1991), however the success of the recycling scheme in terms of participation and recycling rate in the community was applauded during the doorstepping. Furthermore the presence of the block leaders, the Community Committee, NGO and Fudan researchers all help to reinforce the social norm, “recycling is normal” and a “good activity to participate in”. Carlson (2001, 1290) stated that the personal contact aspect of the determinant helps participants to “internalise a recycling norm” this was the case during the intervention used in this study. The block leader approach and doorstepping share similar characteristics in terms of a recycling intervention. Therefore an area for future study would be to investigate doorstepping as not only a method of communication and education but also as a means to develop recycling norms in a community.

Belief / Perceptions of recycling consequences: The belief / Perceptions of recycling consequences determinant featured heavily in the intervention however as a result of the design error it did not have an effect. This determinant can be excluded from the results evaluation and was not directly responsible for the results obtained.

Feedback and prompting: Feedback and prompting was definitely part of the intervention, residents were told how well they had done and how they could do even better. Visiting each household acted as a direct prompt to participate.

Stakeholder involvement and cooperation: The level of stakeholder involvement was evident throughout the intervention with students, international researchers, Community Committee, NGO, block leaders and volunteers. The cooperation between stakeholders helps reinforce the recycling norm and encourage

participation.

International participation: There were 3 international participants participating in the doorstepping including the Author. In China having an international presence in any event is important and increases legitimacy, level of importance and status. This is reflected by a number of questionnaire respondents mentioning their reason for participation was a result of the foreign presence. International cooperation is underrepresented in the literature and this study suggests further research into the impacts of foreign involvement in recycling schemes would generate some interesting findings especially in Asia where foreign involvement is associated with status.

The four determinants highlighted in bold are the determinants most likely to have been addressed to the greatest extent by the intervention. These determinants have been selected based on the Authors knowledge on the execution of the intervention, its design and outcomes. Although the Belief / Perceptions of recycling consequences was paid most attention to make sure it was addressed to the greatest extent it did not have an impact, the reasons for which have already been eluded to. The remaining three determinants, information / education / knowledge, method of communication and norms are what this study suggests had the greatest influence during the intervention and the greatest bearing on the waste quantity and composition results. The dynamic ability of the intervention to deliver tailored and up to date information ensured information / education / knowledge was addressed, the multiple methods of communication incorporated into the intervention ensured method of communication was addresses and the personal contact and wide influence of the intervention ensured that the “recycling is normal” message was conveyed.

The above are suggestions pertaining to the outcomes of the intervention using the WM24. The exact extent to which each determinant has been addressed by the intervention cannot be established without additional data. Supplementary specifically designed questionnaires, similar to the ones already carried out could be conducted for further evaluative purposes however this study proposes in-depth interviews a suitable method to obtain such information. Despite not identifying the exact cause of the intervention’s success the WM24 has provided a framework, which can offer explanations without the need for additional data collection. This study proposes the WM24 as a new conceptual framework for

future testing and refining to offer waste management guidance and solutions across multiple contexts, cultures and environments.

7.5 Study Limitations

7.5.1 WM24 Development

The WM24 is a framework of recycling determinants which was developed through the execution of a meta-analysis of the WM literature which provided the justification for the determinant selection, however the literature and determinants were compiled by one individual, the Author. The limitations of this approach are that bias could be introduced because of that lack of collaboration in literature selection as well as determinant selection. Secondly the determinants identified by the literature were taken out of the context in which they have been presented thus the determinant applicability to wider contexts could not be established. This was acknowledged in this study and in response an effort was made to validate the WM24 and by localising the determinants using the diary approach. An attempt to mitigate the issues of bias were made by the cross-examination with Michie et al. (2005)'s framework, however this approach also was found to have its limitations.

In chapter 3.2 on page 60 the WM24 framework was analysed with respect to a behaviour change framework developed by Michie et al. (2005). Each of the WM24 determinants were considered in turn and linked to one or more of Michie et al. (2005)'s behaviour determinants. The purpose of undertaking this cross-examination was to provide a method to validate the WM24 by ensuring that each determinant from Michie et al. (2005)'s framework had been considered within the WM24 framework. This validation methodology was based on a number of assumptions. Firstly, it was assumed that the Michie et al. (2005) framework was "comprehensive" in terms of the addressing all determinants necessary for successful behaviour change, and therefore successful recycling behaviour change. Thus it was assumed that if the WM24 was able to account for all Michie et al. (2005)'s constructs then the WM24 could also be considered "comprehensive". To evaluate whether this assumption is valid is beyond the scope of this study and would require further analysis of Michie et al. (2005)'s framework. Secondly it assumed that the two frameworks are comparable. The WM24 was developed from a meta-analysis of international recycling studies and all determinants featured in the WM24 were identified and selected by the Author.

Conversely Michie et al. (2005)'s determinants were identified and selected using a consensus approach by a consortium of professionals working in relevant disciplines. The very different approaches used in this study and Michie et al. (2005)'s study create a discontinuity in the methodological approach and is therefore credited as a limitation to the current study. An attempt at "validation" of the WM24 by using Michie et al. (2005) was used as it appeared to offer a convenient way forward and one which was able to provide a level of credibility, the fact that the WM24 appeared to account for Michie et al. (2005)'s determinants further supported this notion. However the process of rigorous validation was far beyond the scope of this study and is offered as an area for future investigations. Additional details are discussed in the Future Work section in Chapter 8.2.2.

7.5.2 Diary

The diary approach used in this study had a number of objectives, these can be found in chapter 5.1 on page 85. One of these objectives was to gather accurate, continuous information on the progress and activities of the waste programme. This information was used along with the WM24 in the determination of a suitable intervention, therefore the suitability of the intervention was directly related to the accuracy of the diary information. The question of methodology appropriateness, given the context in which the study was undertaken might be raised. However the foreign context in which it was carried out, where fewer waste management studies have been conducted and where western methodology may not be appropriate this methodology was deemed most suitable and practice. It could be suggested that instead of the diary gap identification approach a more holistic methodology could be used which aims to undertake an intervention to address as many WM24 determinants as possible, thus eliminating the danger of a narrow focus on one determinant. This is an approach, which can be used for future similar investigations.

An assumption of the approach discussed above is that by using the WM24 in conjunction with the diary information a suitable intervention to improve the waste management situation in the local environment can be identified. The diary information provided a method of localising the programme which was especially important given the foreign context. The diary did provide enough information to begin to understand the local environment, however it could be argued that more should have been done to involve the local citizens. According to Table 8 which

reviewed the WM24 with respect to the diary information, determinant 9 from the WM24 "*Localisation of the programme and community involvement"* was adequately addressed. On closer inspection of determinant 9 it is interesting to reveal that methods employed by this study did little to reinforce this determinant and that the methods used were top-down focused rather than bottom up.

The literature review has consistently pointed to the value of community involvement in the planning stages of a new recycling scheme, yet this current study did not use this approach. This study assumed authority to know and advise the community what intervention would work, based on general academic experiences rather than local knowledge. The community was informed, there was continuous dialogue but ultimately the decisions were executed by the Author and not in collaboration with the community.

An alternate approach would be to involve the community in the initial stages to elicit their ideas and hear their suggestions regarding the best approach and ultimately the most appropriate and effective intervention to improve their waste management situation. The WM24 could be used in conjunction with the community focused approach to help encourage intervention ideas and discussion. This process would ensure the localisation of the WM24 while at the same time ensuring the thorough localisation of the intervention to be taken forward. Unfortunately this community focused alternative approach was not feasible for this study due to cultural and language barriers. It is proposed as a strong method for the future development of the WM24 and as a method which would lend itself to the wider application of the WM24 while mitigating the need for the diary. However it should be noted that for this approach to be successful an expert understanding of the local language would be required.

7.5.3 Data collection

Firstly this study collected data over three separate data collection periods. The limited number of data collection periods means that waste trends and the longer-term impacts of the investigation cannot be determined. With respect to the literature it is usual to see an initial increase after the intervention as observed in this study and then a gradual decrease over time. The extent of the decease will offer a more comprehensive indication of the impacts of the intervention but without additional data this cannot be established.

Secondly, local traditions and customs are likely to have influence on the waste arising's and trends. These were addressed by involving local personnel in the investigation however it is suggested that a number of in-depth interviews would be able to offer greater insight into the local context, the impacts of the intervention and areas to improve.

Finally, no data were collected regarding the food waste separated contamination levels; this will have resulted in slight over estimations in the quantity of food waste separated.

7.5.4 Main Assumptions

Throughout the study assumptions have been made in order to proceed with the research. Firstly the assumption "by focusing on weak or absent areas within the WM24 the food waste-recycling situation can be improved" is a major assumption within this study. This assumption was made based on the results from the literature review and the subsequent results from this study support the assumption. Additional investigations using the WM24 will be able to offer further support for this assumption. Secondly, the compositional analysis assumed that the sample sizes analysed were representative of the food waste in the residual waste for the entire residual waste of the community. This assumption could not be verified without additional data. Thirdly it was assumed that the other separated waste streams not taken into consideration such as hazardous, dry recyclables, glass and textiles only accounted for a small proportion of the entire waste stream (<10%). Finally it was assumed that half the community was representative of the whole community for the questionnaire survey distribution.

8 Conclusions

The aim of this study was to develop a framework and use it to devise a suitable intervention to increase food waste recycling in an urban, gated community in Shanghai. This aim has been addressed and the WM24 framework developed to plan, conduct and evaluate an intervention for a residential community in Shanghai. The objectives included:

1. Identify significant determinants for successful recycling schemes from waste management and behaviour change literatures and use them to develop a framework.
2. Use the framework to plan and conduct a suitable intervention to increase food waste recycling in an urban residential community in Shanghai.
3. Obtain accurate representational waste quantity, composition and questionnaire survey data to evaluate the impact of the intervention.
4. Make recommendations on how to improve recycling schemes and suggest areas for future research.

In chapter 2 a comprehensive literature review and discussion identified determinants of successful recycling schemes, which were subsequently grouped to make the WM24 framework. In chapter 3 the framework was corroborated using behaviour change determinants and then in chapter 5.2 the framework was used to plan an intervention to improve a food waste recycling scheme in a Shanghai residential community.

The intervention used a doorstepping approach to deliver a communication focused on the environmental consequences of waste disposal and to distribute leaflets and colourful stickers. Over the course of one day during the weekend 66.6% of the population was visited by one of the doorstepping team.

Subsequent to the execution of the intervention it was learned that fundamental diary information was overlooked resulting in an error in the intervention design. The reasons for the error were a result of the foreign context in which this study was conducted and a lack of adequate communication between researchers and the community. This study suggests that future investigations seeking to address weak or absent recycling determinants ensure there are no communication barriers prior to undertaking the study. If communication barriers are likely to exist

this study suggests an intervention is designed to address multiple determinants from the WM24 alleviating the risks of a narrow determinant focus. However it should be noted that an intervention designed to address multiple determinants will be more complex to evaluate. The questionnaire surveys used in this investigation were designed to evaluate the impact of the one target determinant, belief / perceptions of recycling consequences. The questionnaires were effective at evaluating the impact of the target determinant however to evaluate the impact of multiple determinants this study suggests that in-depth interviews can provide the necessary evaluative information.

Robust weight quantity, composition and questionnaire survey data were collected before and after the intervention to assess the impact on the quantity of food waste recycled. The results suggest that the intervention led to a statistically significant increase of 29.1% in separated food waste, a 12.5% increase in the food waste capture rate and a 14.6% reduction in food waste not separated one week after the intervention. Furthermore if landfill waste disposal methods are assumed, which account for the majority of waste disposal in Shanghai, the intervention contributed to a 19m^3 reduction in greenhouse gas emissions over a three-day period.

Despite the design error encountered and the limitations presented the study addressed each objective within the contextual, resource and time constraints to produce positive results. The WM24 provides a waste management resource that can be used to generate ideas and help develop interventions, it can be used to identify determinant gaps within an existing scheme but highly detailed information on the scheme's history is required to avoid error. It can be used as an intervention assessment tool to establish which determinants have been addressed and it can be used to design multifaceted interventions aimed at addressing multiple determinants.

The WM24 is not presented as a finished product but provided as a framework, which can be used and developed further to assist in the move towards resource conservation and waste reduction. As quantities of MSW in China and Shanghai continue to increase, new methods and resourceful interventions will become increasingly important if sustainable waste management is to be achieved.

8.1 Implications of the Research

The high moisture content and low calorific value of MSW across Asia, China and Shanghai has been highlighted as the cause of numerous problems for environmentally sustainable waste management. These include problems for incineration, landfill leachates, greenhouse gas emissions and heavy metal concentrations, all of which have been attributed to, or exacerbated by the high levels of organic waste in the residual waste, waste stream. This study has focused on reducing the quantities of organic waste in the residual waste and in doing so helping to elevate the issues raised.

The overall implications of this research can be grouped into two categories; practical and academic.

The academic implications are a result of this study's strong literature review and analysis, which have been able to identify numerous areas for the direction of future studies, these are discussed and presented in the following chapter 8.2.

The practical implications of the research are a deeper understanding of how to conduct research as a foreigner in China, specifically what is involved in collecting rigorous waste data, the many pitfalls that might be encountered and methods to avoid making mistakes and upholding local protocol. Source separation was described by Chen et al. (2010) as still in its infancy, this research is able to offer suggestions on how to improve participation in source separation schemes through the development of localised interventions as well as offering method on how to evaluate them.

The long-term implications of this research are a more efficient and sustainable waste manage system in Shanghai and a deeper understanding on how current practices can be improved.

8.2 Future Work

8.2.1 Determinant Investigations

This study sought to investigate the effects of increasing knowledge relating to the environmental consequences of waste disposal on food waste recycling. However due to the intervention design error this was not achieved. This determinant is likely to be a determinant of importance, as suggested in the literature, however

the extent to which it is important remains an area for future investigations. Likewise, the effects of doorstepping as an interactive communication technique to elicit a positive pro-environmental behaviour change was only partially conclusive. Therefore, it is suggested that further investigations using a doorstepping approach in China would be useful in determining the success of this approach. Furthermore it was suggested that doorstepping could be investigated not only a method of communication and education but also as a means to develop recycling norms in a community.

8.2.2 Future WM24 Development

Future investigations are encouraged to develop the WM24 further. This study has identified a number of possible development approaches.

8.2.2.1 WM24 Validation

This investigation began to consider the validation of the WM24 by using the cross-examination method, the limitations of which have been presented in chapter 7.5.1. However, rigorous validation was beyond the scope of this investigation. This study proposes that the consensus approach used by Michie et al. (2005) in determining their behaviour change framework would provide a suitable method to develop and validate the WM24. The consensus method would bring additional perspectives, experiences and expertise into the literature based WM24 framework helping to eliminate bias and strengthen the determinant selection. Finally, the lack of reference to works in Behaviour Change within the WM arena has been highlighted, therefore any future waste management investigation which draws on behavioural theory will be contributing to a currently underrepresented area of the literature.

8.2.2.2 Establishment of the WM24 Hierarchy

Another area for further investigation and WM24 framework development is the establishment of the WM24 hierarchy. It was beyond the scope of this study to begin to rank the determinants in terms of their importance to a scheme and effectiveness at increasing recycling rates and behaviour. The establishment of a WM24 hierarchy would provide practitioners with a tool which could help with the allocation of resources and increase programme management efficiencies. However caution is urged with respect to the contextualisation of the ranking as the context in which this is established is likely to have influence. The methods

required to achieve the WM24 hierarchy could be established empirically or again by using the consensus approach as outlined by Michie et al. (2005).

8.2.2.3 Community Involvement, Bottom up Approach

This investigation was unable to fully engage with Ying Hua Yuan community (the unit of analysis) as a consequence of the language barrier. However without the hindrance of language restrictions a more bottom up focused approach is believed to offer an interesting area for future investigations. Instead of drawing on published literature and personal experience for authority, the communities themselves are likely to be able to offer insightful suggestions, and recommendations regarding the most beneficial methods to improve their own waste situation. The WM24 could be employed as medium for discussion and idea generation sessions. This approach would ensure localisation has taken place as well as assisting in the development of suitable waste management interventions and possible development of the WM24.

8.2.3 Sense of community

The effect of a “sense of community” has been discussed as a motivator for pro environmental behaviour change in the behaviour chance arena (Jackson, 2005) and a few select studies have alluded to the possibility of a sense of community’s role in waste management recycling schemes (Domina and Koch, 2002, Tabernero and Hernández, 2011, Mongkolnchaiarunya, 2005). However, to the Author’s knowledge no study has been carried out specifically addressing the role played by a “sense of community” in waste management. This study suggests that a “sense of community” is an area of interest for future studies and is required to fill a gap in the current body of waste management literature. For an academic reference on the definition of a sense of community and how to proceed in quantifying it see McMillan and Chavis (1986).

8.2.4 Long-Term Implications of Interventions

In chapter 2.4.8 on page 47, it was established that there was an absence of research into the long-term implications of interventions such as feedback, commitment, goals and prompting and reminder interventions. These interventions have been extensively investigated in the literature and have demonstrated positive outcomes in the short term and are usually relatively cheap and straight forward to execute. This study recommends that the longer-term implications of

such interventions require further investigation and would provide a useful indication of the interventions effectiveness at improving the overall success of waste management recycling schemes.

8.2.5 Foreign involvement

This investigation has suggested that foreign involvement might significantly influence new and existing waste management recycling schemes. The Author found no documentation on the effects of involving foreign stakeholders with respect to pro-environmental behaviour change or waste management programmes. This study suspects that in China and possibly in the wider Asian region where foreign presence can be associated with status and authority, foreign involvement might influence the outcomes of such programmes. It is therefore offered as an area for further investigation.

8.2.6 Multiple WM24 Determinant Focused Intervention

Finally based on the shortcomings of the diary gap identification approach used in this study, a more holistic methodology could be used which aims to develop an intervention capable of addressing the majority of the WM24 determinants thus mitigating the possibility of encountering the errors faced by the current study.

This investigation has presented the WM24 as a preliminary framework, which has been used in China to help improve a food waste recycling scheme. Future waste management investigations are encouraged to use the WM24 in different environments and contexts to improve waste management situations and to develop the WM24 further.

8.3 Recommendations

The following recommendations are offered as a result of this investigation.

1. Clearer definitions for recycling determinants are recommended to reduce ambiguity and to increase determinant transferability
2. Extra care should be exercised when carrying out research in foreign contexts due to communication and cultural barriers
3. Folz and Hazlett (1991) suggest citizen involvement in the planning stages of a programme along with local meetings and tailored information could help increase environmental citizenship and personal responsibility towards

recycling. This study supports this suggestion and recommends a more bottom up community involved approach.

4. On the basis of this study doorstepping can be recommended for future similar investigations in China. The weekend is suggested as a preferable time to conduct doorstepping to increase the contact rate.
5. Similar investigations evaluating recycling determinants addressed would benefit from the execution of in-depth interviews.
6. The area of waste management and recycling is of great importance to the future of China's sustainable waste management goals. The execution of future research that can contribute to these goals is recommended.

9 Appendices

Appendix 1. Recently Published Articles on Waste Management in China

Table 27: Published articles on waste management in China (2008-2014)

Overview / Current WM Practices in China	Relating to Landfill	Relating to Incineration	Recycling and source separation	WM planning and improvement	Other
(Wang and Geng, 2012) (Wang and Wang, 2013) (Xue et al., 2011) (Zhang et al., 2010) (Chen et al., 2010) (Duan et al., 2008) (Edmonds, 2008) (Ma et al., 2014) (Minghua et al., 2009) (Shekdar, 2009)	(Xiaoli et al., 2010) (Xu et al., 2014a) (Zhao et al., 2011) (Bogner et al., 2008) (Duan et al., 2014) (Guan et al., 2014) (Li et al., 2014)	(Zhao et al., 2011) (Bogner et al., 2008) (Cheng and Hu, 2010)	(Zhang et al., 2012) (Zhuang et al., 2008) (An et al., 2014) (Tai et al., 2011)	(Xu et al., 2013) (Xu et al., 2014b) (Geng, 2012) (Chen Liu and Wu, 2011) (Ren and Hu, 2014)	(Tang et al., 2011) (Niu et al., 2013) (Zhang et al., 2008)

Appendix 2. Recycling Determinant Categories

Recycling Determinant Category 1 - Structural / Technical

Table 28: Recycling Determinant Category 1 - Structural / Technical

	Recycling Determinant - Structural / Technical	Reference
Situational Variables		Jenkins et al. (2003); Domina and Koch (2002); Sidique et al. (2010); Yang and Innes (2007); Schultz et al. (1995); Suttibak and Nitivattananon (2008); Noehammer and Byer (1997); Linderhof et al. (2001); Timlett and Williams (2011)
	Service - Accepted / collected materials	Thomas (2001); Woodard et al. (2006); De Young (1990); ATEA (2006); Jenkins et al. (2003); Martin et al. (2006); Domina and Koch (2002); Harder et al. (2006); Timlett and Williams (2011)
	Service - Recycling disposal method (Segregated or comingled collection)	WYG (2012); Pocock et al. (2008); Noehammer and Byer (1997); Oskamp et al. (1996); Williams and Cole (2013); Carlson (2001)
	Service - Collection Frequency	Tucker et al. (2001); Thomas (2001); Noehammer and Byer (1997); Williams and Cole (2013); Pocock et al. (2008); Chao (2008); Martin et al. (2006); Sharholy et al. (2008); Timlett and Williams (2011); Wilson and Williams (2007)
	Storage space	Carey et al. (2005); WasteWatch (2006); Corral-Verdugo (2003); Hansmann et al. (2006); Timlett and Williams (2011); Martin et al. (2006); Domina and Koch (2002); Davies et al. (2002); Refsgaard and Magnussen (2009); Hornik et al. (1995); Strange (2010); Bernstad et al. (2013); Cox (2004)

	Recycling Determinant - Structural / Technical	Reference
Situational Variables	**Sorting time / Time availability**	Matsumoto (2011); Sidique et al. (2010); Martin et al. (2006); Tonglet et al. (2004a); Kinnaman and Fullerton (2000); Refsgaard and Magnussen (2009); Timlett and Williams (2008); Timlett and Williams (2011); Hornik et al. (1995)
	Free waste receptacle / Type of receptacle	Suttibak and Nitivattananon (2008); Chao (2008); Noehammer and Byer (1997); ; Folz and Hazlett (1991); Burn (1991); Refsgaard and Magnussen (2009); Thomas (2001); Timlett and Williams (2011); Martin et al. (2006)
	Convenience / Required effort	Barr (2007); Suttibak and Nitivattananon (2008); Mosler et al. (2006); Refsgaard and Magnussen (2009); Tonglet et al. (2004a); Martin et al. (2006); Timlett and Williams (2011); Hornik et al. (1995); Strange (2010); Perrin and Barton (2001); Folz and Hazlett (1991); Burn (1991); Barr et al. (2003); Cox (2004)
	Information / Education / Knowledge	Kaplowitz et al. (2009); De Young (1990); Burn and Oskamp (1986); Carlson (2001); Chan (1998); WasteWatch (2006); Timlett and Williams (2008); Iyer and Kashyap (2007)
	Method of communication (including research into the block leader approach, study tours and doorstepping)	**Block leader** – Burn (1991); Hopper and Nielsen (1991); Carlson (2001); Folz and Hazlett (1991) **Doorstepping** – Brook Lyndhurst (2007); Cotterill et al. (2009); Timlett and Williams (2008); WasteWatch (2006); Carmel Carey (2005); Cotterill et al. (2009); Sharp et al. (2010); Read (1999) **Study Tours –** Suttibak and Nitivattananon

Recycling Determinant - Structural / Technical	**Reference**
	(2008); Zhuang et al. (2008); Mongkolnchaiarunya (2005)
Localisation of the programme and community involvement	Suttibak and Nitivattananon (2008); Chao (2008); Zhuang et al. (2008); Folz and Hazlett (1991); Maria Muller (2001)
Number of operatives	Mongkolnchaiarunya (2005); Suttibak and Nitivattananon (2008); Refsgaard and Magnussen (2009)

Recycling Determinant Category 2 - Social / Psychological

Table 29: Recycling Determinant Category 2 - Social / Psychological

Recycling Determinant - Social / Psychological	**Reference**
Perceptions / Beliefs - management competence, awareness, waste, waste sorting, environmental problems, convenience	Suttibak and Nitivattananon (2008); Refsgaard and Magnussen (2009); Barr (2007); Tang et al. (2011); Hornik et al. (1995); Williams and Kelly (2003); Tonglet et al. (2004a); Cox (2004)
Attitudes - towards recycling / environment, waste management service provider, local government, includes work using the New Environmental Paradigm (NEP)	Chan (1998); Mongkolnchaiarunya (2005); Schultz et al. (1995); Hopper and Nielsen (1991); Barr (2007); Tang et al. (2011); Hornik et al. (1995); Carlson (2001); Chung and Poon (2001); Schultz and Oskamp (1996)
Norms - Personal norms, social norms and subjective norms. Also includes research into the block leader approach	Chao (2008); Chan (1998); Mongkolnchaiarunya (2005); Hopper and Nielsen (1991); Refsgaard and Magnussen (2009); Barr (2007); Tang et al. (2011); Sidique et al. (2010); Schultz et al. (1995); Bratt (1999) Block leader references - Burn (1991); Hopper and Nielsen (1991); Carlson (2001); Folz and Hazlett (1991)
Belief in one's ability - locus of control, responsibility, response-efficacy which is a belief that the individual can make a difference	Schultz et al. (1995); Refsgaard and Magnussen (2009); Hornik et al. (1995)
Self-efficacy - belief about self-capability or perceived behavioural control	Chan (1998); Barr (2007); Tang et al. (2011); Cox et al. (2010)
Belief / Perceptions of recycling consequences	Barr (2007); Tonglet et al. (2004a); Tang et al. (2011); Ebreo and Vining (2001); Bratt

Recycling Determinant - Social / Psychological	**Reference**
	(1999); Vining and Ebreo (1992); Hansmann et al. (2006); Lindsay and Strathman (1997); Joireman et al. (2001); Andersson and von Borgstede (2010); Bernstad et al. (2013); Tang et al. (2011)
Attachment to or concern for the community	Mongkolnchaiarunya (2005); Tonglet et al. (2004a); Barr (2007); Tang et al. (2011); Shaw and Maynard (2008)
Feedback / Commitment / Goals / Prompting and reminders	Kim et al. (2005); Carlson (2001); Wang and Katzev (1990); Timlett and Williams (2008); Perrin and Barton (2001); Bryce et al. (1997); Folz and Hazlett (1991); Schultz et al. (1995); Burn (1991)
Habit	Schultz et al. (1995); Refsgaard and Magnussen (2009); Barr (2007); Cox et al. (2010); Cotterill et al. (2009)
Previous experience	Tonglet et al. (2004b); Boldero (1995); Cheung et al. (1999); Terry et al. (1999) cited in Tonglet et al. (2004a)

Recycling Determinant Category 3 – Institutional - Stakeholder involvement and cooperation

Table 30: Recycling Determinant Category 3 – Institutional - Stakeholder involvement and cooperation

Recycling Determinant – Institutional - Stakeholder involvement and cooperation	**Reference**
NGO involvement	Suttibak and Nitivattananon (2008); Joseph (2006); Sharholy et al. (2008); Tukahirwa et al. (2013); Zurbrügg et al. (2012)
Private sector cooperation	Suttibak and Nitivattananon (2008)
Local government	Joseph (2006); Heidrich et al. (2009)
Community based partners	Colon and Fawcett (2006); Brook Lyndhurst (2007); Zhuang et al. (2008); Heidrich et al. (2009)
International cooperation	Suttibak and Nitivattananon (2008)

Table 31 Recycling Determinant Category 3 – Institutional – Policies, rules and legislation

Recycling Determinant – Institutional – policies, rules and legislation	**Reference**
Mandatory recycling participation	Folz and Hazlett (1991); Noehammer and Byer (1997); Yang and Innes (2007); Martin et al. (2006); Jenkins et al. (2003); van den Bergh (2008); Shaw and Maynard (2008); Matsumoto (2011)
Unit Pricing	Yang and Innes (2007); Chao (2008); Jenkins et al. (2003); Hong (1999); Kinnaman and Fullerton (2000); Linderhof et al. (2001); Scott (1999)

Recycling Determinant Category 4 – Economic / Financial

Table 32: Recycling Determinant Category 4 – Economic / Financial

Recycling Determinant – Economic / Financial	Reference
Rewards / financial incentives	Suttibak and Nitivattananon (2008); Harder and Woodard (2007); ATEA (2006); Shaw and Maynard (2008); Noehammer and Byer (1997); Timlett and Williams (2008); Mongkolnchaiarunya (2005); Iyer and Kashyap (2007)

Recycling Determinant Category 5 - Demographics

Table 33: Recycling Determinant Category 5 - Demographics

Recycling Determinant	Reference
Demographics	Wang et al. (2008); Schultz et al. (1995); Barr (2007); Mosler et al. (2006); Refsgaard and Magnussen (2009); Corral-Verdugo (2003); Thomas (2001); Matsumoto (2011); Hornik et al. (1995); Martin et al. (2006); Folz and Hazlett (1991); Belton et al. (1994); Chung and Poon (2001); Hansmann et al. (2006); Iyer and Kashyap (2007); Bolaane and Ali (2004)

Role of demographics in recycling schemes (Matsumoto, 2011)

Table 34: Role of demographics in recycling schemes (Matsumoto, 2011)

Demographic variables	Yes	Not necessarily
Gender: Are women more involved in recycling activities?	Schultz et al. (1995); Saphores et al. (2006); Ekere et al. (2009); Sidique et al. (2010)	Vining and Ebreo (1990); Gamba and Oskamp (1994); Werner and Makela (1998)

Income: Do high-income people engage in recycling more actively?	Vining and Ebreo (1990); Oskamp et al. (1991); Gamba and Oskamp (1994); Ekere et al. (2009); Sidique et al. (2010)	Derksen and Gartrell (1993); Scott (1999)
Education: Do well-educated people engage in recycling more actively?	Derksen and Gartrell (1993); Jakus et al. (1996); Owens et al. (2000); Saphores et al. (2006)	Vining and Ebreo (1990); Oskamp et al. (1991); Gamba and Oskamp (1994); Werner and Makela (1998); Meneses and Palacio (2005)
Age: Are elderly people cooperative with respect to waste reduction effort?	Vining and Ebreo (1990); Derksen and Gartrell (1993); Gamba and Oskamp (1994); Jakus et al. (1996); Margai (1997); Scott (1999); Meneses and Palacio (2005); Saphores et al. (2006)	Werner and Makela (1998)

Appendix 3. An Introduction to Pro-Environmental Behaviour Change (BC)

Pro-environmental behaviour refers to behaviour that "seeks to minimise the negative impact of one's actions on the natural and built world" (Kollmuss and Agyeman, 2002, 240). Pro-environmental behaviour and behavioural change has become increasingly important as policy makers and politicians consider sustainable consumption a key component in addressing issues of sustainability in society (Jackson, 2005, Tang et al., 2011). Within the behaviour change literature there are numerous theories and models that have attempted to explain behaviour and offer methods that can assist in influencing behaviour. However the area surrounding behaviour change is considered highly complex (Ajzen, 1991, Jackson, 2005, Kollmuss and Agyeman, 2002, Stern, 2000) and cannot be demonstrated through one model or diagram (Kollmuss and Agyeman, 2002). Some behaviour change theories are given below.

Vatn (2004) discusses the rationality of behaviour or Rational Choice model (Jackson, 2005). Vatn (2004) argues that individuals will choose the behaviour that will bring the greatest overall personal gains. However these decisions are inseparable from the social and 'institutional' context through which the decision is made. When a complicated decision arises Vatn (2004) comments that the individual will rely on what has been previously tested socially. This implies that the rational behaviour will be influenced according to the social and institutional context (Refsgaard and Magnussen, 2009). In order to understand behaviour and how to initiate behaviour change, the institutions, which govern the social norms, need to be considered (Vatn, 2004).

Jackson (2005) argues against the model of Rational Choice commenting that Rational Choice model is simplistic, and overlooks the fact that individuals use habit and routine when making decisions. Using routine or habit in decision making reduces the amount of cognitive effort required. There is also an element of emotional attachment to decisions. Therefore when trying to alter behaviour it becomes far harder when a habit, routine or emotional attachment need changing (Jackson, 2005). However the Rational Choice Model has often been favoured above other approaches for the design of new interventions for behaviour change (Jackson, 2005).

There are numerous existing models that try to explain why an individual will behave in certain ways and what is likely to influence behaviour change. Some models suggest that in order to successfully succeed in altering an individual's behaviour, exogenous factors such as incentives, norms and institutional constraints are paramount, whereas other models focus more on the endogenous (values, attitudes and intentions) (Jackson, 2005). In many cases it will be a combination of both that will constitute the most effective behavioural change model.

Stern (2000) reviewed a variety of models concerned with understanding environmentally significant behaviour and developed a number of new theories. His attitude-behaviour-context (ABC) theory is concerned with predicting and describing pro-environmental behaviour (Jackson, 2005) and his values-belief-norms (VBN) theory endeavours to evaluate whether the individual has a predisposition to pro-environmental behaviours (Stern, 2000). Furthermore Stern introduces a comprehensive behavioural model, which has been developed using his experience and the previous literature. Stern believes that to understand behaviour and to initiate pro-environmental behavioural change the following four variables must be considered.

- **Attitudinal:** Attitudes, motivations, values
- **Contextual:** Social expectations, government regulations and social policies, monetary incentives, physical limitations, advertising, constraints of technology and the built environment, broad influences of the social, economic and political context
- **Personal Capabilities:** Knowledge and skills required to execute the behaviour
- **Habits and Routine**

(Stern, 2000)

Cialdini et al. (1991) introduced their Normative Conduct theory in their paper, "A Focus Theory of Normative Conduct: a theoretical refinement and re-evaluation of the role of norms in human behaviour". Cialdini et al. (1991) discuss two types of norms: *Descriptive Norms,* and *Injunctive Norms.* Descriptive Norms refer to what is perceived to be the normal social behaviour by an individual. Such perceptions can subsequently influence behaviour, "If everyone is doing, thinking or believing it,

it must be a sensible thing to do or think or believe" (Cialdini et al., 1991, 1015). The *Injunctive Norms* refers to the behaviour that "ought" to be carried out and represents the "moral rules of the group" (Cialdini et al., 1991, 1015). Schultz et al. (2007) used Cialdini et al. (1991) Normative Conduct theory in an attempt to reduce energy consumption and promote energy conservation in a sample of householders in California, USA. The results from the study were in concurrence with the work of Cialdini et al. (1991).

When Schultz et al. (2007) provided residents with information containing only a descriptive norm (the average amount of energy consumed by households in the local area) the result was a decrease in energy consumption within the high energy-consuming households. Conversely the households already consuming below average quantities of energy increased their consumption patterns. The outcome of the intervention that provided a descriptive norm only was termed the "boomerang effect" due to the simultaneous occurrence of the positive and negative behavioural outcomes. However, when an injunctive message was included in the intervention (i.e. a message of approval or disapproval of the behaviour), the low consumers did not increase their consumption as before. The injunctive message acted as a buffer to the boomerang effect. The outcome of intervention using both the injunctive message as well as the descriptive message was a decrease in energy consumption within the above average energy consumers while a sustained, below average consumption within the below average consumers (Schultz et al., 2007).

Schultz et al. (2007) demonstrate the practical application of the behaviour change theory, however the success of such interventions will not necessarily work for changing other pro-environmental behaviours in other contexts. For normative information to act as an antecedent for pro-environmental behaviour the subject of the study is required to pay attention to the social norm in question (Cialdini et al., 1991). Theories such as Self-Monitoring theory see Snyder (1974) might prove useful in this context. If the sample population consists of high self-monitors, the theory suggests that the respondents will be more likely to respond to a normative intervention. Conversely populations of low self-monitors will be less likely to act upon normative interventions. Furthermore other studies have found that contradictory norms can co-exist in any one environment, the example highlighted by Cialdini et al. (1991) is the norm of getting involved and the norm of minding

one’s own business (Cialdini et al., 1991).

There are many more behavioural change theories none of which can guarantee behaviour change but can be considered when looking to develop interventions aimed at increasing pro-environmental behaviour (Michie et al., 2005).

Appendix 4. Food Waste Processing Plant – Putuo District Shanghai

The following information was gathered from a site visit made to the food waste processing plant servicing Ying Hua Yuan community by the Author. The typed field notes are given below:

1366 Caoyang Road, Putuo District, Shanghai
Tel: (021)58152648 / (021)58151104 Mob: 13391212869 / 13918851848
yufeng163@sina.com

Visit to the site took place 30th May 11am with The Author and three other Students from the Fudan University. The site is located adjacent to the Caoyang Road within a large open wholesale fruit market complex. The Manager of the site was friendly, very knowledgeable and willing to speak with us. The informal interview lasted approximately 20 minutes and at the end we were permitted to take a few photographs of the process and the finished compost product. We were also given an A4 sheet of information about the site and his business card, the information below has come from the information sheet and field notes.

Information about the facility

- This facility is producing compost from food waste
- The capacity of the facility is 100 to 120 tonnes per day
- Presently it process just 40 tonnes
- The processing cost is 190-200RMB (£19-£20) / 1 tonne
- The return of food waste to fertiliser is 20-30% (100 tonnes of food waste produces 20-30 tonnes of compost)
- The Process:
    - 1) The food waste is collected and transported to the station
    - 2) Then it is weighed
    - 3) Then it has to be sorted again to remove contaminants
    - 4) Then it is ground
    - 5) Then it's compressed to remove the water
    - 6) Then it's put into the bio-digester with chicken manure and wood chips to increase the volume (decrease density) and for better fermentation

    - 7) After 8 hours the material is bagged and left for 45 days to ferment on its own
    - 8) Product ready for use
- Currently the machine is running at under half capacity and the manager stated that they would like more food waste
- The fertiliser used to be sent to a large fruit farm (just south of shanghai) in Nanhui District.
- Now the fertilizer is sent to the Horticultural Science Institute
    - It's used to plant trees and park land on top of the Laogang landfill site
    - If the experiment is successful, they will help to use this fertilizer for the whole city in street greening and with the cooperation of Sanitation Bureau.
- The quality of the wet waste is not so good and often contaminated and therefore needs further sorting

Several organizations, including a Research Group from East Normal University, and other environmental protection institutions, have examined the fertilizer products and waste water it discharged, proving they are safe for the environment.

Appendix 5. Waste Data Recording Sheet

Researcher……..…..Date……..……..Time……..……..Community……..…….. Weather……..……..

Size of BIN		WEIGHT (KG)	VOLUME (cm from waste to top of bin)	Weight of empty bin (kg)	WASTE STATION NUMBER	NUMBER OF THE BIN	WASTE TYPE			NOTES / COMMENTS
120L	240L						WW	DW	MIXED	
120L	240L						WW	DW	MIXED	
120L	240L						WW	DW	MIXED	
120L	240L						WW	DW	MIXED	
120L	240L						WW	DW	MIXED	
120L	240L						WW	DW	MIXED	
120L	240L						WW	DW	MIXED	
120L	240L						WW	DW	MIXED	
120L	240L						WW	DW	MIXED	
120L	240L						WW	DW	MIXED	

Appendix 6. Risk Assessments

Waste Data Collection

University of Brighton

School of the Environment

No

ASSESSMENT OF RISK FORM FOR PROJECTS, OPERATIONS AND WORK AREAS

Activity being assessed:

WASTE DATA COLLECTION

Assessment undertaken (date)
Signature: Michéil Gordon
Date: 15 April 2013
Operative's Signature:
Assessment Review Date

Hazard	Who might be harmed?	Is the risk adequately controlled?	What further action is necessary to control the risk?
Look only for hazards which you could reasonably expect to result in significant harm under the conditions in your workplace. Use the following examples as a guide. Slipping/tripping hazards (eg poorly maintained floors or stairs) Fire (eg from flammable materials) Chemicals (eg battery Acid) Moving parts of machinery (eg blades) Work at height (eg from mezzanine floors) Ejection of material (eg from plastic moulding) Pressure systems (eg steam boilers) Vehicles (eg fork lift trucks) Electricity (poor wiring) Drilling (eg from premises) Fumes (eg welding) Manual handling Noise Poor lighting Low temperature	There is no need to list individuals by name - just think about groups of people doing similar work or who may be affected eg: Office staff Maintenance personnel Contractors People sharing your workplace Operators Cleaners Members of the public **Pay particular attention to:** Staff with disabilities Visitors They may be more vulnerable. Inexperienced staff Lone workers	Have you already taken precautions against the risks from the hazards you listed? For example, have you provided: Adequate information, instructions or training? Adequate systems and procedures? **Do the precautions:** Meet the standards set by a legal requirement? Represent good practice? Comply with a recognised industry standard? Reduce risk as far as reasonably practical? If so, then the risks are adequately controlled, but you need to indicate the precautions you have in place. You may refer to procedures, manuals, company rules etc. giving this information.	What more could you reasonably do for those risks which you found were not adequately controlled? You will need to give priority to those risks which affect large numbers of people and/or could result in serious harm. Apply the principles below when taking further action, if possible in the following order Remove the risk completely Try a less risky option Prevent access to the hazard (eg by guarding) Organise work to reduce exposure to the hazard Issue personal protective equipment Provide welfare facilities (eg washing facilities for removal of contamination and first-aid)
List hazards here:	**List groups of people who are especially at risk from the significant hazards which you have identified:**	**List existing controls here or note where the information may be found:**	**List the risks which are not adequately controlled and the action you will take where it is reasonably practicable to do more. You are entitled to take cost into account, unless the risk is high:**
1. Sharp objects in the bins 2. Working in the dark 3. Lifting heavy objects 4. Hazardous substances 5. Cold 6. Moving vehicles 7. Abuse from public 8. Our scales and equipment placed in the path of residents and vehicles	1. Researchers (especially inexperienced) 2. Cleaners 3. Residents	1. Safety equipment provided (Protective clothing: needle proof gloves, coats, masks) 2. Wash hands, arms and face using soap and antibacterial hand wash used after each session 3. Be aware lifting is optional 4. Information on weather and temperature known and to dress accordingly 5. Bright clothing 6. Visits are pre-arranges with the relevant authorities 7. Make sure equipment is not placed in thoroughfare	1. Schedule data collection on warmer / cooler days, keeping an eye on fellow researchers to make sure they are warm / cool enough. Plenty of hot / cold drinks 2. High visibility jackets 3. Have a letter of invitation in Chinese explaining our research work and demonstrating we have permission 4. Access to a phone number of a member of the housing association, Fudan office, cleaners in case a problem arises 5. Access to a mobile phone

Waste Compositional Analysis

University of Brighton

School of the Environment

No

ASSESSMENT OF RISK FORM FOR PROJECTS, OPERATIONS AND WORK AREAS

Activity being assessed:

Waste Compositional Analysis

Assessment undertaken (date)
Signature: Michael Gordon
Date: 15 April 2013
Operative's Signature:
Assessment Review Date

Hazard

Look only for hazards which you could reasonably expect to result in significant harm under the conditions in your workplace. Use the following examples as a guide.

- Slipping/tripping hazards (eg poorly maintained floors or stairs)
- Fire (eg from flammable materials)
- Chemicals (eg Battery Acid)
- Moving parts of machinery (eg blades)
- Work at height (eg from mezzanine floors)
- Ejection of material (eg from plastic moulding)
- Pressure systems (eg steam boilers)
- Vehicles (eg fork lift trucks)
- Electricity (poor wiring)
- Dusting (eg from grinding)
- Fumes (eg welding)
- Manual handling
- Noise
- Poor lighting
- Low temperatures

Who might be harmed?

There is no need to list individuals by name - just think about groups of people doing similar work or who may be affected eg:

- Office staff
- Maintenance personnel
- Contractors
- People sharing your workplace
- Operators
- Cleaners
- Members of the public

Pay particular attention to:

- Staff with disabilities
- Visitors
- Inexperienced staff
- Lone workers

They may be more vulnerable.

Is the risk adequately controlled?

Have you already taken precautions against the risks from the hazards you listed? For example, have you provided:

- Adequate information, instructions or training?
- Adequate systems and procedures?

Do the precautions:

- Meet the standards set by a legal requirement?
- Represent good practice?
- Comply with a recognised industry standard?
- Reduce risk as far as reasonably practical?

If so, then the risks are adequately controlled, but you need to indicate the precautions you have in place. You may refer to procedures, manuals, company rules etc. giving this information.

What further action is necessary to control the risk?

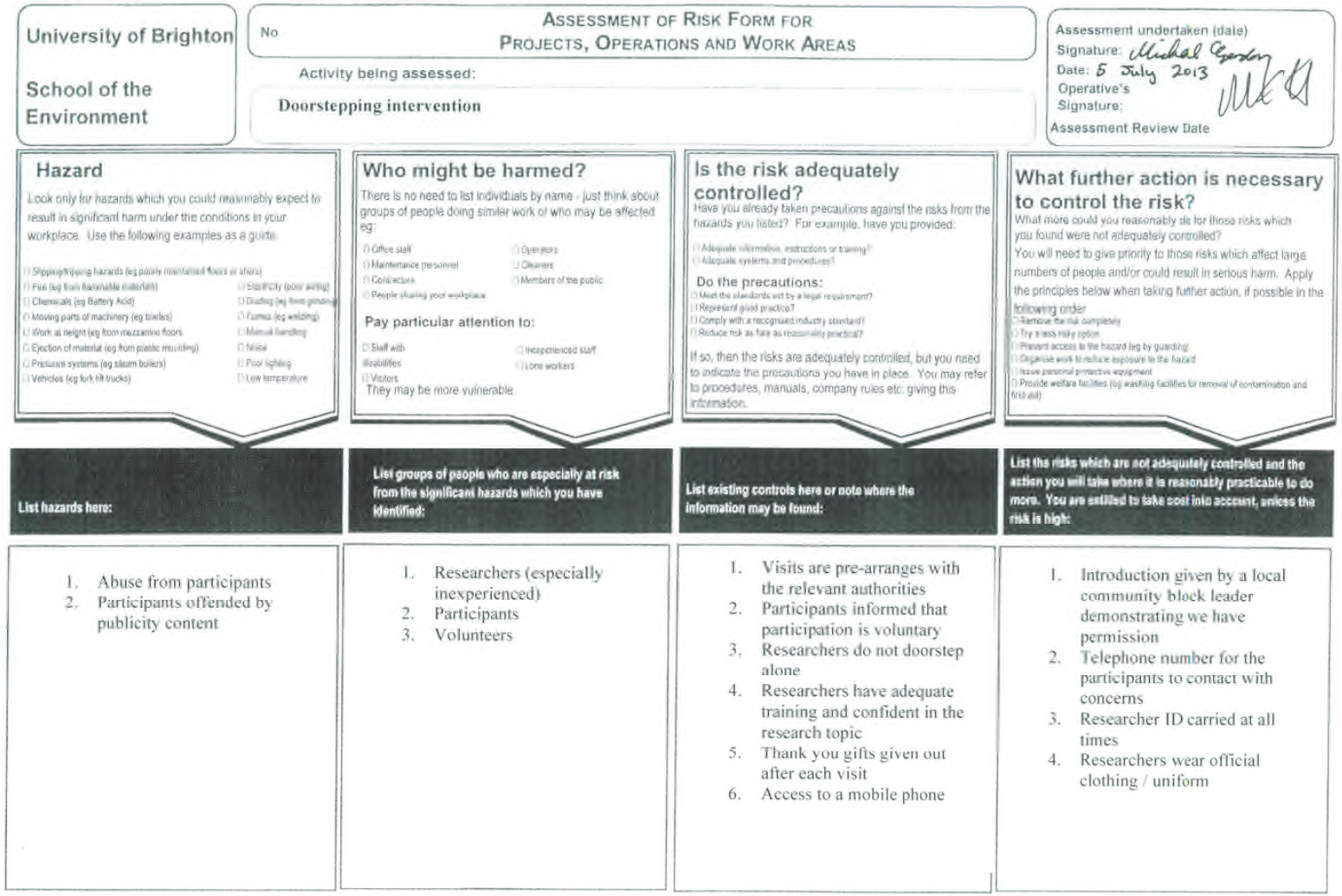
What more could you reasonably do for those risks which you found were not adequately controlled?

You will need to give priority to those risks which affect large numbers of people and/or could result in serious harm. Apply the principles below when taking further action, if possible in the following order

- Remove the risk completely
- Try a less risky option
- Prevent access to the hazard (eg by guarding)
- Organise work to reduce exposure to the hazard
- Issue personal protective equipment
- Provide welfare facilities (eg washing facilities for removal of contamination and first aid)

List hazards here:	List groups of people who are especially at risk from the significant hazards which you have identified:	List existing controls here or note where the information may be found:	List the risks which are not adequately controlled and the action you will take where it is reasonably practicable to do more. You are entitled to take cost into account, unless the risk is high:
1. Sharp objects in the bins 2. Lifting heavy objects 3. Hazardous substances 4. Cold 5. Moving vehicles 6. Abuse from public 7. Our scales, waste and equipment placed in the path of residents and vehicles	1. Researchers (especially inexperienced) 2. Cleaners 3. Residents	1. Safety equipment provided (Protective clothing: needle proof gloves, coats, masks) 2. Wash hands, arms and face using soap and antibacterial hand wash used after each session 3. Be aware lifting is optional 4. Information on weather and temperature known and to dress accordingly 5. Bright clothing 6. Visits are pre-arranges with the relevant authorities 7. Make sure equipment is not placed in thoroughfare	1. Schedule data collection on warmer / cooler days, keeping an eye on fellow researchers to make sure they are warm / cool enough. Plenty of hot / cold drinks 2. High visibility jackets 3. Have a letter of invitation in Chinese explaining our research work and demonstrating we have permission 4. Access to a phone number of a member of the housing association, Fudan office, cleaners in case a problem arises 5. Access to a mobile phone

Doorstepping



University of Brighton

School of the Environment

No

ASSESSMENT OF RISK FORM FOR PROJECTS, OPERATIONS AND WORK AREAS

Activity being assessed:

Doorstepping intervention

Assessment undertaken (date)
Signature: Michael Gordon
Date: 5 July 2013
Operative's Signature:
Assessment Review Date

Hazard

Look only for hazards which you could reasonably expect to result in significant harm under the conditions in your workplace. Use the following examples as a guide:

- Slipping/tripping hazards (eg poorly maintained floors or stairs)
- Fire (eg from flammable materials)
- Chemicals (eg Battery Acid)
- Moving parts of machinery (eg blades)
- Work at height (eg from mezzanine floors)
- Ejection of material (eg from plastic moulding)
- Pressure systems (eg steam boilers)
- Vehicles (eg fork lift trucks)
- Electricity (poor wiring)
- Dusting (eg from grinding)
- Fumes (eg welding)
- Manual handling
- Noise
- Poor lighting
- Low temperature

Who might be harmed?

There is no need to list individuals by name - just think about groups of people doing similar work or who may be affected eg:

- Office staff
- Maintenance personnel
- Contractors
- People sharing your workplace
- Operators
- Cleaners
- Members of the public

Pay particular attention to:

- Staff with disabilities
- Visitors

They may be more vulnerable.

- Inexperienced staff
- Lone workers

Is the risk adequately controlled?

Have you already taken precautions against the risks from the hazards you listed? For example, have you provided:

- Adequate information, instructions or training?
- Adequate systems and procedures?

Do the precautions:

- Meet the standards set by a legal requirement?
- Represent good practice?
- Comply with a recognised industry standard?
- Reduce risk as far as reasonably practical?

If so, then the risks are adequately controlled, but you need to indicate the precautions you have in place. You may refer to procedures, manuals, company rules etc. giving this information.

What further action is necessary to control the risk?

What more could you reasonably do for those risks which you found were not adequately controlled?

You will need to give priority to those risks which affect large numbers of people and/or could result in serious harm. Apply the principles below when taking further action, if possible in the following order:

- Remove the risk completely
- Try a less risky option
- Prevent access to the hazard (eg by guarding)
- Organise work to reduce exposure to the hazard
- Issue personal protective equipment
- Provide welfare facilities (eg washing facilities for removal of contamination and first aid)

List hazards here:	List groups of people who are especially at risk from the significant hazards which you have identified:	List existing controls here or note where the information may be found:	List the risks which are not adequately controlled and the action you will take where it is reasonably practicable to do more. You are entitled to take cost into account, unless the risk is high:
1. Abuse from participants 2. Participants offended by publicity content	1. Researchers (especially inexperienced) 2. Participants 3. Volunteers	1. Visits are pre-arranges with the relevant authorities 2. Participants informed that participation is voluntary 3. Researchers do not doorstep alone 4. Researchers have adequate training and confident in the research topic 5. Thank you gifts given out after each visit 6. Access to a mobile phone	1. Introduction given by a local community block leader demonstrating we have permission 2. Telephone number for the participants to contact with concerns 3. Researcher ID carried at all times 4. Researchers wear official clothing / uniform

Questionnaire Surveys

University of Brighton

School of the Environment

No

ASSESSMENT OF RISK FORM FOR PROJECTS, OPERATIONS AND WORK AREAS

Activity being assessed:

Questionnaire distribution to community residents

Assessment undertaken (date)
Signature: Micheil Gordon
Date: 1 July 2013
Operative's Signature:
Assessment Review Date

Hazard

Look only for hazards which you could reasonably expect to result in significant harm under the conditions in your workplace. Use the following examples as a guide.

- Slipping/tripping hazards (eg poorly maintained floors or stairs)
- Fire (eg from flammable materials)
- Chemicals (eg Battery Acid)
- Moving parts of machinery (eg blades)
- Work at height (eg from mezzanine floors
- Ejection of material (eg from plastic moulding)
- Pressure systems (eg steam boilers)
- Vehicles (eg fork lift trucks)
- Electricity (poor wiring)
- Dusting (eg from grinding)
- Fumes (eg welding)
- Manual handling
- Noise
- Poor lighting
- Low temperature

Who might be harmed?

There is no need to list individuals by name - just think about groups of people doing similar work or who may be affected eg:

- Office staff
- Maintenance personnel
- Contractors
- People sharing your workplace
- Operators
- Cleaners
- Members of the public

Pay particular attention to:

- Staff with disabilities
- Visitors

They may be more vulnerable.

- Inexperienced staff
- Lone workers

Is the risk adequately controlled?

Have you already taken precautions against the risks from the hazards you listed? For example, have you provided:

- Adequate information, instructions or training?
- Adequate systems and procedures?

Do the precautions:

- Meet the standards set by a legal requirement?
- Represent good practice?
- Comply with a recognised industry standard?
- Reduce risk as far as reasonably practical?

If so, then the risks are adequately controlled, but you need to indicate the precautions you have in place. You may refer to procedures, manuals, company rules etc. giving this information.

What further action is necessary to control the risk?

What more could you reasonably do for those risks which you found were not adequately controlled?

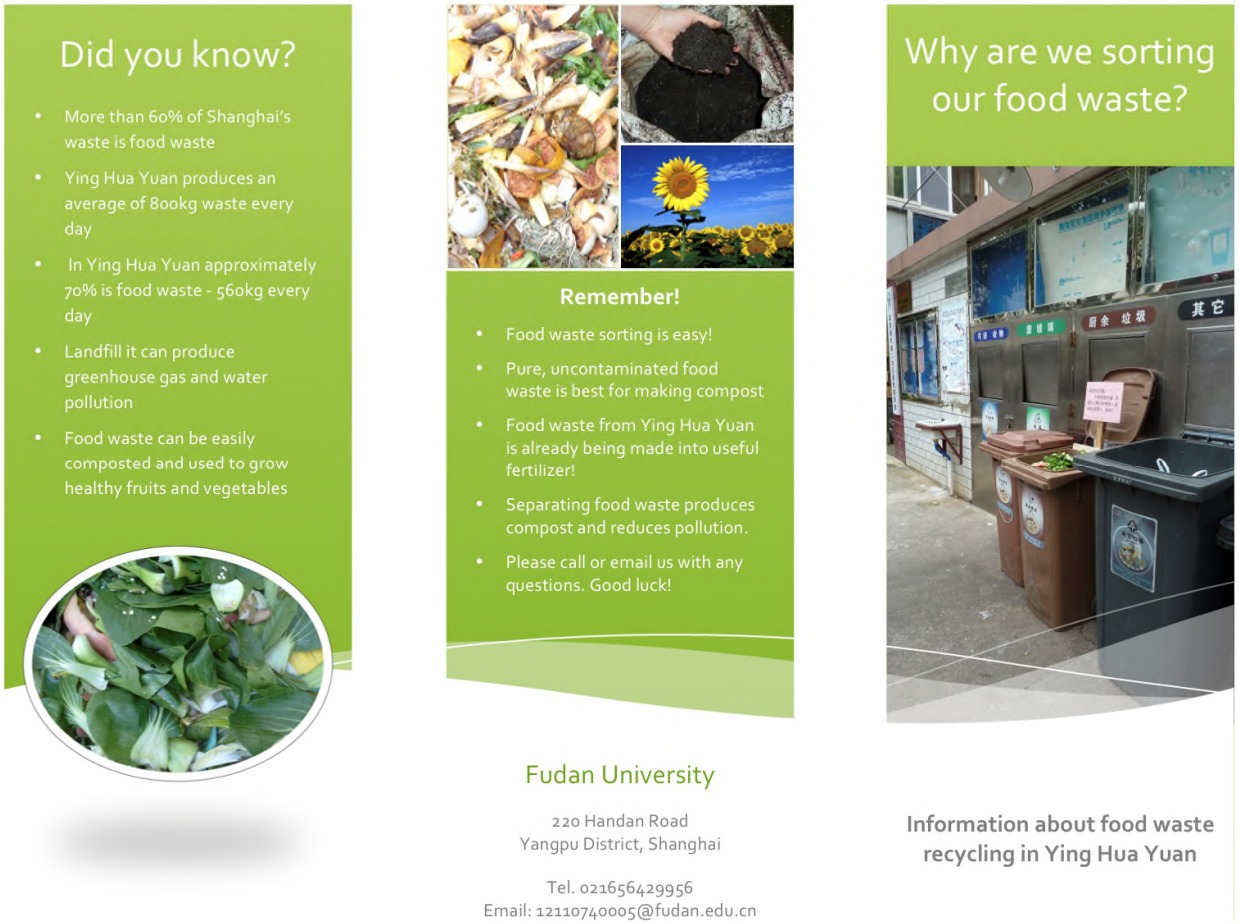
You will need to give priority to those risks which affect large numbers of people and/or could result in serious harm. Apply the principles below when taking further action, if possible in the following order

- Remove the risk completely
- Try a less risky option
- Prevent access to the hazard (eg by guarding)
- Organise work to reduce exposure to the hazard
- Issue personal protective equipment
- Provide welfare facilities (eg washing facilities or removal of contamination and first-aid)

List hazards here:	List groups of people who are especially at risk from the significant hazards which you have identified:	List existing controls here or note where the information may be found:	List the risks which are not adequately controlled and the action you will take where it is reasonably practicable to do more. You are entitled to take cost into account, unless the risk is high:
1. Abuse from participants 2. Participants offended by questionnaire content	1. Researchers (especially inexperienced) 2. Participants 3. Volunteers	1. Visits are pre-arranges with the relevant authorities 2. Participants informed that participation is voluntary 3. Researchers do not disseminate questionnaires alone 4. Researchers have adequate training and confident in the research topic 5. Thank you gifts offered to the first 100 participants 6. Access to a mobile phone	1. Questionnaires given to local community block leaders to disseminate where possible 2. Telephone number for the participants to contact with concerns 3. Researcher ID carried at all times 4. Researchers wear official clothing / uniform

Appendix 7. Leaflet distributed during the doorstepping

English



Original in Colour

What happens to Shanghai's waste?

In Shanghai we produce around 7 million tonnes of waste per year. Most of this waste goes to one of Shanghai's 7 landfill sites or dumps, about 17% is incinerated in one of Shanghai's 3 incineration plants and about 9% is composted. The picture on the right is a mixed waste landfill site.

Sorting our food waste has many benefits

What happens to food waste in Shanghai that is not sorted?

- It is disposed of alongside mixed waste
- It is buried in a landfill or incinerated
- In a landfill food waste decomposes and produces methane which is a gas that contributes to global warming and air pollution
- Food liquids in the landfill can also combine with other substances in the landfill site including hazardous material. This liquid can pollute the ground water
- Incinerating food waste is not useful, it uses more energy because it is so wet

What happens to food waste in Shanghai that is sorted?

- Sorted food waste from Ying Hua Yuan is taken to a local food waste processing facility on Caoyang Road
- In just 8 hours the food is processed into dark, rich and nutritious compost (see the picture on the back of this leaflet)
- The compost is bagged up and is stored for 45 days until it is mature
- The compost is then ready to be used
- The compost is used as a safe and chemical free fertilizer for fields, vegetable farms, fruit farms, and for Shanghai's many beautiful parks

Original in Colour

Chinese

Original in Colour

上海的垃圾都去哪儿了？

每年，全上海总共将产生约 700 万吨的垃圾。其中的大部分都将送到上海 7 大填埋场中被直接填埋，此外，约 17%将被送到市内 3 个垃圾焚烧厂里被焚烧，约 9%被用于堆肥。右图是一个混合垃圾填埋场的照片。

将湿垃圾分拣出来有很多好处

那些未分拣的湿垃圾将被如何处理呢？

- 它们会和其他垃圾一起混合处理。
- 它们会被填埋或者被焚烧。
- 在垃圾填埋场，湿垃圾分解后会产生甲烷，这是一种会造成温室效应（全球变暖）和空气污染的气体。
- 在垃圾填埋场，湿垃圾中的液体会和其他物质混合，包括有害物质。这些液体渗漏之后会污染地表水体。
- 焚烧湿垃圾并不是高效的方法，由于含水量太大，焚烧它将消耗更多的能源。

那些已经被分拣的湿垃圾将被如何处理呢？

- 樱花苑中已分类的湿垃圾被送往位于曹杨路上的一个湿垃圾处理站。
- 仅需 8 个小时，湿垃圾就可以变成黑色的富含营养的肥料（请看背面的彩图）。
- 这些肥料装袋后存放 45 天，直到完全熟化。
- 之后，肥料就可以被使用了。
- 这些肥料可作为一种安全、有机、无化学添加的肥料，广泛用于农田、蔬菜农场、水果种植园和市内众多风景秀丽的公园。

Original in Colour

Appendix 8. Pictorial Posters Used during the Doorstepping

Food Waste After Disposal

Original in Colour

Residual Waste After Disposal

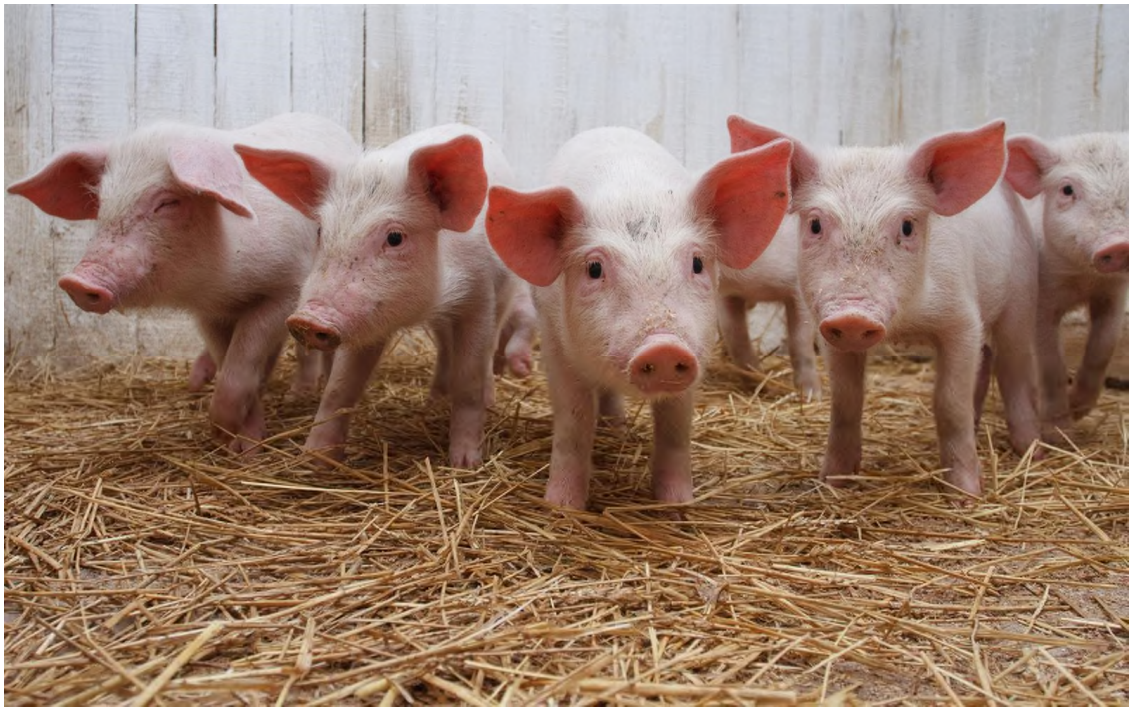
Original in Colour

Appendix 9. Choice of A6 Stickers offered during the Doorstepping

Sticker 1: Sunflower

Sticker 2: Fresh Fruit and Vegetables

Sticker 3: Piglets



The stickers 1, 2 and 3 were offered to the residents of Ying Hua Yuan during the doorstepping. The pictures were chosen to represent the positive outcomes of food waste recycling which was communicated to the residents. Compost from the food waste recycling can be used to fertilise fresh fruit and vegetables, flowers such as sunflowers or fed directly to pigs. Although the food waste from Ying Hua Yuan is currently being processed into compost other food waste recycling schemes in Shanghai are using the food waste as feed.

Appendix 10. Doorstepping Prompts for Doorsteppers

The following prompts were provided to all doorsteppers as guidance while carrying out the doorstepping.

- Shanghai is rolling out a new food waste recycling scheme and the one in this community began 2 months ago
- Separating waste into 5 categories of waste (be ready to announce if need be)
- The focus is food waste
- Sorting is easy
- Your community so far it is doing very well. Well done!
- BUT there is room for improvement
- USE POSTERS to illustrate the waste process after disposal
    - Fertiliser
    - Landfill / Incineration
- Fertiliser can be used to:
    - Produce compost
    - Feed Pigs
- SHOW STICKERS
- Let the resident choose one
- If we do well the waste will be reduced by x amount (Demonstrate using hand gestures to show the waste reducing).
- Show the resident the leaflet and briefly outline the information within
- Ask if the resident has any questions and direct them to the contact details given on the leaflet.
- Thank the resident for their time.

Appendix 11. Questionnaire Survey

English

June 2013

Ying Hua Yuan
Resident Questionnaire

*The first **100** residents who complete this questionnaire will receive a gift from Fudan University! Please fill out this questionnaire as accurately as possible and return to the Community Committee during working hours (8:30 – 16:30) by* ***Friday 5th July to receive a gift.***

Please note that all information in this questionnaire is anonymous and confidential and will be used by Fudan as part of their investigation into recycling in Shanghai and for student research projects. Thank you for your cooperation.

1. If you recycle your food waste at the moment what are the main reasons?

……

……

……

2. What happens to the waste when it leaves the community?

Dry waste ……
Not sure ☐

Wet waste ……
Not sure ☐

3. Does waste disposal have any effects on the environment?

Yes ☐ No ☐ Not sure ☐

If you answered YES what are they? …….

……

4. Approximate age? …… 5. Gender? M ☐ F ☐

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Chinese

2013 年 7 月

樱花苑居民问卷

前一百名完成问卷的居民将获得一份精美的复旦大学校名小礼品！

请您尽可能准确地填写这份问卷,完成后请递交至居委会办公室,截止日期是 7 月 18 号(星期五)。

需要特别说明的是：这份问卷完全是匿名保密的，其结果仅供复旦大学上海垃圾回收研究以及相关学生科研项目，非常感谢您的支持与帮助！

您的性别：……　　您的年龄：……

1. 如果您现在已经开始做垃圾分类了，那么促使您这么做的主要原因是什么呢？

……

……

2.您是否知道，当垃圾运出小区之后，被如何处理了？

其他垃圾 ……

不清楚 □

湿垃圾 ……

不清楚 □

3.您认为，现行的上海的垃圾处理方式（填埋或焚烧等）是否会对环境产生影响呢？

是 □　　否 □　　不清楚 □

如果您选择了“是”，请简单谈谈是哪些影响? ……

……

复旦大学
环境科学与工程系
邯郸路 220 号
65642995

Appendix 12. Summary of research activities and roles

Table 35: Summary of research activities and roles

Research Activity	Researchers and roles
Data collection methodology development	Led by Author with assistance from an academic supervisor
Waste quantity and composition data collection	Led by Author with support from a team of Masters and PhD students
Liaisons with the Community Committee, NGO, cleaners and other stakeholders	Carried out by Masters and PhD students
Meetings with the Community Committee and other stakeholders	Author present and involved in the meeting preparations but communications led by Masters and PhD students.
Questionnaire design	Led by Author with assistance from an academic supervisor
Questionnaire distribution	Led by Author with assistance from PhD students, the Community Committee and block leaders
Doorstepping training session	Led by Academic supervisor with materials and preparations supplied by Author
Leaflet and poster design and development	Author
Doorstepping	Led by Author and academic supervisor with assistance from Masters students, PhD students, Community Committee, block leaders, NGO and NGO volunteers
Translations	Masters and PhD students

Appendix 13. Minitab Statistics

9.1.1 Normal Probability Plots

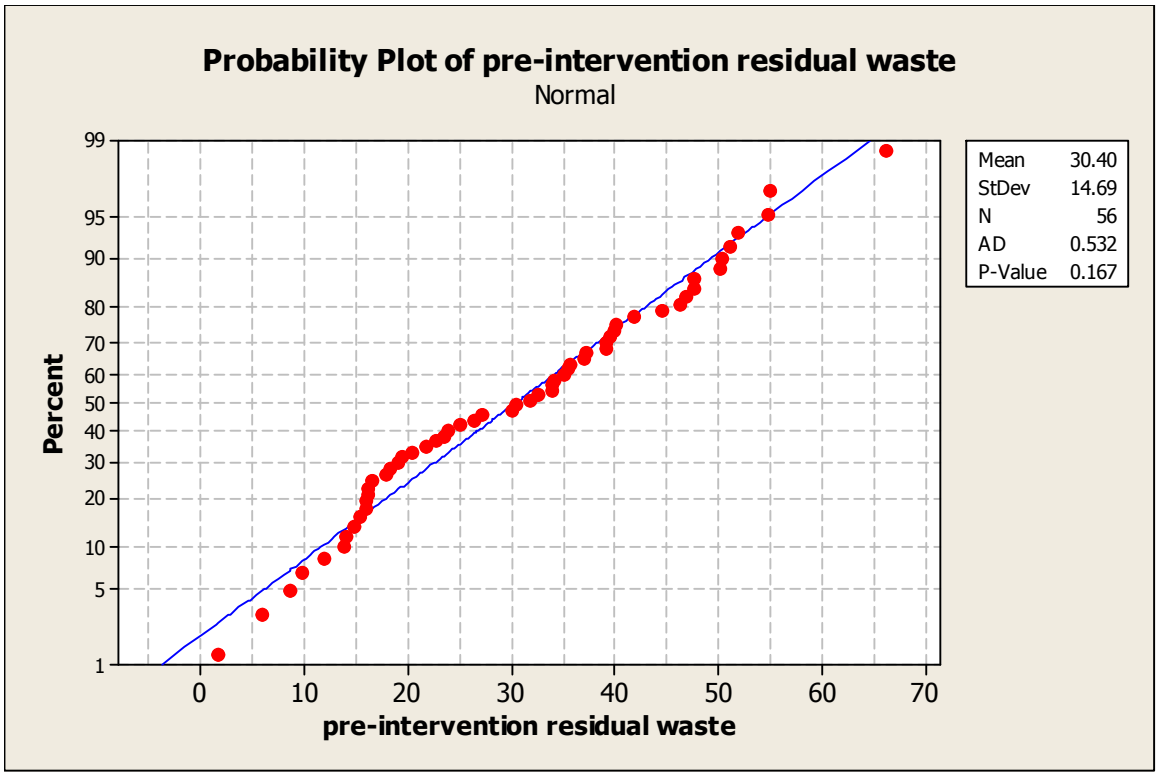

Figure 22: Probability plot for the pre-intervention residual waste data for the period 18th - 20th June

Above is the probability plot for the pre-intervention residual waste data for the period 18th - 20th June and includes the weight of the residual waste only from all three waste stations. Over the three days 56 readings were recorded from all waste stations. From the graph and p value it can be concluded that the data is normally distributed ($p > 0.05$).

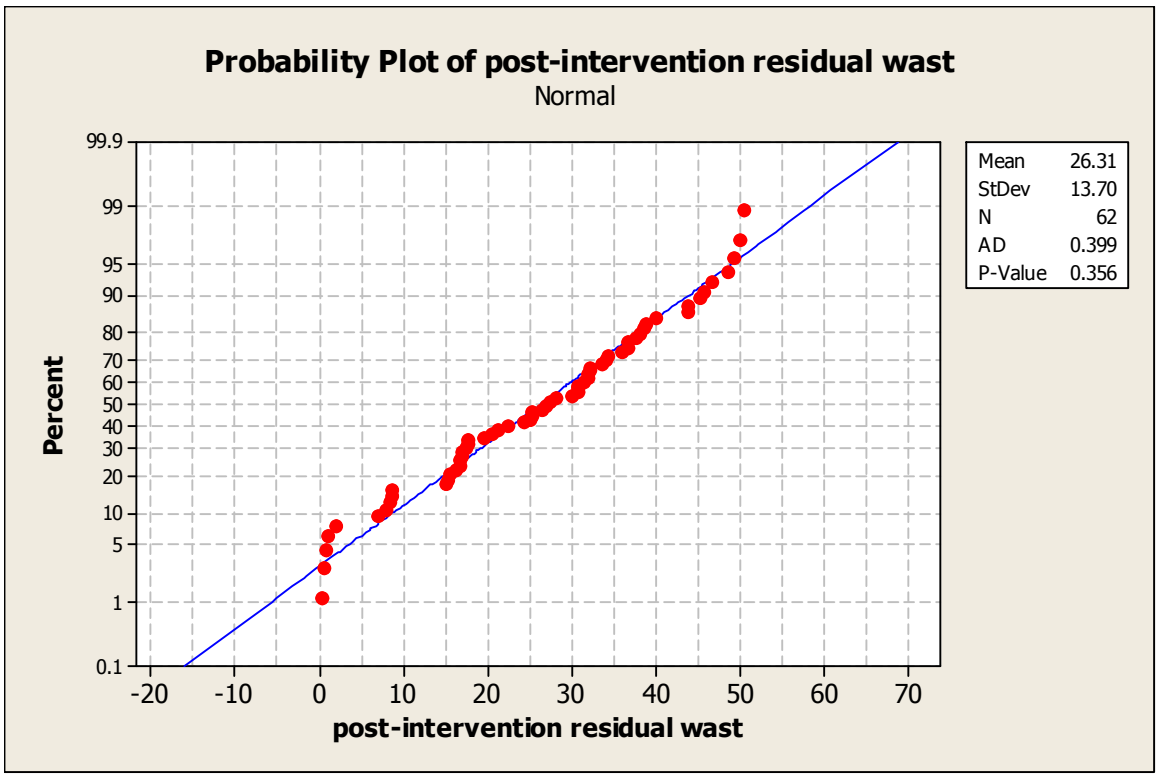

Figure 23: probability plot for the post-intervention residual waste data for the period 16th - 18th July

Above is the probability plot for the post-intervention residual waste data for the period 16th - 18th July and includes the weight of the residual waste only from all three waste stations. Over the three days 62 readings were recorded from all waste stations. From the graph and p value it can be concluded that the data is normally distributed ($p > 0.05$).

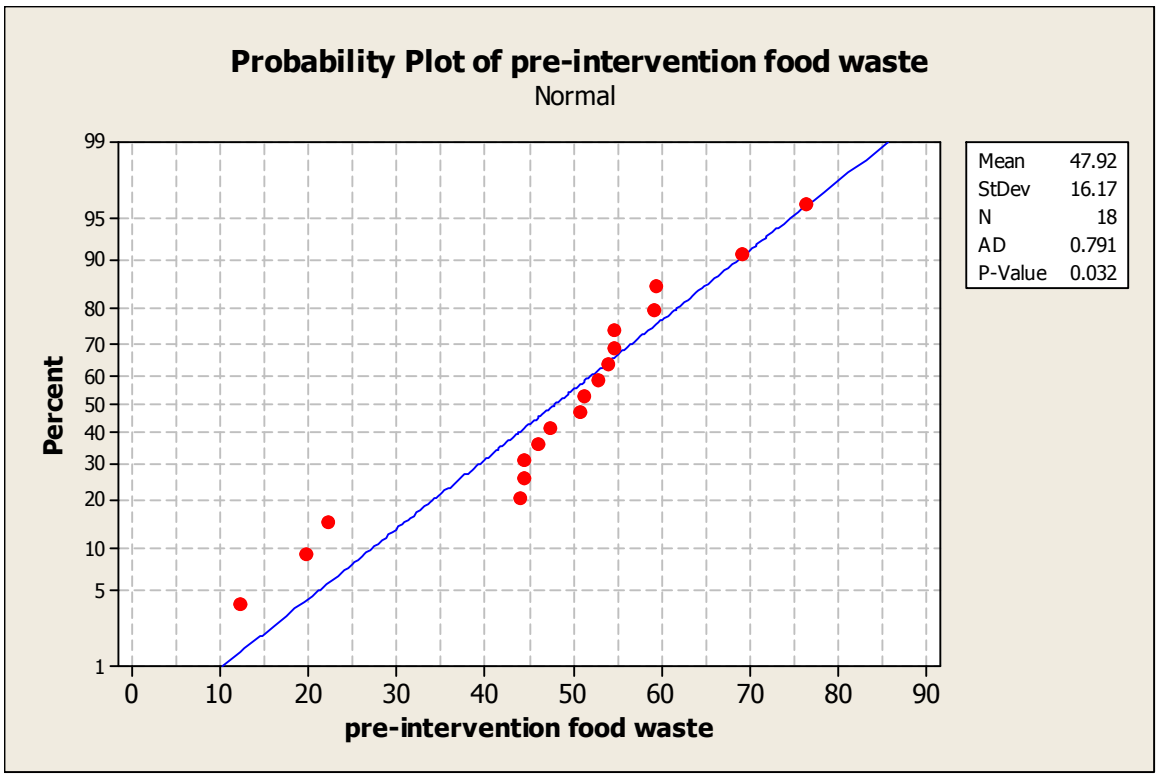

Figure 24: Probability plot for the pre-intervention food waste separated data for the period 18th - 20th June

Above is the probability plot for the pre-intervention food waste separated data for the period 18th - 20th June and includes the weight of the food waste data only from all three waste stations. Over the three days 18 readings were recorded from all waste stations. From the graph and p value it can be concluded that the data is not normally distributed ($p < 0.05$).

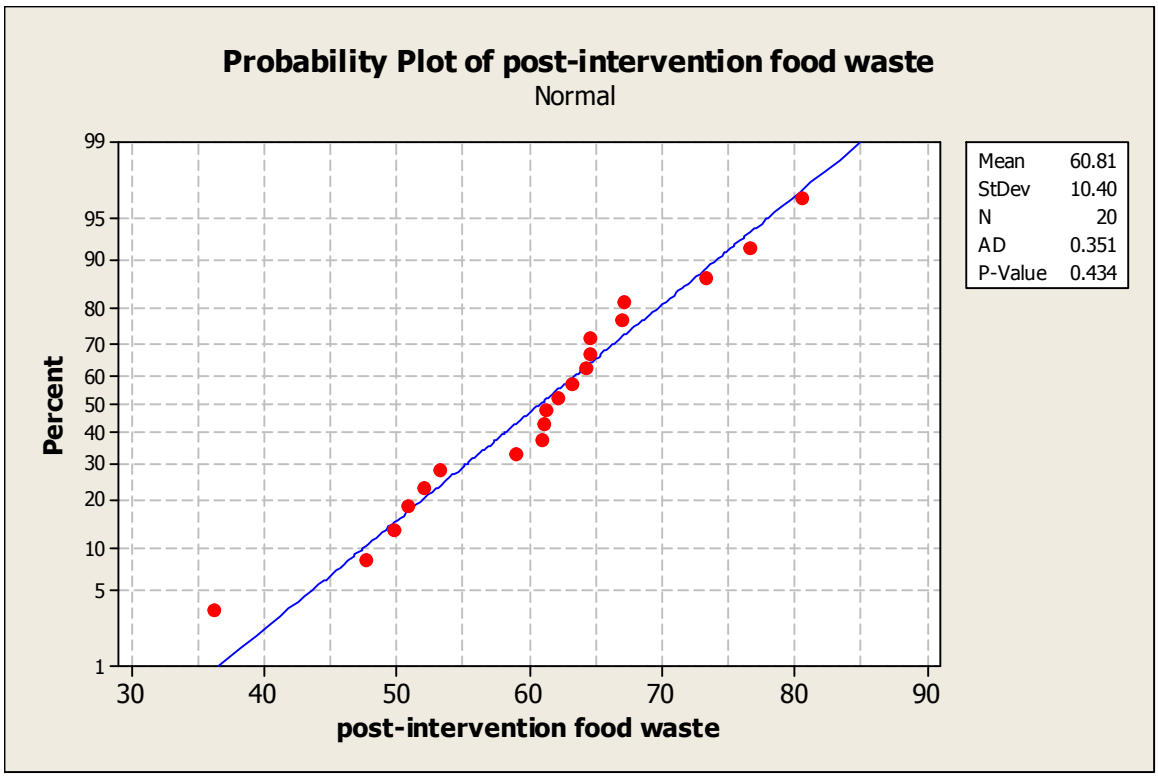

Figure 25: Probability plot for the post-intervention food waste data separated for the period 16th - 18th July

Above is the probability plot for the post-intervention food waste separated data for the period 16th - 18th July and includes the weight of the food waste data only from all three waste stations. Over the three days 20 readings were recorded from all waste stations. From the graph and p value it can be concluded that the data is normally distributed ($p > 0.05$).

9.1.2 Statistics

Table 36: Descriptive statistics to determine which statistical test to use

Data set	Data collection period	Mean	Standard Deviation	N (number of data points)	P-Value	Normally distributed?	Statistical test to use
Residual waste	18-20 June	30.40	14.69	56	0.167	Yes	Two sample T- test
	16-18 July	26.31	13.70	62	0.356	Yes	
Food waste	18-20 June	47.92	16.17	18	0.032	No	Mann-Whitney U-test
	16-18 July	60.81	10.40	20	0.434	Yes	

Minitab output: Two Sample T-Test – Residual Waste Data

Two-sample T for pre-intervention residual waste vs post-intervention residual waste

	N	Mean	StDev	SE Mean
pre-intervention residua	56	30.4	14.7	2.0
post-intervention residu	62	26.3	13.7	1.7

Difference = mu (pre-intervention residual waste) - mu (post-intervention residual waste)

Estimate for difference: 4.09

95% CI for difference: (-1.11, 9.28)

T-Test of difference = 0 (vs not =): T-Value = 1.56 P-Value = 0.122 DF = 112

Minitab output: Mann-Whitney U-Test – Food Separated Waste Data

---

	N	Median
pre-intervention food waste	18	51.06
post-intervention food waste	20	61.71

Point estimate for ETA1-ETA2 is -10.76

95.2 Percent CI for ETA1-ETA2 is (-18.79,-4.44)

W = 255.0

Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0052

---

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