A study of best practice principles on which to base interventions used to improve municipal material recycling rates achieved by English local authorities

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Abstract

Municipal waste management in England has changed beyond recognition in the last 30 years. In response to legislative requirements to reduce the amount of waste going to landfill and to recycle material, English Local Authorities (LA) have moved from a predominantly linear waste management model that used landfill for disposal, to a sophisticated network of treatment facilities that separate and prepare materials for recycling, closing the loop on material markets and feeding into the circular economy. Recently, however, England's recycling performance has stagnated, even declining in some areas, and with a backdrop of budget cuts, increasing targets to divert waste from landfill and to increase recycling performance, LAs face a huge task to meet these demands. Presently, it is estimated that 26% of material that is placed in the residual waste bin is recyclable, so there is material in the system to further enhance recycling levels, the question is whether LAs will be able to nudge closer to these targets within the current system. The variable performance between LAs suggests that there is capacity to do this, with a 44% difference in recycling rates between the best and poorest performing LAs in England. This study aimed to understand what is responsible for this difference and to extract best practice on which to base intervention tools designed to enhance public participation in recycling to achieve the more consistent level of material recovery across LAs required to meet future national targets.

Using geo-socio-economic characteristics English LAs were placed into 6 groups of commonality intended to remove the influence of factors outside of the LA's control, such as the demography and rurality of an area. The LAs were then ranked in order of recycling performance, based on both the quantity and quality of material collected. This demonstrated a range of LA performance in each group, from which examples of the better and poorer performing LAs were chosen for in-depth analysis; exploring the core attributes and identifying the best practices that explain the difference in performance.

The findings confirm the known influence of geo-socio-economic factors on performance; recycling positively related to increasing affluence and rurality. However, inter-group comparisons revealed that education appears to be as important as infrastructure and service delivery in influencing recycling performance and has yet generally suffered from dis-investment as a result of austerity measures. In cases where LAs managed to retain budget commitments for providing continual education, these were rewarded by an increase in the income received from increased recyclate tonnages and from the substantial savings made from reducing contaminated loads being rejected and sent for disposal. These findings imply that education budgets need to be increased and protected if English LAs are to maximise the recycling performance possible from existing infrastructure; thereby optimising environmental and economic returns and standing a chance of meeting future recycling targets.

The key outcomes of the study include.

- Education, especially face to face communication, appears to be as important as infrastructure and service delivery in influencing recycling performance.
- Increasing and protecting education budgets is necessary for LAs to maximise their recycling performance using current infrastructure.

- Confirmation of the influence GSE factors have on recycling performance and the positive relationship between quantity and quality of recyclate.
- Unintended consequences from policy changes such as material light weighting are having a negative impact on LAs.
- Lack of downstream infrastructure could inhibit standardised waste collection schemes throughout England.

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“There is no such thing as ‘away’. When we throw anything away it must go somewhere.”

Annie Leonard
Executive Director
Greenpeace

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List of Abbreviations and Acronyms

AD	Anaerobic Digestion
BMW	Biodegradable Municipal Waste
CHP	Combined Heat and Power
DEFRA	Department for Environment, Food & Rural Affairs
EfW	Energy from Waste
GSE	Geo-Socio-Economic
GMCA	Greater Manchester Combined Authority
HDPE	High Density Polyethylene
HMO	Houses of Multiple Occupation
HWRC	Household Waste Recycling Centres
IMD	Index of Multiple Deprivation
IVC	In-Vessel Composting
LA	Local Authority
LFT	Lateral Flow Test
MBT	Mechanical Biological Treatment
MRF	Material Recovery Facility
MSW	Municipal Solid Waste
MTMM	Multitrait-Multimethod Matrix
NHS	National Health Service
ONS	Office for National Statistics
PERN	Packaging Export Recovery Note
PET	Polyethylene Terephthalate
PFI	Private Finance Initiative
PPE	Personal Protective Equipment
PRN	Packaging Recovery Note
Qual	Qualitative
Quan	Quantitative
QR	Quality Rate
RDF	Refuse Derived Fuel
RR	Recycling Rate
SRF	Solid Recovered Fuel
TLS	Transfer Loading Station
TPB	Theory of Planned Behaviour
TRF	Thermal Recovery Facility
UA	Unitary Authority
UK	United Kingdom
UNESCO	United Nations Education, Scientific and Cultural Organization
USA	United States of America
WCA	Waste Collection Authority
WRAP	Waste and Resources Action Programme
WDA	Waste Disposal Authority
WEEE	Waste from Electrical and Electronic Equipment

1. Introduction

The World Health Organisation recognises that ending poverty goes hand in hand with improving public health, and through the Sustainable Development Goals describe waste collection and management as an essential public service (United Nations, 2021). From the moment we are born to the day we die we produce waste; clothing, packaging, food, and items made to educate, transport, and amuse us all end their life somewhere. Increasing consumption and concerns over resource depletion have seen the Circular Economy at the heart of recent policy which advocates a closed loop on material use in product and process design, making recycling a vital part of our future (Stahel, 2016).

In 2020 English households produced 22.6 million tonnes of waste (DEFRA, 2022). Until the 1990s, the majority of municipal waste was sent to landfill in England, but due to adverse environmental impacts from harmful gases and leachate, the need to divert waste from landfill and to use alternative waste disposal methods became critical (El Fadel et al., 1997). Waste policies such as the Landfill Tax (1996) and the EU Landfill Directive (1999) were introduced to encourage landfill diversion, and the Waste Hierarchy was reintroduced through the Waste Framework Directive (2008) that prioritises waste management options based on their impact on the environment, emphasising material reduction, reuse and recycling (DEFRA, 2011b). The amount of household waste going to landfill has reduced from 79% in 2000/01 to 7.8% in 2020/21 (DEFRA, 2012; DEFRA, 2022).

In 2003 England saw significant changes to its waste infrastructure with the introduction of the Household Waste Recycling Act. This Act required Local Authorities to collect at least two further materials for recycling by 2010. The Waste Framework Directive (2008) was transposed into UK regulation in 2011 resulting in the Waste Regulations (2011) (amended 2012) which then required four materials to be collected for recycling direct from residential properties by 2015. Local Authorities (LA) were expected to facilitate this new kerbside service, and residents were expected to separate their own waste materials in a series of containers (DEFRA, 2011a). Residential properties across England were provided with a separate bin (or bins) for their recyclate, a bin for their garden waste, a food waste bin (if a food waste collection was offered) and one for residual waste (often

referred to as black-bag waste). A network of waste management facilities were built to further separate and prepare the material for downstream reprocessing technologies, attracting significant interest from the fast growing international markets (Gregson and Foreman, 2020). This sophisticated network has resulted in 44% of municipal waste being collected for recycling in 2020/21, re-introducing the material back into the economy, with the majority of residual, or non-recycled waste sent to incinerators to produce energy (DEFRA, 2021b).

The pressure on English LAs to divert waste from landfill and increase material recycling is still growing. The Circular Economy package together with the Waste Framework Directive set material recycling targets of 50% by 2020, 55% by 2025, and 65%[1] by 2035 (European Commission, 2016). England fell short of meeting the 2020 target by 7% and has seen an overall reduction in material recycling from households by 1.5% from the previous year (DEFRA, 2021b). This immediate pressure, combined with government austerity measures and continuing stress on service delivery, means UK LAs face a monumental task to meet these future targets.

While overall England did not achieve the 2020 target, there is considerable variation between LAs. In 2020/21 the recycling performance ranged from 16% to 64%, indicating that some LAs have already met and exceeded the 2025 target. This demonstrates that the target is achievable, and those that are performing significantly below average may have room for improvement using the current infrastructure (DEFRA, 2021b). Indeed, DEFRA has estimated that 26% of household residual waste is recyclable (DEFRA, 2018b). That equates to 3.28 million tonnes of material in 2020/21 that could be recycled but is being landfilled or incinerated for energy (DEFRA, 2021b). Further to this, material that is presented for recycling may be contaminated with non-target material resulting in it being rejected by the recycling facilities with high disposal costs, for example one English LA reportedly pays £1 million annually for their rejected material (HampshireCC, 2020). These issues indicate that the existing system is not being used to its optimum and that by increasing recycling participation levels and increasing the quality of the recyclate, LAs may

[1] The difference between landfill divergence and material recycling can be attributed to thermal recovery, anaerobic digestion, incineration, gasification and pyrolysis.

be able to nudge closer to the material recycling targets using effective interventions whilst minimising cost.

This research seeks to assist in closing the gap in recycling performance between what is currently achieved and that demanded by future targets. By exploring the factors that influence the recycling performance of English LAs, the research will identify best practice to extract recyclate from the residual waste and to increase the quality of that recovered material.

1.1. Information needs for policy and practice and research gaps

The waste and recycling industry is continually changing, so it is vital that new policy is based on up-to-date research. Technological advances, increasing the range of material recycling, removal of the government's Private Finance Initiative, and the impact that austerity has had on resource availability has changed the way LAs deliver their waste and recycling services.

To understand what is responsible for the range of recycling performance between LAs in England (16% to 64%) and to extract best practice, it is first important to understand what is used to calculate the recycling rate. The UK government calculates the recycling rate as the amount of material collected for dry recycling[2], reuse and composting. The existing literature uses recycling performance defined by the quantity of recyclate collected too (Wilson and Williams, 2007; Abbott et al., 2011; Andreasi Bassi et al., 2017), but a gap exists where calculating a LA's recycling performance includes both the quantity of material collected and the quality of the material that arrives at the material recycling facilities.

Factors that influence a LA's recycling performance largely fall in to two categories; those within the control of the LA and those outside of the LA's control. The existing literature demonstrates a wealth of research that investigate the impact of single factors outside of a LA's control such as gender (Stogia et al., 2015), income (Abbott et al., 2011), and

[2] Recycled material quantity does not include rejected material.

rurality (du Toit and Wagner, 2020). Or those factors that are within a LA's control, such as green waste charges (Collinson, 2019), frequency of collections (Williams and Cole, 2013), and the type of bin (Keramitsoglou and Tsagarakis, 2018). One other study has attempted to explain the variations in household recycling rates in the UK (Abbott et al., 2011), and concentrated on infrastructure and service provision. There is a gap in the research, however, that does not limit the study to specific factors, so that a broader overview of how they may be interrelated and whether their impact explains the range of recycling performance in England.

The factors outside of the control of a LA can be described as their Geo-Socio-Economic (GSE) characteristics and have been widely used to group like for like LAs for comparative studies, for example, to study the availability of food, immigration and ethnic diversity (Lake et al., 2012; Lymperopoulou, 2020). A gap in the literature exists using a GSE classification scale to remove the impact on recycling performance from factors out of the control of the LAs, so that when comparing seemingly similar LAs, the reasons behind the range of recycling performance can be explained by those factors within their control.

By addressing the gaps in the literature, this study attempts to understand the reasons for the range of recycling performance in English LAs and to extract best practices, with a view to tailor them to individual LA circumstances, thus the following aims and objectives were set.

1.2. Aims and objectives

The principal aim of this study is to establish critical success factors for effective intervention tools, for use by English LAs, designed to enhance public participation in recycling.

The study objectives are;

Objective 1: Establish the key influences on LA recycling performance (Chapter 2).

Objective 2: Develop a LA classification framework using geo-socio-economic factors and a method to compare both the quality and quantity of recycling performance across LAs to allow for their grouping and ranking (Chapter 3 and Chapter 4).

Objective 3: Explore the core attributes that explain the difference between best and poorest performers within the novel LA groupings, and to distil good practice principles and the extent to which they may need to be tailored to local circumstances (Chapter 5 and Chapter 6).

1.3. Thesis outline

This chapter provided an introduction to the study area, presented the gaps in the research, and listed the principal aim and objectives. The structure of the remainder of the thesis is summarised as follows:

Chapter 2 critically reviews of the literature detailing factors that influence recycling performance, interventions used to change recycling behaviour, and waste infrastructure, addressing Objective 1.

Chapter 3 presents the methodology, explaining the choice of the pragmatic, mixed-methods approach using an explanatory sequential design.

Chapter 4 addresses research Objective 2, the quantitative element of the study, which used a GSE classification scale to group all English LAs with a view to remove the influence of factors out of their control. They were then ranked within the 6 groups using the recycling performance, calculated from both the quantity and quality of material collected for recycling.

Chapter 5 presents the qualitative element of the study, contributing the Objective 3. Best and poorest performers from each of the six LA groups were sampled to use as case studies to explore the reasons for the difference in the observed recycling performance.

Chapter 6 addresses research Objective 3, presenting a discussion of the positive and negative factors influencing recycling performance that emerged during the study, and the best practices distilled from the discussion and how they might be tailored for specific LA characteristics.

Chapter 7 presents the main findings of the study, a research critique and identifies further lines of enquiry. The implications for policy and practice are also discussed.

The empirical work has achieved a number of research outputs including conference presentations, papers and includes a paper in press examining the influence of geo-socio-economic factors on English LA recycling performance. Additionally, a paper has been published in a peer reviewed journal that uses a section of the literature review, details of which can be found in Chapter 7.

2. Literature Review

2.1. Introduction and Chapter Outline

This chapter presents a review of the literature investigating influences on household recycling performance. In order to understand why LAs have arrived at the current levels of recycling quantity and quality and thus how they might best address future challenges, it is first necessary to appreciate the local government structure in England, policy commitments and ensuing legislative actions that have shaped the development of household waste recycling infrastructure and performance in England.

2.2. Local Government Structure in England

The local Government structure in England is complex, having evolved over many years. The first Local Government Act in 1888 created 66 County Councils and a London County Council that, for the first time, held devolved responsibility for local services that were previously managed in London (Politics, 2020). The Act has been updated numerous times over the last 120 years with the most recent version in 2010; it currently lists 343 LAs in England consisting of five different types:

- 26 County Councils which oversee 192 District Councils
- 55 Unitary Authorities
- 36 Metropolitan District Councils
- 32 London Boroughs
- 1 City of London
- 1 Isles of Scilly.

The two-tier structure, which includes District and County Councils, split statutory responsibilities between them (Table 2.1) whereas the other LAs are single tier Councils that are responsible for all services (MHCLG, 2019). The Local Democracy, Economic Development and Construction Act (2009) introduced the 'combined authority' which is a voluntary system whereby several single tier LAs join together to pool responsibilities for services such as fire, police, transport and waste disposal. There are ten Combined Authorities in England that consist of several Metropolitan District Councils. The Greater

Manchester Combined Authority was the first Combined Authority, formed in April 2011. It consists of; Bolton, Bury, Oldham, Manchester, Rochdale, Salford, Stockport, Tameside, Trafford and Wigan metropolitan district councils (Denham, 2010).

England also has approximately 10,000 Town and Parish Councils that provide non-statutory services such as community centres, allotments and war memorials (NALC, 2017).

Table 2.1: Responsibility of services by English LA type (MHCLG, 2019)

Authority Type	**Responsibility**	**Names**
County Council	Education, highways and transport plan, passenger transport, social care, libraries, waste disposal, and strategic planning.	County Councils
District Councils	Housing, leisure and recreation, environmental health, waste collection, planning applications, and local tax collection.	District Council Borough Council City Council
Unitary Authority	Same as County Council **and** District Council.	City Council Borough Council County Council District Council
Metropolitan District Councils (also Unitary Authorities)	Same as Unitary Authorities	Metropolitan District Council Metropolitan Borough Council Metropolitan City Council
Combined Authorities	Collection of MDCs to combine services for highways and transport, waste disposal, economic development, and regeneration.	Combined Authority
London Boroughs	Same as Unitary Authorities	London Borough

Waste collection and disposal from residential properties in England is a service funded by Council Tax, a monthly tax paid to a District (including London) Authority by residents living in its geographical/administrative area. In the two-tier structure waste is collected by the District Councils and disposed of by the County Council. In the case of a Combined Authority the Metropolitan District Councils collect the waste and the Combined

Authority is responsible for its disposal. Unitary Authorities are responsible for both the collection and disposal of waste. With respect to waste, LAs are classified as one of the following;

- Waste Collection Authority
- Waste Disposal Authority
- Unitary Authority.

Local Authorities in England have a statutory duty to fulfil local services in line with legislation set by the UK Central Government and Parliament (UKParliament, 2020). To understand the current waste infrastructure in England it is necessary to appreciate the policies that have shaped it.

2.3. Waste Policy

Waste policy has influenced waste infrastructure in England over hundreds of years. Currently Local Authorities (LAs) have a statutory duty to collect and dispose of waste from residential properties as set out in the Environmental Protection Act 1990 (UKParliament, 2001), however the need to remove waste was first made official when a report was commissioned during a cholera outbreak in 1842, 'The Sanitary condition of the labouring population'. The report highlighted the need for waste removal, including human waste, from habited areas to curb diseases in the late 19th century (Chadwick, 1843). This report led to the first waste management regulation, the Nuisance Removal & Disease Prevention Act (1846) which linked the spread of disease with squalid housing conditions and filthy streets. The Act, amongst other things, highlighted street cleansing as an important factor in combatting the reoccurring cholera, influenza and plague epidemics that wiped out tens of thousands of people at that time. The subsequent 1875 Public Health Act made it compulsory for every household to present waste in a moveable receptacle for disposal, thus the first dustbin was born.

Since 1875 there have been various legislative changes, however a landmark policy commitment that has influenced the UK waste regulations for more than two decades is the EU Landfill Directive (1999). It placed a series of targets on the UK to reduce the amount of Biodegradable Municipal Waste (BMW) going to landfill. The targets were

staggered to ease the pressure on LAs, as at that time the UK was sending approximately 80% of its municipal waste to landfill and would need time to develop the infrastructure to collect and process the 'green' waste. The UK committed to reduce the BMW sent to landfill to 75% of that produced in 1995 by 2010, 50% by 2013 and 35% by 2020 (CIWM, 2017).

Preceding the EU Landfill Directive, the Landfill Tax was introduced in the UK in 1996. This tax placed a levy or gate fee based on the weight of material being disposed of in landfill, the intention being to better reflect the environmental damage of landfilling and to alleviate the ever decreasing capacity, so to divert waste away from ultimate landfill disposal (IEEP, 2016). In 2009, to support the changes necessary to achieve the Landfill Directive and further encourage landfill diversion, the Landfill Tax (Amendment) Regulations (HMSO, 2009) modified the tax to distinguish between inert/non-hazardous (or inactive) waste and hazardous (or active) waste such as BMW (Fletcher et al., 2018). In 2009 the tax rates were £2/tonne for inactive waste and £7/tonne for active waste, however it became clear that the system did not provide enough of a financial incentive for LAs to reduce the amount of BMW arriving at landfill. Over the years the tax for disposing of inactive waste has remained near to its starting price however the cost of disposing active waste has increased substantially. Today the landfill tax is £3/tonne for inactive waste and £94.15/tonne for active waste.

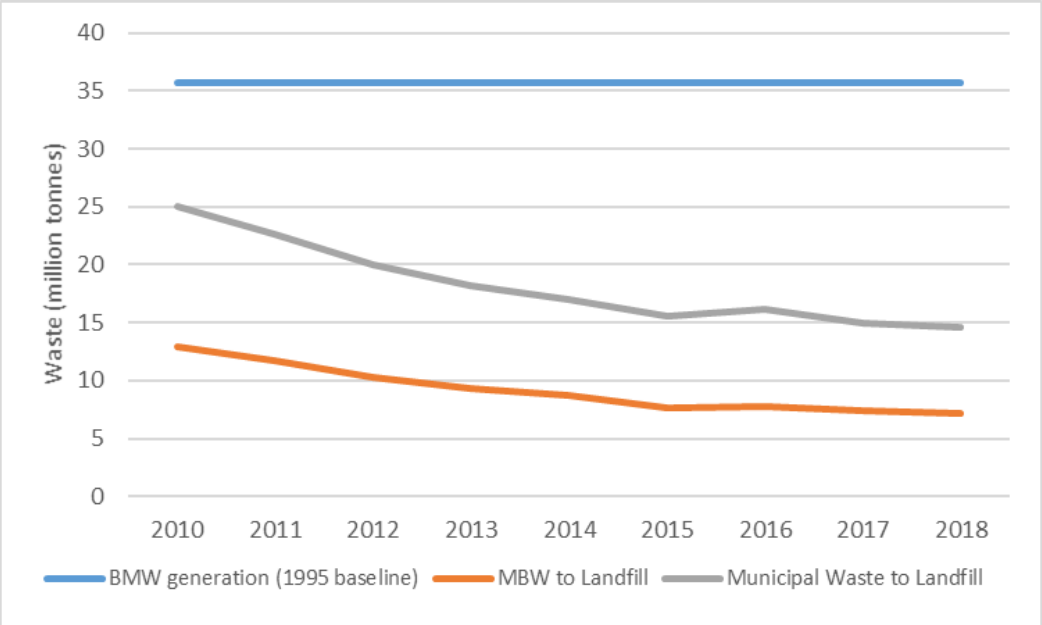

Figure 2.1 Municipal Waste and BMW to Landfill in the UK 2010-18 (DEFRA, 2020b)

The impetus to reduce BMW to landfill from the Landfill Directive and subsequent financial incentive from the Landfill Tax saw many LAs provide households with a separate receptacle that could take garden and food waste, depending on the type of downstream processes that were available in the area.

The Landfill Directive had a huge effect on the municipal waste going to landfill, Figure 2.1 shows the baseline BMW for the UK in 1995 at 35.7 million tonnes and how it had dropped to 13 million tonnes by 2010. From 2010 onwards there has been a steady reduction in waste, however this trend inevitably shows diminishing returns at the margin. The latest data released by the government has indicated the UK has exceeded the target set by the Landfill Directive and is currently sending 20% of the 1995 BMW baseline to landfill.

Further measures to divert other waste streams from landfill followed and in 2003 England saw significant changes to its waste infrastructure with the introduction of the Household Waste Recycling Act. This Act required Local Authorities to collect at least two further recyclables by 2010. Meanwhile, the EU Waste Framework Directive (2008) resulted in the Waste (England and Wales) Regulations 2011 where 'Regulation 12 - Waste Hierarchy' came into force in September of that year.

Figure 2.2 Waste Hierarchy (ISLWM, 2017)

The Waste Hierarchy (Figure 2.2) prioritises waste management options based on their impact on the environment; Prevention, Reuse, Recycle, Other Recovery (e.g. energy) and

Disposal (DEFRA, 2011a). Consequently, the Waste Regulations were amended in October 2012, specifically Regulation 13 which stated that LAs would have to provide a separate collection for at least four materials by January 2015. Many LAs successfully argued that the quality of the recyclate would not suffer if some materials are collected together due to an ever-increasing sophistication of downstream technologies. Therefore Regulation 13 is currently fulfilled by the collection of co-mingled recyclates in most areas (WRAP, 2014).

In a further development in the shift towards minimising waste disposal, the EU Circular Economy package (EuropeanUnion, 2021) was released in December 2015, which whilst continuing to place importance on the Waste Hierarchy, advocates a change in direction from a 'waste management' system to one that closes the loop on material use in product and process design (Stahel, 2016). The UK government has placed the circular economy at the heart of their Resources and Waste Strategy (DEFRA, 2018b) with emphasis on designing out waste and extending producer responsibility, a policy to push treatment and disposal costs to producers.

Policy changes further afield such as China banning the import of low-grade materials for recycling, known as the Chinese National Sword, has had substantial impacts on the export of waste from the UK (Johnson, 2018). The government acknowledged the need to accept responsibility for domestic waste in the new Environment Bill (DEFRA, 2020a) by banning exports to low income countries, including measures to strengthen the UK-based recycling market.

These policies and the responses they have elicited have changed the face of UK municipal waste management beyond recognition over the last two decades. The impacts of these policies have filtered down to every household in the country and have placed LAs at the centre of reconstructing the waste management infrastructure in England.

2.4. UK Waste infrastructure

To understand the impact of the legislative changes highlighted above on waste infrastructure and consequent recycling performance it is first important to understand the local and regional responsibilities of key actors within the waste management sector.

LAs manage local services in England, this includes responsibility for the collection and disposal of household waste in line with legislative requirements set by central government. There are 352 authorities that collect and/or dispose of waste and these broadly follow the same boundaries as LAs. These authorities fall in to one of three categories;

- Waste Collection Authority (WCA): responsible for the collection of household waste
- Waste Disposal Authority (WDA): responsible for waste disposal. WDAs are usually responsible for several WCAs
- Unitary Authority (UA): responsible for both collecting and disposing of household waste.

The requirements of the Waste Regulations 2011 (amended 2012) placed the challenging task on the LAs of designing a waste collection infrastructure capable of handling the kerbside collection of four recyclable materials by 2015. Much of the infrastructure at the time involved residents taking their recycling to civic amenity sites, also known as Household Waste Recycling Centres (HWRC), supermarket or local neighbourhood sites such as those in carparks and mini recycling centres that serviced between 250 to 400 properties (Butler and Hooper, 1999). Butler and Hooper's study highlighted the environmental burden associated with the transport used to take materials to recycling sites and that, although expensive to implement, a kerbside collection would be beneficial both in terms of reducing the impact of transport and by reducing the amount of material contamination, the effects of which will be discussed in Section 2.5. The study also concluded that a kerbside scheme is the only means by which recycling rates could be increased to the levels required by legislation.

The new 2011 regulations meant that households began to benefit from a kerbside collection of recyclable materials using dedicated receptacles, the number of which increased dramatically to include one for green waste, one or more for the four recyclables (e.g. glass, plastic bottles, cans and cardboard) (Figure 2.3).

Figure 2.3 Bins for one property in Greater Manchester (About Manchester, 2017)

Aside from the legislative requirements to collect and dispose of municipal solid waste (MSW) there is no one standard infrastructure that the LAs must use. Consequently, there are noticeable differences around the country with the type, size and colour of receptacle, frequency of collection, and type and co-mingling of materials collected for recycling (Neohammer & Byer, 1997). Infrastructure can vary greatly even within a LA, partly due to the range of housing types. Residents who live in apartments may have shared bins located in bins stores, those with no gardens may have boxes and bags and those in houses with garden space may be supplied with wheelie bins, all of which require different types of vehicles to service them.

In 2018 the UK Government announced that it will overhaul the waste and recycling collection system after conducting a series of consultations into standardising separate green and food waste collections and the type of packaging waste collected (DEFRA, 2018b), although this is welcomed, there is some hesitation from the LAs due to cost implications and availability of appropriate processing plants.

Large processing facilities were set up around the country to sort and distribute the increasing amount of recyclable material now being collected and there was pressure to provide increasingly sophisticated means of extracting value from the residual waste stream. Private Finance Initiatives were used to finance some of the processing facilities which included different technologies that, as with local waste collection infrastructure, varied around the country.

2.4.1. Private Finance Initiatives

Many processing facilities were built using the Government's Private Finance Initiative (PFI) scheme that allowed private investors to pay for public infrastructure. The Waste Disposal Authorities (WDA) and Unitary Authorities (UA) signed contracts with private organisations, some lasting up to 30 years. The PFI scheme was first introduced in the UK in the 1990s, with this privatisation, new markets opened up in the UK waste management sector and the once local/regional haulage transport to landfill activity was replaced with a major international market attracting established waste management firms from the continent (Gregson and Foreman, 2020). To illustrate the size of the market, in 2017/18 the 'Big Five' waste management companies (Veolia, Suez, Viridor, Biffa and FCC) generated around £5 billion in revenue from the UK's municipal waste market (Binns, 2021). Although the individual WDAs and UAs were the signatories of the contracts, the PFI scheme had an allocated budget from central government of £1.7 billion, paid via the 28 LAs in England with a PFI project (NAO, 2014).

One major benefit of the PFI contract ensures the infrastructure, when handed back to the authority at the end of the contract, must be in good condition and well maintained throughout. Although at the time of signing, the PFI contract allowed for infrastructure that was progressive and at the forefront of the waste management industry, they soon came under criticism for 'locking-in' technologies for the term of the contract in a rapidly developing industry (DEFRA, 2010; Corvellec et al., 2013). As an example, Gregson and Foreman (2020), when reviewing the English waste regime, found that a few LAs still do not collect HDPE and PET plastic. These LAs signed their contracts in the 1990s, when plastic was considered a lightweight material and so was not prioritised for collection with glass and paper, materials that produced greater gains when aiming for a recycling performance determined by weight. More recent challenges, such as the collapse of the

export market for low grade materials, specifically to China (Gregson et al., 2015), has resulted in a loss of commodity sales for LAs and with the knock-on increased material quality standards implemented by the Material Recycling Facilities, LAs are paying more in landfill taxes for the disposal of the rejected material.

To guarantee the smooth delivery of the PFI contracts the government set up a Waste Infrastructure Delivery Programme overseen by DEFRA (Agilia, 2019). The programme had over 30 projects, many of them successfully taken through development and procurement to delivery. In 2014, however, an investigation carried out by the National Audit Office into three failing FPI waste contracts concluded the costly delays were due to;

> *"…a range of problems, including difficulties obtaining planning permission, complex commercial considerations, opposition from local groups and uncertainty over technology."* (Moore, 2014)

The report further explained that;

> *"It was clear from the correspondence we received that there was a lack of clarity over both the facts and figures relating to these three projects and the roles and responsibilities of the parties involved"*

The three contracts had different outcomes; the first LA re-profiled its funding, the second withdrew from the contract at a cost of £33.7m as it was deemed a saving for the taxpayer. The third varied their contract which resulted in a £30m reduction in funding from the government. This WDA borrowed capital themselves to complete the infrastructure and in doing so made substantial savings on the private finance – enough to offset the £30m reduction of funding from the Government (NAO, 2014). In all three cases the LA (WDA or UA) had a responsibility for ensuring their waste contracts represented value for money, it is telling that two out of the three contracts were either terminated at great cost or re-funded through non-PFI routes.

Terminating PFI contracts is complex and vast sums of money are required for the debt repayment, termination fees and transfer of operation costs. An example from the NHS includes a Trust having paid £67m over 10 years for the use of a hospital valued at £54m.

The 25 year contract still had another 15 years left, the Trust calculated terminating the contract would cost £114.2m, despite this large sum of money there would still be savings of £14.3m (Hellowell, 2015). PFI contracts have since been the source of bad press (TheIPaper, 2019), some stating that a hospital trust paid more than £5,500 for a new sink and a police force that paid £884 for a single chair, but all with the overarching theme of tax payers losing billions of pounds on very expensive, long-term private financing.

In 2018, the government withdrew the PFI funding model (NAO, 2020) for new contracts, however, existing contracts remain in place with those that signed in the 1990s coming to an end at this time. Other LAs that signed contracts in the 2000s or later have a way to go, with some deeming the long-term costs so prohibitive as to be worth paying short-term costs to terminate contracts early, as with the NHS trust above and Greater Manchester WDA.

2.4.2. PFI Case Study: Greater Manchester Waste Disposal Authority

To illustrate the complexity of the waste management infrastructure; one of the first and largest PFI contracts in England was signed in 2009 between the Greater Manchester Waste Disposal Authority (GMWDA) and Viridor Laing (Greater Manchester) Limited (VLGM). Currently, GMWDA (now known as GMCA) handles 4% of the UK's municipal solid waste, collecting 1.1 million tonnes of waste from over 1 million homes (GMCA, 2019). The £631 million contract transformed a system dominated by landfill into a network of state-of-the-art recycling and waste management facilities that required the interdependency between technologies, institutions and practices (Gee and Uyarra, 2013). The facilities (Table 2.2) had a capacity to process 1.35 million tonnes of materials per annum at 42 facilities that included (GMWDA, 2014);

- 4 education centres
- 20 household waste recycling centres
- 5 mechanical biological treatment plants (4 with anaerobic digestion)
- 4 in-vessel composting plants
- 1 thermal recovery facility
- 7 transfer loading stations
- 1 + 2 material recovery facility/green waste facilities

- 1 thermal power station (CHP)

Although most of the facilities were built from new, there were already some facilities in place that were renovated; including 2 education centres, the thermal recovery facility and 16 household waste recycling centres (Dunn, 2010).

Table 2.2: Methods of waste treatment (adapted from GMWDA, 2014)

Name	Acronym	Description
Mechanical biological treatment plants	MBT	A one and sometimes two stage process; residual waste is mechanically separated and then biologically treated to produce SRF.
Refuse derived fuel	RDF	A fuel produced from dried and shredded residual waste that has had the recyclates removed.
Anaerobic digestion	AD	Plant and animal materials are broken down by microorganisms, without air, in sealed tanks, producing methane and carbon dioxide. The methane is often burnt in a Combined Heat and Power (CHP) engine to power the plant's operations with any excess electricity exported to the National Grid
Household waste recycling centres	HWRC	Facility for residents to take items for recycling that are not collected kerbside and to dispose of waste.
In-vessel composting	IVC	Green waste is shredded and placed in cells for aerobic decomposition.
Thermal recovery facility	TRF	Incinerator that burns residual waste at high temperatures. The heat generated boils water to produce steam, which in turn powers a turbine driving a generator to produce electricity.
Transfer loading station	TLS	Facility to receive and sort waste from collection vehicles, not used for storage.
Material recovery facility	MRF	Mechanical sorting of co-mingled recyclate such as glass, plastic bottles and cans into separate material streams.
Solid recovered fuel	SRF	A non-hazardous version of RDF produced by the MBT for use in the thermal power station, defined above, as EfW.

The Greater Manchester WDA set recycling targets for the nine Greater Manchester WCAs and to meet these targets each LA (the WCA) gave residential properties a set of bins to collect the separated waste from the kerbside. Despite having the same WDA, each of the WCAs chose different colours for their bins; for example, residual waste is collected in a black bin in Manchester and Stockport but in a grey bin in Trafford.

The WCAs implemented these changes at different times with Stockport being one of the first to provide a separate collection for the recyclates. When setting targets, the WDA distributed them based on the WCAs current recycling rate i.e. Stockport was given a higher target than its neighbour, Manchester, as Stockport had already started collecting recyclates and therefore had a higher recycling rate, one of the highest in the country at that time. This placed a higher burden on Stockport to extract more recyclate from its residents than for a poorer performing WCA, which could meet its targets by simply moving to the separate collection of residual waste and recyclates.

Figure 2.4 shows a breakdown of the individual Greater Manchester LAs projected recycling rate for 2014/15 and the potential recycling rate based on a waste composition analysis conducted in 2011. GMWDA estimated that around 72% of waste in residential bins in Greater Manchester was recyclable, with 41.3% of it being captured at that time (GMWDA, 2015), that meant a further 30% of material could theoretically be recycled using the current infrastructure. It is worth noting here that there is significant variation in the recycling rates achieved by the WCAs with Manchester the poorest, achieving a rate of 32% and Stockport nearly double that at 61%. Factors such as population density (Figure 2.4) and deprivation can influence recycling rates. Stockport has a mixture of urban and rural areas whereas Manchester is predominantly urban with a higher level of deprivation. Factors influencing recycling performance are discussed in more detail later in this chapter.

The waste composition analysis identified 100,000 tonnes of paper being placed in the wrong bin. This not only has significant environmental impacts but also negative financial implications. To get to a 60% recycling rate, GMCA calculated 8 out of 10 residents would need to be good and accurate recyclers all the time, this highlighted the need to drive behaviour change in the area.

GMWDA had four education centres for school visits and a team dedicated to the communication and dissemination of recycling education and information. Each WCA also had various officers employed to encourage recycling through education and/or enforcement.

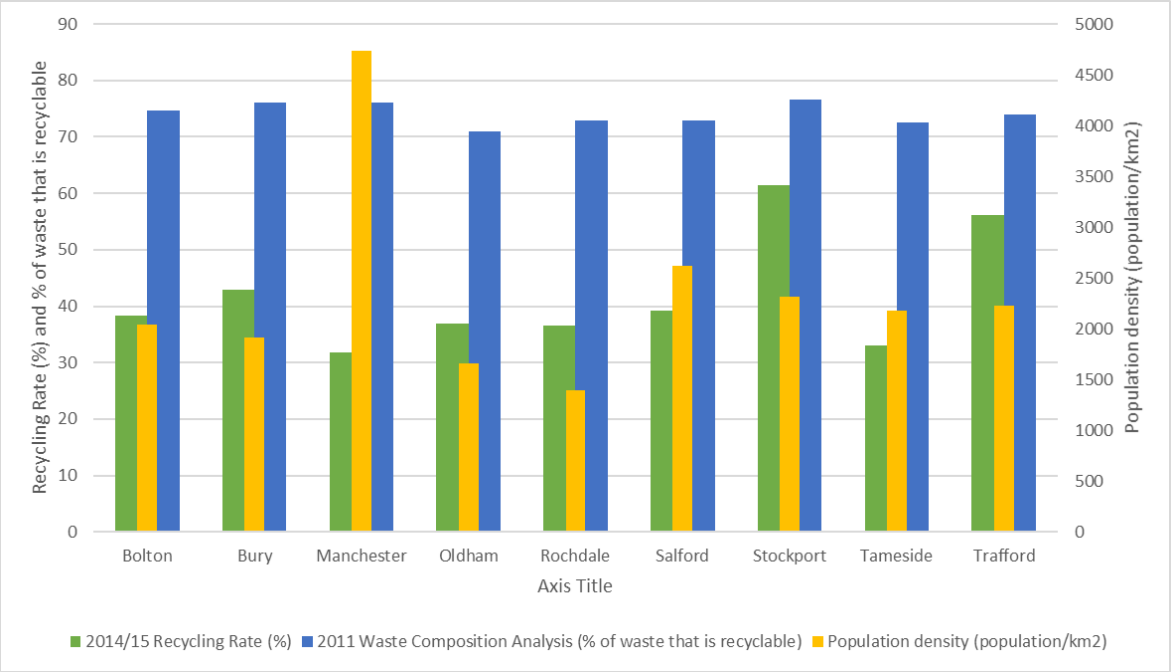

Figure 2.4: Recycling rates, potential recycling rates and population density in GM (GMWDA, 2015)

Greater Manchester has seen vast improvements in its recycling rate over the years. Figure 2.5 shows GMWDA ranking 346 in the recycling league table for English authorities in 2002/03 moving to 104 in 2018/19 (DEFRA, 2021c). This rise in rank reflects the continuing rise in annual recycling rates that start at 7% in 2002/03 rising to 48% in 2018/19. A jump is seen with the rank and the recycling rate between 2010/11 and 2011/12 when the PFI funded infrastructure was introduced.

In 2015/16, however, GMWDA reported overspending on the £170 million annual budget by around £2.5 million. Problems associated with the anaerobic digesters, namely corrosion of a hydrolysis tank (Randviir, 2019) leading to expensive safety remedial actions and the increased waste needing treatment at the MBT were responsible for the rising costs. Insurance was also increasing at that time due to the number of fires at waste treatment facilities in recent years (Date, 2016). GMWDA required the WCAs to make

larger contributions towards the costs of the contract, however, when an estimated levy increase of 7.6% for 2018/19 was announced the 9 WCAs announced that they could not afford the increase due to national Government austerity measures. Consequently, in 2017 the contract, that was estimated to be worth £3.2 billion to the contractor over the course of the 25 years, was voted by the authority to end early. As part of the requirements they fulfilled the payments of the outstanding bank loans at full value, £500 million, and procured new contractors to handle the waste management services (Slow, 2017). Through lower borrowing rates in the new financial structure, GMWDA made annual savings of £20m, with no impact on provision of service (LGC, 2017).

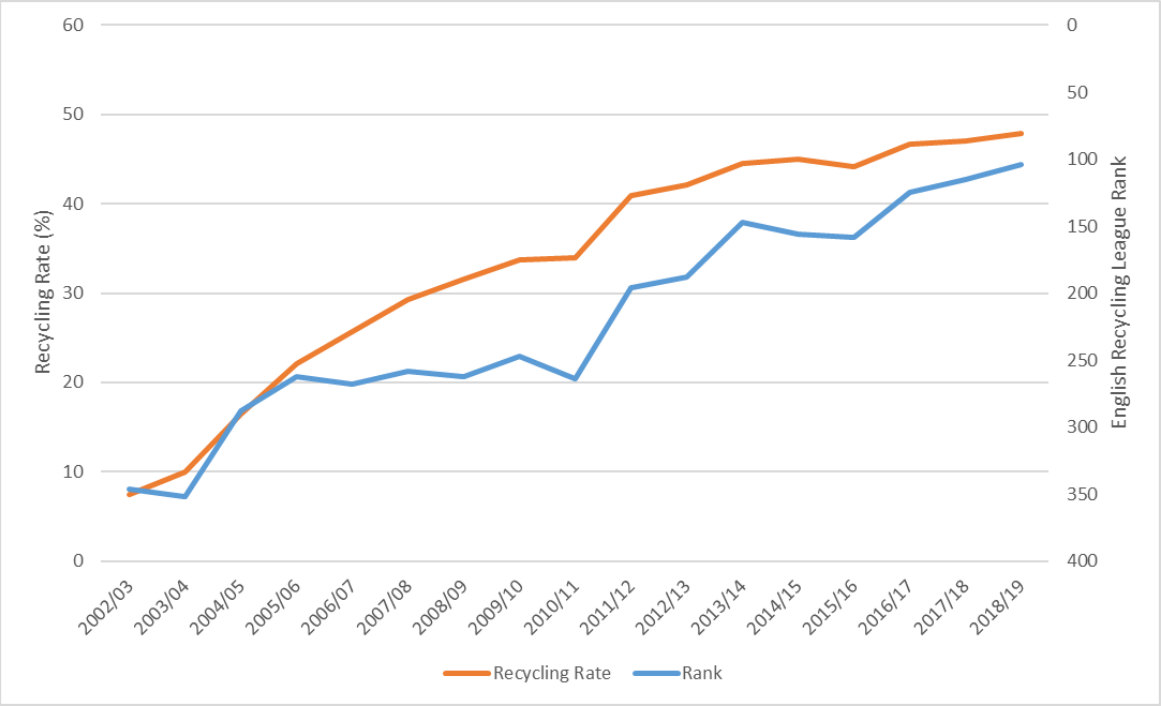

Figure 2.5: GMWDA recycling rate and league ranking 2002 to 2019 (letsrecycle, 2020)

Measures to increase savings are not just a Greater Manchester consideration but are echoed around the country. Years of austerity have applied huge budgetary pressures on LAs and this has inevitably affected the delivery of statutory waste services.

2.4.3. Austerity

Pressures to increase both the quality and the quantity of recycling from residential houses in England is ever increasing and yet in 2010 the Financial Crisis caused the UK

Government to introduce a programme of austerity that saw LA budgets cut by £18 billion (19%) (Gainsbury and Neville, 2015). Austerity is still in effect and some LAs continue to experience substantial budget cuts; building stock has been rationalised and non-statutory services removed. Through a Freedom of Information request to all LAs by Unison, a Local Government trade union, it was revealed that Environmental Services have seen job cuts of 25% and this is still increasing (Eichler, 2019). These changes have had an impact on the waste and recycling service delivery seeing recycling rates plateau and even fall in places (Purnell, 2019); services are being rationalised by dropping food waste collections in some areas, chargeable green waste services have been introduced, and with fewer staff there is less education and enforcement.

Despite the continued reduction in budgets and services, huge amounts of waste and recyclate is produced in England each day that needs to be collected and treated. Figure 2.5 illustrates how the pace of improvement in the rate of recycling diminishes as higher recycling rates are achieved so it becomes paramount for LAs to collect good quality recyclate. A good quality recyclate is not contaminated by other materials and so is not rejected from the recycling facilities. To understand the significance of contamination it is first important to consider the composition of waste in England and appreciate downstream material recovery processes.

2.5. Waste Composition

The composition of household waste has shown minor fluctuations between residual waste, dry recycling, food waste and other organic wastes since 2010 when the majority of England saw kerbside recycling schemes introduced (Figure 2.6). This indicates that the improvement in landfill diversion over this period is a function of improved downstream separation and recovery from the residual waste stream.

Dry recycling accounts for the second largest quantity of waste produced, after residual waste, with 5.9 million tonnes collected in 2019. Paper and card make up 36% of the dry recyclate, glass is 21% and plastic is 9%, Figure 2.7 gives a full breakdown of the other materials collected.

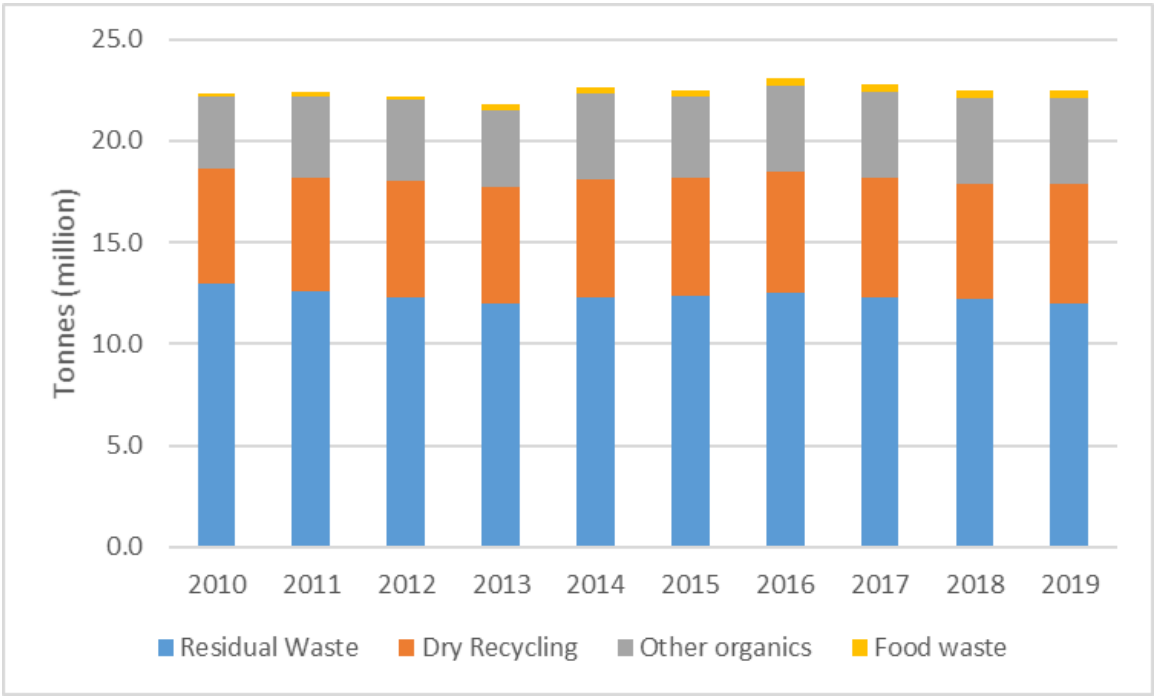

Figure 2.6: Composition of waste from households, England 2010 to 2019 (DEFRA 2019a)

The data shown in Figure 2.6 and Figure 2.7 is available due to legislative requirements for LAs to report on the waste that they collect. Dry recycling is a valuable commodity therefore further detail on the quantity of each recyclate (Figure 2.7) is also easily obtainable due to requirements to document the transfer of materials. The composition of the residual waste, however, is not measured so frequently. In 2017 an analysis of Municipal Solid Waste (MSW) was undertaken by WRAP to estimate the composition and tonnage arising from materials collected in England (WRAP, 2020b), this is the most comprehensive analysis to-date, with the previous analysis conducted in 2011.

Household waste is commonly termed as MSW, however it is defined by the UK Government as;

> "…waste that includes both household waste and waste from other sources that is similar in nature and composition (i.e. household-like commercial waste)." (WRAP, 2020b)

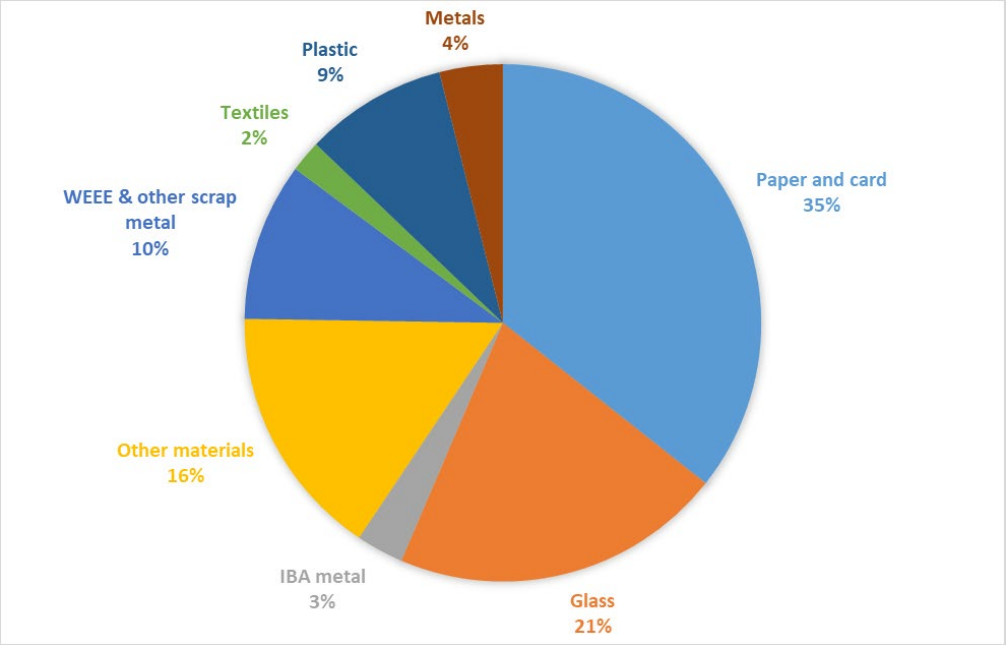

Figure 2.7: Composition of dry recycling from households in England (DEFRA, 2019a)

In 2017, WRAP estimated that English LAs collected 13.1 million tonnes of residual waste from households and 11.9 million tonnes from commercial properties (household-like waste only), a total of 25.1 million tonnes. A compositional estimate was produced (Figure 2.8) using audits from various LA waste and recycling streams, alongside tonnages taken from Waste Data Flow, the national waste data base (DEFRA, 2013). For this purpose, the total residual MSW is used, rather than a breakdown for households, to allow for comparison with the 2011 data.

Food waste and other organics account for the largest share of municipal waste producing 30% of all arisings. The amount of food waste estimated in the residual waste stream has significantly increased between 2011 and 2017. This increase could be explained by the reduction in food waste collections due to austerity, the capture rate for food recycling was approximately 12% in 2017 (WRAP, 2020b). There has been substantial focus on reducing food waste in recent years in response to the Sustainable Development Goal (SDG) 12.3 – Global Food Loss and Waste which set a target to reduce food waste by 50% per capita by 2030 (United Nations, 2021).

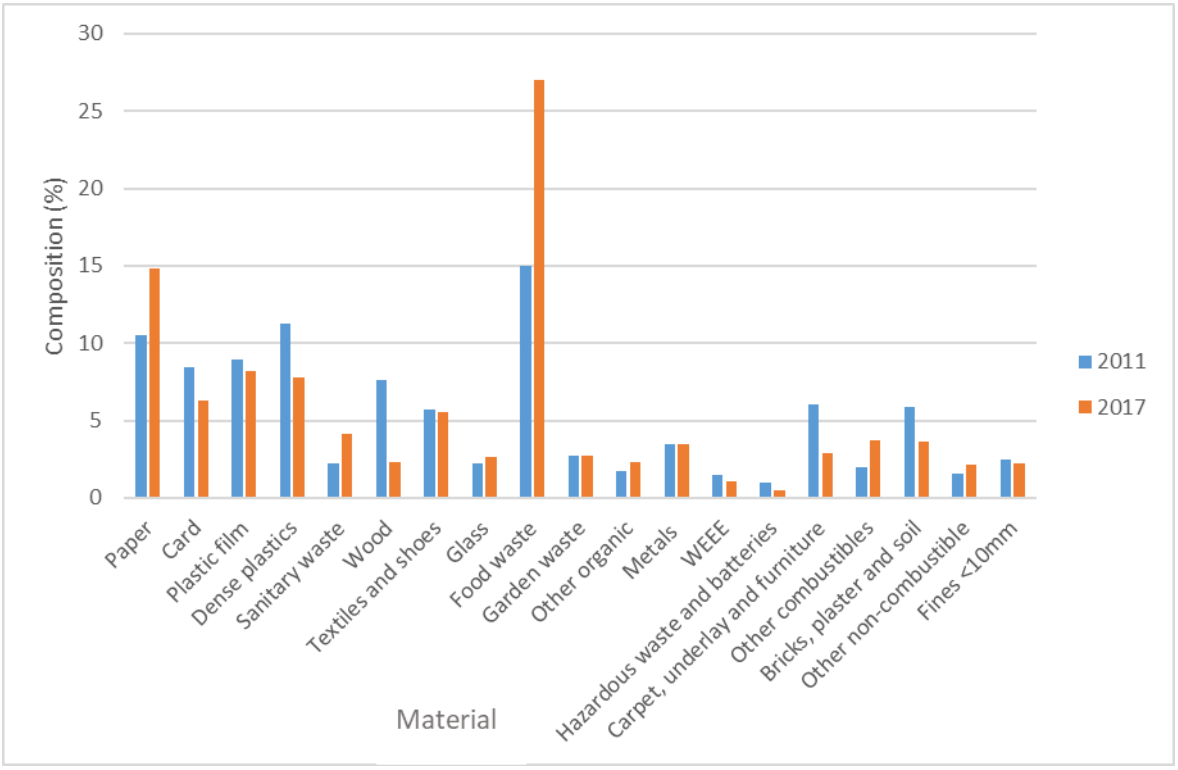

Figure 2.8: Composition of residual Municipal Solid Waste in 2011 and 2017 (DEFRA, 2018a)

Paper, card, plastic film, dense plastics, and textiles also accounted for substantial arisings, in fact, it was estimated that 25.6% of waste going to landfill in 2011 was recyclable (Figure 2.9). Over half was estimated to be biodegradable (51.4%) and 58.3% was estimated to be combustible (DEFRA, 2018a). The most recent figures show a fall in the biodegradable municipal waste from approximately 7.2 million tonnes in 2018 to 6.6 million tonnes in 2019 (DEFRA, 2021b).

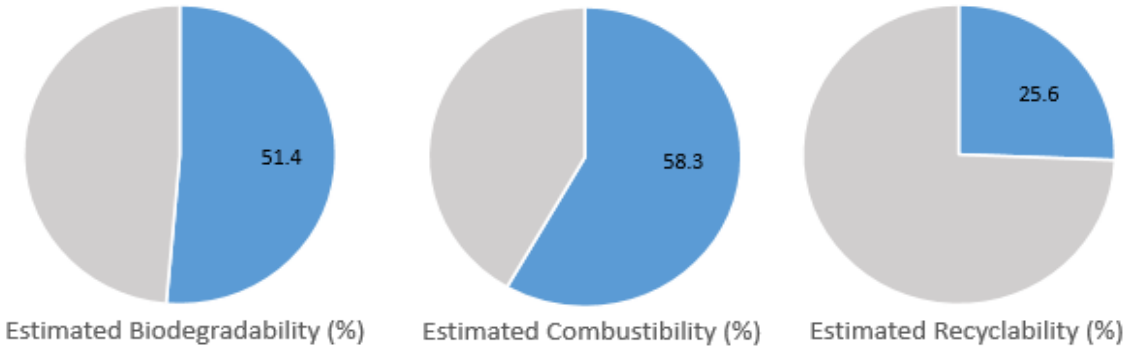

Figure 2.9: Biodegradability, combustibility, and recyclability of waste to landfill (DEFRA, 2018a)

The composition analysis clearly indicates that materials that can be recycled using the current infrastructure are being disposed of in the residual waste streams. This not only increases disposal costs but contributes to the enormous tax on the environment when producing materials from virgin stock to keep up with demand. Despite this, there are still millions of tonnes of material sent for recycling each year that uses a complex mix of logistics and sophisticated technologies.

2.5.1. Material Recycling

Although there are a variety of materials collected for dry recycling from households by different LAs in England, the majority tend to collect glass, plastic bottles, cans, paper and card. Once collected and sorted in waste transfer stations or material recycling facilities they are passed on to reprocessors who treat and recycle the materials. The reprocessors can either be UK based or part of the global trade system, located as far away as China (Xu et al., 2020). Reprocessors sell Packaging Recovery Notes (PRNs) to companies that manufacture, fill or sell packaging materials. PRNs, internal to UK, and Packaging Export Recovery Notes (PERNs), external to the UK, provide evidence that these companies are contributing to the cost of recovery and recycling of materials, and therefore impacting the type of material collected by LAs. This is a Pigouvian tax intended to correct the impact of resource use and waste production as covered by the Extended Producer Responsibilities policies (Matsueda and Nagase, 2012). Obligated businesses must purchase the PRNs from the correct reprocessor for the material they make, use, or sell (LetsRecycle, 2021b). There are different reprocessors for different materials, using different recycling methodologies.

<u>Cans</u>

Cans are sorted into aluminium using eddy current separators and steel using magnets. The aluminium cans are shredded and heated to remove any coating or decoration before being heated in a furnace to 750^0C where they become molten. The molten aluminium is poured in to moulds to form ingots that are flatted to produce aluminium sheets, these sheets can produce 1.5 million cans each year (recyclenow, 2020c). Aluminium foil and scraps are made of a different alloy and are used to cast items such as engine components, used for the metal's lightweight properties.

The market for recycled aluminium is high due to the recycled material being just as good as the virgin, with the ability to be recycled over and over without losing its quality. The production of the recycled version has considerable environmental and financial benefits too as it takes around 5% of the energy required to produce the virgin equivalent (recyclenow, 2020c).

Figure 2.10 clearly shows that as the value of aluminium increases the amount disposed of in landfill decreases (Dahlström and Ekins, 2007). Despite 51% of the aluminium used for packaging being recycled in the UK (DEFRA, 2018a) there is still around 49% not being captured, the monetary worth of this is not just the value of the metal itself but also from the savings in disposal costs.

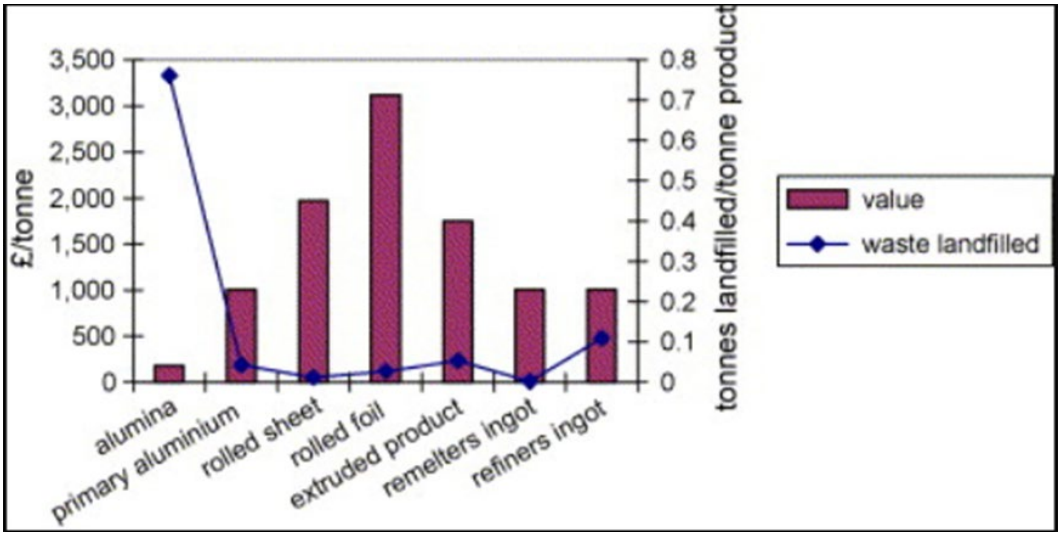

Figure 2.10: Value and waste generation of aluminium (Dahlström and Ekins, 2007)

Steel cans are recycled using a similar method to that of aluminium, they are shredded and placed in a furnace. Iron is added and oxygen is blasted in to raise the temperature to 1700^0C. The resulting molten metal is poured into moulds to form slabs that are then rolled in to coils (recyclenow, 2020c), this process can be repeated indefinitely with no loss of quality. The coils can be used to make various items from bicycles, cars, paper clips to larger structures such as bridges. In 2016 74% of steel packaging waste was recovered, that is 416,000 tonnes out of a total of 559 thousand tonnes produced (DEFRA, 2018a) leaving 143 thousand tonnes either being burnt or sent to landfill.

Glass

Glass is another resource that can be repeatedly recycled with only a fractional loss in quality, this can be accounted for by the addition of small amounts of virgin material. The UK currently recycles 68.8% of post-consumer glass (Britglass, 2017) meeting the 67% national target set by the government (EA, 2017), however there is still 33% not recovered. The glass bottles and jars, once collected, go through a series of checks to remove contaminants such as metal, using magnets, and plastics using suction. Using X-rays, further contaminants such as heat resistant glass and lead glass are identified and removed. The glass is then crushed, and colour sorted using optical sorting technologies. Finally the crushed glass is sieved; the smaller sizes, 0-5mm, are used by the construction industry, the larger pieces, known as cullet are melted at 1500^0C with additives and poured in to gobs which can be blown or pressed in to new products (recyclenow, 2020a).

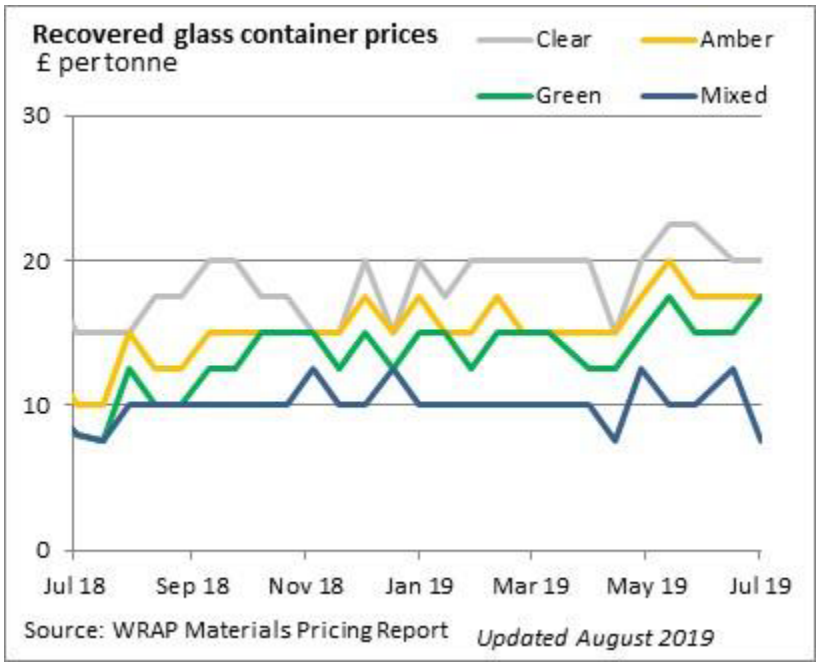

Figure 2.11: Recovered glass container prices (WRAP, 2019a)

The market for glass cullet varies depending on the colour, Figure 2.11 shows the variability in the price per tonne of cullet, with clear glass demanding a higher price than mixed. The mixed glass is primarily sold to the aggregates sector, meaning the glass is downcycled to be used for construction purposes. The clear, green and amber cullet can be sold to reprocessors that will turn the glass back in to bottles, jars, windows, fibre glass

and tiny glass beads for industrial uses (Britglass, 2017). When considering energy use, there are greater environmental benefits when recycling glass back in to glass packaging containers than using it as aggregate (Butler and Hooper, 2005). Butler and Hooper's study found that there was still substantial environmental gain to be had by transporting cullet to France for recycling, which would otherwise be used for aggregate in the UK. Figure 2.12, taken from WRAPs Market Knowledge Portal, shows that the UK still exports a considerable amount of cullet to other countries with the majority of exports going to Spain, Italy and Portugal for closed-loop recycling in the wine industry. The tolerances for the specifications in wine bottles tend to be less stringent than those with the lighter green bottles used for beer in the UK. The movement of glass cullet around Europe can also be demand led, for example, in 2007 the UK exported greater amounts of green cullet to meet a demand in Southern Europe due to an early grape harvest (WRAP, 2008a).

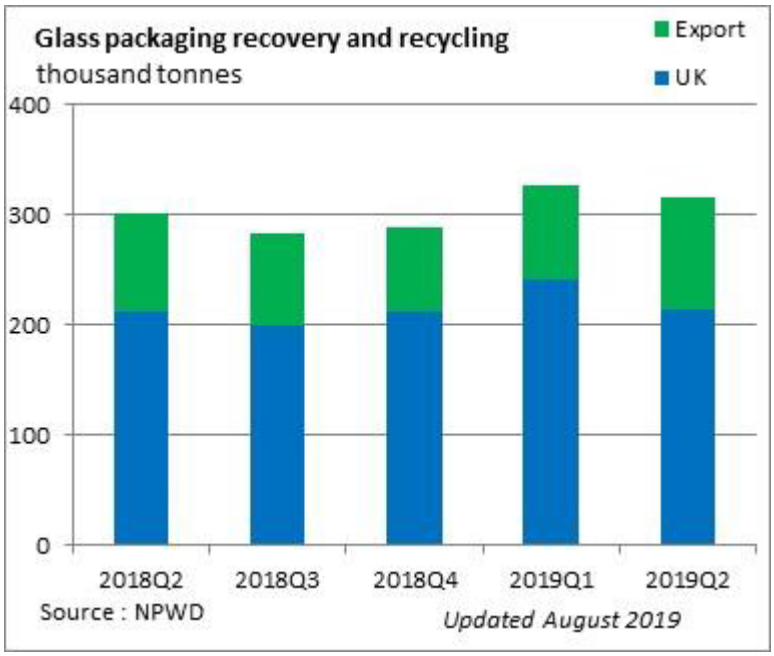

Figure 2.12: Glass packaging recovery and recycling (WRAP, 2020a)

Paper and cardboard

Unlike cans and glass, paper and cardboard cannot be recycled indefinitely. It can be recycled approximately five to seven times and is an important raw material for the UK

paper and board industry making up 70% of the fibre used in 2019, the equivalent of 3.1 million tonnes (CPI, 2020). The UK recovered 68% of the paper and cardboard that was consumed in 2019 which is approximately 12.5 million tonnes (recyclingbins, 2020). Once collected, the paper is sorted and graded and then pulped in water with chemicals. The pulp, now 99% water and 1% fibre is screened for paper clips, staples and any other contaminants before being spun with colourants. The mixture is sprayed on to a moving mesh that removes some of the water, the pulp moves through a series of heated rollers until the desired thickness is achieved and the water has been removed (recyclenow, 2020b). The large sheets of paper are rolled on to reels ready to be shipped to customers for uses such as newspapers.

The term 'recovered paper' can be applied to paper and card that has been collected, graded and the contaminants removed (CPI, 2020). International trade heavily dominates the recovered paper and cardboard industry (Figure 2.13). This is due to the decreasing number of paper mills in the UK and therefore the decreased capacity to recycle the ever-increasing amount of paper that is collected. A majority of the exported recovered paper and cardboard is sent to China who recently lowered the acceptable contamination levels from 2% non-fibre contamination to 0.5% (Quinault, 2019).

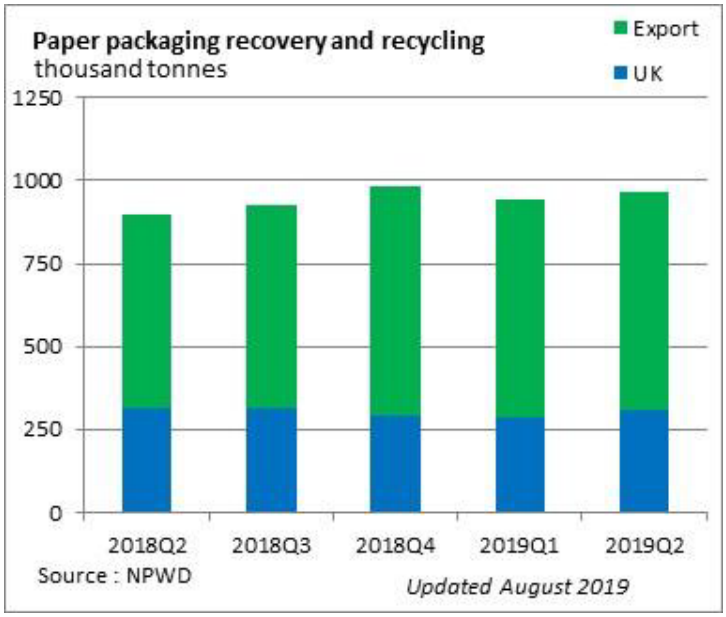

Figure 2.13: Paper packaging recovery and recycling (WRAP, 2019b)

As China moves its heavy industry out of the country, emerging paper and cardboard markets in SE Asia have demanded the same lower contamination level. The knock-on effect of this is that exporters are demanding a higher quality of paper recovery which is feeding back to the local authorities. In 2019, the UK industry saw waste paper prices at a ten-year low, with recovered material outstripping the UK capacity to recycle it by over 50%. However, with the government's commitment to a circular economy and the newly published Ten Point Plan for a Green Industrial Revolution (BEIS, 2020) more funding is being provided to increase infrastructure. There are hopes within the industry that the policy on plastic packaging will be extended to paper packaging so that all packaging contains 30% recycled content, thereby increasing UK demand for recovered paper and cardboard.

Plastic

Plastic packaging makes up the majority of plastic waste in the UK, accounting for approximately 70% of the 3.7 million tonnes produced each year (WRAP, 2019c). The main plastic collected by kerbside schemes include bottles, tubs and trays, although not all LAs collect these materials. The plastic is first cleaned and sorted into polymer type and then by colour; green, blue and mixed. These sorted materials are shredded, washed, melted and reformed in to pellets ready for reuse. The majority of the recycled plastic pellets are turned back in to packaging such as bottles, however they are also used in other products such as clothing, toys and furniture (LetsRecycle, 2021a).

This type of recycling is known as mechanical recycling, the physical breakdown of plastic without altering the chemical structure, and although it can be repeated, the material suffers from degradation (Schyns and Shaver, 2021). An emerging technology 'chemical recycling' is relatively new and aims to extract the value of hard to recycle plastics by turning them back into base chemicals (BPF, 2021). This method can process mixed plastic waste, something that could solve the issue of flexible plastics, such as films, wrappers and bags. Flexible plastics account for 25% of consumer packaging in the UK however only 6% is currently recycled, mainly due to a lack of infrastructure. Amendments to the Extended Producer Responsibility system, whereby producers of flexible plastics will need to fund the collection of their packaging for recycling by 2023, mean that waste management companies are starting to explore how the infrastructure

can incorporate this collection and sorting before passing on to reprocessors (Suez, 2021). Table 2.3 highlights the range and quantity of flexible plastics currently placed on the UK market, each requiring different sorting and collection methods. Standardisation of the polymers, waste collections and sorting are key to retaining and maximizing their value (Burgess et al., 2021).

Table 2.3: Flexible plastic packaging placed on the UK market (Suez, 2021)

Type	**PE mono**	**PP mono**	**PE/PP mix**	**Metallised layer with plastic**	**Aluminium layer with plastic**	**Other forms**
Tonnes	~430,000	180,000	~15,000	~60,000	~120,000	90,000
No. of Packs	~105 billion	~42 billion	~4 billion	13 billion	31 billion	20 billion
Share of materials	48%	20%	2%	7%	13%	10%

Recycling plastics has many environmental benefits; firstly, 95% of the energy used producing virgin plastic comes from oil refining and the polymerisation of monomers, steps avoided in the recycling process (WRAP, 2019c). Secondly, capturing the material before it 'leaks' into the environment, as highlighted in David Attenborough's 2017 Blue Planet II film. The documentary successfully increased public awareness around the detrimental impact of escaped plastic waste and has provided long lasting effects on both the media and political agendas (Burgess et al., 2021; Males and Van Aelst, 2021). The harm caused by smaller fragments of plastic, including micro and nano plastics, have also been widely communicated and have changed policy, such as banning the use of microbeads in cosmetics.

These issues and the public reaction to them, however, have not translated in to increases in plastic recycling from residential properties (Burgess et al., 2021). Reasons for this could include a reduction in the use of single use plastics or confusion around which plastics are accepted (Agarwal et al., 2020), as this can vary across the country. Plastics could easily be contaminated with other plastic which could result in whole wagon loads

of material being rejected. Contamination causes many problems for all members of the waste value chain, from the collectors to the reprocessors.

2.6. Contamination

As the amount of material collected for recycling from households increases, there is a diminishing rate of return and to make further small percentage increases is often significant. As this effort increases so does the importance of collecting clean, non-contaminated recyclate. Additionally, environmental benefits are enhanced when recovered materials are of a high quality requiring less energy to clean or sort them (Andreasi Bassi et al., 2017). This section explains the effects that contamination can have on a LA's recycling rate.

Contamination of household recyclate occurs when material is placed in the wrong bin, such as placing a metal can in a paper recycling bin. Excess food waste left on packaging or grease that has soaked into cardboard from a pizza are also considered contamination and can therefore affect what happens to the material once it has been collected. This type of contamination can be due to the householder being confused as to what can be recycled and therefore unknowingly contaminating the bin, for instance some English LAs can recycle plastic pots and tubs and others cannot, some will collect carrier bags, others only plastic bottles. A study on the municipal recycling performance in Victoria, Australia found that contamination presented as one of the major challenges and that residents were unable to distinguish between those plastic materials that could be recycled and those that were not accepted (Agarwal et al., 2020b).

The contamination problem is said to be exacerbated by the actions of residents who, when unsure whether something can be recycled or not, place it in the recycling bin in the mistaken hope that it will be recycled and if not then it will be removed, otherwise known as 'aspirational recyclers' or 'wishcycling' (Rubicon, 2019). Purposeful contamination also occurs, as is the case when a household runs out of space in their residual bin and deliberately puts residual waste into their recycling bin. This can sometimes be picked up by the Waste Operatives when they empty the bins, however, a small number of residents may cover the top of the contamination with accepted material to disguise their actions therefore contaminating the whole wagon load. Fife

Council in the east of Scotland found that when the frequency of the residual waste collection was reduced to once a month, they saw an increase in the recycling rate, however they also saw an increase in the amount of contamination from bags of general waste arriving at the Material Recycling Facility (MRF) (Phillipson, 2016).

Contamination causes issues from taking up space in the collection vehicle to damaging equipment causing expensive repairs and downtime in separation or processing plants, (Figure 2.14). The financial burden of each of these impacts invariably ends with the LA; Hampshire County Council, for example, reportedly pays £1 million per year in landfill fees for their rejected material (HampshireCC, 2020).

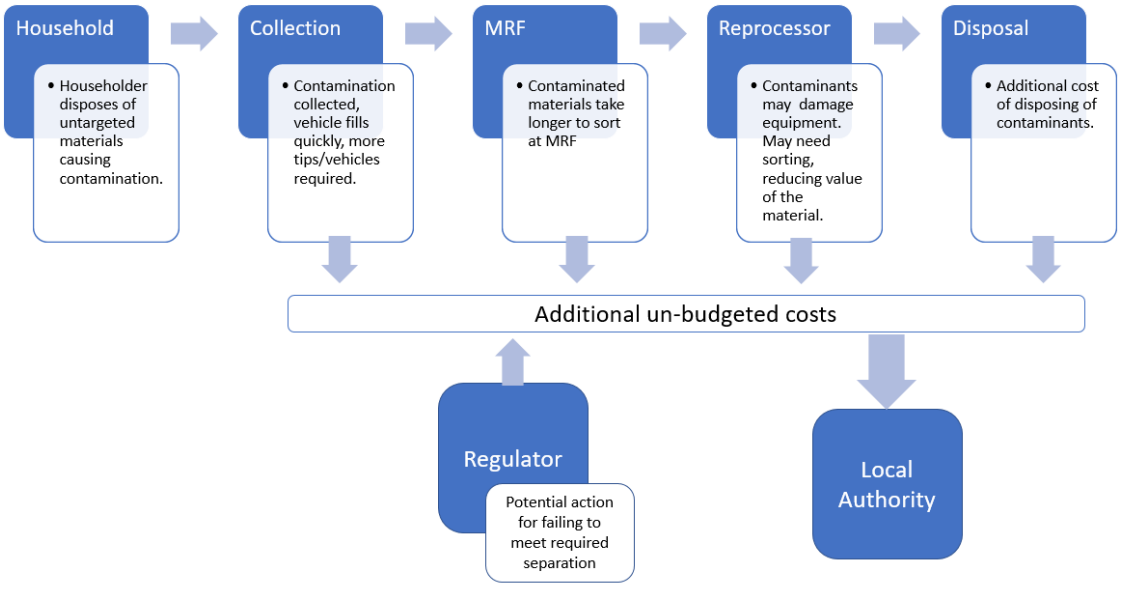

Figure 2.14: Impact of contamination (adapted from WRAP, 2015b)

Acceptable limits of contamination vary and depend on the type and technical capability of the Material Recycling Facility (MRF) that a LA is using. A report commissioned by WRAP considered three different types of contracting options between a MRF and a LA (Graham, 2008);

1. ‘Merchant’ MRF – a private sector MRF that is commercially available to process LA and commercial recyclates.
2. ‘Dedicated’ MRF – a MRF put in place by the private sector through a tender process that is primarily dedicated for use by the Contracting Authority.
3. Local Authority owned MRF – a MRF that an Authority finances and owns, but procures through a competitive tender, often a design/build/operate or design/build/operate/maintain contract with a private sector operator.

The limits that a MRF will accept will depend on the technical capabilities of the plant and also the influence of the reprocessors they sell the material to. There is no formal MRF output quality threshold set by the Government, these quality standards are set by the individual reprocessors either by way of a written quality specification document or by an informal inspection of the material. This informal method has divided opinion in the perception of the quality of the output materials from the MRFs, and where the three different contracting MRF options may have most influence. In a survey sent to both MRFs and reprocessors, across all materials most MRF operators claimed that they “always” met the required quality standard whereas the majority of reprocessors responded with only “sometimes” the standards were met (Harris, 2009). Despite this difference in perception, there was little appetite for the introduction of a formal quality management system implemented by the UK Government.

Contamination is increasing in England, in 2015/16 the Government recorded 405,272 tonnes of rejected material that was re-directed to either landfill or incineration and in 2017/18 the figure increased to 442,663 tonnes (DEFRA, 2019b). With this increase in tonnage comes an increase in landfill tax. In 2015/16 the landfill tax was set by Government at £82.60/tonne and in April 2020 it was increased to £94.15/tonne. With the financial implications of waste disposal and the pressures of austerity on LAs, the importance of reducing contamination has never been greater. Although there is a plethora of research in the field of recycling and recycling behaviour, little has incorporated the element of contamination.

For LAs to monitor their waste and recycling rates, including contamination rates, they must report their waste data regularly to the Government. The next section explains how waste data is reported in England.

2.7. Waste reporting

The UK government produces annual waste statistics in line with the requirements of the EC Waste Framework Directive (2008/98/EC) and the EC Waste Statistics Regulation (2150/2002/EC) reporting requirements (DEFRA, 2017). In 2004, the UK government released an on-line reporting system, WasteDataFlow, allowing UK LAs to report their municipal waste data directly to the government. Number of households provided with specific services such as green waste collections, the amount of waste and material collected for recycling (tonnages), and financial information is inputted on either a quarterly or annual basis depending on the question. This database captures data to monitor progress towards targets and to produce statistical overviews to inform government policy making (WasteDataFlow, 2016). Waste Disposal Authorities (WDA) in England are legally obliged to make quarterly returns to WasteDataFlow in line with the Waste and Emissions Trading Act 2003 (Regulations 2013) making WasteDataFlow one of the most reliable and up-to-date sources for waste data in the UK. It is data obtained from the 'Local Authority collected and household waste statistics 2014/2015' (DEFRA, 2015a), based on inputs from WasteDataFlow, that was used to calculate the recycling performance of LAs assessed in this study.

Waste infrastructure, service delivery and education are factors that are within the control of the LAs, however the size of the budget available to spend on them is often largely controlled by the funding decisions of central government. In this context it is imperative that LAs make effective and efficient decisions tailored to local circumstances. To appreciate what this might require it is first important to understand how local circumstances (i.e. factors outside the control of LAs, or the inherent qualities of LAs) influence recycling performance if we are to address how factors within the control of LAs might be changed to optimise recycling activity.

2.8. Geo-Socio-Economic factors impact on recycling rates

Qualities that Local Authorities have no control over can be described as their geo-socio-economic profile. These qualities will have an impact on the type of waste produced and

the available infrastructure. To determine the extent of their influence on a LAs recycling performance they are discussed in the following two sections: socio-economic factors and geographic factors. A final section will include a commentary on the impact that Covid-19 has had on recycling performance.

2.8.1. Socio-economic factors

The influence of socio-economic factors on recycling rates has attracted significant academic research (Berger, 1997, Schultz et al., 1995, Martinho et al., 2017, Assaf et al., 2019, Okonta and Mohlalifi, 2020), which has often resulted in conflicting evidence and contrary messages. For instance, a quote from a study carried out on self-reported recycling behaviour in Devon, UK, in 2005 states that if there were a model waste recycler their characteristics would be, "in crude terms";

> "…a young, female, employed, well-educated, high income-earning liberal individual." (Barr et al., 2005).

To take these characteristics separately:

<u>Age</u>

A study conducted in Athens agreed that young people were more inclined to recycle (Stogia et al., 2015) and age was also found to have a significant impact on household recycling rates in a study carried out in London (Swamia et al., 2011), however, it concluded that it was the older generation who would recycle more, contrary to Barr *et al's* findings. The latter study found the younger population were more inclined to reuse, rather than dispose for recycling or landfill (Swamia et al., 2011). The same conclusion was reached in a study in Portugal where age was also a factor when considering small Waste from Electrical and Electronic Equipment (WEEE). Younger people (≤35 years) preferred to keep hold of broken smartphones or pass them on to friends, they also did not know where to recycle them which was consistent with their general recycling habits. The older generations were found to have fewer smartphones than the younger generations and were aware of recycling schemes available to them (Martinho et al., 2017). In contrast, studies by Assaf et al. (2019), Schultz et al. (1995) and Oskamp et al. (1991) found no correlation between age and recycling rates. The effect of age goes

beyond whether a person recycles or not, it also includes what they consume and therefore the wastes they produce. A study carried out in Czech cities found that age had no impact on the production of glass waste whereas there were significant differences in the plastic waste stream between the older and younger generations, with the younger population producing more (Rybova and Slavík, 2017).

Gender

Several studies have found that gender does have an impact on recycling behaviour within the home with studies showing males less likely to recycle (Barr et al., 2005; Stogia et al., 2015). A possible explanation for this is provided in a study based in Greater Manchester, UK, where certain communities have females as the primary housekeepers and males are employed in a role out of the home, therefore the female would be more likely to recycle due to being in the home more often (GMWDA, 2015). It is also worth noting that genders have different consumption habits which could have a knock-on effect on waste production and recycling. For instance, in Portugal, women reported owning fewer broken smartphones in their home compared to men, indicating that they participate in more recycling or reuse programmes (Martinho et al., 2017). However, when asked, the men suggested that they update their phones more regularly than the women and keep older phones for a backup or as a tool to get a discount on future purchases. A contrary view Is expressed by Schultz et al. (1995) when summarising five studies which unanimously demonstrated that gender has no influence on recycling rates, this position is further corroborated by a study carried out in Ras Al Khaimah (RAK) in the United Arab Emirates where gender was not significantly associated with recycling attitude or behaviour (Assaf et al., 2019).

Employment and Income

Shultz *et al.* found an overwhelming positive correlation between income and recycling with recyclers earning more than those who do not recycle (Schultz et al., 1995). However, a study that attempted to explain the variation in recycling rates between all UK LAs found that economic status had an insignificant effect on recycling rate (Abbott et al., 2011). Despite this, the ability to purchase goods increases with higher incomes (Rybova and Slavík, 2017), such as replacing smartphones to upgrade to a newer version

rather than at the end-of-life stage, thereby producing more waste, although this does not always translate into greater recycling rates (Martinho et al. (2017). In fact, an audit of waste production from lower economic, high-rise buildings in a London Borough found less food waste than was predicted. The study surmised that this was due to the recession and with the cost of food increasing residents were either buying less or wasting less (Rispo et al., 2015). The same conclusions were drawn when areas of high unemployment had significantly lower plastic waste generation in the Czech Republic. The authors explained the variance as a result of frugal lifestyles and reduced consumption (Rybova and Slavík, 2017). It is worth noting that access to facilities and attributes such as income as influences on recycling activity are sometimes related but not necessarily one and the same. An early Canadian study found that household income significantly influenced whether a person had access to paper recycling facilities. Just over 65% of households with an income greater than $100,000 had paper recycling facilities compared to 40% of those with incomes less than $15,000 (Berger, 1997).

Academic Education

Agreeing with Barr *et al.* (2005), Berger's (1997) study found that 58% of university educated people had access to paper recycling, whereas this number dropped significantly to 35% with a Grade 8 education or lower, two points to note here are that even though facilities are available it does not mean that residents use them, and that education and income are covariates when studying recycling behaviour (Owens et al., 2000). Education level was found to be significantly associated with pro recycling behaviour in RAK (Assaf et al., 2019), the Czech Republic (Rybova and Slavík, 2017) and positively correlated in Johannesburg (Okonta and Mohlalifi, 2020). Oskamp *et al*, however, found no relationship between education and household recycling rates in their US study (Oskamp et al., 1991).

Social Impacts

When looking at the multi-dimensional aspects of household waste management, the study carried out in Devon, UK, found that a large proportion of non-recyclers were Labour voters or non-voters and those with a propensity to recycle were more likely to vote Green or Liberal Democrat (Barr et al., 2005). A London based survey corroborates

these findings to an extent also concluding that the less Machiavellian and less politically cynical a person is the more likely they are to recycle (Swamia et al., 2011).

The perception of the behaviour of others can also have a positive effect on recycling as shown by graduates in Johannesburg. They explained that they had a social responsibility to recycle, this major driving force was complemented with those who had larger family sizes (Okonta and Mohlalifi, 2020). This inter-generational influence on positive recycling behaviour was also seen in a study in Rotherham, UK (Maddox et al., 2011) and in the Czech Republic (Rybova and Slavík, 2017). However, a study carried out in an area in France known to have low household waste recycling found that a lack of recycling behaviour in neighbours had a negative impact on nearby household recycling (Kirakozian, 2016). An assumption was that individuals who wanted to recycle felt that their efforts were pointless due to their neighbours not participating and so did not participate themselves. Shaw (2008) concluded that the influence from neighbours was linked to street architecture and that those in cul-de-sacs saw the greatest influence.

Ethnicity

There has been less research carried out on the link between ethnicity and recycling behaviour (Schultz et al., 1995), however, an early study conducted on college students in Chicago found that 28% of Asians, 28% of Blacks, 12% of Hispanics, and 51% of Whites claimed to recycle (Howenstine, 1993). The assessment was limited as it did not take in to account the other demographic variables such as parental income and education. Perry and Williams (2006) found that British Indians were more likely to recycle than their White British counterparts in a study in Preston, UK, and also in the UK, The Up and Forward project in Greater Manchester attempted to provide recycling communication to the 'hard to reach' members of society, including those whose first language was not English. The project found that even when the literature was written in languages predominant for certain areas it had little effect on the recycling performance (GMWDA, 2015). In fact, data collected from religious institutions in Canada demonstrated that community leaders were more successful in changing recycling behaviour among ethnic minorities than education efforts from local authorities (Lakhan, 2018).

Despite the contrary messaging from the literature concerning the impacts of individual qualities, it is clear that socio-economic factors influence recycling performance. The recycling performance will be further influenced by the locality of the Local Authority and the impact this has on how people live, consume, and recycle.

2.8.2. Geographical factors

The human and physical geographical nature of a LA have both been shown to influence recycling performance (du Toit and Wagner, 2020; Berger, 1997; Calvin Lakhan, 2016; Kirakozian, 2016).

Rurality and housing type

Those LAs that have a more rural population and therefore more space will most likely have a higher proportion of individual dwellings compared to urban LAs that have more buildings with multiple occupation (Roberts et al., 2015). Those living in houses are more likely to recycle according to Kirakozian (2016), this could be due to having the space for receptacles such as wheelie bins or a greater awareness of 'keeping up with the neighbours. In a study carried out in Canada, the author found that 60% of single family dwellings reported having paper recycling facilities, whereas only 35% of apartments did (Berger, 1997). Apartments and houses of multiple occupation have lower recycling rates possibly because amenities are shared and no one person takes ownership to ensure that the waste is properly segregated. In a self-reported participation questionnaire in Pretoria, South Africa, respondents living in apartments said that they could not recycle due to lack of space (du Toit and Wagner, 2020). There is also an 'out of sight, out of mind' mentality as evidenced by one study in Ontario, Canada where recycling participation increased when the bins were placed in the lobby of an apartment block, rather than in the bin store (Calvin Lakhan, 2016). As urban populations expand and with more single person residents there will be more pressure on the LA to provide efficient waste management systems (Omran and Read, 2008).

Population demographics and waste type

Determining the type and amount of waste a population produces is vital in providing a suitable waste and recycling collection scheme. For instance, an aging population will not

produce as much plastic as an area predominantly filled with families (Rybova and Slavík, 2017). This becomes more complicated when a portion of the population are transient, which is the case in higher populated, urban areas. By monitoring recycling bins from properties, a study in Portsmouth determined that many of the properties that were once recyclers but then turned non-recyclers were explained by a change in occupant. Timely education was suggested to resolve this issue, especially within the student population that increases population during term times and generally move at the same time each year (Timlett and Williams, 2009).

Tourists, another form of transient population, provide seasonal challenges to LAs when designing infrastructure to cope with the temporary increased population (Bashir and Goswami, 2016; Fennell and Bowyer, 2020). Certain areas such as coastal LAs can have greater retired populations and as consumption habits change with age, so do waste streams, which may have an impact on waste management systems (Rybova and Slavík, 2017). However, out of town areas popular for retirement are also popular for tourists and so the demand on the systems changes. It is highly likely that materials collected for recycling will be different in the holiday destination than at home and so will be a barrier to some when disposing of waste and materials for recycling (DEFRA, 2018b). This problem of tourism is echoed around the world in India (Bashir and Goswami, 2016), Bahamas (Sealey and Smith, 2014) and Russia (Korchagina et al., 2018), to name a few.

Geographic location

The physical location of a LA can also provide challenges to the waste management system and therefore recycling performance. Areas that have hills or mountains will find remote, hard to reach communities a challenge to provide similar services to those in the plains (Bashir and Goswami, 2016). Temperatures can affect the type of waste management system, although an extreme example Bharti et al. (2016) explains that waste generation and management from scientific stations in Antarctica is sub optimal with large proportions being discharged to the environment with unknown consequences. Coastal areas have beaches to clean, which is defined as municipal solid waste, and have increased waste produced by tourists (Seckin et al., 1997). Coastal areas also have the added challenge of seagulls ripping open bags (Britten, 2019). Wildlife can cause issues in urban areas too with foxes, rats and pigeons feeding from waste bags

(Portsmouth City Council, 2021). Animals, however, are not always a pest and can be part of the waste management system, as are goats in Khartoum, Sudan, where organic waste is used as a feed supplement (Richardson and Whitney, 1995).

Overall, the influence of these inherent, geo-socio-economic factors are clearly complex and sometimes confounded by the interplay with factors within the control of a LA such as infrastructure provision. Nevertheless, the consensus is that these factors influence the recycling performance of a LA.

Other factors that a LA has little control can include political changes, such as the introduction of austerity and the UK leaving the European Union (Brexit), and changes in waste disposal legislation and recycling targets, as discussed earlier in this chapter. Recently, however, new challenges emerged when a worldwide pandemic, Covid-19, swept the globe.

2.8.3. Covid-19 pandemic and the impacts on recycling performance

Covid-19, a novel coronavirus, was declared a pandemic in March 2020 by the World Health Organisation (Pavone, 2020). In response to the increasing pressure in hospitals, governments around the world imposed strict lockdowns where residents were confined to their homes and only permitted to leave for precise reasons such as to shop for food. Schools, shops, hospitality, and workplaces were closed with only front-line services allowed to continue.

In response to the lockdowns, LAs closed household waste recycling centres across the UK and most reduced their kerbside collection service due to staff shortages from illness. Waste data reporting saw long delays also due to staff absence, but also because of redeployment of staff to new services set up to manage the pandemic (DEFRA, 2021a).

Covid-19 caused the quantity and composition of municipal solid waste to change (Yousefi et al., 2021), much lower tonnages of commercial municipal waste were produced (DEFRA, 2021a), however there was an increase in waste and recyclate from residential properties. A study comparing residential waste production between pre pandemic 2019 with mid pandemic 2020 saw an increase of 9% in Trento, Italy and a 12% increase in waste in Montreal, Canada (Cai et al., 2021). Card increased due to an increase

in on-line shopping delivery boxes and food and food packaging waste increased due to lunches that would have otherwise been eaten in the workplace or at school were now being prepared and eaten at home (Liang et al., 2021).

There has been a marked increase in the use and therefore disposal of personal protective equipment (PPE) too, with increases of between 18%-425% seen during this time (Liang et al., 2021). PPE waste is produced primarily from healthcare settings (Ahmadifard, 2020) however, with changes in government policy and guidance there has been a marked increase in the use of facemasks by the general public therefore increasing PPE from residential properties too. This has instigated a new wave of research into recycling PPE, such as using disposable facemasks as acoustic absorbers in the building sector (Maderuelo-Sanz et al., 2021).

In addition to face masks, lateral flow tests (LFT), a rapid antigen test to detect Covid-19 at home, is widely used in the UK, especially by school children and their families. After the 2021 January lockdown ended on the 17th of March, all secondary school children were required to use the LFT twice a week, in that first week back to school just over 7.6 million LFTs were used (DEFRA, 2021d). The tests are provided in boxes of seven and contain plastic vials, plastic bags, swabs and test strips with a small desiccant bag in each to prevent moisture, all of which is disposed of in the residual bin causing further changes to the composition of the residual waste stream.

In response to the potential to transmit the disease through the handling of waste (Kulkarni and Anantharama, 2020) the UK government requires residents who test positive for Covid-19 to double bag their waste, including PPE and LFTs, and leave it for 72 hours before placing it in the residual waste bin (DEFRA, 2021d). Liang et al. (2021) suggest the need for PPE and its safe disposal has overshadowed policies related to the reduction of plastic use and recycling, only time will tell, however, to what extent this has impacted on efforts to increasing recycling.

The impact of Covid-19 has extended to the transportation of waste and recyclate due to disruptions within the shipping industry, including operators, port operators, shippers, and supply chain operators (Yazir et al., 2020). With reduced staff and lockdowns, approximately 25 million shipping containers were taken off their routes during 2020.

This caused the cost of shipping containers to surge, resulting in the transportation of waste to skyrocket (Bloomberg, 2021) invariably ending up working down the chain to sit with the LA.

These unprecedented times have changed the way people commute, work, eat, and shop and even though it has been 18 months since Covid-19 was declared a pandemic, the resulting impact on the waste sector has yet to be fully realised.

The pandemic was out of the control of the English LAs, yet their response to it, changing infrastructure provision, was within their control. The next section takes a closer look at what factors LAs do have control over and the impact they have on recycling performance.

2.9. Factors under the control of LAs that affect recycling rates

The analysis of the literature highlighted factors that a LA has control over with regards to recycling rates will be discussed in the following two sections: waste infrastructure and education & interventions.

2.9.1. Waste infrastructure and service delivery

Waste collection schemes are managed by Waste Collection Authorities or Unitary Authorities in England and the services are carried out either internally or sub-contracted to external organisations. The services can differ from one LA to another from the frequency of collections to whether the household waste recycling centres (HWRC) house re-use shops as well as recycling facilities.

Route optimisation and the number and type of vehicles are precisely planned for the type and amount of waste that is collected. Models are available that help forecast the amount of fuel vehicles use if, say, a new source separated food waste collection was added to a kerbside scheme (Edwards et al., 2016) and in Texas (Vu et al., 2020) and China models have been used to determine the most efficient routes for vehicles based on their capacity and predicted collection tonnages (Wu et al., 2020). This information can also inform residents as to when their bins will be emptied, something residents in

Bharatpur, Nepal found helpful to reduce the amount of waste placed in their bins from passing pedestrians on collection day (Rai et al., 2019).

Calculating the cost of waste collection and transportation is essential when designing a scheme as this is where 70% of the total costs lie (Boskovic et al., 2016). England uses a tax system, the Council Tax, to fund the waste and recycling collection so residents do not use pay-as-you throw type schemes. However, some LAs do have separate charges for garden waste (Collinson, 2019) with residents paying an annual fee per bin. A study conducted in Malta found that taxing garden waste disposal promoted composting uptake, however schemes such as this also have unintended consequences as it can induce illegal waste disposal (Briguglio, 2021). Despite this, a marked reduction in waste is seen when residents pay for disposal using pay-as-you-go schemes, indicating that when people see a direct correlation between waste and their money it might cultivate a sense of responsibility when controlling the amount of waste they produce (Briguglio, 2021; Wada et al., 2009; Rai et al., 2019).

When designing waste and recycling infrastructure, although no one scheme is perfect (Neohammer & Byer, 1997), convenience is key to participation, and kerbside collections provide a much more convenient way for residents to recycle than the previous bring-to-site schemes (Struk, 2017). LAs should still consider distances people need to travel for take back or buy back schemes, as if they are too great or inconvenient the journey will be a deterrent (Okonta and Mohlalifi, 2020; Becker et al., 2021). This is particularly important as England is in the planning stages of a deposit return scheme for drinks bottles.

The frequency of collections can impact the recycling rate; a study in Litchfield, UK, found that when the residual waste changed from a weekly to a fortnightly collection the recycling performance increased (Williams and Cole, 2013), agreeing with Wilson and Williams (2007). The study also found that residents recycled more when they had only one bin for all recyclate, rather than when they had to sort the recyclate further in to two bins.

Design variables of recycling bins include shape, colour, type of lid and insert slot (Keramitsoglou and Tsagarakis, 2018), and the variety of bins in England is vast. There has

been substantial research in to how these variables influence participation and recycling performance, however LAs must also be aware of manual handling risks for waste operatives (Thomas et al., 2019; Thomas et al., 2021), lifting mechanisms of vehicles and suitability for the property such as having larger Euro bins for communal facilities (Figure 2.15) would not be appropriate for a terraced property.

Figure 2.15: Photograph of communal bins in Northampton (Circular, 2013)

Public participation in designing street recycling bins to encourage recycling was investigated in Greece. The study concluded that the public preferred a rectangular slot for recyclate other than for food and glass (Keramitsoglou and Tsagarakis, 2018). Although, a Japanese study found that a bin with a round slot for plastic bottles received the least contamination than other designs (Jiang et al., 2019). The Greek study also found that people preferred bins coloured orange, yellow or purple, however they associated certain materials with certain colours such as white or grey for paper, and metallic grey for cans and clear glass. Bin colour was found to have no influence over recycling behaviour cross culturally in a study conducted in Taiwan and East Asia and the Pacific area (Chang, 2020). However, a study in Thailand found that bins coloured with least favourable colours were less likely to be noticed and that there was a significantly negative correlation with the recycling rate and noticeability i.e. there was more recyclate in the less noticeable bins (least favourable colour) and there was also less contamination too (Leeabai et al., 2021).

With the advances in technology and the introduction of the Internet of Things (IoT) there has been research towards making bins smart. Increased recycling motivation was seen

with the installation of a camera inside a household bin lid termed a ‘social persuasive system’. The camera identified materials as they were placed in the bin, then uploaded the data to an APP where users could interact with each other (Thieme et al., 2012). Baras et al. (2020) also used a sensor in the bin to take images of material, the data is then uploaded and analysed in the cloud, reducing the cost of the equipment physically in the bin.

Using technology to identify materials, a prototype of an automated sorting recycle bin was developed in Malaysia (Hassan et al., 2018). The bin is able to sort aluminium, paper and plastic (Figure 2.16) by first sensing the type of material followed by mechanically sorting it. This design relies on the correct type of waste being place in the bin, however, it could be developed to remove contamination. Using the IoT and an APP with controls, a prototype of a smart waste recycling bin has also been developed for residential use transforming organic waste into liquid fertilizer (Harjoseputro et al., 2020). Another type of smart bin has been tested that weighs the amount of material in it and by using a radio frequency identification system integrated with a web-based information system, the waste can be tracked along the whole recycling chain (Abd Wahab et al., 2014). Other studies have attempted to gamify recycling, for example one study added an LCD screen to the bin to provide visual and audio cues when material was placed in the bin. This example saw a 3-fold increase in collection rates when the emoticons and sounds were used (Berengueres et al., 2013).

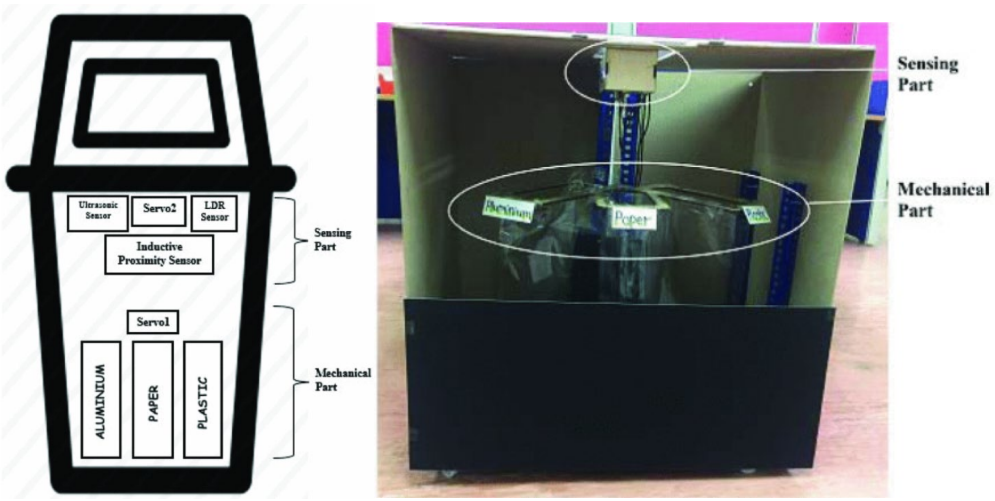

Figure 2.16: Prototype of an automated sorting recycling bin (Hassan et al., 2018)

There are undoubtably many decisions to make when designing a waste collection scheme, and to make even small tweaks could see high costs once upscaled for all residents in an area. Regardless of how the scheme is run or what bins are used, it is fundamental that the residents know how to use them. LAs are responsible for providing the resources needed to make sure this information is known by every person in their area.

2.9.2. Education & interventions

Education and interventions are tools used by LAs to encourage the public to recycle (Timlett & Williams, 2010). Factors such as policy and availability of recycling facilities help explain the variation in recycling rates between LAs; however, along with access to facilities and pay-as-you-throw Schemes, education and on-going environmental awareness campaigns were found to be one of the biggest influences on recycling rates within the control of LAs in a study conducted in Massachusetts (Starr and Nicolson, 2015). To support this, a study in China also concluded that publicity and education has the most significant impact on source separation (Peng et al., 2021).

Schultz et al. (1995) carried out a literature review of studies into the determinants of environmental behaviour. They concluded that awareness and attitude were fundamental factors in whether a person will recycle or not. Their review found it was specific knowledge of the recycling scheme available, rather than general environmental knowledge that was the predictor of positive recycling behaviour. Further to this, a study carried out on five deprived high-rise estates in the London Borough of Haringey concluded that continued communication to change behaviour over time is required to increase recycling performance (Rispo et al., 2015).

The importance of continual communication and education was echoed in a study carried out in Texas, USA, where the LA, waste contractor and a primary school worked in partnership to determine the effects of recycling education (Cunningham-Scott, 2005). The study found that recycling rates increased during the term time and fell dramatically during the summer months, increasing again once the children had returned to school and were again exposed to the recycling education. The project was deemed a success

and the LA confirmed that the campaign would be rolled out to the rest of the primary schools in the area.

The Taking Home Action on Waste (THAW) project was conducted in Rotherham, United Kingdom to determine the effects of intensive education in infant and primary schools (Maddox et al., 2011). The project centred around the 3'R's (Reduce, Reuse and Recycle) and involved assemblies, workshops and homework to complete with parents. The results were overwhelmingly positive with residual wastes falling by 4.5%, paper recycling increasing by 4.3% and glass, cans and textiles by 8.7%. The project concluded that as well as producing a waste aware cohort of children there was also evidence that intergenerational influence can have substantial effects on waste and recycling rates, this is echoed in a study in the Czech Republic (Rybova and Slavík, 2017).

Environmental education in school has been of growing importance on the global stage for many years. In 1994 'Eco-Schools' was set up by the Foundation for Environmental Education. This voluntary, pupil-led programme empowers young people to develop an environmentally conscious world (FEE, 2020). This seven-stage programme guides young people through forming an eco-committee, carrying out environmental reviews, making action plans linking to the curriculum and producing an eco-code for the school. Initially Eco-Schools were European based but the scheme now has over 59,000 schools in 68 countries around the world (EcoSchools, 2020).

The education system in the United Kingdom has incorporated environmental education (EE) at certain points over the years. It was introduced as a cross-curriculum topic 'the built and natural environment' in 1990 but was removed from classrooms in 1994. In 2000, UNESCO's Education for Sustainable Development initiative introduced environmental education as a non-statutory topic, this was updated in 2006 by the Sustainable Schools Strategy which included a 'Purchasing and Waste' module, but again this was removed in 2010 (NAEE(UK), 2015). Since 2014 there has been little formal environmental education let alone specific waste and recycling education in schools, although it is mentioned as a small element within the Science subject in Key Stage 3 (DfE, 2014). Organisations such as the National Association for Environmental Education, a UK based charity, and Waste Watch who later merged with Keep Britain Tidy, provide support to teachers wanting to teach EE in their classrooms, this relies heavily on the

interests of teachers and their willingness to incorporate EE into their classroom activities.

Many local authorities offer recycling resources for schools, for example Wigan Council in Greater Manchester, UK, provides videos, visits to waste depots and help with setting up recycling facilities (Wigan Council, 2021). Good signage in education facilities leads to an increase in recycling performance. A university campus saw increases from 27% to 74% in the amount of plastic and glass bottles recycled before and after educational signs with positive cues were posted next to recycling bins 'Feel Good for Doing Good' (Becker et al., 2021).

Message framing has an impact on people's propensity to recycle. Positive cues, such as 'Feel Good for Doing Good' or a 'thank you' sticker can attract higher recycling rates, however, Yang and Liu (2021) suggests that people's reluctance to suffer negative consequences is greater than their desire to gain a positive consequence of similar value. The study, based in China, also found negative frames more effective on those with a lower environmental involvement.

The theory of planned behaviour (TPB) is a theory used to understand and predict human behaviour and has been used widely in recycling behaviour studies (Ajzen, 1985; Pakpour et al., 2014; Razali et al., 2020; Aboelmaged, 2021). TPB explains that behavioural intentions are determined by 'attitudes towards the behaviour, subjective norms, and perceived behavioural control' (Kan and Fabrigar, 2017). TPB was applied to the recycling intention of e-waste in young people; the outcome found that recycling habits and perceived attitudes were strong predictors of recycling intention (Aboelmaged, 2021). TPB also explained 47% of the variance in household waste behaviour in a study in Iran, which suggests that this knowledge can be used to inform public campaigns and interventions. Their study found that targeting moral obligations would be of most benefit in their target area (Pakpour et al., 2014).

WRAP considered classifying recycling behaviour into four categories based on competences derived from a learning model developed by Dreyfus & Dreyfus in 1986; Level 1- unconsciously incompetent, Level 2 – consciously incompetent, Level 3 – consciously competent and Level 4 – unconsciously competent (WRAP, 2008c). Moving

people up through the levels will not only see an increase in the participation and quantity collected but also an increase in the quality of the separated recyclates. Jesson (2009) explains, however, that to move non recyclers into recycling further steps are required so expanded the four competencies in to seven: Recycling unaware, Aware but inactive, Contemplated, Sporadic, Trying their best, Broadly competent, and The complete recycler.

Every year LAs deliver a calendar listing the recycling and waste collection dates to their residents, this is often accompanied by literature explaining what goes in which bin. In 2008 WRAP commissioned a study 'Barriers to recycling at home', which found that despite this information one third of the recyclers who responded to the questionnaire would recycle more if they had better information, with the vast majority (86%) also indicating that seeing the practical impact of recycling in their local area would increase the amount they recycled (WRAP, 2008c). Evison and Read (2001) found that education should be delivered frequently to maintain an impact on participation and Willman's study concluded that door-to-door literature had a far greater impact than relying on bills or websites as communication vehicles for educational/awareness messages (Willman, 2015).

Different media such as leaflets, websites, newsletters, calendars, pamphlets, face-to-face and social media can be used to convey these messages (Timlett and Williams, 2008; Shearer et al., 2017; Lu et al., 2018; Cotterill et al., 2009). Including information about other systems such as on-pack recycling labels and the plastic-based three-arrow triangle with a numbering system can aid the correct identification of materials too, thereby decreasing contamination (Coltro et al., 2008). Targeted education, raising awareness and interventions are considered crucial for a waste and recycling scheme to be successful (Jamal et al., 2019) and as such should be considered just as important as infrastructure.

2.10. Chapter Summary

The role LAs play in the management of waste in England is a complex mix of fulfilling statutory requirements, minimising costs, and designing an easy-to-use service whilst educating their residents on how to use that system. The challenges of meeting the ever-increasing demand to collect, transport and separate material for recycling have been

met during a period of austerity, reducing resources such as service provision and personnel.

Approximately 23 million tonnes of household waste was produced in the 2019/2020 financial year (DEFRA, 2021c) with dry recycling accounting for 5.9 million tonnes. Waste audits have estimated that nearly 26% of material disposed of in the residual waste steam is recyclable using the current system. The infrastructure required to handle this huge quantity of waste is both costly and complex and some LAs have found themselves tied to long, expensive PFI contracts with outdated technology. Extracting the 26% of recyclable material is the most economical way a LA can increase their recycling performance and would see England rise from a recycling rate of 44% to one that would sit comfortably with the best recyclers in the world such as Wales at 65% and Germany at 66%.

The recycling performance of a Local Authority can be impacted by factors within and outside of their control and have attracted significant scientific interest, resulting in a wealth of research in the field. Until recently, many studies have concentrated on increasing landfill diversion rates which includes incineration producing energy from waste (Price, 2001; Mazzanti and Zoboli, 2009). Although this is still prominent in waste management, there has been a shift towards material recycling rather than incineration as a Circular Economy has become the focus (Merrild et al., 2012; Farmer et al., 2015). Those studies that have investigated recycling rates have mostly focused on the quantity of output (Abbott et al., 2011; Grazhdani, 2016) yet few are concerned with the quality of the separation. There is now a greater significance for good quality recycling as policy is changing towards a Circular Economy (European Commission, 2016), reprocessors are demanding higher quality separation and increasingly downstream separation technologies, in particular with the residual waste stream, are peaking in their capabilities.

Inherent characteristics, such as GSE factors, are largely out of the control of a LA, however it goes to reason that the impact these factors have on recycling performance would be similar on LAs with similar characteristics. Research in this area, together with factors LAs have control over (Figure 2.17) has predominantly concentrated on single subjects such as collection frequency (Evison and Read, 2001), intervention type (Shearer et al., 2017) or a single LA (Cole et al., 2014), however, they have shown that responses to

GSE characteristics should be well designed to suit local requirements to extract greater amounts of clean recyclate. Few studies attempt to combine these factors providing a holistic view of the options available to a LA on which to base infrastructure changes or interventions.

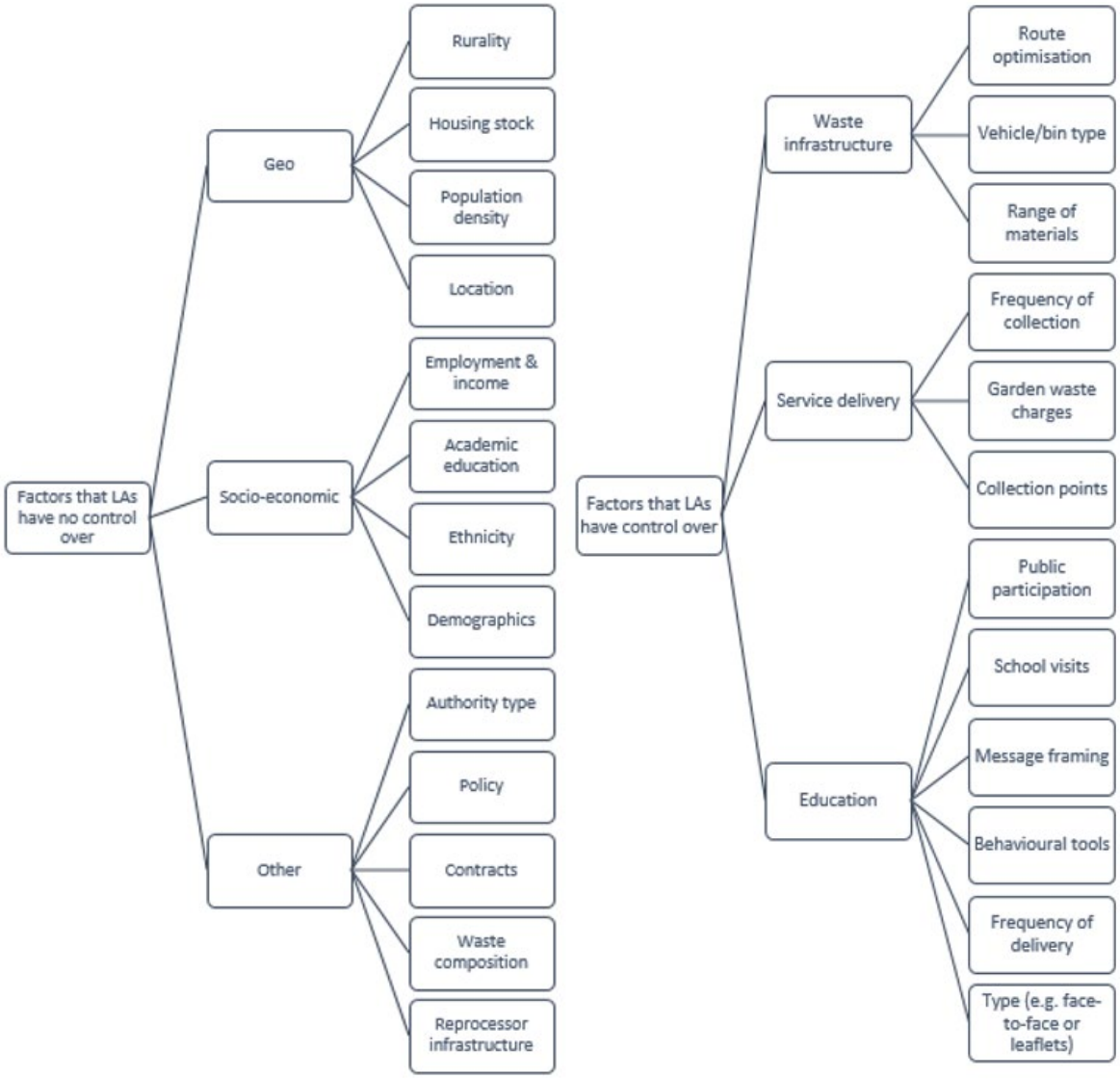

Figure 2.17: Summary of factors that influence LA recycling performance

To figure out what works best and why, it is necessary to factor out the GSE characteristics and investigate the recycling performance of seemingly similar LAs with a view to identifying the reasons for the difference in performances, which in turn can be

used to target those actions under LA control to optimise recycling performance. GSE factors have been used to create a number of tools such as the government's Index of Multiple Deprivation (IMD) which aims to classify LAs based on their deprivation using factors such as edcuation, employment, and income (DCLG, 2015). Geographic factors are also used in a Rural-Urban Classification to distinguish English LAs based on their degree of rurality, quantifying the amount of rural dwellings (DEFRA, 2015b). These official statistics allow for the grouping LAs with similar characteristics thereby minimising the influence of GSE factors, this is discussed further in Section 3.4.1.

It is here where this research contributes to knowledge, it enhances an understanding of the factors influencing recycling rates and investigates the dynamics between them. The outputs provide benefits to LAs for assessing their recycling performance and provides best practice examples specific to their GSE group. The results can be used to inform policy too, providing a rich understanding of recycling performances incorporating on-the-ground knowledge. For these reasons the aims and objectives as set out in Chapter 1 are fulfilled.

3. Methodology

3.1. Chapter outline

The following chapter describes the philosophical approach taken to investigating the aims and objectives set out in Section 1.2 of this thesis. Reasons for the chosen research paradigm and design are discussed, drawing from experience in the social science field. The research methods are then presented using the four main sections of an explanatory sequential design (Figure 3.3): the first phase is the quantitative element of the study – the Influence of geo-socio-economic (GSE) factors on recycling performance. The second phase is the qualitative element, the case studies. The quantitative and qualitative data are connected through the case selection and finally, the interpretation of results.

3.2. The research approach

The purpose of this study is to understand why recycling performance varies between LAs with seemingly similar GSE characteristics, with a view to learn from the best and poorest performers. It is exploratory in nature so can be characterised as a phenomenological study (Creswell, 2014) using inductive reasoning, rather than an experimental study that starts with a theory or hypothesis, using deductive reasoning (Figure 3.1).

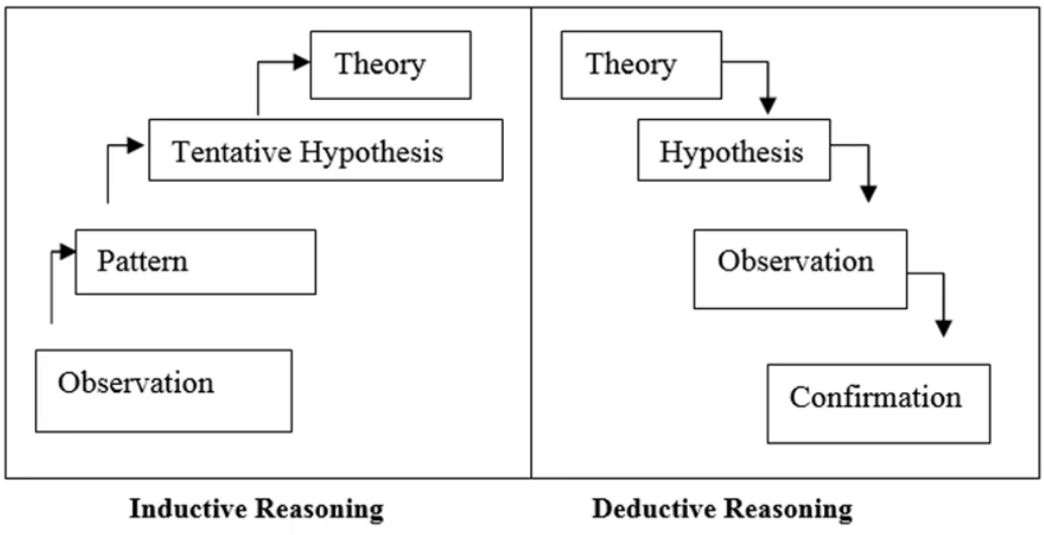

Figure 3.1: Inductive reasoning vs deductive reasoning (Munim, 2019)

The Oxford Languages Dictionary defines a phenomenon as;

> "A fact or situation that is observed to exist or happen, especially one whose cause or explanation is in question."

Therefore, to frame this study within the phenomenological philosophy, the research phenomenon is;

> 'LAs with seemingly similar GSE characteristics have different recycling performance'.

Methodological philosophies determine the design of a research study (Mackenzie and Knipe, 2006), to decide which one to use it is first important to know what type of data the researcher is going to collect. The research question, devised from the research phenomenon, helps to identify what data is needed to conduct the study and therefore will help to identify the research philosophy (Creswell, 2014). This study's research question is;

> 'How can a better understanding of the determinants of differing recycling performance among LAs with seemingly similar geo-socio-economic characteristics be used to enhance interventions used to improve recycling activity?'

The data needed to help answer the question is both qualitative and quantitative in nature;

- The quantitative element includes the GSE data that informs a classification scale, used to group LAs with similar GSE characteristics, and waste and recycling statistics used to calculate recycling performance. This large, quantitative data set is used to investigate trends and relationships using comparisons.
- The qualitative element of the study involves taking samples from within the groups to investigate why there are differences in the recycling performance. This smaller, qualitative data set is descriptive and contextual in nature.

Quantitative and qualitative data require different data collection and analytical methods, these are informed by theoretical approaches, referred to as philosophical paradigms (Mackenzie and Knipe, 2006). Guba and Lincoln (1994) define a paradigm as;

> "…a set of beliefs (or metaphysics) that deals with ultimates or first principles. It represents a worldview that defines, for its holder, the nature of the 'world', the individual's place in it, and the range of possible relationships to that world and its parts."

It is important to define the paradigm because it provides a consistent framework for studies to be critically analysed and assessed for trustworthiness (Spencer et al., 2003). The first stage of defining the paradigm is to classify the study's ontological stance, the belief about reality, what is the truth (Creswell, 2014)? For the quantitative element of this study a realist perspective is taken, that is, only one truth exists that can be objectively measured, the GSE and waste collection data.

The qualitative element, to investigate why there are differences in recycling performance, takes on a relativistic ontological perspective (Creswell, 2014). The relativist research is shaped by context where truth evolves based on experiences and rather than one truth, there are multiple realities based on differing experiences.

The ontological belief dictates the epistemological belief, the second stage of determining the research paradigm. This stage places a value on the relationship of the researcher with the study (Denzin and Lincoln, 2011). For the quantitative, realist element of this study the data is collected objectively, therefore using an etic epistemological method, with the researcher removed from the context of the study.

In the qualitative, relativistic element, the researcher interacts with the research to discover meanings and reasons for the differing recycling performances. This emic epistemological approach includes in-depth interviews with the LAs where the researcher accepts that this is a value-laden process (Creswell, 2015).

The ontological and epistemological beliefs for each element of the study are the determining factors when considering the research paradigm (Guba and Lincoln, 1994). There are four main paradigms used for research in the social sciences; postpositivism,

Basic beliefs	**Postpositivism**	**Constructivism**	**Transformative**	**Pragmatic**
Axiology (nature of ethical behaviour)	Respect privacy; informed consent; minimise harm (beneficence); justice/equal opportunity	Balanced representation of views; raise participants' awareness; community rapport	Respect for cultural norms; beneficence is defined in terms of the promotion of human rights and increase in social justice; reciprocity	Gain knowledge in pursuit of desired ends as influenced by the researcher's values and politics
Ontology (nature of reality)	One reality; knowable within a specified level of probability	Multiple, socially constructed realities	Rejects cultural relativism; recognises that various versions of reality are based on social positioning; conscious recognition of consequences of privileging versions of reality	Asserts that there is a single reality and that all individuals have their own unique interpretation of reality
Epistemology (nature of knowledge; relation between knower and would-be known)	Objectivity is important; the researcher manipulates and observes in a dispassionate, objective manner	Interactive link between researcher and participants; values are made explicit; create findings	Interactive link between researcher and participants; knowledge is socially and historically situated; need to address issues of power and trust	Relationships in research are determined by what the researcher deems as appropriate to that particular study
Methodology (approach to systematic inquiry)	Quantitative (primarily); interventionist; decontextualized	Qualitative (primarily); hermeneutical; dialectical; contextual factors are described	Qualitative (dialogic), but quantitative and mixed methods can be used; contextual and historical factors are described, especially as they relate to oppression	Match methods to specific questions and purposes of research; mixed methods can be used as researcher works back and forth between various approaches

Table 3.1: Basic beliefs associated with the major paradigms (Mertens, 2005)

constructivist, transformative and pragmatic (Mertens, 2005), see Table 3.1 for a review of the basic beliefs of each paradigm.

If the two elements are seen as two distinct studies (Figure 3.2) then simplistically the realistic, etic element can be described with postpositivism, a paradigm that involves absolute truths with objective facts (Teddlie and Tashakkori, 2009). Postpositivistic research must be replicable and generalised (Johnson and Onwuegbuzie, 2004), such as with GSE and waste collection data, primarily quantitative in nature and decontextualized (Mertens, 2005).

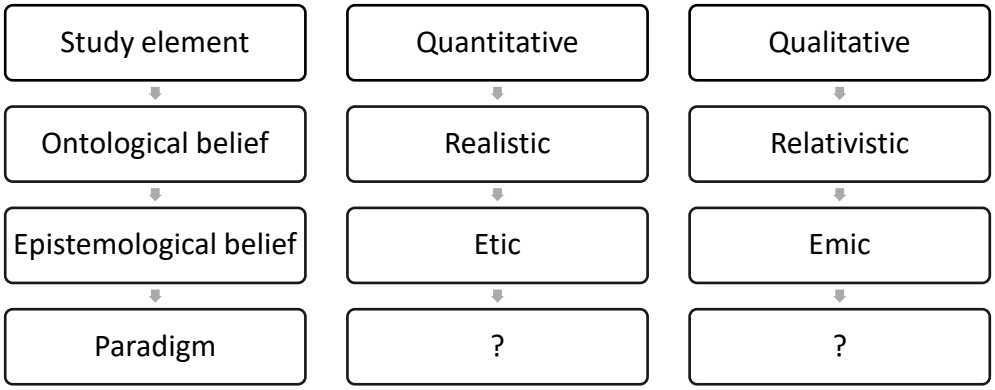

Figure 3.2: Applying the research paradigm

The relativistic, emic element of the study can be defined as constructivism in nature, where perception can change reality with a truth that is socially constructed (Denzin and Lincoln, 2011). This paradigm seeks to understand context based on experience, it is primarily qualitative and acknowledges the link between researcher and participants (Mertens, 2005).

Although these paradigms are clearly different with, generally speaking positivism involving numbers and interpretivism involving words (O'Leary, 2004), in reality there is a spectrum between the two. Both elements of this study are interlinked, crossing over the distinct boundaries of just a qualitative study or just a quantitative study, therefore either the positivist or constructivist paradigms are not fully descriptive of the study as a whole. Both the transformative and pragmatic paradigms enable the use of mixed methods, that

is, there is justification for the use of both qualitative and quantitative methodologies within a single study.

The transformative paradigm became popular in the 1980s and 1990s and uses historical evidence related to oppression with a view to address issues of social injustice (Mackenzie and Knipe, 2006). Although elements of this paradigm could be applied to sections of this study, again, it does not fully encompass all aspects of the research.

Finally, the paradigm with no philosophical loyalty to any alternative paradigm (Mackenzie and Knipe, 2006), Pragmatism. This paradigm focuses on the research question/problem and how to understand it utilising both qualitative and quantitative methods. Tools from both the positivist and constructivist paradigms can be used allowing dynamic responses to evolving research data, rejecting the need to choose one or the other (Johnson and Onwuegbuzie, 2004). This methodological pluralism is often referred to as 'mixed methods' (Bryman, 2006; Kalof et al., 2008).

Mixed methods research has not always been accepted within the scientific community, with methodological purists asserting that studies should be either quantitative or qualitative, it can be time consuming, costly and researchers require knowledge of both pure methodologies (Johnson and Onwuegbuzie, 2004). Despite the resistance, researchers have been using mixed methods since the 1950s when the Multitrait-Multimethod Matrix (MTMM) was developed. This 'convergent' method uses two or more measures of the same trait, if they correlated it validated the results (Campbell and Fiske, 1959). This convergent methodology, or triangulation, was expanded upon in the 1970s when Jick suggested combing case studies with surveys, integrating quantitative and qualitative data (Jick, 1979). Rather than relying on one data set, the two data sets for one phenomenon (the three sides of the triangle) would provide strengths to the combined data where the weaknesses of one data set is off set by the strengths of the other (Jick, 1979).

Although mixed methods has its weaknesses, its strength lies with bringing meaning to numbers and precision to words; it can strengthen conclusions through corroborations of findings; and provides rich, in-depth knowledge that would otherwise be missed with one, generalised data set (Johnson and Onwuegbuzie, 2004). Due to these strengths the

pragmatic, mixed methods research has expanded in to many disciplines and countries around the world (Creswell, 2015), and has therefore been chosen for this project.

There are different mixed methods research designs and to determine which one to use the intent, timing and emphasis of data collection must first be discussed (Creswell, 2014). The following section details the adoption of the explanatory sequential design, a mixed method approach taken for this study.

3.3. Explanatory Sequential Design

There are three main types of mixed methods research design described by Creswell and Plano Clark (2017): Explanatory sequential design, Exploratory sequential design and the Convergent design. This fast-paced field of research, however, has seen their design typology continually evolve (Table 3.2). The names of the designs have changed to reflect the intent for using and integrating the quantitative and qualitative data in the research design.

Table 3.2: Evolution of mixed methods typology. Adapted from (Creswell and Plano Clark, 2017)

2003 Typology	2007 Typology	2011 Typology	Present Typology
Sequential explanatory	Explanatory design	Explanatory sequential design	Explanatory sequential design
Sequential exploratory	Exploratory design	Exploratory sequential design	Exploratory sequential design
Sequential transformative		Transformative design	
Concurrent triangulation	Triangulation design	Convergent parallel design	Convergent design
Concurrent nested	Embedded design	Embedded design	
Concurrent transformative		Transformative design	
		Multiphase design	

The intent of the design, whether the research aims to explain, explore, or converge data is the first word in the design name in present day typology. This takes the focus from the

timing or the priority of the data, concentrating on the research outcomes and how the data will be used. This is not to say that the timing in which the data is gathered, or the priority is not important or should not be conveyed. Sequential being the second descriptor of the name shows that the data is gathered in order of either quantitative then qualitative or qualitative then quantitative. The convergent design intends to compare or combine the quantitative and qualitative data together, and so is not relevant to this study. The intent of this study is, instead, to use quantitative data to group English LAs with similar geo-socio-economic characteristics and to determine their recycling performance. Qualitative data is then gathered from best and poorest performers from each category to help explain the differences in recycling performance. So, with the intent and timing of the qualitative data explaining the quantitative data, the explanatory sequential design, as outlined in Figure 3.3, is a best fit for this study. It is worth noting that often one set of data is seen as a supporting role to the other, but in this case both sets of data are equally dominant.

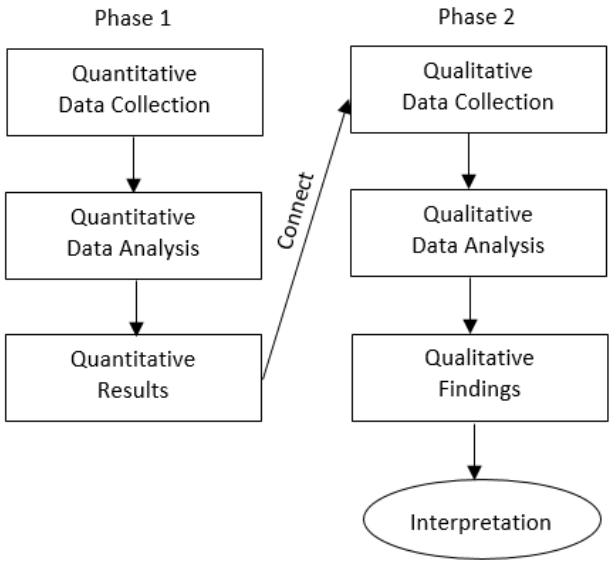

Figure 3.3: Explanatory sequential design. Adapted from (Creswell, 2015)

Explanatory sequential design has been widely used in the social sciences (Johansson and Osterman, 2017; Ajayi and Oyedele, 2018; McCrudden and McTigue, 2019) and, as with all mixed method designs, integrating the quantitative with the qualitative data is an important step in the research (Creswell and Plano Clark, 2017).

Table 3.3 describes the two phases of this study and where the two points of data integration are; the connect and the interpretation stage. The following sections of this chapter will focus on the methods used for each of these stages in the project design.

Table 3.3: Research process using the explanatory sequential design. Adapted from (Clark, 2016; Creswell, 2015)

Phase	Stage	Procedure	Product
Phase 1	Quantitative Data Collection	• Sample: Local Authorities (WCAs and UAs) n = 287 • Scale based on Urban/Rural classification and Index of Multiple Deprivation • Household waste collection tonnages • Recyclate collection tonnages • Recyclate rejection tonnages • Recycling performance calculation	Numeric data
	Quantitative Data Analysis	• Correlation • Regression • Frequencies	Inter and intra group examination of the influence on recycling performance by geo-socio-economic factors
Connect	Case selection	Purposeful selection of 12 LAs based on one best and one poorest performer from each classification group	Sample n = 12 LAs identified
		Semi-structured interview questions refined	Interview protocol
Phase 2	Qualitative data collection	Case Studies including; • Desk study • Individual, face to face interviews with 12 participants • Website content	Text data, interview transcripts.
	Qualitative data analysis	Coding and thematic analysis Inter and intra class group theme development.	Case description, codes, themes, visual representation of data
Interpretation	Integration of the quantitative and qualitative results	Discussion, implications.	How the qualitative results explained the quantitative results. Deepening understanding.

3.4. Phase 1 Quantitative: Influence of GSE factors on recycling performance

Phase 1 aimed to arrange LAs based on similar geo-socio-economic characteristics and then once arranged in groups, rank the LAs based on their calculated recycling performance. As such, the methods used for Phase 1 are split into two sections, the GSE classification scale and calculating recycling performance.

3.4.1. GSE classification scale

The literature review highlighted the influence that individual geo-socio-economic factors can have on a LA's recycling performance such as rurality (Kirakozian, 2016; Roberts et al., 2015), age (Martinho et al., 2017) and employment rates (Rispo et al., 2015; Rybova and Slavík, 2017). This study aimed to investigate all LAs in England to determine what actions, within the control of the LA, can be taken to increase recycling performance. To do this, firstly the influence from factors outside of their control, their GSE characteristics, needed to be removed so a comparison between seemingly similar LAs could be investigated.

The literature review revealed many studies that use GSE classifications to, for example, compare the availability of food (Lake et al., 2012) and immigration and ethnic diversity (Lymperopoulou, 2020). Other studies have used ACORN (Emery et al., 2003), a geo-demographical system devised by the government to classify postcode areas as struggling estates, career climbers and lavish lifestyles to name a few (HM Land Registry, 2021). However, a classification scale that was most appropriate for this study was devised by the Waste and Resources Action Programme. It considered LAs based on their waste authority classification i.e. whether an authority was a waste collection authority, unitary authority or waste disposal authority and incorporated their geo-socio-economic factors.

In 2008 WRAP developed a tool for LAs, the Kerbside Recycling: Indicative Cost and Performance tool (WRAP, 2008b). It allows LAs to predict the cost and outcomes of changes to a recycling scheme. For instance, what would be the cost of a change to residual waste collection from a weekly to a fortnightly collection? A LA can input various data about themselves to the on-line tool, such as landfill fees, income from recycling and the frequency of residual waste collection. The tool then calculates the cost per

household to implement the change. This is, broadly speaking, carried out by comparing LAs that are similar to each other and to do that WRAP developed a six-point classification. They published a document 'ICP2 – Online Tool Modelling Assumptions Technical Annex' to explain the method used to inform the calculations in more detail (WRAP, 2015a). To our knowledge this classification scale has not been used to assess current recycling performance of English LAs.

The six-point LA classification tool first places authorities into three population density categories; Urban, Mixed Urban/Rural and Rural using a Rural-Urban Classification for English LAs produced by The Office of National Statistics using data from the 2011 census (DEFRA, 2015b). This involves classifying English LAs against six categories based on the percentage of rural dwellings within the LA. WRAP analysed this data and found that there was some overlap and so rationalised the six categories down to the aforementioned three. Each of the three categories were then sub divided into High Deprivation and Low Deprivation groups. The latter was based on the Index of Multiple Deprivation (IMD); a government study which aims to quantify the deprivation of LAs using 37 indicators that fall in to 7 groups; income, employment, health deprivation and disability, education skills and training, barriers to housing and services, crime, and living environment. The methodology for the IMD involves giving a score to each of the above groups and combining them to give an overall score for the Index (DCLG, 2015).

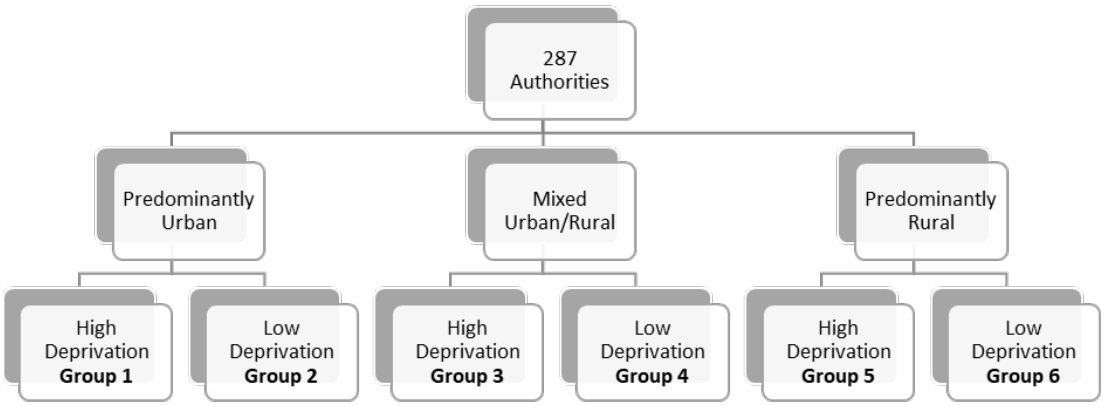

Figure 3.4: Local Authority classification scale

English LAs, n=287, obtained from the Local Authority Waste and Recycling Information Portal (WRAP, 2016), were grouped using WRAPs classification scale (Figure 3.4). After grouping the LAs, their respective recycling performance data was calculated using data from the UK Waste Data Management system, WasteDataFlow.

3.4.2. Calculating recycling performance

Data obtained from the 'Local Authority collected and household waste statistics 2014/2015' (DEFRA, 2015a), based on inputs from WasteDataFlow, was used to calculate the recycling performance of LAs assessed in this study. The 2014/2015 DEFRA report listed 352 English LAs, of which 32 were Waste Disposal Authorities. The latter were removed for the purpose of this study and data from only Collection and Unitary Authorities were used. The Disposal Authorities were omitted as this risked duplication of figures (Disposal authorities are made up of several Collection authorities). A further 31 LAs that provided a negative value for the Estimated Rejects of Dry Recycling were also removed from this study. These apparently illogical results arise from accounting practice that does not allow a LA to change its data once submitted, to correct any errors LAs therefore adjust their data in following reporting periods by adding negative amounts to account for inaccuracies; these data points were subsequently removed on the basis of being unreliable and inaccurate representations of their rejection rates. Lastly, two LAs were removed as they were not included in the WRAP database. This left a total 287 LAs.

The recycling performance of the LAs was determined using four main data sets; the total household collected waste and the amount collected for recycling/composting/reuse was used to calculate the percentage Recycling Rate (RR); and the household dry recycling/reuse and the estimated rejects of dry recycling was used to calculate the Quality Rate (QR).

The RR (%) was calculated by taking the weight of Household waste sent for recycling/composting/reuse per LA, dividing it by the Total Household Waste collected for that LA and multiplying by one hundred, Equation 1.

$$RR\% = \frac{Household\ waste\ sent\ for\ recycling,composting,reuse\ (t)}{Total\ Household\ Waste\ collected\ (t)} \times 100 \qquad \text{Equation 1}$$

The QR (%) was calculated using the Estimated Rejects of Dry Recycling per LA and dividing that figure by the total weight of household dry recycling/reuse collected for that LA. This gives the amount of waste rejected as a ratio of the total recycling/reuse collected. In order to describe the Reject Ratio as a quality factor that increases with improved performance i.e. the percentage of waste accepted, Equation 2 was used;

$$QR\% = \left(1 - \frac{Estimated\ Rejects\ of\ Dry\ Recycling\ (t)}{Household\ Dry\ Recycing,Reuse(t)}\right) \times 100 \qquad \text{Equation 2}$$

For each of the 6 classification groups a scatter graph was produced with the QR on the y axis and the RR on the x axis. The mean national average of the RR (42%) and QR (93%) was calculated and used to define four quadrants (Figure 3.5).

Figure 3.5: Key to recycling performance scatter graphs

The four quadrants represent differing recycling performance with the best performers for both quality and quantity in the top right quadrant and the poorest performers in the lower left quadrant. These quadrants aim to provide an overall impression of the range

of LAs performance within each classification group; whether there are clusters within a particular quadrant and whether they are performing above or below the national average. The percentage of LAs falling within each quadrant is shown in each corner of the graph and the most populated quadrant is highlighted by a black outline. The Group name (1 to 6) is indicated by a grey number near the centre of the graph.

3.4.3. Data analysis

A univariate analysis was conducted on the data using both descriptive and inferential statistics. The relationship between the Quality Rate and the Recycling Rate was investigated within the classification groups 1 to 6 using a line of best fit for each graph and a regression report was run on each set of data in Minitab to determine if there was a statistical significance between the RR and QR. A report was also run on the combined data for all LAs. Recycling performance was also analysed to determine and/or confirm the influence of geo-socio-economic factors within and between groups.

3.4.4. Validity and reliability

The validity and reliability of the Phase 1, quantitative study lies in the data collected by the Government. The WasteDataFlow database is the only one in England collecting waste and recycling data from all LAs and is reliant on the LAs to input their data, this entails weigh bridge tickets and balancing of figures between companies and therefore is self-checking. It is worth noting that rejected material accounts for wagons of material where the majority of waste may be of good quality but has been let down by a small percentage of contamination. The rural/urban data and deprivation index data were both taken from the Office of National Statistics. The accuracy of these Government databases cannot be compared with others as they are one of a kind, however, they do represent the most accurate and reliable resources available for this study.

3.4.5. Limitations

The empirical data is cross-sectional so that is it represents a period of time; 2014-15 for the recycling performance, 2011 for the urban/rural classification and 2015 for the Index of Multiple Deprivation. The limitations associated with this type of data is that it lacks the time depth that longitudinal data provides (Kalof et al., 2008). The changes in geo-

socio-economic characteristics are slow, however, and as Phase 2 of the study shows, the recycling performance has changed very little from 2014-2015 to today.

3.5. Connect: Case selection

The first point of integration between the Phase 1 Quantitative strand of this study and the Phase 2 Qual strand is during the Connect stage. As the name suggests, this is where the two strands connect, a hallmark of high-quality mixed methods research (Guetterman et al.). The connect stage involved selecting LAs for further investigation to determine the reasons for the difference in recycling performance within each group.

3.5.1. Selecting the cases

Selecting the participants for the qualitative phase of the project used data from phase 1, specifically the scatter graphs of groups 1 to 6. The study design required one LA to represent the good performers and one to represent the poorest performers from each group so that a case study, involving an interview and desk study, could be carried out to determine the reasons for the observed differences in recycling performance.

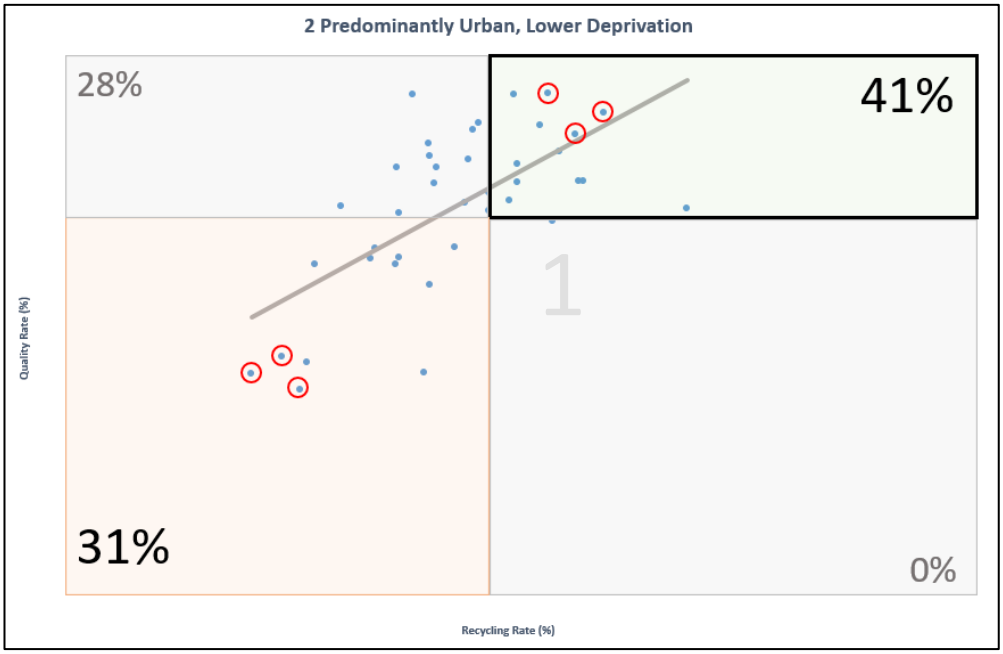

Figure 3.6: Case selection example

To select the LA to use as the case study, for each group three LAs from the best performing and three from the poorest performing quadrants were selected, see Figure 3.6 for an example. This provided a selection should a first choice of LA, based on being the furthest from the national averages, not be available for an interview. This was a fairly common problem with only 5 of the 1st choice LAs interviewed, 3 of the 2nd choice and 4 of the 3rd choice. LAs have predominantly moved to on-line communications or use general customer service contact centres which can make connecting with the correct personnel difficult. This study aimed to interview the Head of Environmental Services or a Team leader of the Waste and Recycling team and if connecting with them through the standard routes was not possible, further methods were employed such as searching LinkedIn, committee papers and experimenting with email addresses using known names.

Repeating this process for all 6 LA categories identifed a total of 12 LAs to use for case studies (Figure 3.7), so that for each of the 6 original groups a best and poorest performing LA was added. The names of the LAs are not included to preserve anonymity and to foster openness during the interviews.

The following phase of the study involved the qualitative element to the research design; case studies involving in-depth interviews, desk studies and an analysis of website content.

Figure 3.7: Case selection model

3.6. Phase 2 Qualitative: Case studies

Case studies are widely used within the social sciences to study phenomena within their context (Krikke, 2011; Yin, 2012; Zacho et al., 2018). By studying the LAs within the context of their GSE characteristics, an in-depth understanding of what is responsible for the range of recycling performance within each of the classification groups is possible.

A key characteristic of case study research is the use of multiple sources of data collection (Gillham, 2000) and can include both quantitative and qualitative methods with the weaknesses of one source of evidence offset by the strengths of another. For example, what people believe they do, uncovered through interviews or surveys, compared with what they actually do, determined by analysis of recycling data, can often be very different. That is not to say what they believe they do is not important evidence to consider when planning how to change their behaviour. On the flip side, just considering the recycling data does not give a rich, in-depth understanding as to why people are recycling the way they do. The combination, or triangulation, of the two provides real life data that captures the complexity of situations, especially when considering people (Rosenberg and Yates, 2007).

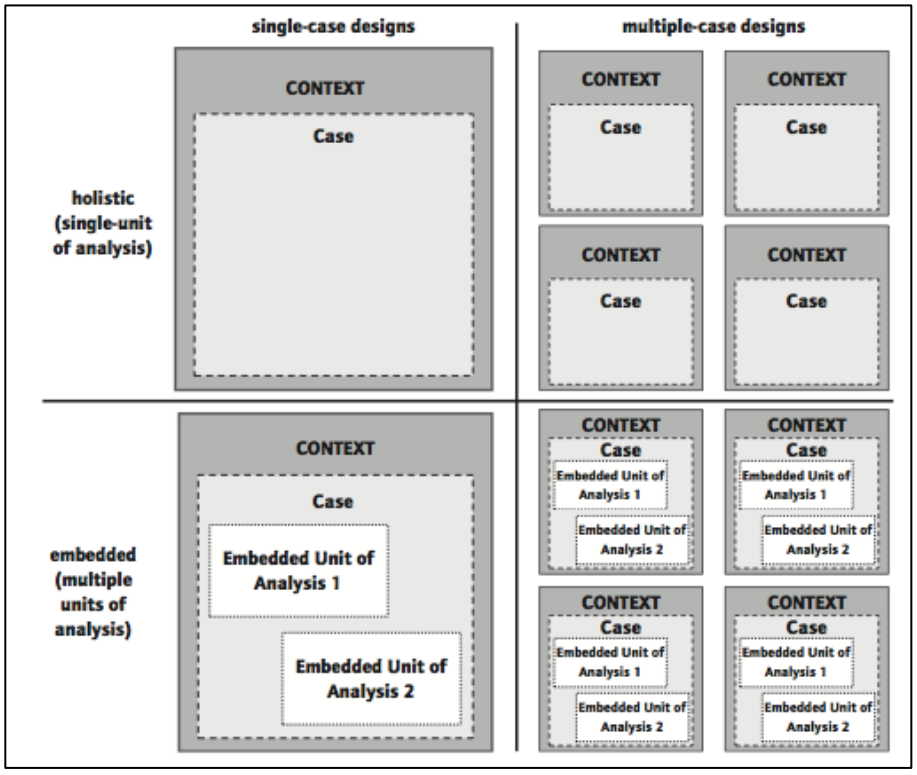

Figure 3.8: Basic types of design for case studies (Yin, 2012)

The basic types of case study designs are outlined in Figure 3.8. This study involved the purposeful selection of 12 LAs so utilised a multiple-case design. Yin (2012) explains that there are six main types of data that can be collected during a case study; documents, archival records, interviews, direct observation, participants observation, and physical artifacts. The flexibility of case study inquiry allows the researcher to adapt the methods or data collection to suit the study as it evolves (Luck, 2006). This study evolved from a holistic multiple-case design, with the intention of just using in-depth interviews, however it evolved to an embedded approach where specific units are investigated (Figure 3.9). The expansion to include desk study information, such as local infrastructure and recycling schemes, gave the researcher a greater understanding of the LA before the interview. This prior research was perceived as positive from the perspective of the interviewee, but as already noted the interview is a value laden process so the data may have influenced the interview (Creswell, 2015).

Figure 3.9: Embedded case study design used in this study

The website content analysis was further added to the case study, representing a third embedded unit of analysis, after the completion of the desk studies and interviews because this was the one form of communication used consistently across all LAs and where the majority used this as the main source of information for their residents.

The methods used for each of the embedded units are address in the following sections.

3.6.1. Desk study data collection

In preparation for each interview a desk study was undertaken to provide the researcher with a general knowledge of the LA and its waste and recycling service. This was advantageous as the interviewee perceived this as a positive so they did not have to explain the readily available data and consequently the interview could concentrate on the finer details or other elements of the service that may have an impact on recycling rates.

Information about the waste and recycling service was taken from WRAP's LA Portal, a database detailing the number of schemes, number of properties, materials collected, container types, and collection frequency provided by each LA (WRAP, 2016). Appendix 3 provides an example of a waste and recycling collection scheme typical of the data collected. Information such as the population and area of the LA was also collected along with contact details, see Appendix 2, this data is not included in this thesis due to confidentiality. The identity of the LAs are anonymised to foster openness in the interviews as interviewees knew in advance that their comments would be treated confidentially.

The data gathered was used to calculate the population density to confirm the urban/rural denomination used in the classification scale and to calculate the amount of waste collected per resident. The influence of local waste and recycling infrastructure on recycling performance was noted as well as any influence from the political leadership of each LA.

3.6.2. In-depth Interviews

The 'interview' is primarily a conversation that has structure and a purpose, with a view to discover an interviewee's opinion, view and/or reason for specific actions (Kvale and Brinkmann, 2015). They provide a rich understanding of the subject matter, placing value on people and their experience, it can uncover data that would otherwise be overlooked as it is not documented in a library or journal. It is for this reason that the method was used to investigate the reasons for the differences in recycling performance between LAs.

Interview development, implementation and interpretation followed the seven stages (Table 3.4) described by Kvale and Brinkmann (2015). Firstly, the purpose, to gain an understanding of the methods the LA are using to extract good quality recyclate from their residents, provided the theme of the interview [Stage 1]. The theme informed the design of the interview [Stage 2] i.e. choosing a method to best extract the experiences of the interviewee in relation to actions taken to influence recycling performance, both positively and negatively.

Table 3.4: Seven stages of an interview enquiry, adapted from Kvale and Brinkmann (2015)

Stage	Detail
1 Thematizing	Formulate the purpose and theme of the investigation before the interviews start.
2 Designing	Plan the study considering all seven stages before the interview. Design the interview with regard to obtaining the intended knowledge and taking in to account moral implications.
3 Interviewing	Conduct the interviews based on a guide and with a reflective approach, considering the interview context and interpersonal relation of the interview situation.
4 Transcribing	Prepare the interview for analysis.
5 Analysing	Decide which modes of analysis are appropriate.
6 Verifying	Ascertain the validity, reliability, and generalizability of the interview findings.
7 Reporting	Communicate findings taking in to account ethical considerations.

There are three main forms of interview; the structured interview which does not allow for deviation from questions, the unstructured interview, conversely, has no structure to speak of and allows the conversation to flow in any direction. Finally, the semi-structured interview allows for questions to guide an interview and to act as a prompt should the conversation need. This latter approach was taken and the interviews were designed so that they followed a series of questions, but they were flexible enough to allow for

exploration of new ideas (Adeoye-Olatunde and Olenik, 2021). Ten questions were devised for this study.

1. How are residents educated about waste and recycling in the home? How frequently is the material delivered and what methods are used?
2. Who designs the communication campaigns/interventions?
3. What resources are used to help design the campaigns/interventions?
4. What campaigns/interventions have been used in the past that stand out as having a positive effect on recycling rates?
5. What are those that have had a negative or neutral effect on changing behaviour?
6. What budget is there for campaigns/interventions?
7. What is the biggest obstacle to people not recycling in your area?
8. Is there an issue with the quality of the recyclate, if so, what are the main sources of contamination?
9. Are you aware of the circular economy principles? If so, what implications do you think it has on LAs with respect to waste and recycling.
10. What is your opinion about the recent government announcement proposing standardised collections for recycling materials, regardless of their location?

An extract of the government announcement was included for information.

> ***Consistent recycling collections***
>
> *To help drive up household recycling levels, the government will introduce a consistent set of recyclable materials for collection in England (including separate food waste collections), no matter which part of the country people live in.*
> *The consultation sets out options for how this will work in practice and which widely recyclable material should be included, such as plastic bottles and plastic pots, tubs and trays, glass packaging (bottles and jars), paper and card, and metal packaging.*

Although, as per standard practice, the questions were not given to the participants in advance of the meeting, two of them asked for and were sent the questions ahead of the interview so they could prepare.

Interviews conducted in-person are often considered superior to those held over the telephone or teleconferencing as they result in richer conversations and therefore data. However, when considering the interview length or substantive coding of the data, there is little difference between the different modes of interviews (Johnson et al., 2019). This study aimed to interview each LA in-person within their place of work, so that it provided a convenient location for the interviewees and to increase the richness of conversation and data. One interview was carried out over Skype, however, at the request of the LA and one using Microsoft Teams. This latter interview was conducted substantially after the others due to the disruption of Covid and LAs not responding to interview requests.

As the interviews with the LAs progressed the influence of the location became apparent, 'micro-geographies' of social interaction between interviewees or external non-participants were observed (Elwood and Martin, 2000). For instance, many of the interviews were held in board rooms or offices allowing for privacy and low background noise which limited interference with the conversation or the sound recording. However, one interview was conducted in a grand hallway in the Town Hall which had a high background noise level, and a passing colleague of the interviewee interrupted the interview which in turn interrupted the flow of conversation. Another interview involved both the Waste Collection Authority (WCA) and the Waste Disposal Authority (WDA) which may have influenced the discussion as the WDA was keen to express how their waste and recycling service provided value for money for the WCA. Being a semi-structured interview meant that the researcher could revisit questions and explore different ways to approach ideas that arose during the interviews, making up for interruptions or deviations from topics that would otherwise be lost in a more structured interview.

Before the interview

Having identified a contact within the LA an email was sent introducing the study and requesting an interview lasting no longer than an hour, for an example email see Appendix 4. A participant information sheet was attached to the email providing information about the study and how their data would be handled, see Appendix 5. Further information about data use and storage is covered in section 3.7 (Ethical

considerations). As mentioned previously, two LAs also requested the guide questions before the interview took place so they could prepare.

Table 3.5: Interview and interviewee details

LA No.	LA Code	Location	No of participants	Job title	Date of interview
1	PU,HD,BP	On-site	1	Head of Waste Policy and Partnership	27/01/20
2	PU,HD,PP	On-site	3	WCA Contracts Manager WDA Contracts Manager WCA Communications Officer	05/03/19
3	PU,LD,BP	On-site	2	Waste Promotions Officer Depot Manager	13/03/19
4	PU,LD,PP	On-site	1	Waste Action Officer	26/09/19
5	Mx,HD,BP	On-site	1	Recycling Manager	03/04/19
6	Mx,HD,PP	On-site	1	Contract Policy and Performance Officer	07/03/19
7	Mx,LD,BP	On-site	1	Waste and Street Scene Commissioner	07/10/19
8	Mx,LD,PP	On-site	1	Interim Waste Manager (since November 2018)	24/04/19
9	PR,HD,BP	On-site	1	Waste Services Manager	04/09/19
10	PR,HD,PP	On-site	1	Environmental Services Manager	11/10/19
11	PR,LD,BP	Skype	1	Environmental Services Officer	23/09/19
12	PR,LD,PP	Teams	1	Environmental Services Manager	06/12/21

Stage 3 - Interviewing

Before the interview began a Consent Form, Appendix 6, was completed by all participants and any questions were answered by the researcher. The interview was audio recorded using an application on a mobile phone, the recording was to allow the interview to flow naturally and to capture the data efficiently for analysis at a later time

(Adeoye-Olatunde and Olenik, 2021). The 12 semi-structured interviews were conducted with a range of personnel, Table 3.5 details the LA code (based on the classification scale in Figure 3.7), location of the interview, the number of participants, their job title, and the interview date.

Notes were also taken alongside the audio recordings to allow the researcher to revisit points from earlier in the conversation if needed. A box of chocolates was given to the participants to thank them at the end of the on-site interviews. The Skype and Teams interviews were also recorded using the same application on a mobile phone.

Stage 4 Transcription and coding

Full, verbatim transcriptions were undertaken of the interviews by the researcher using NVivo, a qualitative data analysis application. NVivo allows the researcher to code the text using key words or phrases and has a memo function to compile thoughts on potential theories. Transcripts provide a written mode of the oral communication between the interviewer and interviewee but are not the whole story, non-linguistic observations such as body language and facial expressions are not captured (Kvale and Brinkmann, 2015). This is the first stage of data reduction, that is, the researcher decides what details are taken from the interview and what is excluded (McLellan et al., 2003). Challenges of transcribing can include overlapping speech, merging of words and incomplete sentences; care was taken when applying grammar so that the intent or emphasis was not altered (Kvale and Brinkmann, 2015).

Transcribing verbatim is a time consuming process and for research that aims to discover patterns or themes, automatic transcription can be just as effective (McLellan et al., 2003). After the first four interviews were transcribed by the researcher, a cloud-based speech recognition software was used to provide the body of text. The researcher then formatted the text whilst listening to the audio file to ensure that the intent was not altered. The principles used for this stage and the analysis of the interview followed the Grounded Theory approach as described by Urquhart (2013). The coding is an iterative process that requires constant comparison allowing for conceptualisation of a theory during the analysis stage.

3.6.3. Stage 5 Thematic analysis

Case studies can be used to test or build a theory, can be used to experiment with trialling something or in this case it can be used to illustrate a phenomenon. Generating themes using thematic analysis aims to provide an in-depth understanding of the research question; what is the reason for a LA's recycling performance, asserting plausible relationships between concepts (Urquhart, 2013).

Data analysis starts straight away and continues throughout the process requiring constant comparison with each additional piece of data. Data collection should only stop once a theoretical saturation has been reached, if practicable (Kvale and Brinkmann, 2015).

The initial coding, the open codes, were further analysed to produce master-codes and sub-codes, see Appendix 7 for the interview codes table. Theoretical relationships between the codes were investigated with memos written during the analysis. Using this method provides a narrative of the emerging story and theory, establishing trustworthiness and rigour of the analysis, Stage 6 of the interview enquiry. (Spencer et al., 2003).

The final stage of the interview enquiry is Stage 7 Reporting. The findings from the interview are combined with the desk study and website content analysis and reported in Chapter 5.

3.6.4. Website content

Every case study utilized the LA website to communicate details of the waste and recycling service provided in the area. Website communication was the one tool used by all LAs, and for some the only method of communication, and so during the case study process the scope of the data collection increased to include the website content.

To investigate the size, structure and ease of use information on the number of pages and content for the waste and recycling service was gathered. For pages that provided examples of materials that could and could not be place in bins, the number of examples were counted. Links to external sites as well as broken links were also noted and general

notes on the useability of the website and the ease at which information could be retrieved were made by the researcher. An example website content table can be found in Appendix 8.

The analysis used a similar coding method to that used for the interviews, the emerging codes were tabulated using master-codes and sub-codes with examples of the content (Halpern et al., 2013). Useability notes were made including whether there was a site map or breadcrumb trail, a secondary navigation system that shows a user's location in a site.

3.6.5. Case study analysis

The analysis of the case studies was led by the research question,

> 'How can a better understanding of the determinants of differing recycling performance among LAs with seemingly similar geo-socio-economic characteristics be used to enhance interventions used to improve recycling activity?'

The LAs were chosen as representative of best and poorest recycling performers from their classification group. A comparative case study method (Bartlett and Vavrus, 2017; Sakata Nozomi et al., 2021) was utilised to understand the similarities and differences between the two LAs with a view to understand those features influencing the difference in recycling performance. Triangulation of the interview, website content and desk study allowed for the corroboration of results that yielded rich, robust data on which to base the comparisons. As such, the results were presented in pairs; a best performer and a poorest performer from each of the six geo-socio-economic groups.

3.6.6. Validity and reliability

To ensure the validity and reliability of the data the study utilised principles that have undergone academic scrutiny and that are widely used in mixed methods studies (Kvale and Brinkmann, 2015). Using case study and interview protocols, for example the seven stages of an interview enquiry described by Kvale and Brinkmann (2015), increased the reliability and therefore the dependability of the data providing an element of

consistency and credibility (Bryman, 2006; Moon et al., 2016). Thematic analysis and coding were conducted in NVivo10, a qualitative analysis software specifically designed to log theoretical memos which provide evidence of thought processes with emerging patterns and conclusions (Yin, 2012). NVivo also allows for ease of data retrieval when cross referencing, increasing the ability to capture links between different data sources, again increasing the dependability and the confirmability of the data (Moon et al., 2016).

The interviews were accepted as value laden, with the researcher influencing the conversation (Creswell, 2015). This reflexivity does not remove bias; however, it does highlight the potential for the researcher's experiences and assumptions to influence the process (Moon et al., 2016).

3.6.7. Limitations

The sample size could be considered a limitation in the case study design where more than one example of good and poorest performing LAs from each category was used. However, given the samples were selected to represent their category using robust, government data, small samples can be an acceptable method (Kvale and Brinkmann, 2015).

The researcher had previously worked within a LA in the Waste and Recycling department so already had knowledge on how departments such as those being interviewed operated. This may have been advantageous, however, as more time was spent discussing topics specific to the LA being interviewed rather than generalized content that the interviewer was already aware of.

3.7. Ethical considerations

Ethical approval was sought during the initial stages of the research design. The importance of informed consent, confidentiality, consequences and the researcher's role was deemed part of the high standards set by research governance (Kvale and Brinkmann, 2015).

Research governance is the framework and principles used by researchers to ensure consistency of high standards and compliance with agendas such as research integrity and data management. This improves research by (MMU, 2021):

- Safeguarding participants
- Providing clear frameworks offering protection for researchers
- Enhancing scientific quality and ethical awareness
- Minimising risk
- Monitoring practice and performance and preventing misconduct
- Promoting good practice and ensuring lessons are learned

The application for ethical approval was submitted using the University's online system, EthOS. The study was deemed a low risk as none of the participants were classified as vulnerable. A participant information sheet was provided outlining the study's aims and how the data would be handled in line the General Data Protection Regulations (ICO, 2022).

The data collected as part of this study was held electronically on a password protected computer that only the researcher had access to. The participants were given the option to contact the researcher and their supervisor at any time and could withdraw from the study if they wanted to.

The LAs were anonymised and although quotes would be used in the written work, the identification of the LA and the participant were anonymised. All participants agreed to this and signed a consent form before the interviews were conducted.

3.8. Chapter summary

The use of a pragmatic, mixed method approach allowed a degree of flexibility when designing the study. Being in two distinct phases and explanatory in nature the Explanatory Sequential Design was the best fit, where the qualitative phase was used to explain the quantitative phase, thereby connecting the two data sets. All aspects of the design were continually referenced with the research question and objectives as set out in Chapter 1.

The quantitative phase involved calculating the recycling performance and classifying all English LAs based on large government data sets, using both descriptive and inferential analysis. Best and poorest performers were then purposively sampled from each classification group to use as case studies involving desk studies, interviews, and website content. This qualitative data was thematically analysed to investigate why the LAs with seemingly similar characteristics had different recycling performances.

4. GSE Classification scale and recycling performance

4.1. Introduction and Chapter Outline

This chapter presents the results of the classification framework used to identify similar groups of LAs as defined by their geo-socio-economic (GSE) characteristics, allowing for a comparison of recycling performance with seemingly similar LAs, thereby addressing Objective 2.

By examining variations in LA recycling performance between these groups, it should be possible to understand the combined impact these factors have on recycling performance (i.e. inter group performance). Further, intra group variations will allow poorer and better performing LAs to be identified for further investigation to determine the influence of factors under the control of a LA on its recycling performance.

The next section presents the recycling performance of English LAs in their corresponding 6 GSE classification groups. Section 4.3 explores the influence of rurality on recycling performance and Section 4.4 the influence of deprivation. Section 4.5 provides a summary of the chapter and the resulting classification tool which informs the next stage of the study designed to address Objective 3: exploring the core attributes that explain the difference between best and poorest performers within their GSE groups.

4.2. Recycling quality and recycling quantity

The scatter graphs for each of the six groups in the classification scale are shown in Figure 4.1. Refer to Figure 3.5 for the key to the scatter graphs and Section 3.4.2 for how the recycling performance was calculated. The graphs are presented in a table with deprivation along the rows and rurality in the columns. For the individual graphs the recycling rate (RR) is on the X-axis and quality rate (QR) on the Y-axis. The line of best fit or regression line, in red, shows a positive relationship between the RR and QR in each graph albeit to varying degrees.

Figure 4.1: English LA recycling performance in GSE groups

A summary of the Simple Regression reports carried out on both sets of data is shown in Table 4.1. The data shows no statistical significance between RR and QR in the Predominantly Urban, Higher Deprivation group and both Predominantly Rural groups. However, for the Mixed Urban/Rural groups and the Predominantly Urban, Lower Deprivation group there is a positive statistically significant relationship between the quantity of recycling collected and the quality. The full regression summary reports can be found in Appendix 9.

Table 4.1: Simple Regression Analysis summary

Group		Statistical Significance?	Is there a relationship between QR & RR? ($p<0.05$)	R^2 (%)	N value (sample size)
1	PU, HD	No	0.208	3.66	45
2	PU, LD	Yes	<0.001	43.03	39
3	MX, HD	Yes	0.043	9.86	42
4	MX, LD	Yes	0.001	20.32	47
5	PR, HD	No	0.202	3.3	51
6	PR, LD	No	0.071	5.26	63
	All LAs	Yes	<0.001	10.15	287

The Simple Regression report also shows a significant relationship based on the combined data of all the LAs, meaning that as the tonnage of collected recycling increases, so does the quality. This general pattern conflicts with anecdotal evidence suggesting that increasing recycling rates might negatively affect quality rates. However, the influence of rurality and deprivation can be subtle here as acknowledged in the following sections.

4.3. Influence of rurality

The percentage of Local Authorities found in the best performing and poorest performing quadrant for each classification group are presented in Figure 4.2 and Figure 4.3. For the low deprivation groups of each of the three Urban/Mixed/Rural categories the best performers quadrant was the most populated (Figure 4.2). Within this grouping the trend

is that a higher proportion of LAs are in the Best Performers quadrant as one moves from Urban through Mixed to Rural; 41%, 60% and 62% respectively. This indicates that the more rural a LA the better their recycling performance.

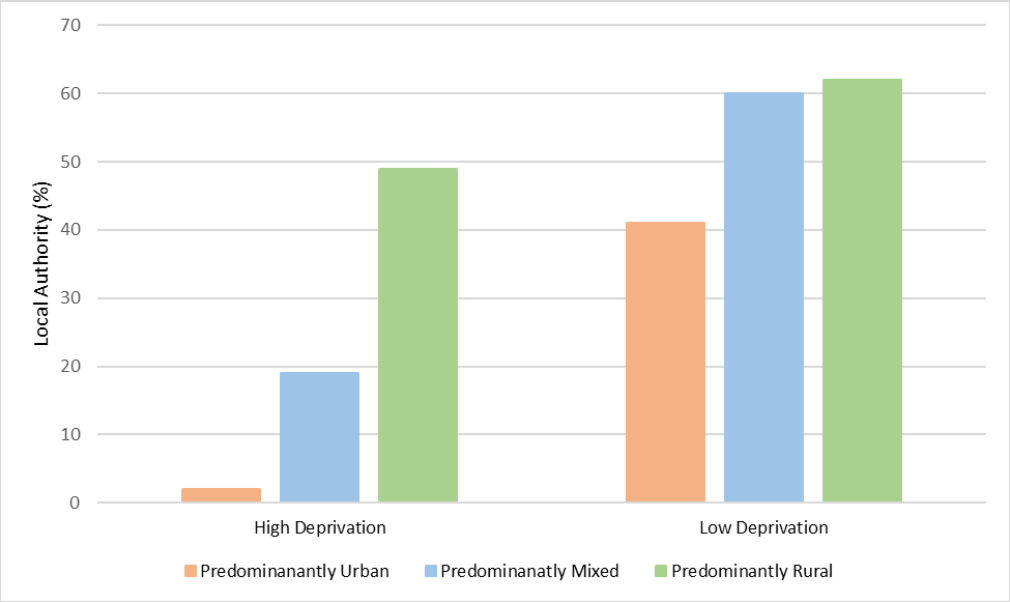

Figure 4.2: The percentage of best performing LAs in each classification group

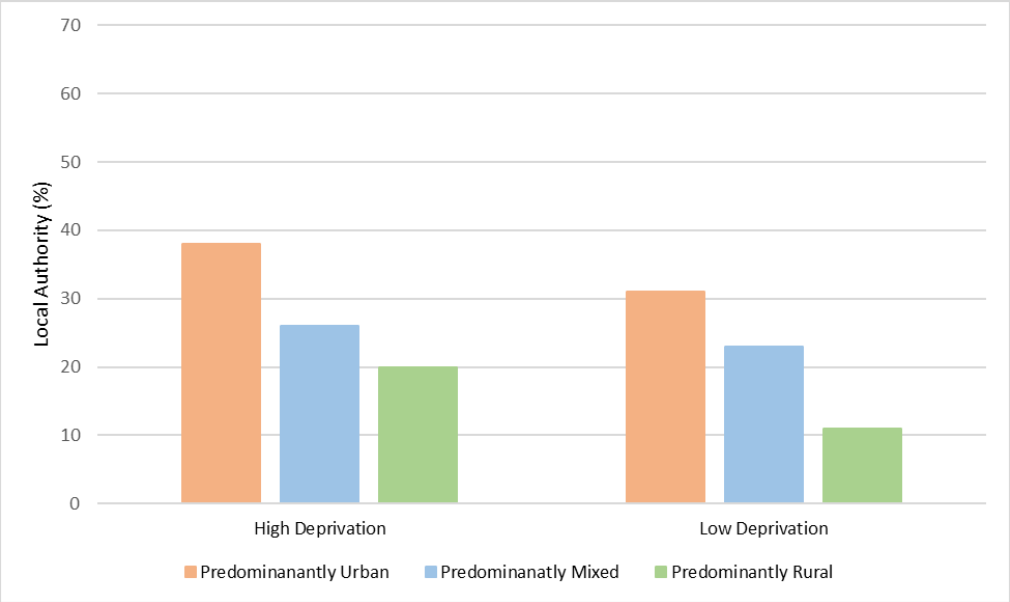

Figure 4.3: The percentage of poorest performing LAs in each classification group

The higher deprivation LAs of each of the three categories showed a similar pattern to those in the lower deprivation areas. As one moves from Urban to Rural the numbers of

best performer LAs jumps significantly from 2% to 19% and 49%, once again indicating that as LAs become more rural their recycling performance increases.

This pattern of performance is reflected at the other end of the spectrum (Figure 4.3), all groups showed a decline in the percentage of LAs within the Poorest Performing quadrant as they became more rural. The high deprivation LAs had figures of 38%, 26% and 20% from Urban to Rural and the lower deprivation areas saw 31%, 23% and 11% again concluding that the more rural a LA is the better the recycling performance.

4.3.1. Recycling and quality rates across rurality categories

The most notable feature relating to recycling rates (RR) and levels of rurality is the large change in the proportion of local authorities with above average performance (i.e. the proportion of LAs in the two right quadrants for each group). There is a difference of 61% in the higher deprivation category as one moves from predominately urban (6% of LAs above the average recycling rate) to rural (67%). The lower deprivation category shows a similar trend where there is a difference of 38% moving from urban (41%) through to rural (79%).

The pattern is not one of consistent increases in the proportion of above average performers as we move across the Groups from 1 to 6 (Figure 4.1). Group 2 (Predominantly Urban lower deprivation) and Group 4 (mixed urban/rural lower deprivation) buck this trend with a higher proportion of LAs (41% and 71% respectively) above average for RR than Groups 3 and 5 (mixed urban/rural higher deprivation at 33% and Predominantly Rural higher deprivation at 67%). In these cases, the effect of deprivation appears to outweigh the influence of rurality on RR.

The quality rate (QR) shows a consistent small increase in the proportion of LAs above average moving from Urban to Rural areas for areas of higher deprivation at 58%, 60% and 63% (i.e. proportion of LAs in the upper two quadrants for each Group). For lower deprivation, there is again a narrow range of change in the proportion of LAs performing above average QR but with Urban, lower deprivation LAs outperforming Mixed, lower deprivation LAs at 69%, 66% and 72%.

Overall, from the perspective of rurality there is a general trend of increasing recycling quantity and quality across the urban to rural spectrum.

4.4. Influence of deprivation

The influence of deprivation on LA performance within categories of rurality is discussed in the following sections.

4.4.1. Predominantly urban

Referring to Figure 4.1, the best performers quadrant is the most populated in the predominantly urban lower deprivation category (41%), whereas for high deprivation LAs the most populated quadrant was the top left quadrant at 56% (above average for QR, below average for RR). This pattern of relatively good recycling quality is reflected in the proportion of LAs with above average QR values of 58% for higher deprivation and 69% for lower deprivation (i.e. the combined value of LAs in the top two quadrants); indicating that where recycling is undertaken it is done so to a relatively high quality. However, recycling rates are generally below the national average across both deprivation categories at 94% for higher and 59% for lower deprivation (i.e. two left quadrants for each group). Overall, therefore urban LAs are characterised in general as performing better on quality than the quantity of recycling; although the influence of deprivation is very clear in the relative proportion of LAs in the best performing quadrant which is the largest proportional difference in any of the rurality categories at 2% and 41% for higher and lower deprivation respectively.

4.4.2. Predominantly mixed urban/rural

The LAs in the Mixed groups show a similar pattern to the Urban LAs with the best performers quadrant (high quality and quantity) being the most populated in the lower deprivation group (60%) and the top left quadrant (quality over quantity) being the most populated for the higher deprivation (40%) group (Figure 4.1). The pattern of relatively good recycling quality is, as with the Urban groups, reflected in the proportion of LAs with above average QR; 60% for higher deprivation and 66% for lower deprivation (i.e. two upper quadrants for each group), indicating that where recycling is collected it is of a relatively high quality. The recycling rates for the higher deprivation group are low with

67% of LAs performing below national average whereas the lower deprivation group flips to 71% of LAs performing above the national average. Overall, the Mixed Urban/Rural group can be categorised having a good standard of quality, however the recycling rate is clearly influenced by deprivation where the higher the deprivation the lower the recycling rate.

4.4.3. Predominantly rural

Figure 4.1 shows the best performing quadrant (high quality and high quantity) was clearly the most populated for both high deprivation (49%) and low deprivation (62%) LAs in the Rural groups. The QR for both deprivation groups was above average with 63% of LAs in the high deprivation group and 72% in the low deprivation group above the national average (see upper two quadrants). The pattern repeats for the RR with 67% of LAs in the high deprivation and 79% of LAs in the low deprivation group performing above the national average (see two right quadrants). Overall, the performance of the Rural category is above the national average for both quality and quantity and although deprivation has an influence on the recycling performance it is more marked for quantity than quality when compared to the Urban and Mixed groups.

4.4.4. Overall recycling rate and quality rate

Two of the three groups in the high deprivation category, Urban and Mixed, had low RR performance (i.e. two left quadrants for each group), with 94% and 67% respectively of LAs performing below the national average at 42%. The lower deprivation groups had just one, the urban group, where the majority of LAs (59%) perform below the RR national average.

The pattern of QR performance is more consistent across all Groups with the majority of LAs performing above the average QR of 93% (58-72% range), indicating that the average performance is disproportionately affected by a relatively small number of very poorly performing LAs from a quality perspective. The proportion of above average quality performers is higher in all categories of lower deprivation indicating the burden of costs associated with rejections is higher for more deprived LAs.

Overall, deprivation consistently influences recycling performance, that is the higher the deprivation, the lower the recycling performance in each category of rurality.

4.5. Chapter summary

As indicated by the literature, both deprivation and population density have an influence over the recycling performance of LAs. Generally, as deprivation increases recycling performance decreases, with quantity effected more than quality. This could indicate that in areas of deprivation the recyclers that do participate are highly motivated, but it is the lack of access to facilities that results in a lower RR, agreeing with Berger (1997) and Roberts et al. (2015).

High deprivation housing is more likely to consist of houses of multiple occupation (HMO), often with shared bin stores. These HMOs and high-rise buildings present many problems for waste collection due to mis-use of bins (Roberts et al., 2015), lack of access, no one taking responsibility for the waste segregation and the 'out of sight, out of mind' mindset described by Lakhan (2016). The higher deprivation areas might also see a more transient population as residents are likely to rent rather than own the property, so new residents will be unfamiliar with the recycling infrastructure and associated segregation requirements (Timlett and Williams, 2009).

Rurality has a clear influence over recycling performance with rural LAs outperforming the urban. Rural areas are less likely to have transient populations, with their residents being homeowners rather than renters therefore retaining their knowledge of the local recycling infrastructure and service. There are less HMOs and high-rise buildings with more residents living in sole occupancy dwellings with single ownership over their bins and space to store recyclables. The move from an urban LA to a rural LA usually indicates an increase in wealth, a factor associated with higher performing recyclers as indicated by Barr *et al.* (2005) and age as indicated by Stogia et al. (2015).

Interestingly, both the quality and the quantity of recyclate in the lower deprivation urban group outperformed the higher deprivation mixed group, and the lower deprivation mixed group outperformed the higher deprivation, rural group. This pattern indicates that deprivation has more of an influence on recycling performance than rurality.

This chapter has presented the influence GSE factors can have on recycling performances. The classification scale has attempted to factor out these qualities by grouping LAs with similar characteristics, yet we still see wide variation in recycling performance *within* the 6 groups. This analysis suggests that such variation is likely to be a result of factors within the control of the LA such as education, service delivery and infrastructure. This intra category variation is investigated in the next chapter using case studies of representative poorest and best performers identified from each group.

5. In-depth Case Studies

5.1. Introduction and Chapter Outline

This chapter presents the results of the case studies used to address Objective 3: exploring the core attributes that explain the difference between best and poorest performers within each GSE group. A summary of the 12 LAs chosen as case studies are presented in Table 5.1.

Table 5.1: Summary key features and attributes of the 12 local authorities

	LA1	LA2	LA3	LA4	LA5	LA6	LA7	LA8	LA9	LA10	LA11	LA12
Group name	1		2		3		4		5		6	
Urban/rural class	Predominantly Urban				Mixed Urban/Rural				Predominantly Rural			
Deprivation	High		Low		High		Low		High		Low	
Deprivation quartile*	1	1	3	2	1	1	3	3	3	3	4	4
Performer	Better	Poorer	Better	Poorer	Better	Poorer	Better	Poorer	Better	Poorer	Better	Poorer
Quality Rate (%)	98.0	74.0	100.0	84.3	99.7	77.9	100	84.0	100.0	84.4	99.2	88.1
Quantity Rate (%)	40.0	41.0	48.8	25.3	51.6	36.8	59.0	39.0	49.0	41.4	59.5	32.0
Population density (residents/Km²)	4009	3784	2387	12871	1447	1077	376	1052	101	108	154	199
Waste & recycling (tonnes/year/resident)	0.45	0.38	0.29	0.35	0.37	0.38	0.47	0.38	0.4	0.47	0.4	0.32

*For Deprivation quartile, 1 is most deprived and 4 is least deprived based on IMD.

The 6 groups are presented separately to allow for an intra group comparison between the better and poorer performers. The structure is repeated for each group using the key themes identified during the analysis of the desk studies, interviews, and website content analysis;

- Introduction to the group
- Local Authority context
- Infrastructure and service delivery
- Education and interventions
- Website content
- Contamination

- Political influence
- Summary

To identify common examples or features shared by the LAs, a table summarising the positive and negative factors affecting the recycling performance is provided in the summary section for each group. Factors that stood out as best practice are highlighted in bold, factors beyond the control of the LA are in blue and factors considered poor practice, but within the control of the LA are in red. The summary tables will also inform the discussion in the following chapter which seeks to provide an inter group comparison and to distil best practice for LAs to optimise their recycling performance and fully address Objective 3.

5.2. Predominantly urban, high deprivation – Group 1

Group 1 represents the predominantly urban, higher deprivation Local Authorities (LA) in this study, Figure 5.1 shows Group 1 on the classification scale. LA1 represents the best performers and LA2 the poorest from this group. The two LAs do not differ in their quantity rates, 40% for LA1 and 41% for LA2, however their quality rates are significantly different. 98% of LA1's recycling is accepted, whereas LA2 only has a 74% acceptance rate meaning 26% is rejected by the MRFs.

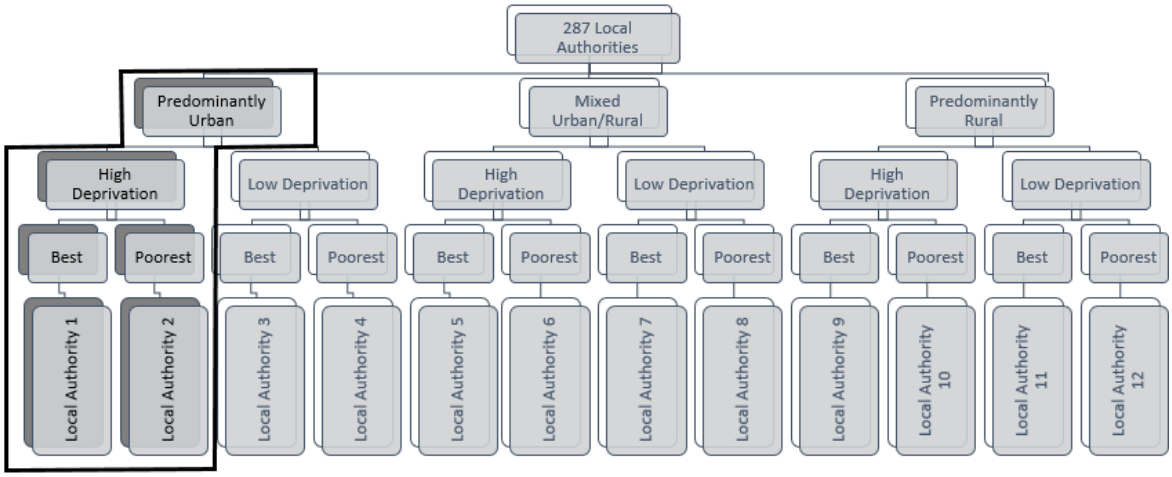

Figure 5.1: Classification scale - Group 1

To begin to explore why there is this difference in performance, a brief overview of their location and situation is given in the next section.

5.2.1. Local Authority context

The better performing authority, LA1, is a small coastal town in Northern England that is considered to be the most densely populated area outside of London. Having a coastal boundary along one side, the urban populous occupies an area 7 miles long and 3 miles wide. The town receives 17 million tourists each year which is vital to economic stability but also provides a series of challenges where waste and recycling is concerned. LA1 is a Unitary Authority (UA), responsible for the collection and disposal of its waste since it parted from a failing PFI contract. It now shares waste facilities with a nearby Waste Disposal Authority (WDA). The interview with LA1 was conducted at the council offices with the Head of Waste Policy and Partnership.

LA2, the poorest performing representative authority in this group, is landlocked, located in the centre of England. It is bordered by two English cities and two further densely populated Metropolitan Boroughs. It has a population 2.3 times the size of LA1, however, when comparing population density, 4009 residents/km^2 for LA1 and 3784 residents/km^2 for LA2, the areas show a greater similarity. The amount of waste and recycling collected per resident equate to 0.45 tonnes/year/resident (t/yr/r) in LA1 and 0.38 t/yr/r in LA2. These quantities fall within the minimum and maximum amount found from all 12 case studies, 0.29 and 0.47 tonnes respectively, indicating that neither LA has more or less than what would be expected in terms of quantity of waste produced.

LA2 is a Waste Collection Authority (WCA) and is 11 years in to a 25-year PFI contract with the WDA. The interview took place in the council offices and included the WDA Contracts Manager, the WCA Contracts Manager and the WCA Communications Officer.

5.2.2. Infrastructure and service delivery

As already mentioned, LA1 was part of a 25-year PFI contract that failed to meet its contractual requirements with respect to landfill diversion. The contract was signed in 2007 and was terminated 7 years later when the waste facilities were handed over to LA1, that they now share with the nearby WDA. The facilities have been scaled back from

two Mechanical Biological Treatment facilities (MBT) to become one of mechanical separation, removing metals and glass, and shredding, preparing the residual waste as Refuse Derived Fuel (RDF) for an energy from waste plant. Recycled materials pass through a Material Recycling Facility (MRF) on to reprocessors in the UK.

LA2, a WCA, collects the waste and recycling from its area and passes it on to the WDA. The WDA employs a national waste management contractor to manage the materials. Due to this national network and the central location near to several motorways, LA2 has access to many reprocessors within a relatively short distance compared to LA1.

LA2 provides a weekly collection for all materials except for garden waste which is provided fortnightly. LA1 provides a fortnightly collection for all materials for most of their residents. Some harder to reach properties, such as those in flats on high streets, receive a weekly residual collection in reusable sacks.

Both areas contain high-rises with communal bins, LA1 has 1354 high-rise properties. LA2 does not provide a breakdown of the number of high-rises, however during the interview it was stated that there are not many in the area. A benefit of living in a high-rise was noted by LA2 that residents do not need to remember to put their bins out as they are often collected from the bin stores or building managers are responsible. LA2 also suggested that residents in urban areas benefit from being near neighbours because they are reminded to place the correct bin out on the correct day therefore increasing participation.

Dry recycling

The materials collected for recycling by both LAs are shown in Figure 5.2, the colours represent the bin colours for the different materials. The better performing LA1 provides a 2-stream dry recycling service with a grey sack for textile collection. They do not collect as many materials as LA2, who provide additional collections for composites[3] and plastic

[3] Composites are packaging made with more than one type of material that the resident cannot separate.

carrier bags – some of the harder to recycle materials. Both LAs collect plastic pots, tubs and trays, however, this service had only recently been offered by LA1.

The textile collection provided by LA1 is unusual for a kerbside collection service provided by LAs, only 2 of the 12 LAs interviewed provided this, both of which are best performers for their category.

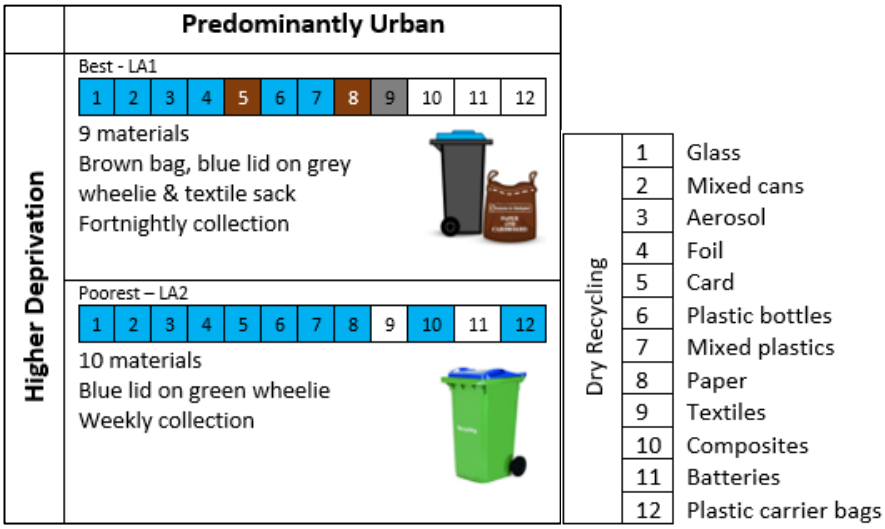

Figure 5.2: Group 1 dry recycling service

As already mentioned, LA2 provides a weekly collection and LA1 a fortnightly collection for their dry recycling with LA2 collecting all materials within the same bin, a 1-stream or co-mingled service. When asked if the quality of the paper and card was affected by the potential for food contamination from cans or bottles, the LA advised that it was not an issue. They have a requirement that materials are washed and dried before being placed in the bin.

LA1 stressed that space was an issue both inside and outside of the properties to store recycling with many residents in densely populated areas. To relieve this the LA installed on-street bring banks for certain areas, however they produced low grade material and suffered with fly tipping, so they were removed. Other initiatives such as underground bins were installed for the high-rises, however they too were removed as maintenance costs were high due to sea air weathering. They now provide a service with a mixture of bins and bags depending on the property.

Food and garden waste

LA2 provides a separate food collection service using a small, brown caddie and has an 18% participation rate. The food waste service was received positively when it was first launched but they have experienced a steady decline over time. LA1 does not provide a food waste collection although it was previously trialled in one area. Residents could add food waste to their garden waste, however due to downstream processing issues the scheme was removed. The reason was that the infrastructure was only available for composting garden waste and could not accept food waste at that time.

LA1 suggested that the leafier suburbs have higher recycling performance statistics due to their garden waste collection and that if this was removed from the calculations urban areas can perform equally with their dry recycling. Garden waste collection is provided fortnightly by both LAs, although LA2 is under pressure from residents requesting a weekly collection, but the service is too costly to increase collection frequency. LA1 charges an annual subscription fee of £35 for the service and the respondent expressed concerns about the introduction of 'free' green waste collections across the whole of England that the Government is mandating in 2022, noting the potential problems it would create as:

> "Not only does it pay for the delivery of the service, but it also contributes revenue to the authority to take the pressure off savings in other places."

A common theme throughout all the interviews was the pressure of budgets which is covered further in the Political influence section.

Residual waste

Both LAs provide residual waste collections using 140l to 180l wheelie bins and both use the colour grey. The clear difference is that LA1 provides a fortnightly service and LA2 a weekly one. LA1 also provides sacks and seagull proof sacks for the properties that cannot accommodate bins. Seagulls cause a significant issues, from ripping apart bin sacks to attacking residents. They are changing their nesting habits to move closer to these urban areas where discarded food is readily available.

Bulky Waste

An ad hoc service for bulky items is available in both LAs. Residents can request a collection with LA1 charging £19.50 and LA2 £18.87 for up to three items, additional items can be added for an additional cost. LA1 will collect from inside the property and encourages residents to leave items inside until collected so that they can potentially be repaired or refurbished for re-use. In contrast, LA2 requests that items are placed on the boundary of their property, nearest the road.

Household Waste Recycling Centres

There is one Household Waste Recycling Centre (HWRC) servicing each LA, however residents may use neighbouring facilities too. To curb this both LAs have requested residents to take proof of address and will get turned away if they do not live in the area. LA2 also has a booking system to use the HWRC.

There is a reuse shop in the HWRC in LA1 where residents can give unwanted goods that could be reused or repaired/refurbished for resale. The town centre houses another shop where goods from the HWRC are sold for charity. LA1 also provides a mobile HWRC recycling unit to help those who are not able to get to an HWRC, this has reduced fly tipping in the area and is very popular with residents whilst increasing the quantity and quality of goods arriving at the reuse shops.

Personnel

A positive element of being part of an PFI contract is having access to the shared partnership resources, this includes a team of Waste Awareness Officers for LA2. When the PFI contract came to an early end for LA1, however, the authority lost the additional PFI funds from the Government. This budget cut and years of austerity meant that the department reduced from 300 to 90 staff members which inevitably impacted the level of service provided above statutory requirements such as education and interventions.

5.2.3. Education and interventions

As LA1 explained, budgetary cuts and the subsequent staff reductions considerably reduced the amount of education and communication delivered. To counteract the reductions, the LA now concentrates on targeted communications and have found it more effective. Street cleansing officers have since been trained to issue Fixed Penalty Notices for incorrectly placed waste and they also go door to door (door knock) providing targeted communication where needed. An external organisation was brought in for a small time to manage enforcement, the organisation did not charge the LA but in return kept the income from enforcement charges. Tourism, however, means that the LA need to tread carefully with enforcement and so removed the external company.

LA1 has made large savings by bringing the collection service in-house which has additional benefits; officers can be allocated to accompany the collection wagons and provide additional on-the-spot education where it is needed such as when contamination is identified. Low borrowing rates from the Government meant that they could purchase a new fleet of wagons. Wagons are often purchased in this way, even for use by contractors as it reduces costs to the LA.

LA1 has not delivered any communication campaigns that have had negative results; however, some residents are difficult to communicate with. The interviewee explained that waste and recycling are low on the priority list for some and they often do not care, which makes engaging with them hard.

LA2 has carried out extensive work on categorising their residents in to good, medium and non-recyclers so they can provide targeted communications. They have also explored the influence of demographics and people's relationship with recycling to provide education and interventions that are fine tuned to the receiving residents.

Methods of communication

Most communications carried out by the LAs are via social media, although they both also use the council quarterly magazine to communicate with those not online. Both LAs do not mail yearly collection calendars to their residents, however LA2's collection day has stayed the same for years and they provide a weekly collection, so it is not a difficult

service to follow. Both rely on their website as their main source of information for the service they provide. As most residents are on-line now there is a push towards self-service education.

Door knocking and leafleting are used in areas that need a service improvement programme by LA1. Stickers are rarely used now as they made a mess of the bins, instead hangers are attached to the handles of wheelie bins to communicate if, for example, contamination was found in a recycling bin. Door knocking and leafleting are used by LA2 occasionally should there be a change in service or if they are, as with LA1, targeting an area that needs improving.

Due to the waste contract lasting 25 years between LA2 and the WDA, long term initiatives are encouraged such as investing in a bus to provide education in schools.

Challenges

One of the major challenges that LA2 experiences is the confusion that different bin types and colours from area to area present.

> "that is a big challenge we are facing as communicators because what we are trying to tell our residents might not be what some of their friends and relatives are doing in other areas."

LA1 found their biggest challenge was if they are to reach the 50% recycling target set for 2025, they would need to…

> "…get the education side back up and running."

Referring again to the impact austerity and staff reductions have had on their service delivery.

Campaigns

Since opting for a more targeted approach to communication, LA1 has used sustained campaigns working closely with Keep Britain Tidy. This provides a branding and messaging for all communications. They use the consistent message 'right thing, right bin' that intends to reinforce behaviour.

Other one-off campaigns or 'stunts' have been used by LA1 to bring waste and recycling to the forefront of people's mind. A wagon full of residual waste was emptied in the middle of a shopping precinct which received a lot of attention, and a replica of a local landmark was also built using rubbish, again bringing waste and recycling to the forefront of passers-by.

LA2 have tried incentive schemes in the past such as shopping vouchers for good recyclers. Although it was received well by the community, they did not see an increase in the overall recycling performance.

Workshops and training

LA1 provides workshops to upskill residents to repair and refurbish used goods for the reuse shops. This not only provides benefits to reducing waste but also provides an opportunity for residents to get back in to work who may otherwise find employment hard to come by.

5.2.1. Website content

The website for LA1 is a smaller, more concise website that has a very easy to use layout. The top page is called 'Waste and Recycling' which has four main menus that lead to 3 subpages. LA2's website contains more information; however, it has 19 menus on the top page which is called 'Bins and Recycling'. The website then leads to 2 subpages, although most of the information is on the first. This frontloading of information made the website difficult to navigate and to obtain information quickly, such as a quick reference guide for what materials are accepted in each bin, despite this information being on the 1st subpage for both LAs.

The examples of materials that are accepted (yes) or not accepted (no) were counted; LA1 has 185 Yes and 92 No examples, and LA2 has 153 Yes and 124 No examples, it is worth noting that some materials are repeated examples on different pages. Also, the name of the menu made a difference to finding this information; for example, LA1 uses 'Bin Collections' on the top page which leads to 'What goes in my bin' on the subpage. LA2 uses 'Putting out rubbish for collection' leading to 'What goes in your bin'. The wordier title on a top page with 18 other menu options was harder to find.

Neither LAs contained links to charities nor information on reduce/reuse, other than LA1 providing information about the LA owned reuse shops. Neither provided resources for schools, surprisingly LA2 had no information about the school bus that is a partnership resource either. LA2 did, however, have a section providing information about what happens to the materials after they are collected.

Both websites contained 'breadcrumb' navigation bars which helped retrace steps and both were light on the number of graphics, relying heavily on text. They also provided information about home composting and provided a link to purchase a compost bin.

Overall LA1's website had a purpose built for their service feel to it and was easy to use and navigate around for everyday needs such as finding collection day information and what materials are accepted in which bin. LA2's website was frontloaded with information making it difficult and time consuming to access the service required, familiarity would overcome this obstacle, however, LA2 provided more information above the service increasing general knowledge of waste and recycling processes.

5.2.2. Contamination

Contamination can be discovered both at the kerbside and in the MRF. Refuse collectors who discover contamination during the rounds can refuse to empty the bin, placing a hanger on the handle explaining why it was not emptied. Repeated contamination is met with a withdrawal of recycling bins in both LAs and only a residual waste service is provided. On average LA2 has around 400 reports of contamination per week, most of which is resolved with communication such as leafleting or door knocking. Approximately 20 bins are removed each week once all other avenues are exhausted.

LA2 finds that contamination is higher in less affluent areas, however this has not increased over the years. The reason for the higher rejected materials is due to 'the fussiness' in the demand for quality by reprocessors and says,

> "I would argue that contamination has probably remained quite consistent but because they are getting fussier at the next level/stage of the journey, then those pressures are coming back to us at the first stage of the journey."

Notably, LA1 has increased their recycling rate by re-running the rejected material through the MRF to extract more recyclable material that was lost on the first run.

The consistent messaging of 'right thing, right bin' is part of the reason for increased quality rates according to LA1. Combining this consistent messaging with the trained Street Cleansing Officers door knocking and providing first stage enforcement has increased their quality.

Much of the contamination found by LA2 is due to residents using the recycling bins as a secondary, overflow residual waste bin. This purposeful contamination is often covered over with accepted materials so is not noticed by the refuse crew. Food waste also accounts for a lot of the contamination being wet and heavy. It was noted that if participation in the food waste collection increased, the recycling performance would also significantly increase as a result of material diversion and reduced contamination of other recycling streams.

5.2.3. Political influence

The influence of national policy may be affecting the appearance of recycling performance. For example, LA2 explains that figures may hint at decreasing recycling performance, but it could also be that manufacturers are using less material in packaging, making them lighter weight which is reflected in the tonnages.

Locally, LA2 advises…

> "In the eyes of the voters here, the council empties your bin. Forget about all the other wealth of services the council provides you with, they see bins…"

LA2 advises that weekly collections are too popular to move to fortnightly. In fact, the councillors use the weekly collections as a policy initiative to gain votes. Despite providing a service popular with the residents, the interviewee from the WCA suggested that the weekly residual service was hindering the recycling performance in the area. Local politics were also mentioned with LA1 explaining that certain ward councillors will pay for additional resources out of their own ward budgets, so they know their community is

getting the attention it needs. A clear message from LA1 was that budgets were the overriding influence on their service delivery.

Budgets

As already discussed, LA1 had a £360 million share of a 25-year FPI contract which ended early due to 'fraught relationships' where two MBTs producing organic growth media (compost) were not delivering in terms of diversion from landfill. There was no requirement to buy out the term of the contract, as the contractors did not meet the contract specifications. However, the LA suffered financially as it lost the PFI supplementary funding from the Government which added to already strained budgets.

LA1 suggested that recycling performance is characterised by high deprivation indices and to add to that they suffered the highest proportion of austerity cuts from central government in terms of per capita funding. LA2 has seen an improvement in their deprivation indices but this has not translated into an increase in the recycling rates.

To combat issues around poor-quality housing and absent landlords LA1 uses the Selective Licencing Scheme. This scheme requires landlords to pay a yearly licence fee and to detail the steps they put in place with regards to bins and informing tenants about their waste and recycling responsibility as well as other issues such as noise and housing standards. The properties are inspected regularly to ensure landlords are stepping up to their duties. This has been a success with the transient, student housing where information is given to each new tenant as they arrive.

Customer satisfaction

Satisfaction surveys are conducted every three years with residents in LA1. They continually show positive responses for street cleansing and with the kerbside waste and recycling collection. Residents in LA2 are contacted quarterly by the WDA for feedback; they are also consistently given positive responses.

5.2.4. Summary

A summary of the positive and negative factors that influence the recycling performance of LA1 and LA2 are given in Table 5.2. The positive influences that stand out as best practice, such as rerunning the rejected material through the MRF, are highlighted in bold. Those influences that are deemed poor practice or those could be adjusted by the LA to improve the service, such as providing a weekly residual collection, are highlighted in red. Finally, those influences that the LAs have little to no control over, such as increasing demand from reprocessors for higher quality recyclate, are highlighted in blue.

		LA1 PU, HD, BP	LA2 PU, HD, PP
Context	Positive	Unitary authority	Well connected
Context	Negative	Coastal - seagulls Less connected Transient population	WDA control materials
Infrastructure & Service delivery	Positive	**Fortnightly collections** Neighbours influence Textile collections **2 - Stream collection** **Bulky waste from inside** Reuse shops in HWRC	Less high-rises Neighbours influence **Composite collections** **Food waste collection** Shared Officers WDA
Infrastructure & Service delivery	Negative	Many high-rises Space restrictions No food waste	Weekly collection Co-mingled
Education & Interventions	Positive	**Targeted communication** **Door knocking** Leaflets, hangers **In-house collections** Keep Britain Tidy messaging Campaign stunts Repair workshops	Categorises residents School bus investment
Education & Interventions	Negative	Stickers are messy Reduced staff numbers	Incentive schemes 'pointless'
Website content	Positive	Concise Home composting **User friendly**	What happens after collection Home composting
Website content	Negative	No school resources No Charity links No reuse/repair No What happens after collection	No school resources No Charity links No reuse/repair Not concise or user friendly
Contamination	Positive	**Reruns at MRF** Consistent messaging **Trained extra officers**	
Contamination	Negative		Increased quality demand Purposeful contamination
Political Influence	Positive	Councillors contribute financially **Selective licencing scheme**	
Political Influence	Negative	Financial losses from FPI Austerity High deprivation indices	Weekly collections gain votes

Bold - Best practice
Red - Poor practice
Blue - No control
SFW - Standardised food and waste collections

Table 5.2: Group 1 summary of influences on recycling performance

5.3. Predominantly urban, low deprivation – Group 2

Group 2 represents the predominantly urban, low deprivation LAs, Figure 5.3 shows Group 2 on the classification scale. LA3 represents the best performers, with a Quantity Rate of 48.8% and a Quality Rate of 100%. LA4 represents the poorest performers with a Quantity Rate of 25.3% and a Quality Rate of 84.3%.

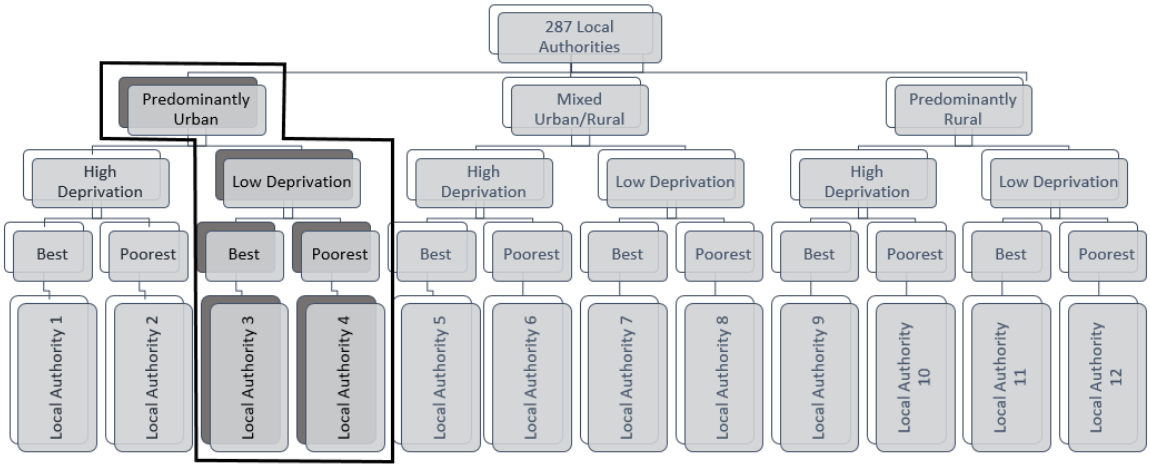

Figure 5.3: Classification scale - Group 2

As with the previous group, the location and situation are discussed in the next section to provide a deeper understanding of the context around the LAs.

5.3.1. Local Authority context

The best performing LA of Group 2 (LA3) is landlocked in central England, bordering a small city to one side and with access to major motorway routes. LA4, the poorest performer, is a London borough and although both LAs are classified as predominantly urban there is a vast difference in population density between the two. LA3 has 2387 residents/km^2 which is the lowest population density out of the 4 urban representative LAs but still above those in the Mixed Urban/Rural groups. Strikingly LA4 has a population density of 12,871 residents/km^2, over 3 times the density to that of the next dense LA in the study. London has an approximate population of 9 million residents, 16% of England's total population, which is housed in 1.2% of England's total land area.

Both LAs fall within the low deprivation groups, however, the LA4 interviewee likened the area as a dumbbell with lots of social housing on one end and a lot of super rich on the other with very little in between. There are a lot of high-rises in the area and many of the kerbside properties have been split into multiple occupancy, sometimes having up to 20 doorbells. LA4 lists 64,400 kerbside collection points and 24,188 flats. LA3 has 20,665 kerbside and 1817 flats.

Despite this difference in population, the amount of waste collected per person falls within the expected amount with 0.29 t/yr/r in LA3 and 0.35 t/yr/r in LA4. Both LAs are WCAs and transport their waste to facilities located outside of their area, interestingly LA4 uses a barge on the River Thames as their method of transport.

Both interviews were conducted in the LA offices, LA3 had two interviewees, a Waste Promotions Officer and the Depot Manager, and LA4 had one interviewee, a Waste Action Officer.

5.3.2. Infrastructure and service delivery

The frequency of collections is weekly for LA3 and twice a week for LA4, for both residual and recycled materials. Lack of space to store bins or bags, internally or externally, was the reason for the increased frequency in LA4. Popularity with residents was the reason for LA3 to retain weekly collections and there were no plans to move to fortnightly collections. The interviewee suggested that all LAs that had fortnightly collections would eventually move back to weekly due to popular demand.

LA3 provides wheelie bins for their kerbside collections, however, residents in LA4 are expected to provide their own bags for the residual waste but are provided with clear bags for the recyclable materials. Residents are not permitted to use wheelie bins as the wagons do not have the lifting mechanism required to empty them, instead LA4 uses split wagons for a ‘one pass’ service, meaning that they collect both the residual and dry recycling bags at the same time.

Dry recycling

The materials collected for recycling by both LAs are shown in Figure 5.4, using a green bin with brown lid for LA3 and the clear bag for LA4. LA3 collects a greater range including plastic carrier bags and more recently the service has been expanded to collect plant pots, bubble wrap and cling film too – although that had not been communicated to the residents yet.

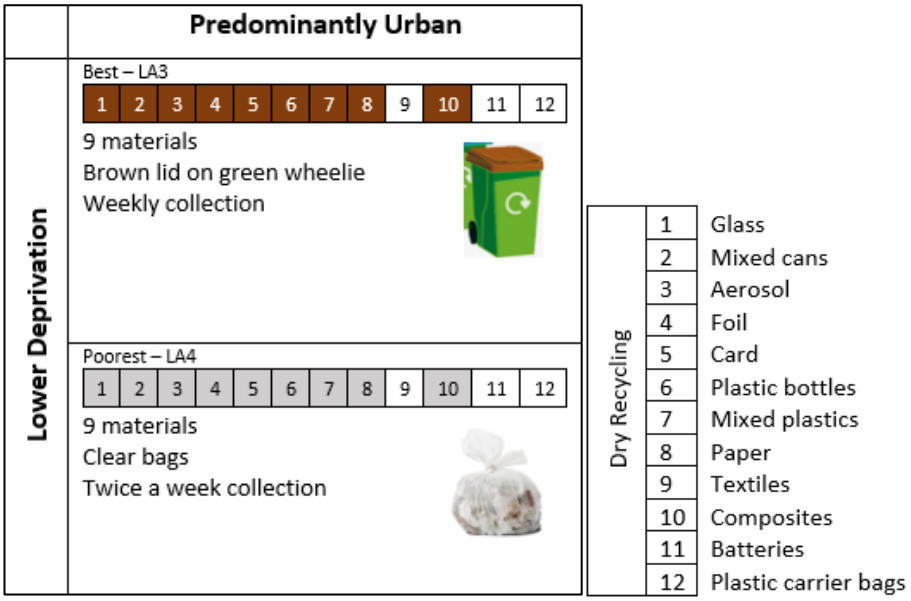

Figure 5.4: Group 2 dry recycling service

Both LAs have provided bring banks in the past, however LA3 removed them due to high rates of fly tipping and low-quality material. LA4 have had their on-street textile collection banks stolen, rebranded and placed back in different locations. Due to the tight space restrictions in the area the banks were then removed to prevent health and safety issues. Since then, LA4 teamed up with a local charity that will collect textiles from residential properties, and more recently have expanded the service to include small WEEE. The interviewee explained that private companies offering to collect textiles by posting plastic bags through residents' doors often increase when oil prices increase, however they did not provide a reason for this.

To encourage the use of shared recycling bins by making them more attractive for high-rises in LA4, bin stores have been film wrapped with a photo of the location from the

Victorian era, or if that could not be sourced a photographer was hired to take an interesting photo. This has been well received by residents, although it is expensive to maintain.

LA3 has recently experienced a decrease in their recycling performance, both the quantity and quality. The LA previously owned a MRF that had 12 staff members picking material for resale. This provided a clean source of recyclate, an income from the sales and from the recycling credits scheme offered by the government. A credit was received for every tonne of material sent for recycling, these were 'cashed in' at the end of the year producing £80,000 to £100,000 per year for this LA. Due to austerity the credit scheme was terminated and LA3 was instructed to deliver the recyclate direct to the WDA, therefore making their MRF redundant.

Since the change in service, the previous 2-stream dry recyclate collection became a co-mingled collection where all recyclables are placed in a single bin. LA3 purchased stronger bags to cater for the increased weight, but this proved too expensive so after just 4 weeks they provided wheelie bins instead. The interviewee suggested the disruption caused by the mixed messaging and changes in the service confused residents, resulting in a drop in recycling performance.

LA4 had previously trialled individual doorstep collections from flats but the service reverted to shared bins due to the high running costs of the scheme. There were also two incidents of arson where the bags were set on fire, prompting health and safety concerns.

Food and garden waste

Food waste collections are being trialled in LA4 with 1800 properties currently being offered the service, the interviewee said that the trial was going well but that there were no plans to roll this out to the rest of the households due to the high number of flats and shared accommodations, again referring to the lack of space for the caddies. LA3 have previously trialled a food waste collection in 3 areas, however after 2 years the service was terminated due to running costs. They found they collected 2.5 tonnes per week and that weight did not warrant cost of a vehicle with 3 crew members, in fact the LA lost money on the service.

LA4 had the same view when discussing the removal of the 'free' garden waste service in the area.

> "… you don't want to be producing more carbon than you're actually saving, basically running huge fleets of vehicles just to capture every little scrap probably doesn't make sense and would cost a fortune, so it's getting that balance right…"

After several complaints from residents the LA reintroduced the garden waste collection but with a charge of £66. This was justified given that:

> "75% of people don't have a garden, so they are effectively subsidising those that do."

The interviewee also explained that the annual fee is cheaper than hiring a man with a van to otherwise remove the waste.

LA3 also charge for their garden waste service, a £35 annual fee, that provides the LA with £35,000 annually. The resulting compost is sold, providing a further income of approximately £300,000, which:

> "…keeps the council afloat."

Removing the annual fee for garden waste and the introduction of a separate food waste collection imposed by the Government would result in LAs financially suffering according to LA3. LA4 did not think the scheme could feasibly be introduced in their area due to the space constraints and the cost of the vehicles to accommodate the collections.

Residual waste

The residual waste collection in LA3 was about to change from a bag to wheelie bin collection. The interviewees expressed concern as the current black bag service includes 3 x 40l bags, however many residents use larger bags which are taken away by the crews. Once these residents are restricted by the size of the wheelie bin and no extra bags will be taken, they will need to either recycle more or reduce their waste. One interviewee suggested that some residents may use their recycling bin as an overflow causing increased contamination.

Bulky waste

Bulky waste was not discussed in either interview however both LAs provide a service. LA3 charges £21 for the first item, including WEEE, then a further £4 for each additional item. LA4 charges £32.60 for up to 10 items.

Household waste recycling centres

The HWRC that residents can use in LA4 is located outside of the area, however most residents do not own a car so rely on other methods of disposal. LA3 has a HWRC that is run by the WDA, they did note that it was open 7 days a week but was reduced to 5 days due to austerity. To communicate this to the residents a member of staff from the WCA was stationed on the gate and redirected residents to other nearby HWRCs that were open.

Personnel

There is a team of 12 Public Liaison Officers in LA3 that are primarily a customer service team for all LA services. As well as providing information such as collection day queries, they have been trained to answer frequently asked questions such as why black plastic is not accepted for recycling. LA4 has a team of 3 staff dedicated to communicating about waste and recycling.

5.3.3. Education and interventions

The interviewee from LA4 said that it was probably people's behaviour that will prevent them from reaching the 50% recycling target set by the Government by 2025, rather than infrastructure capacity. With a 25% transient population, providing communication on how the service operates is like:

> "…painting the Forth Bridge."

However, being a WCA the LA benefits from budget and communication material from the WDA. As LA3 commented:

> "It is in their favour that they get good, clean recycling so they [WDA] do all our talks and resident forums."

LA3 also explained that budgets have been severely cut over the years and although leaflets are paid for out of another budget, they are given £300 to £400 per year for communications.

Methods of communication

Both LAs rely on their website to provide information on the waste and recycling service, however both do provide calendars through the post annually. LA4 mentioned that they do not use social media frequently as the account is tightly controlled by another department, making it tricky to update. However, the interviewee commented,

> "We use a number of media, obviously social media is one of the big ones now, everything we do, a lot of it is digital."

On the occasions that LA3 have accompanied the WDA for a roadshow or resident forum such as a farmers' market, they have been received positively and this is perceived to be the best form of educating residents as it allows for more face-to-face communication.

LA3 use stickers and bin hangers to communicate with their residents too. LA4 have also used stickers to highlight contamination in the recycling bags when they were left, however, it was not possible to continue as leaving bin bags on the pavements was not practicable and presented a health and safety issue.

LA4 also mentioned the use of the quarterly LA owned magazine where they consistently provide advice on how to use the service.

Challenges

As mentioned above, LA4 has a high transient student population that provides the biggest challenge. The area also has a large population where their first language is not English, in fact there are approximately 200 languages spoken in the local authority. This becomes a challenge for communication and, as the LA deem it too costly to translate their correspondence, they rely heavily on images.

LA4 also mentioned that 'green fatigue' had been responsible for a reduction in recycling but that programmes such as Blue Planet had re-energised people's behaviour.

Confusion over which materials can be recycled is seen as LA3's biggest challenge. Despite an easier system, the one bin for all recyclates, the elderly in the area still struggle to know what can be recycled especially since the change in service. Confusion over what can be recycled occurs mainly with plastics and understanding that there are many different types that can and cannot be recycled.

Campaigns

Campaigns are paid for by the WDA in LA3, a request can be submitted on an ad hoc basis for communication tools such as leaflets. LA4 provided more information on campaigns in the area such as a door knocking campaign they use intermittently, most recently for the trialling of the food waste campaign. These campaigns have a positive effect on participation and are highly regarded.

LA4 have used WRAP icons for the communications, and they try to convey recycling as a normal behaviour by using pictures of people queuing to use a bin in leaflets. LA4 also encourage reusing by promoting Freecycle and eBay, however they find that residents want their items removed immediately, not next week, they even find the 2 days wait for the bulky waste collection is too long for some.

Workshops and training

Only LA4 mentioned training, they had worked with a charity that provided workshops for upcycling items at one point, but they went out of business and have not been replaced.

5.3.4. Website content

The best performing LA, LA3, has a simple website with clearly labelled menus making information retrieval easy. The breadcrumb navigation also allows a user to retrace their steps through the maximum 3 subpages of information. The main theme of the website is a guide to the service provided, i.e. what goes in what bin, but does not contain information on reducing or reusing materials. There are links to the WDA website and they also provide information on what happens to the recycling after it has been collected with a link direct to the MRF. The overall feel of the website is that it was planned and

built for ease of use for the service; the top page is called 'Household Waste' and the 'what can and cannot be recycled' is on the 2nd subpage under 'Recycling Collection'.

LA4's website, on the contrary, provides a vast amount of information that is harder to navigate. Their top page is called 'Rubbish collections', and to find the 'We recycle' list on the 3rd subpage, the user must navigate through 'Recycling in the borough' on the 1st subpage and 'How to Recycle' on the 2nd. For a quick reference guide, there is an A-Z of recycling that lists 44 materials, but again this is found on the 3rd subpage. Overall LA4 gives 153 examples of items they accept, 'Yes' examples, and 124 that they don't ('No'), LA3 gives 185 'Yes' and 92 'No' examples. LA3 provides these examples as a list of text whereas LA4 gives graphics too that could be helpful to non-English speaking residents.

LA4 goes beyond providing information about the service by providing a wealth of information about reusing items, giving 11 external links to charity and reuse networks (not all of the links worked at the time of analysis). The website also provides information about what happens to the materials after collection, offering free tours of the MRF, and also explaining why some materials cannot be recycled.

The food waste scheme is covered in detail, including a 4-page document with frequently asked questions about the service. Other documents include 16 PDFs for the HWRCs, downloadable calendars and maps of mini-recycling sites in the area. Notably there is a section on 'Rats and rubbish collections' detailing how to prevent them and what happens if they are spotted, this was the only website to cover rodents in the waste and recycling section of the LA website.

LA4 also covers waste minimisation, composting, reasons to recycle, collections in cold weather and has information on climate change. Despite this large quantity of information, the website is unhelpful in its design, it has a 'built over time feel' to it with add-on sections making useability poor rather than providing a cohesive, easy to navigate experience that LA3 offers.

5.3.5. Contamination

Hard plastics such as plastic toys and hangers are the main contaminants found by LA3, whereas it is food for LA4. LA4 finds it easy to identify contamination as the recyclate is

presented in clear plastic bags and due to the split wagons, the crews make a judgement whether the bag is good enough to be recycled or if it needs to go in the residual waste. This could be called a 2-stage sort before the material reaches the MRF. Bags are not provided to repeat offenders, however if one is requested from a resident, a bag will be sent to them in a sealed envelope for their use only. Shared bins that become contaminated in LA4 can be locked so that residents need to pass their recyclate through an aperture, minimising the risk of residual waste.

LA3 used to provide clear bags for the recyclate, however, since moving over to wheelie bins they have experienced higher contamination. They believe that the crews are spotting less contamination as it is hidden from view and suggested, in an ideal world, the bins could be made from clear plastic.

As mentioned, LA3 attributes most of the contamination to residents' confusion over what can and cannot be recycled using an example of a hand mixer, saying;

> "this is what had confused me because the number one thing that residents say 'well, I don't know what goes in my bin because my mother-in-law's bin takes something else'… but I have a set of bins and just because my mum has a different collection to me, I don't put something different in my bin. Though maybe it's because I'm in the industry, I don't know. I don't really get that excuse for not recycling…"

When contamination is found they may not empty the bin and will use a hanger to communicate why they have taken this action. An officer will follow up with a visit to provide further clarification. The interviewee did mention, however, that occasionally residents may put non-recyclable material in the recycling bin if they run out of room in their residual bin.

Increased levels of contamination are found in areas with higher deprivation, especially those with a number of houses of multiple occupation (HMO) in LA4. Many of the large, Victorian homes have been subdivided into many, sometimes up to 20, individual residences called bedsits. As with other shared bin facilities, one or two non-recyclers can contaminate the recyclate coming from their recycling neighbours. To combat this, as

discussed earlier, LA4 trialled a doorstep collection from flats which was too costly to continue.

5.3.6. Political influence

The interviewees in Group 2 did not refer to political influences on the recycling performance or the service delivery as much as it featured in Group 1. When asked about communications budgets, LA4, responded that they were not able to disclose the amount for confidential reasons. LA3 discussed austerity though and the effect it has had on their service. LA3 also spoke about the Government attempting to standardise the collections to prevent confusion when it comes to material recycling.

Budgets

Austerity featured several times in the interview with LA3; the loss of recycling credits and therefore their MRF influenced their recycling rates. The cost of stronger recycling bags for residents instigated the changeover to wheelie bins, therefore upping contamination through accidental and purposeful contamination. They have also had their communications budget cut to just £2-300 which has reduced their ability to educate.

Both LAs discussed the financial impact of providing a 'free' separate garden and food waste collection, both in terms of lost revenue and the costs associated with buying new wagons to implement the service.

Customer satisfaction

Customer satisfaction was not mentioned by either LA.

5.3.7. Summary

Table 5.3 summarises the positive and negative factors that influence the recycling performance of LA3 and LA4. Acknowledging face to face communication as the most effective form of education and normalising recycling as a driver for changing behaviour are some of the best practices taken from this group. As the most populated LAs in the study, the number of high-rises and houses of multiple occupation present additional challenges that are beyond the control of the LAs and explains the twice weekly collections in LA4. A lack of social media presence, graphics and lack of contamination education are some of the factors that are considered poor practice in Group 2.

		LA3 PU, LD, BP	LA4 PU, LD, PP
Context	Positive	Lowest population density	
Context	Negative		Super rich distorting wealth Lots of high-rises Transient population Most populated LA
Infrastructure & Service delivery	Positive	**Greater range of materials** Training customer services **Residual capacity reducing**	**Wrapped bin stores** **Food waste trial** Generous bulky waste **3 communications officers**
Infrastructure & Service delivery	Negative	Weekly collections Removal of recycling credits Confusion (changes to service) No food waste	Twice weekly collections Space restrictions No cars for HWRC
Education & Interventions	Positive	WDA manages comms Calendar mailed **Face to face most effective** Resident forums (WDA) School visits (WDA)	Calendar mailed Blue Planet effect **Door knocking** **Normalising recycling** **Graphics (language barrier)**
Education & Interventions	Negative	Material confusion (plastics) Austerity budget cuts	Transient population No social media Language barriers No contamination education Green fatigue
Website content	Positive	**User friendly** What happens after collection	A2Z material recycling What happens after collection Reuse & repair MRF tours Charity links
Website content	Negative	No reuse/repair No graphics	Not as user friendly Too much information Too many documents
Contamination	Positive	Bin hangers **Door knocking**	**Clear bags** Removal of service
Contamination	Negative	Bins hard to spot contamination Closed MRF with 12 pickers	Contamination collected Removal of doorstep collection flats (costs)
Political Influence	Positive	SFW will reduce confusion	
Political Influence	Negative	Austerity Lost recycling credits MRF removal Move to wheelie bins Budget cuts to comms	Cost dictates service SFW not feasible

Bold - Best practice
Red - Poor practice
Blue - No control
SFW - Standardised food and waste collections

Table 5.3: Group 2 summary of influences on recycling performance

5.4. Mixed urban/rural, high deprivation – Group 3

Group 3 represents the mixed urban/rural, higher deprivation LAs, Figure 5.5 shows Group 3 on the classification scale. LA5 represents the best performers with a recycling Quantity Rate of 51.6% and a Quality Rate of 99.7%. LA6 represents the poorest performers with a Quantity Rate of 36.8% and a Quality Rate of 77.9%.

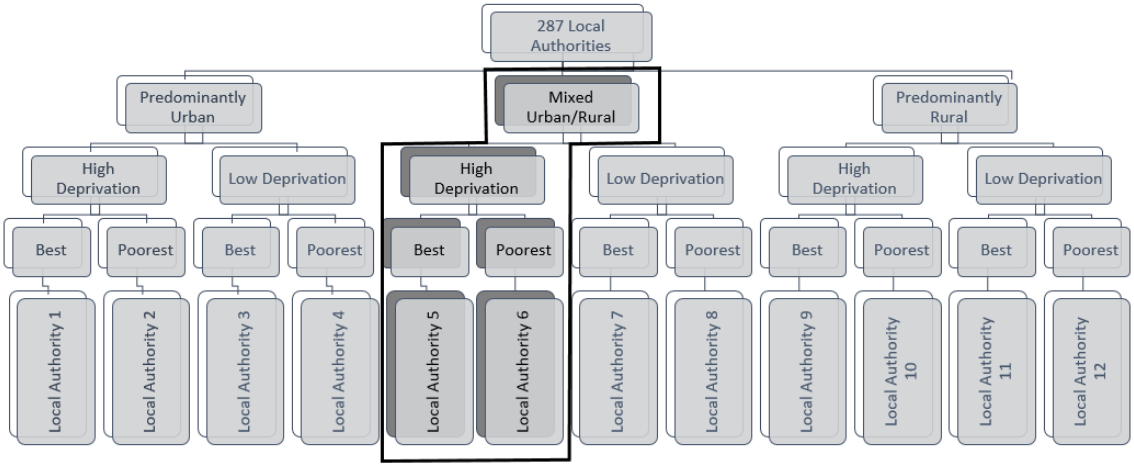

Figure 5.5: Classification scale - Group 3

The location and situation of the Group 3 LAs are described in the next section, providing context to the subsequent description of recycling activity.

5.4.1. Local Authority context

Both LAs are landlocked in the north of England and are bordered by a city to one side and rural to the rest, explaining the mixed urban/rural description. LA5, the best performer has a higher population density, with 1447 residents/km^2, LA6 has 1077 residents/km^2. The waste collected per resident, however, is nearly the same at 0.37 t/yr/r in LA5 and 0.38 t/yr/r in LA6.

The LA5 interviewee explained that the population is increasing and in response to the growing number of houses they have been continually increasing the number of rounds of waste collection. LA6 explained that they have a high proportion of terraced houses with steep back streets and that they have four times the national average of Asians living

in the borough with over 30% of the total population being Muslim. The interviewee explained in areas with higher Asian populations more food waste is presented, this is discussed further in the food waste section.

LA5 is a WCA and LA6 is a UA, however LA6 uses a facility that is shared with other LAs so has waste data similar to that of a WCA. For instance, the contamination rate is distributed between the users of the MRF. Also, the facility that handles the residual waste for LA6 adjusts the amount sent to an Energy from Waste (EfW) plant or landfill each month, this is reflected in varying monthly disposal costs.

Both interviews were conducted in the LA offices, the LA5 interviewee was the Recycling Manager and the LA6 was the Contract Policy and Performance Officer.

5.4.2. Infrastructure and service delivery

Both LAs provide a fortnightly collection for the residual and recycled materials. The best performer has a residual bin that is greater in capacity than the poorer performer at >240l and 141 – 180l respectively.

LA5 provides a bespoke collection for the rural properties, especially those that are hard to access with narrow lanes. Some have collection points which has not always been well received, but due to budget reductions the previous 'front door' collection is now not possible.

LA6 recently introduced a textile collection, not for recycling reasons, but to remove the material from the recycling bin as it clogs up the machinery in the MRF causing expensive down time. The textiles are recycled when a merchant can be found, but often it is disposed of in landfill.

Dry recycling

The materials collected for recycling by both LAs are shown in Figure 5.6, with LA5 providing a co-mingled collection for all materials and LA6 having a two-bin collection with paper and card separately. LA6 have also recently introduced a small WEEE collection at the kerbside.

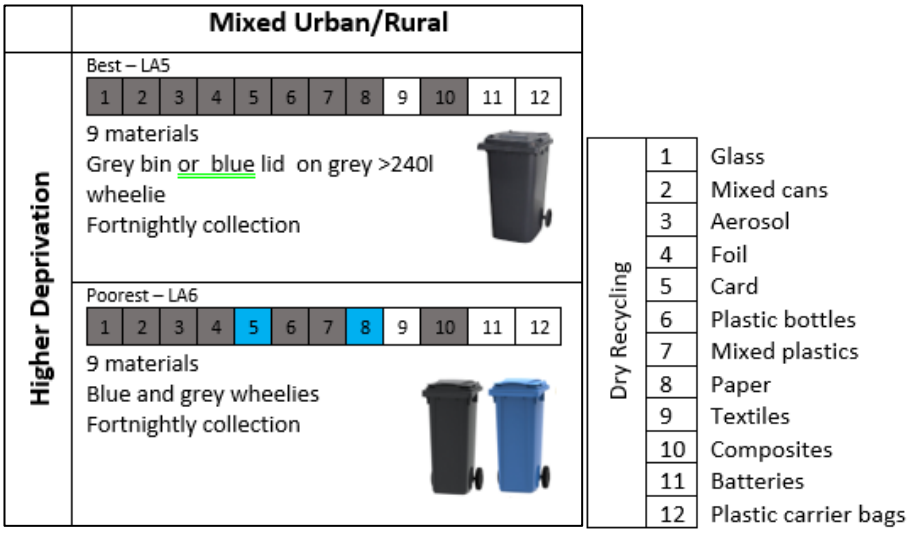

Figure 5.6: Group 3 dry recycling service

Previously LA5 had collected the dry recycling (previously a 2 bin service) and residual waste weekly, however due to budgetary reasons they reduced the collections to fortnightly. To offset the reduced capacity in the residual waste bin they increased the materials accepted for recycling by introducing tubs, pots and trays, the introduction of a reprocessor in the local area made this possible. The change from a 2 bin to a 1 bin dry recycling service, although simpler, took some time to change behaviour accordingly and resulted in a temporary dip in recycling performance.

The LA5 interviewee discussed how the markets for recycled materials are fluid and quality requirements can change. They also mentioned the change in foreign policy, when China announced that it would no longer accept low grade plastics, and how the programme Blue Planet has affected recycling figures positively. These discussions indicated a deeper understanding of broader reasons for material recycling.

LA6 advised that their dry recycling goes through two stages, a mixture of automatic and hand sorting in the MRF. The plastics are then taken on to a second MRF that has more sophisticated separation technologies for the pots, tubs and trays. Although they do not accept or recycle plastic film, they do turn a blind eye to it in the dry recycling bins due to the frequency with which it occurs.

Food and garden waste

Neither LAs provide a food waste collection service with LA5 explaining that there is no anaerobic digester near to them, and they believe it is a very expensive way to collect waste. LA6 also cited budgetary reasons for the lack of food collection, noting that pure garden waste collection costs the authority £20/tonne to treat whereas if food is added it would cost £60/tonne as it would need to be treated in an anaerobic digester or in-vessel composter.

LA5 charges £37 per year for the garden waste collection and LA6 charges £30. Interestingly when the charge was implemented in LA6 only 50% of the residents previously using the service signed up for it yet the service is still producing 80% of the original tonnages.

Residual waste

Both LAs provide a fortnightly residual collection, however LA5 provides larger capacity bins and unusually they are coloured green. LA6 also has an unusual dark red coloured residual bin, the colour of the rival football team's kit. LA6 was also one of the first LAs to introduce fortnightly collections and LA5 commented on the amount of money that has been saved moving from weekly to fortnightly collections.

Bulky waste

Both LAs provide a kerbside, paid for bulky waste service. LA6 uses a point system where the bigger the item the more points it has, and therefore takes up more space in the collection vehicle which is reflected in the charge.

Household waste recycling centres

No discussion during the interview.

Personnel

A team of 6 recycling officers work in LA5. The Recycling Manager, the interviewee, had made a case for the team by providing evidence that they pay for themselves by reducing

the charges associated with contamination. The team has grown quickly from 2 to 6, the interviewee commented,

> "…1 recycling officer isn't enough; you need a team."

LA6 mentioned that a team of personnel hand delivers the annual recycling pack that is offered to residents, however there was no mention of a dedicated recycling team.

5.4.3. Education and interventions

Both LAs indicated that communication is the key to increasing the recycling performance. LA5 has a dedicated team who continually communicate the messages of what goes in what bin. The interviewee, as with one other LA in this study, likened the job to 'painting the Forth Bridge', using the phrase to suggest that education is an on-going job due to people moving in or out of the borough or to pick those up that slip into bad habits. LA5 also suggested that;

> "The key is to get to the people who put their waste out, so when you knock on the door those are the ones you speak to."

LA6 discussed the theory of governance to nudge residents into changing their behaviour such as using local residents as 'messengers' in leaflets. These tools can provide subconscious cues and change behaviour without the resident realising. The interviewee suggested these theories should be applied to the whole service but there is the barrier of budgets preventing it.

Both LAs agreed that making the service as simple as possible for residents was important for increasing recycling performance and LA6 commented,

> "You can change people's behaviour without changing their attitude."

That is, by providing a bin for recycling, residents will recycle but they do not necessarily need to have a positive attitude towards recycling.

Both LAs use positive reinforcement such as 'Thank you for recycling well' stickers for bins. LA6 also believes powerful messages can work too, such as a leaflet that uses a baby

picking up a dog faeces with the wording ‘To her it looks like chocolate, just one lick and she could lose her eyesight’.

LA5 no longer sends a yearly calendar to residents and now relies on the website and the LA APP as the primary means of communication. LA6, however, delivers an annual ‘recycling pack’ to residents that contains a calendar, HWRC information, green waste application details, Christmas collections and information on what goes in which bin. This pack is hand delivered by staff.

Methods of communication

As mentioned, LA6 uses an annual recycling pack as the main form of communication with residents. They also use leaflets and bin stickers for various campaigns or for messaging about contamination. The website can also be used for reference by residents. Despite having a number of social media accounts, the LA does not use these for relaying waste or recycling information due to a lack of resources for managing content and responding to messages.

Both LAs try to incorporate images as much as possible to communicate with those residents who do not read English. LA5 has over 100 languages spoken in their area and have previously translated some leaflets; however, the feedback has been that they are too wordy and not well received. The interviewee explained that door knocking was by far the most effective form of communication and that language is less of a barrier if you can show people what to do.

LA6 uses a council newsletter, social media, the council APP, door knocking, exhibitions, school visits and finally they recruit ‘Recycling Champions’ who have ‘ask me about what to recycle’ stickers on their bins. They attend a training session and are given support when giving talks at local events about recycling. They are also given a chance to visit the MRF to get a better understanding of how the material is sorted and processed.

Challenges

The main challenges for both areas are housing type/access, transient residents and language barriers for non-English speaking residents. LA5 also adds that rogue landlords

often house the transient populations which causes extra problems. Budgetary constraints had affected both LAs with LA5 reducing the number of vehicles to save money, which changed the service for some properties, i.e. going from a door step service to a collection point. LA5 explains,

> "we've had a few challenges to over come because they've had such a good service where we've come to the door in that old farmhouse, but we can't do that anymore because of the budgetary reasons."

Campaigns

LA6 has designed two characters based on the local football team and these are used sporadically for communications. They have also contacted faith leaders to help design literature for the Asian community. It is difficult to know how well these campaigns work as the data is not so granular to pick up any local changes.

LA5 has a large campaign called 'Operation Contamination' that tackles contamination using door knocking and leaflets. It has been so successful that the money saved from reducing the rejected material at the MRF has paid for the team of 6 Recycling Officers. LA5 also concentrates on Recycle Week, an annual celebration of recycling in the UK. They involve their Recycling Champions to lead the week, asking for advice on where the LA should spend their resources.

Workshops and training

As discussed, residents who volunteer to become Recycling Champions in LA5 are provided with training and visits to the MRF. No other workshops or training were discussed during the interviews.

5.4.4. Website content

Both LA websites have a top page titled 'Waste and Recycling' with a list of links to further information contained in 3 subpages for LA5 and 5 subpages for LA6. Despite having more subpages, the LA6 website was easy to navigate with clear signposting. LA5, although thorough, had front loaded the website with 43 links on the top page (LA6 had 12) making it difficult to find information, so even though the list of materials accepted is available on

the 2nd subpage for LA5 and the 3rd subpage for LA6, it were easier to find in LA6's website.

LA5 provided 134 'yes' examples of materials that could be accepted and 168 'no' examples of those that are not and LA6 provided 120 yes and 17 nos. Both websites were attractive and had images and photographs to aid comprehension. LA6 included cartoons and recycling games too.

LA5 has a comprehensive Reduce, Reuse and Recycle (3Rs) section offering 18 links to charity and reuse websites. The website provided more information on waste reduction such as reusable nappies, food waste and composting but not on what happens to the materials after collection. Conversely, the LA6 website contains 10 videos explaining what happens to the waste after it is collected but less information on waste reduction, although 8 links to charity sites are provided. Unusually LA6 had downloadable information for landlords to provide to new tenants.

Both LA websites contained a vast amount of information with LA5 providing more information on reducing waste using the 3Rs, however LA6 had a more user-friendly experience.

5.4.5. Contamination

Both LAs have campaigns to tackle the contamination in their areas. LA5 notably has the successful 'Operation Contamination' which saw a 24% reduction in contamination and a 9% increase in recycling during the first round. Through door knocking and speaking to residents, the officers were often surprised to learn how little the residents knew. The interviewee said,

> "We as recycling managers assume too much sometimes. We think it's just enough to put a leaflet in a door. It's not, you've got to follow it up and talk to people, find ways to reach people."

The intensive campaign has encouraged partnership working with the local wardens who have been trained and are helping to door knock subsequent rounds, some of which have

1700 properties. This is possible due to backing from the leadership team who have realised the savings that can be made by reducing contamination levels.

LA6 described a similar campaign that dealt with 12000 properties, tackled in rounds, called 'A Clean Start'. All bins are initially emptied, including contaminated bins. Bin stickers are then used detailing what can and cannot be placed in the bins and then the area is monitored by the Waste Operatives checking the bins on collection day. The interviewee said that this process had been positive, however, both LAs discussed the issue with on-going monitoring as this requires more resources than they have and the data that comes from the MRF is not detailed enough to provide evidence to track performance changes as it includes data from other LAs.

Wheelie bins are difficult to monitor for contamination due to only the top layer being visible, LA6 suggests boxes are better for a higher quality recyclate. Plastic bags and films are the most frequent contaminants in the dry recycling bins for both LAs.

If, after several attempts to change behaviour, residents are still contaminating, the bins will not get emptied in LA5. They have also served Notices in accordance with the Environmental Protection Act 1990, the Notice imposes a legal requirement on the resident to present their waste in a specific way. If they fail, they can receive a penalty, they may need to attend a recorded interview under caution or they can ultimately be prosecuted. The LA has served approximately 5000 notices to date with no further enforcement required. This final push would appear to be necessary for some residents to change their behaviour.

LA6 has not used enforcement but will not empty contaminated bins, however this is dependent on the political influence at the time, as discussed in the next section.

5.4.6. Political influence

The influence of national policy such as the imminent introduction of the standardized green and food waste collections were a cause of concern for both LAs; specifically, how they can provide the service to the hard to access properties and the costs involved. LA5 mentioned the need to consider the 25-year contract that the LA is signed to and that,

> "If we could start again tomorrow, we'd do everything differently. It has been a piecemeal service from 1998. It's [the green and food waste collection] another add on."

On a local level, LA6 also explains that during pre-election periods, officers are unable to leave contaminated bins as, despite purdah restricting communications,

> "…people get voted in for favourable bin collections."

The portfolio of partners, or the political leadership of a LA, and the importance they place on recycling is paramount to funding a waste and recycling department according to LA5. However, since 2010 and the start of austerity, LA6 explained that,

> "…keeping up with the day job was very difficult. Doing anything proactive is impossible."

Budget restrictions were mentioned throughout both interviews.

Budgets

Budget reductions and austerity were driving factors in the changes to service provision in LA5. Savings were made by reducing the number of vehicles and therefore moving from a 2 stream to a 1 stream recyclate collection, from a weekly to a fortnightly collection and from a doorstep to a collection point service. Savings have also been made by reducing the residual bin capacity which increases recycling rates and reduces disposal costs. The team of Recycling Officers decrease contamination therefore saving disposal costs and providing enough savings to pay for their own salaries. However, the savings made by these changes are being offset by the increased housing stock and the vehicles needed to service them.

The interview with LA6 highlighted similar issues, with staff prevented from more proactive interventions due to a lack of resources. Examples of activities restricted to reduce costs included monitoring and responding to questions on social media, door knocking, and the communications intended to 'nudge' residents into behavioural change. LA6, however, did have a £20,000 annual budget for communications but there was not much left after the cost of the 'Recycling Pack' which consumes £14,000. LA5 did

not have a dedicated budget but could apply for money from the ‘corporate pot’ for leaflets or stickers when needed.

Customer satisfaction

Neither LA mentioned satisfaction surveys, however both said that they had received positive feedback from the contamination campaigns they had run.

5.4.7. Summary

Table 5.4 summarises the positive and negative factors that influence the recycling performance of LA5 and LA6. Operation Contamination, using football or faith leaders for messaging, and downloadable packs for landlords/new tenants were some of the examples of best practice from Group 3. The language barriers, housing type and population increases were factors beyond the LA’s control. Finally, those factors considered poor practice include larger residual waste bins in LA5, lack of social media and the political influence on emptying contaminated bins in LA6.

		LA5 Mx, HD, BP	LA6 Mx, HD, PP
Context	Positive		UA - short contracts
Context	Negative	Increasing population Transient population Rural hard to access properties	Terraces with back streets Asian population (food waste)
Infrastructure & Service delivery	Positive	**Fortnightly collections** Co-mingled (less confusion) Collect PTT **Team of officers**	**Fortnightly collections** **2-stream** Collects WEEE, PTT **2 stage MRF, hand and automatic**
Infrastructure & Service delivery	Negative	Large residual bins Inaccurate MRF data Collection points for rural Reduced vehicles (austerity)	Textile collection often landfilled Inaccurate MRF data No mention of recycling officers
Education & Interventions	Positive	**Door knocking** Positive reinforcement **Operation contamination** Recycling champions MRF visits LA APP School visits Exhibitions	**Implements nudge theory** Positive reinforcement Annual recycling pack **Contamination campaign** **Football and faith messengers**
Education & Interventions	Negative	Relies on APP for calendar 100 languages spoken Language barriers	No door knocking No social media Language barriers No budget/resources
Website content	Positive	Reuse & repair Charity links Thorough details	**Fun, user friendly** Cartoons with videos and games What happens after collection **Landlord/new tenant information**
Website content	Negative	Front loaded (43 links) Not as user friendly	No reduce/reuse/repair
Contamination	Positive	**Operation contamination** **Door knocking** **Enforcement** Not emptying contaminated bins	**Contamination campaign**
Contamination	Negative		Lack of resources Political influence re emptying bins
Political Influence	Positive	**Political leadership backing**	
Political Influence	Negative	Austerity Savings offset by increased housing	Austerity Emptying contaminated bins during election periods

Bold - Best practice
Red - Poor practice
Blue - No control
SFW - Standardised food and waste collections

Table 5.4: Group 3 summary of influences on recycling performance

5.5. Mixed urban/rural, low deprivation – Group 4

Group 4 represents the mixed urban/rural, lower deprivation LAs, Figure 5.7 shows the group on the classification scale. LA7 represents the best performers with a recycling Quantity Rate of 59% and Quality Rate of 100%. LA8 represents the poorest performers with a Quantity Rate of 39% and a Quality Rate of 84%.

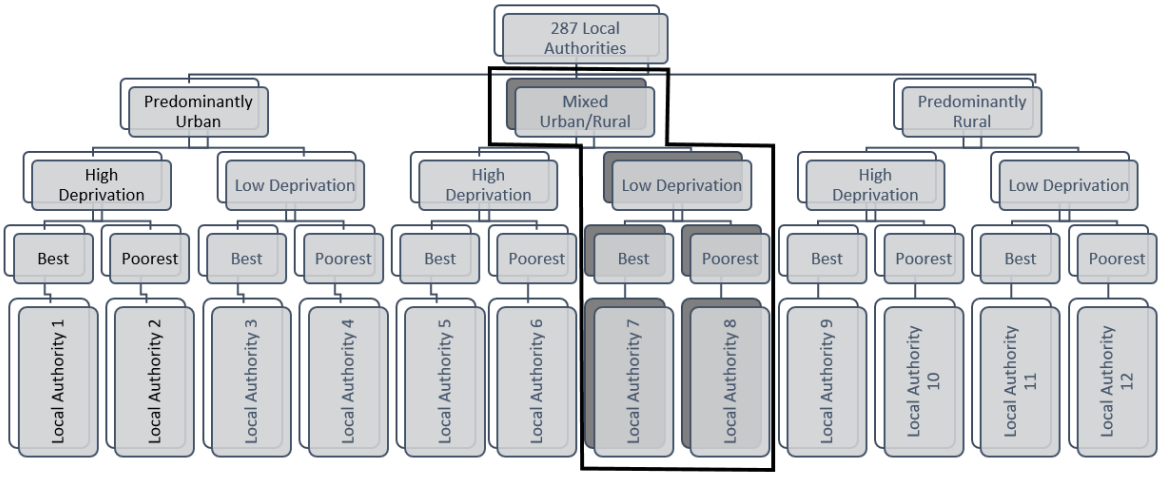

Figure 5.7: Classification scale - Group 4

The location and situation of Group 4 LAs are described in the next section, providing context to the subsequent description of recycling activity

5.5.1. Local Authority context

The best performing LA (LA7) is a UA and was established in 2009 with the merger of 3 district councils and a county council. It contains a city with a small portion bordering the coast. The authority is geographically large covering 917 km^2, compared to LA8 which is 110km^2, it can take up to 1.5 hours to reach some rounds or to do a site visit. This difference in area accounts for the difference in population density, LA7 has 376 residents/km^2 and LA8 has 1052 residents/km^2. Despite LA7 having a low population density, one of the lowest in the group, it is still classified as a mixed urban/rural LA. The two collect similar quantities of all types of waste with LA7 collecting slightly more at 0.47 t/yr/r and LA8 collecting 0.38 t/yr/r.

LA7 is experiencing an increase in flats which traditionally, as an authority, they have not had to deal with. The interviewee explained that often the flats are built with no waste storage facilities causing issues for the department. Other planning problems include new build estates that have been designed with roads that cannot service the weight of the waste collection vehicles. The department must decide whether they drive onto the estate or not, the roads are not adopted as they do not meet the required standards and so insurance must be considered should there be damage to the road. The interviewee explained that this was down to developers cutting their costs.

LA8 is a landlocked, central English LA that was formed in the 1970s by merging an urban district with a rural one. It sits between 2 cities and is well connected by major motorways. LA8 is a WCA that is serviced by the County Council, the WDA.

Both interviews were conducted in the LA offices, the interview with LA7 was with the Waste and Street Scene Commissioner and LA8 was with the Interim Waste Manager who had been in position for 6 months at the time. The interview with LA8 was influenced by this and includes some examples of the Manager's experience that was not relevant to LA8, these will be highlighted as such in the text.

5.5.2. Infrastructure and service delivery

The best performing authority LA7 manages its services via 3 contracts that include the waste collection, waste disposal and communications. The interviewee, when asked what is responsible for their high recycling rates, responded saying that it was a mixture of a box collection for the recyclates, a wide range of materials accepted for recycling (Figure 5.8) a small residual bin that has a fortnightly collection, and good communications. Road sweeping silt is sent for land reclamation on landfill sites so can be classed as municipal recycling that increases the figures too.

LA8 is a WCA and sends their recyclate to a MRF that is located approximately 45 minutes from their site, yet there is a MRF on the same street that they cannot use due their contract. This travel increases the wear and tear on the vehicles, increases insurance claims due to road accidents and increases the chance of damage to the vehicle, not to mention the cost of the fuel. Interestingly a vehicle was termed by the interviewee as the

'work horse' of the department and has an average useful life of 6 or 7 years, less in urban environments. The upcoming government changes to standardise the food waste collections will also need a fleet of vehicles that can handle the acidic nature of the waste. The interviewee also explained that electric vehicles will need to be prioritised in the future, but they were currently too expensive for a LA budget.

Dry recycling

The materials collected by both LAs are shown in Figure 5.8, with LA7 providing a weekly, two box service and LA8 providing a single stream, fortnightly collection using wheelie bins.

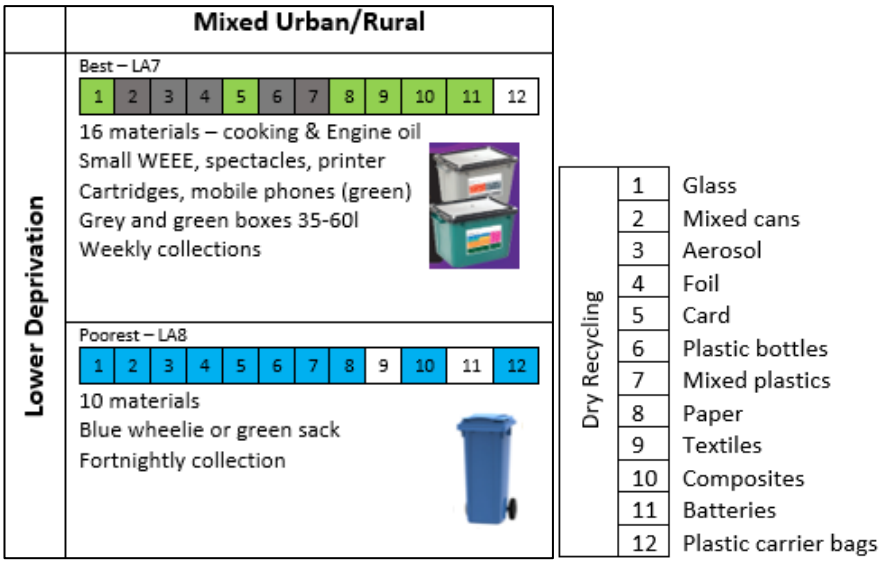

Figure 5.8: Group 4 dry recycling service

LA7 has a two-step sort; firstly, the wide range of materials are source separated by the residents and then the Waste Operatives provide a second sort at the kerbside using a vehicle with several compartments. The interviewee explained that,

> "The boxes offer a high quality and high value material, but people would love a wheelie bin."

The authority is keen to keep the box system as the high-quality material secures the reprocessor markets. However, the contractor has mentioned Health and Safety concerns

with the boxes and that there may be muscular and skeletal issues for the operatives. Another problem is that the lids go missing or get blown off causing windblown litter. This service is costly for the department; however, these costs are offset by having no contamination fees. LA7 explained that their residents are keen recyclers and there is a demand to recycle more materials, including black plastic and plastic film.

LA8 has an interesting annual change to their dry recycling collection. During the winter months, November to March, the garden waste collection is halted and residents can use the container as an extra recycling bin. If a resident prefers this service and does not want to switch back to the garden waste collection, the bin lid is changed from brown to blue. A blue re-useable bag is also given to residents for extra dry recyclate, however there are issues with the bags blowing away after they are emptied.

Food and garden waste

LA7 provides a separate food waste collection that is collected alongside the dry recycling, having a separate compartment in the vehicle. Despite offering the service, the authority would like to increase participation. LA8 does not provide this service and the interviewee explained that it would be too expensive and has a lot of issues such as odour and increased vehicular maintenance, experience he has from working in other LAs.

The introduction of the governments standardised separate food and garden waste collection was problematic for both LAs. As already discussed, LA8 explained that the cost of implementing the scheme would be too high and that there is no anaerobic digester near to the authority to send the waste to. LA7 had other financial concerns, however. The interviewee had heard rumours that those LAs that were currently charging for their food and/or garden waste collection would receive funding to change to a ‘free’ service. The interviewee felt that their LA was being penalised as they had made savings elsewhere to pay for the already free service.

Residual waste

Both LAs provide a fortnightly residual collection, using 141-180l black wheelie bins.

Bulky waste

Both LAs provide a kerbside, chargeable bulky waste collection.

Household waste recycling centres

LA7 explained that their HWRCs offer a wide range of recycling services, and despite some of them only servicing a small number of residents in the rural areas, the LA decided to keep them open as they are usually used by the aging population who are unable to travel further.

LA8 ran a one-off campaign to offer a mobile HWRC for residents who may not have a car, they found that it was very popular in some areas. However, due to budget cuts this service was unable to continue.

Personnel

Budget cuts were also the reason for there being no dedicated team dealing with recycling in LA8. Austerity has meant that the service has been eroded so there is no 'pot' of money for education or communication.

LA7 has 4 'Waste Doctors' working in the area, but due to the geographical size of the authority, they are spread very thin. These staff members, however, are secure due to being written into the contract with the waste management company. 2 staff members are supplied by the external company, and they must be matched by the LA as per the contract, a similar agreement is in place with regards to the budget for communications.

5.5.3. Education and interventions

The contract LA7 has with their waste management company stipulates they must fund and provide a recycling awareness staff member and spend an annual budget (£150,000) on communications and awareness. Contractually, the staff member and the budget is matched by the LA thereby providing an element of protection from austerity cuts.

LA7 has an overarching 3-year communications strategy and smaller annual goals that are based on the waste analysis and feedback from a customer satisfaction questionnaire. The interviewee explained that they understand that recycling is not easy for residents

and that they are demanding a higher quality from them than other LAs are from their residents, however they believe that their residents are responsive and keen to improve.

As already mentioned, LA8 has no budget for their communication and heavily rely on communicating digitally through their website.

Methods of communication

Both LAs use their website, LA8 more so than LA7, however both interviewees criticised them for being difficult to use. Calendars are sent annually through the post in LA7 and further communications are sent via the authority newsletter. LA8 occasionally adds an article to the authority pamphlet that is sent to residents, but this is more on an ad hoc basis.

Neither LA use door knocking, through lack of staff and the high costs, and although both have stickers they can use, neither of them do very often. LA7 explained that they do not want to over-sticker bins and LA8 mentioned that the Waste Operatives do not have time to add them to the bins on their rounds. LA7 did however have success using stickers for a campaign to prevent residents from putting food waste in their residual bin, and they had a sustained impact.

LA7 is starting to change from blanket to targeted communications. For instance, they ran a nappy recycling service at one point and rather than inform all residents they target those with babies. This service was terminated after the reprocessor went out of business, however.

Challenges

Both interviewees explained that despite extensive communications, promotions and targeted awareness, residents are still unsure of what they can recycle. Both LAs suggest it is because of the mixed messages in the public domain with the LA8 interviewee stating,

> "It's difficult to keep tabs on what goes where and why, I can understand why Joe Public are confused."

Flats and transient populations, such as students, were highlighted as being an issue for both LAs and LA8 explained that some rural areas do not have mobile phone reception so using the website is impossible. LA8 also explained that some properties are very difficult to find and that the staff who know how to find these properties are more valuable than the collection vehicles.

Campaigns

The mobile HWRC was a success in LA8, unfortunately the budget was finite and the service has not been renewed so the campaign has been paused. Both LAs previously had provided a disposable nappy recycling scheme, they both discontinued the service due to their reprocessors closing.

LA7 introduced a campaign to collect crisp packets at collection points and increased the kerbside service to accept small WEEE. They are also in the process of planning a plastic free campaign but are keen to implement it internally first so there is no criticism of hypocrisy should they sell water in plastic bottles, for instance.

Workshops and training

Neither LA had workshops nor offered training.

5.5.4. Website content

Overall, both LA websites were easy to use with a breadcrumb navigation. LA7 had 11 options on the first page and LA8 had 9, so they were similar in their simplicity to locate information. They both had information on composting, links to charity and reuse websites and they also included information on what happens to the material after it has been collected. Both websites lacked images or pictures and presented the information predominantly in text, however neither mentioned language as a barrier when discussing challenges in their authority.

The website for LA8 relied on an A-Z of 65 materials for their recycling information rather than detailing what can go in each bin, there is only a 1 stream recycling bin system, which may explain this approach. This website was small but well-formed containing information about the service, reuse, and charity links.

LA7 had similar information to LA8 however it contained more detail. There is a lot of information on the history of plastic, example sections include Bakelite, cellophane, billiard balls, Teflon, and thermoplastic polyester. There are also many links to external sources for recycling facts and details on how to reduce and reuse materials such as a link to ethical fashion and living fuels websites. The LA has set up a site specifically for children, the Junior Environmental Club, where mascots are used with games and many other resources to get the children and their school involved. There is a separate section for students too with a 'how to' guide for using the service.

5.5.5. Contamination

The interviewee for LA7 believes that contamination is not an issue for the LA due to the 2-stage material sort, firstly by the resident and secondly by the Waste Operative in the process of allocating materials to compartments on the wagon. The box collection also allows for an easy inspection so that any non-target material is identified and left with a notice explaining why. The LA have yet to have a repeat problem from the same residence. When the three authorities combined to form LA7, one of them had a wheelie bin, dry recycling system with high contamination levels. It was deemed a cost saving to remove the wheelie bins and replace with the boxes.

The interviewee for LA8 advised that the authority tends not to have an issue with contamination but instead discussed the standard expected by the MRF. LA8 does not have a contractual amount of contamination that the MRF will accept, unlike others that allow 10 – 15%. An example was given; a wagon of dry recyclate was delivered to the MRF with a small amount of garden waste contamination. A photo was taken by the Waste Operatives showing only small amounts of contamination, whereas the MRF took a photo showing from a different angle which made it look a lot more than it was. The LA in this instance paid the additional £600 disposal costs for the rejected material, however felt that it was not warranted. Occasionally the Waste Manager has attended the MRF and removed the contamination by hand so that the rest of the load can be processed.

5.5.6. Political influence

The implementation of the proposed separate garden and food waste service was discussed by both LAs. The cost of implementation, providing new bins and vehicles was highlighted as an issue for LA8. As discussed previously, LA7 mentioned the concern regarding the unfair funding for LAs that currently charge for the service.

National influences such as Brexit and changes in political leadership can change the direction of decisions, such as with the mobile HWRC campaign in LA8 and both LAs discussed the need for more reprocessors locally. LA7 explained that they collect the material very well, but they are lacking reprocessors to sell it to, LA8 also mentioned the lack of anaerobic digesters and how this would be a barrier to collecting food waste in the authority.

Exporting waste to other countries needs tighter controls but is otherwise is an acceptable form of waste disposal according to LA7. However, these conversations are difficult to have with the public, including those around carbon emissions versus recycling rates. LA7 is exploring different avenues for the plastic recycling and maybe the public has less of an appetite for using it as a fuel, for example. The interviewee explained that residents understand recycling rates better than they understand carbon accounting.

Budgets

When describing the waste industry, the interviewee at LA8 said,

> "…it's all about money and cost savings. It doesn't matter if you're a WCA, WDA or UA they've all got to save money."

When talking about the introduction of the standardised separate food and garden waste services, the same interviewee also commented,

> "I don't know a waste manager up and down the land that could tell you what implications there would be apart from cost."

Austerity and the resulting cuts to services had affected both LAs significantly with job losses and reductions in service. Despite LA7 securing a healthy budget via their waste contract it was still less than before.

The unique position held by the Interim Waste Manager in LA8 meant that the experience brought from other LAs in terms of cost savings and efficiencies, was being utilized. The interviewee believed that digitizing the service was the key to cost savings, moving to digital collection calendars, for example.

Customer satisfaction

Every 3 years LA7 outsources a customer satisfaction survey involving 1000 residents, the results of which feed into the communications strategies. The main findings were that there is still a lot of confusion about what can be recycled and there was a request for more information on what happens to the materials once they are collected. This latter information was previously included on the website until the corporate team decided that it should not be public knowledge, it has since been re-added due to the survey. LA8 does not carry out customer satisfaction surveys.

5.5.7. Summary

The summary of positive and negative factors on recycling performance in Group 4 can be found in Table 5.5. A communications strategy, contractual communications budget and a box collection are highlights of best practice for the two LAs with austerity, lack of reprocessors and infrastructure as some of the factors out of their control. Neither LA uses face to face communications and combined with a lack of images on the websites these were considered some of the poor practices in Group 4.

		LA7 Mx, LD, BP	LA8 Mx, LD, PP
Context	Positive	Low population density	
Context	Negative	Very large area Collects high tonnages More high-rises Substandard roads	
Infrastructure & Service delivery	Positive	**2 box collections** **Source and kerbside sort** Food waste collection Free garden waste collection **4 Officers secured with contract**	Co-mingled (less confusion) Change garden for recycling in winter Free garden waste collection **Mobile MRF (trial finished)**
Infrastructure & Service delivery	Negative	H&S concerns with boxes No end markets More reprocessors needed	MRF 45 mins away No AD locally for food No recycling officers
Education & Interventions	Positive	**3-year strategy/annual goals** **Healthy budget** **Targeted comms** Calendars mailed	Website
Education & Interventions	Negative	No door knocking	No comms (only website) No budget therefore eroded service Reduced 3/4G networks (website access) Difficult to find rural properties
Website content	Positive	Detailed recycling facts Reduce/Reuse Charity links What happens after collection	User friendly Reduce/Reuse Charity links What happens after collection
Website content	Negative	Lacked images, lots of text	Lacked images No school resources
Contamination	Positive	**Kerbside sort = no contamination** Non target material left Notice explaining left materials	
Contamination	Negative	H&S concerns with boxes	Increase quality demand
Political Influence	Positive	**3-year strategy/annual goals** **£150k contractual budget** **Budget matched by contract (safe)** Leadership buy-in for research Cust. Sat. surveys informs strategies	**Mobile HWRC successful** although the funding was removed so service stopped.
Political Influence	Negative		No budget Austerity eroded service Uncertain futures (Brexit, changes in political leadership) Lack of infrastructure (No AD)

Bold - Best practice
Red - Poor practice
Blue - No control
SFW - Standardised food and waste collections

Table 5.5: Group 4 summary of influences on recycling performance

5.6. Predominantly rural, high deprivation – Group 5

Group 5 represents the predominantly rural, high deprivation LAs, Figure 5.9 shows the group on the classification scale. LA9 represents the best performers with a recycling Quantity Rate of 49% and a Quality Rate of 100%. LA10 represents the poorest performers with a Quantity Rate of 41.4% and a Quality Rate of 84.4%.

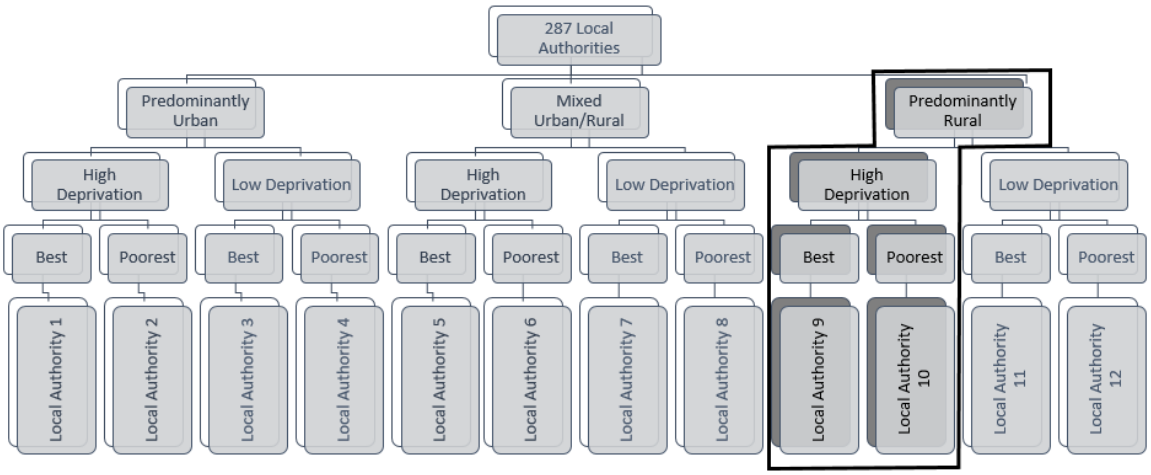

Figure 5.9: Classification scale - Group 5

The location and situation of the two LAs in Group 5 are discussed in the following section.

5.6.1. Local Authority context

The LA representing the best performing authorities, LA9, is a landlocked UA with a population density of 101 residents/km^2. It is one of the most sparsely populated authorities in England and one of the largest with an area of nearly 3200km^2. LA10, the representative of the poorest performers, is a WCA and has a similar population density at 108 residents/km^2. It has a 73km coastline and one of the oldest age profiles in the UK, being a popular location for retirement.

The amount of waste collected by both LAs are similar with LA9 and LA10 collecting 0.4 and 0.47 t/yr/r respectively, these figures are in line with the rest of the groups, if on the high side.

Both interviews were conducted in the LA offices, LA9 involved the Waste Management Officer and LA10 the Environmental Services Manager.

5.6.2. Infrastructure and service delivery

LA9 is a UA that has a 28-year contract with a waste management company to collect and dispose of their waste. This long contract has resulted in a well-formed relationship between the LA and the contractor, one of the many positive outcomes of the contract. The contractor works hard to hit recycling targets, if they default more than 3 times in a row there are financial penalties. However, the contractor dedicates time to training their staff and they are strong on health and safety which supports their high performance.

LA10 is a WCA, one of 7 LAs that are part of a waste partnership run by the County Council WDA. The waste partnership has shared resources, other than the waste treatment infrastructure, such as a communications officer.

Dry recycling

The materials collected by both LAs are shown in Figure 5.10, with LA9 providing a fortnightly dry recycling collection using a box and bag system. LA10 also collects fortnightly but uses a green wheelie bin, they also take additional materials if they are presented in a clear bag or box, for ease of spotting non-targeted materials.

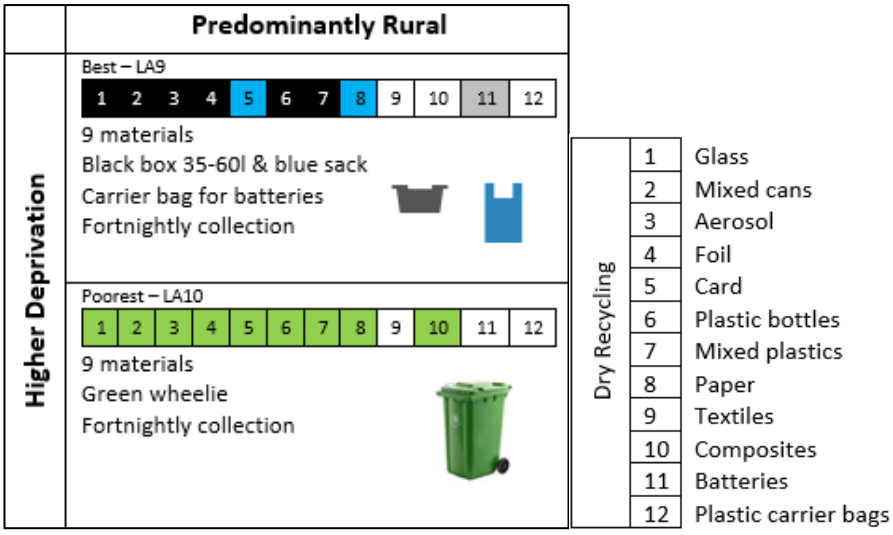

Figure 5.10: Group 5 dry recycling service

It is recognised by LA9 that the box and bag collection service has manual handling issues, that they can result in windblown litter and that residents would prefer wheelie bins, but due to the low contamination rates and the cost for issuing wheelie bins to all residents they are not changing the service for the foreseeable future. They have, however, introduced a comingled collection so that the materials can be presented mixed in both the box and the bag, rather than the paper and card in the bag which has been positively received by residents.

LA9 collects batteries in clear plastic bags but despite being widely communicated, residents do not use this service frequently. LA10 collects composites and in 2014 started collecting glass from the kerbside along with pots, tubs, and trays. However, despite collecting more material, tonnages are not increasing proportionally due to products using less materials, termed 'light weighting'.

Food and garden waste

Currently, LA9 provides a combined food and garden waste collection at no additional cost to most of their residents. The food waste collection does not extend to all residents due to capacity constraints with the in-vessel composter servicing the LA. There is a further plant due to be built and forms part of the 28-year contract with the waste management company. The LA are also resisting any changes to their collection until the Government firms the plans to introduce the separate food and garden waste collections.

LA10 explained that the cost of collecting food waste is not financially viable for them due to budget cuts through austerity. The costs are elevated due to the distances between the rural properties, so the service involves more driving, time, and fuel.

Residual waste

Both LAs provide fortnightly residual waste collections using 141-180l grey wheelie bins.

Bulky waste

Both LAs provide a kerbside, chargeable bulky waste collection.

Household waste recycling centres

Neither LA discussed the HWRCs in the interviews.

Personnel

Being a WCA, LA10 benefits from a shared Communications Officer who sits in the WDA working for all 7 partner authorities. LA10 also has 3 Contracts Officers that deal with all services provided by the contract with the WDA, such as ground maintenance, waste, and recycling. The Contract Officers deal with issues such as contaminated bins and will get involved in the campaigns led by the WDA.

Austerity has seen a team of 14 Recycling Officers being reduced through job losses to a team of 3 in LA9 and despite being one of the smallest teams in the council, they receive the highest number of phone calls and complaints. As is common with many LAs, the Customer Services team are trained to provide information on the service, relieving the workload of the 3 Recycling Officers.

5.6.3. Education and interventions

Most communications are provided by the contractor in both LAs and coincidentally both allocate an annual £25,000 to pay for the service. The Officers in the LAs provide support to the contractor during specific campaigns if they can, depending on their workload.

LA10 has moved to a targeted approach to communication, rather than blanketing all residents, and they have used the WRAP's branding to keep their messaging consistent. LA10's representative made the point that most campaigns have an immediate positive impact, however it is the longevity of the effects that decline over time and when discussing the overarching design of communications and education the interviewee said,

> "It's about continuing the drip feeding that people need."

As a side note, the LA9 interviewee explained that in their experience there were more women in the waste and recycling communications job sector but did not offer any explanation as to why.

Methods of communication

Both LAs provide collection calendars through the post to their residents, LA9 provides them twice a year and LA10, although previously twice, now sends them once a year. Both LAs use leaflets but they rely more on digital communications through their websites and social media accounts. However, LA9 explained that occasionally the corporate communications team have tweeted incorrect information, such as saying that a material can be included in the recycling bin when should not.

LA10 attends an annual event called 'Sustainable Living', providing information on the service and they also run campaigns during Recycle Week. When talking about press advertising, however, the interviewee stated,

> "If you're trying to communicate the message these days, print advertising especially in newspapers is not, in my opinion, that effective."

Neither LAs have the capacity to carry out door knocking campaigns and both mentioned the negative impacts that austerity has had on the service they provide.

Challenges

LA9 explained that bin stores can be an issue with improper use, sometimes they are crammed full so the Waste Operatives cannot access them. When communication and education has not changed behaviour, jobs are referred to the Environmental Health team who use enforcement procedures. Another challenge for LA9 is that some of their aging populations are not on-line which needs to be considered when using digital media.

LA10 explained that there is no in-depth monitoring and evaluation of the service so quantifying the effects of campaigns is difficult.

Campaigns

The interviewee for LA9 expressed a personal interest in waste minimisation and was incorporating this into their role. The LA officers and the WDA officer provide educational visits to schools, on request, and have a campaign called 'pass it on' to instigate intergeneration influence. There is also an annual scheme called 'Crucial Crew' that aims

to prepare Year 6 children for the transition to secondary school. They cover topics such as dangers around farm machinery, stranger danger, and in more recent years they have introduced waste and recycling to encourage the children to become responsible citizens. Crucial Crew has reached thousands of children over the years.

A further campaign is run each Christmas to encourage tree recycling where the LA gives money to a local charity for every tree that is recycled, this usually raises around £5000 annually.

LA10 explained that the financial benefits of waste reduction sit with their WDA, so they tend not to include that in their communications. Instead, they focus on increasing recycling rates because that provides them with an income. The interviewee mentioned that campaigns do not have positive effects on the recycling rates, it is a change of service such as collection frequency or types of materials collected that have substantial, long-lasting effects.

Workshops and training

Neither LA had workshops nor offered training.

5.6.4. Website content

The website for LA9 has a very attractive top page with graphics for the 14 options leading to further information. Contained within 3 subpages, information regarding the service was easy to locate with additional information about what happens to the materials after they are collected. Videos, made by the LA and Recycle Now, an external resource, are used to illustrate the MRF and how materials are recycled. A video explaining how the Energy from Waste plant works is also provided along with air emission data from the local site. The website has 14 links to reuse and charity sites and has a separate page for Reduce, Reuse and Recycle. There is a blog called The Wonderful World of Waste that provides information on how residents can work towards a zero waste lifestyle and a section for residents to participate by sharing their recycling tips on Facebook and Twitter. Overall, this website clearly signposts information about the service and provides a large quantity of wider environmental messaging.

The website for LA10 is smaller, however it provides a clear and straight forward explanation of the service provided by the LA within 2 subpages. The top page has 6 menu options and the list of what can go in each bin is located on the 1st subpage, illustrated with graphics. No information or links are provided to reuse networks or charity sites and it does not contain any further information on what happens to the materials once they are collected. There is no information on composting or how residents can reduce their waste, however there is a link to the WDA's website that contains this information.

5.6.5. Contamination

The LA9 interviewee believed that their low contamination rates are a result of collecting the dry recycling in boxes and bags. The Waste Operatives are not expected to report contamination; however, they do leave non-targeted materials in the box with a card to explain why. Repeat offenders have their recycling service removed. The interviewee explained that the contractor has recently increased their education and this has decreased contamination levels and increased their recycling rates.

LA10 explains that their contamination fees are calculated annually based on a series of audits on the materials arriving at the MRF. Samples are taken, there were 14 x 60kg samples taken the month before the interview, and a report is provided detailing what contaminants were found. In the latest report, nappies were the most frequent contaminant but objects such as a beer keg, lawnmower blade, gate hinge, and drainpipe were identified. Textiles are also one of the biggest contaminants, causing issues with the machinery in the MRF.

The LA10 leadership team are becoming increasingly concerned with contamination and the associated fees, however the interviewee suggested that the cost of communications used to change behaviour, which is short lived, could just be spent on paying the reject fees. The interviewee described themselves as 'jaded' and their years of experience had shown that communications were not effective when tackling contamination. Although, they also noted that the direct cost for disposing of the rejected materials were not obvious as they are absorbed in the annual gate fees.

5.6.6. Political influence

National policy changes such as changes to the rules on collecting street sweepings for compost had reduced LA10's recycling rate by 3-4% and when asked if they would be meeting the 50% recycling target by 2020 the answer was 'no way'. They did, however, explain that this would be a UK target and that individual LAs would not get penalised for not meeting it.

The introduction of the Extended Producer Responsibility was influencing the tonnages of recyclate collected. Despite increasing the range of materials collected, the lightweight design of packaging was offsetting any increases in materials from extending collections to, for example, pots, trays, and tubs. The interviewee for LA10 explained that,

> "…as much as recycling should be about environmental factors, the whole industry is led by economic factors."

On a more positive note, however, LA10 did think that communication would be easier if the whole country had the same collections, such as is being proposed by the standardised food and garden waste collections. Campaigns could be communicated using prime time television adverts, increasing awareness at a much-reduced cost to individual LAs. However, to service these changes LA9 expressed concern over the lack of infrastructure in the UK and available end markets.

Budgets

Austerity has impacted the services provided by both LAs. LA10 was clear that economic factors drive the recycling services provided by their authority, and LA9 explained that the service has been reduced with job losses. The recycling team had been reduced from 14 down to 3, also explaining that budget cuts had hit communications first.

LA9 conducted a review in 2016 to price a change in service from boxes to wheelie bins, the £3 million required was not feasible at that time and with the imminent statutory changes in food and garden waste collections, the authority is not willing to spend taxpayers' money before confirming what is required of them.

Customer satisfaction

Neither LAs discussed customer satisfaction.

5.7. Summary

Table 5.6 provides a summary of positive and negative influences on recycling performance in Group 5. Best practice highlights include providing a platform for residents to share recycling tips, school visits (intergenerational influence) and videos that detail what happens to the materials once they are collected for recycling. Material light-weighting, austerity, and lack of waste processing infrastructure in the UK are factors out of the control of the LAs and factors considered poor practice include a lack of appetite for reducing contamination and incorrect messaging from central communication teams.

		LA9 PR, HD, BP	LA10 PR, HD, PP
Context	Positive	Space/less flats Less transient populations	Retirees Less transient populations
Context	Negative		Large distances between collection
Infrastructure & Service delivery	Positive	**28-year contract with good relationship** **Targets for contractor** **Box collections** Free food & garden collection 3 recycling officers (also contract officer)	WDA shared resources 3 Contract officers
Infrastructure & Service delivery	Negative	H&S issues with boxes Windblown litter IVC at capacity limited food collections (New IVC to be built)	Light weighting of materials No food waste Time/fuel distances between properties
Education & Interventions	Positive	**£25k budget** Calendars x 2 mailed per year Digital communications School visits Reduce/reuse Large number of campaigns	**£25k budget** Targeted communications WRAP branding Campaigns Annual event
Education & Interventions	Negative	Confusion - incorrect tweets from central LA communications team Bin stores	No lasting effect from campaigns No monitoring and evaluation No reduce/reuse (not financially lucrative for WCA)
Website content	Positive	User friendly Reduce/Reuse Charity links What happens after collection **Resident participation (recycling tips)**	User friendly
Website content	Negative		Service information only No composting No reduce/reuse/repair No school resources
Contamination	Positive	**Boxes - easy to spot contamination** Non target materials left with card Contractor has increased education	
Contamination	Negative		No direct costs from contamination No appetite to reduce contamination
Political Influence	Positive		SFW scheme easier comms
Political Influence	Negative	Lack of infrastructure in UK Austerity Too costly to change to wheelie bins	Material light weighting Austerity Cost dictates service

Bold - Best practice
Red - Poor practice
Blue - No control
SFW - Standardised food and waste collections

Table 5.6: Group 5 summary of influences on recycling performance

5.8. Predominantly rural, low deprivation – Group 6

Group 6 represents the predominantly rural, low deprivation LAs, Figure 5.11 shows the group on the classification scale. LA11 represents the best performers with a recycling Quantity Rate of 59.5% and a Quality Rate of 99.2%. LA12 represents the poorest performers with a Quantity Rate of 32% and a Quality Rate of 88.1%.

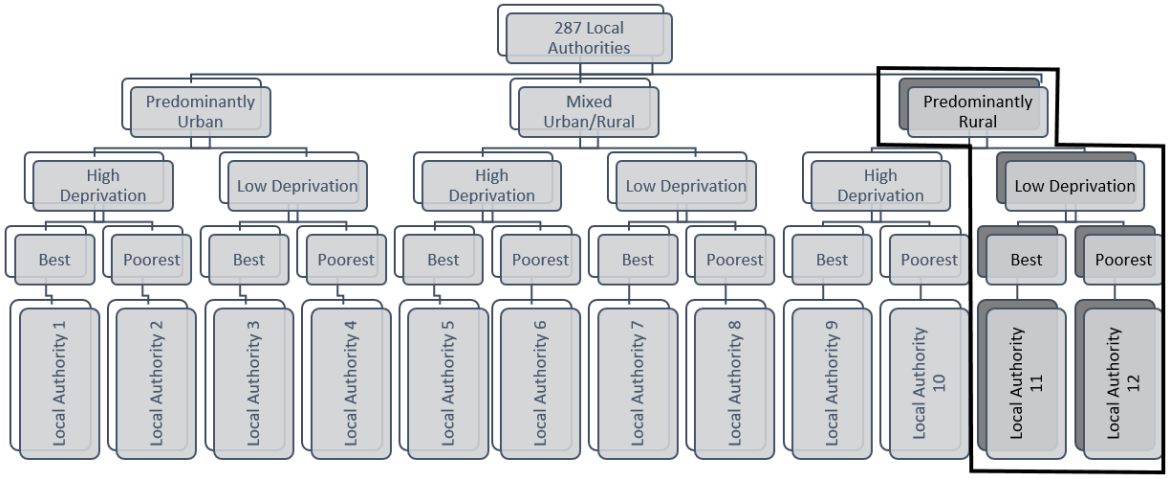

Figure 5.11: Classification scale - Group 6

The location and situation of each LA is discussed in the following section to understand the context and the influence this may have on the recycling performance.

5.8.1. Local Authority context

Both LAs in Group 6 are landlocked, located in the South of England and are of similar size. LA11 has a population density of 154 residents/km^2 and LA12 has 199 residents/km^2. Both LAs are WCAs with LA11 collecting 0.4 t/yr/r and LA12 collecting 0.32 t/yr/r.

LA11 explained that they have an expanding population with the development of thousands of new homes, mostly houses and LA12 explained that although there are few flats in their area they have been increasing recently. LA11 explained that they are an affluent area and that affluent areas have a better recycling performance than those that have higher deprivation. The authority is predominantly white British with no language or cultural barriers, making communication straight forward.

Both interviews were conducted remotely, LA11 was conducted using Skype with an Environmental Services Officer and LA12 interview used Microsoft Teams and was with the Environmental Services Manager.

5.8.2. Infrastructure and service delivery

A quote from LA12 succinctly explains what drives their department.

> "…we spend our time trying to maximise recycling and minimise contamination to get the best we can out of the system we've got."

Collections are managed in-house which is seen as more efficient than contracting out the service. The LA12 interviewee explained that they are outperforming other WCAs in their partnership who do contract this service out. By keeping the service in-house they have a greater control, for example they can request that the Waste Operatives also provide information as and when needed such as attaching bin hangers during campaigns, something that an external company may not consider or would apply additional charges for.

LA11 explained that most of their recycling is carried out in the authority or within the UK, other than plastics that are sent to Turkey. Both LAs send most of their residual waste to local EfW plants.

There are 10 WCAs in the WDA partnership that LA12 belongs to, and 4 WCA linked to LA11. LA12 explains that the authority was a beacon example for recycling performance in the 1990s but has since been 'trapped' in a contract, collecting the same materials. However, a new 'Super MRF', or SMRF, is due to be built soon that will allow the LA to increase the range of materials collected for recycling.

Dry recycling

The materials collected by both LAs are shown in Figure 5.12, with LA11 providing a fortnightly, co-mingled collection of 15 materials and LA12 providing a fortnightly, co-mingled collection of 5 materials. Noticeably LA12 does not collect glass at the kerbside, instead collecting in bring banks around the authority. Interestingly, their recycling performance exceeds those of their neighbouring LAs that do collect glass from the

kerbside. When asked if the LA are considering a change in service to collect glass, the response was,

> "Why fix something that's not broken?"

The introduction of the super MRF, however, may change their service as well as the application of the Environment Act dictating what services LAs must offer.

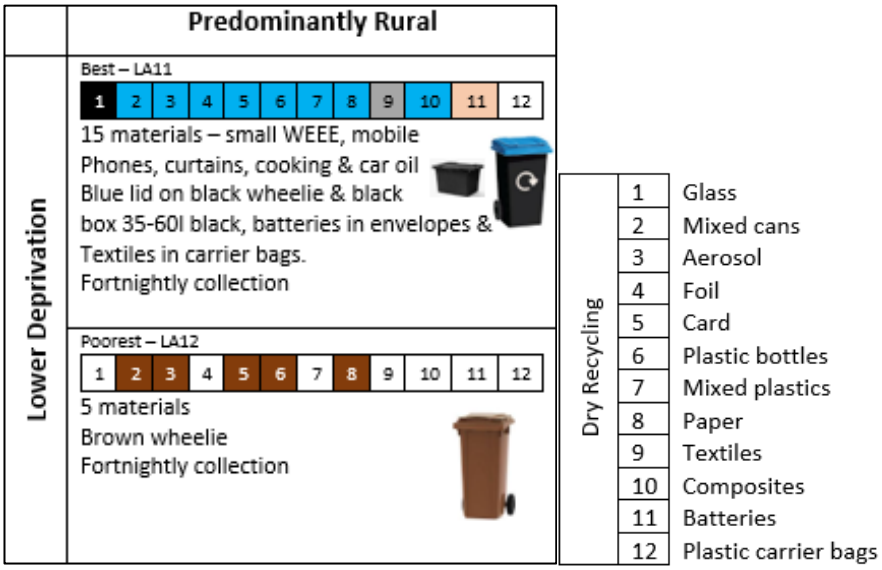

Figure 5.12: Group 6 dry recycling service

The number of materials collected by LA11 partly explains the high recycling Quantity Rate. Textiles and less common items such as small WEE, cooking oil, and batteries are also collected at the kerbside. Each of these items need to be presented in bags/bottles provided by the resident.

Food and garden waste

A separate food and (paid for) garden waste service is provided by LA11. The interviewee explained that LAs that provide a combined food and garden waste service have lower participation rates for food waste than where it is provided separately. The reason being that those residents without a garden will not bother to use the bin.

LA12 charges for the garden waste at a slighter higher rate of £35 per year (LA12 is £30). They have found that the number of subscribers has increased by 2000 properties since

the pandemic, maybe due to people staying at home and gardening more through lockdowns. A food waste service is not provided but is currently being investigated; the interviewee explained that they are in a fortunate position where they can learn best practice from other LAs who have already set up their services.

Residual waste

Both LAs provide a fortnightly residual collection in 141-180l wheelie bins. A recent scheme run by LA12 requires their residents who had previously received larger bins, say because their household is greater than 4 residents, re apply as it was recognised that household numbers can change. They had a number of complaints; however it did encourage those who had reduced in numbers to recycle more.

> "…people need to be responsible for their waste and think about why they are overproducing, because we know our system works for a family of 4 or less so if you've got a family of 2 and they can't cope then something's going wrong."

Officers provide support to these households to help them recycle more reducing the need for a larger residual bin.

Bulky waste

Both LAs provide a kerbside, chargeable bulky waste collection.

Household waste recycling centres

LA11 explained that although they provide a kerbside textile collection, they find that most residents take their textiles to the bring banks located in the HWRCs.

Personnel

LA11 explains that there are no dedicated recycling officers and that their own job is a project planner for recycling campaigns. If extra hands are needed, say for a door knocking campaign, they hire temporary staff. LA12 has 1 Recycling Officer and 2 Recycling Development Officers, the latter spending more time on site. The Waste Operatives in LA12 receive training too, providing support with communication whilst on their collection rounds.

5.8.3. Education and interventions

Communications are seen as an on-going task in both LAs with the LA12 representative commenting,

> "With behavioural change you are playing the long game because you can change somebody's mind quickly, but it's changing their behaviour and habits that takes time."

And LA11 explained that,

> "It's easy to get out of the habit [of recycling], say if you run out of food waste bags. That's why continuous, direct communication is best, but it is expensive."

LA12 discussed using Nudge Theory and targeted campaigns to reach low to medium recyclers, as those are the type of recycler that they would get the most out of. Although LA12 have found the bin hangers most effective, they see everything as a network of communication, so if residents start out looking at the hanger they may end up using the website.

Both LAs have annual written communications delivered direct to the residents, and despite the cost is seen as a worthwhile investment in LA12. The budget for communication is £10,000 in LA12 and £54,000 in LA11. However, both explained that it was not enough once the annual written communication had been produced.

Methods of communication

Both LAs use bin hangers, stickers and their websites that are continuously updated. LA11 has a large social media presence and have a rolling advert in the local newspaper. The materials are designed using WRAP resources and using best practice taken from previous experience. The interviewee explained that not all residents respond the same way to the same material and therefore it needs to be designed accordingly. The position of the LA12 representative differed, explaining that a consistent message is used across all media, trying to prevent confusion.

The LA12 interviewee highlighted that before austerity they would provide educational visits to schools but now they have a self-help guide on their website for teachers and hire out their model MRF for the schools to use. They appreciate that the intergeneration influence increases recycling performance, or as the interviewee called it 'The nag factor.'

Direct home communication, or door knocking, is the most effective form of communication according to the LA11 representative. They also explained that when giving evening talks, the feedback is overwhelmingly positive. Rather than provide a PowerPoint presentation they have a chat with the audience, although it is acknowledged that more often than not these groups are already good recyclers. However, with such a small team, often time constraints limit the number of talks that can be given. The interviewee noted,

> "I wish I could have five minutes with every resident to have a chat, that's all you'd need to improve the waste service."

Challenges

Despite continued communication, the biggest obstacle to enhanced recycling performance is the national press confusing residents, according to LA11. Habits are also tough to break, and busy lives are what drives waste and recycling decisions in the household. The facilities are provided, it is getting people to use them that is a challenge, according to LA11. The authority collects a higher than average tonnage of waste per resident, this is explained by a throw away culture driven by affluence as less consideration is given to purchases. To counter this the LA have pushed the reuse message, however only certain demographics are reached or those that are already interested.

LA12 find the increasing number of flats in the area are a challenge to recycling performance. Communicating with the residents and managing agents is often fraught as the LA often has to charge extra for clearing bin stores that are a mess. To bridge language barriers, particularly in the flats, they have adopted pictorial information to try and stress that contamination is not accepted in the dry recycling.

Interestingly, LA12 finds the residents who believe they are already great recyclers are difficult to communicate with as they will not read the literature, as they think they already know it. The interviewee explained that there are quite a few people who believe they are 'amazing recyclers', whether they are or not.

Campaigns

LA12 had recently targeted a 20-year-old housing estate that had started to see higher contamination levels. The Recycling Officer put stickers on the bins and posted literature through the door. This alone saw the contamination levels drop by 5% in the area. Although the LA12 representative acknowledged that face to face communication is most effective, the time required makes this method unworkable, and they agree that messages on the bins, using either a sticker or hanger, is the next best method.

Recently, LA11 have employed a team of 6 temporary officers to door knock targeted areas where participation in the food waste collection was low. Staff handed out bin caddies, liners, and information to encourage participation. They were also trained to answer questions on dry recycling and addressed contamination too. Although the outcome of this campaign had yet to be measured, the interviewee explained that previous similar campaigns had seen food recycling increase and residual tonnages go down. In this campaign 6000 properties had been contacted and 1500 new caddies were given out.

Workshops and training

There is on-going training for Waste Operatives in LA12, ensuring the importance of uncontaminated recycling is understood. This training session also covers the number of hangers the operatives have used since the last meeting. Although there are no targets, it is an indication of how engaged the staff are.

Both LAs also provide training to the Customer Service Teams who handle a lot of the calls regarding the service.

5.8.4. Website content

The best performer, LA11, has a straightforward website with clear and easy to find information about the service provision for the area. There is an 8-page document for residents giving information on recycling in the area with what goes in what bin. The examples in the document are illustrated and colourful, however the examples given on the website are plain text. There are no links to charity or reuse organisations, however it does have a link to a composting site.

LA12 conversely has a great deal of information on reducing and reusing materials, both for schools and residents. There is information about what can be recycled with a link to the WDA, and it also includes a section entitled 'Why can't I recycle plastic pots, tubs or trays?'. The website is easy to use and to find out what material goes in what bin, located on the 2nd subpage, was easy to find. There is a large section for schools with downloadable documents covering the 3 Rs, how to carry out a waste audit, and a history resource sheet to name a few. There is also a cartoon character that guides you through the site, making it fun and attractive to use. Overall, LA12's website is easy to use and contains a lot of information than the service provide, as is the case with LA11.

5.8.5. Contamination

A recent change of service has resulted in increased contamination rates in LA11. 'Squishy plastics' such as carrier bags and films were previously collected but are no more and the interviewee expressed their concern that they have not communicated the changes enough to the residents. They did think that this was short lived, however as residents got used to the new service. Other than squishy plastics, textiles and food waste are the main contaminants. Textiles are collected and placed in a cage under the wagons which can fill up quickly. The interviewee suspects that once full, the Waste Operatives are adding the textiles to the dry recyclates and indicated further training is required.

Flats and communal bins are also problematic for LA11, with residents purposely hiding non-target materials under recyclate. Some are also placing bags in the incorrect container as the bin stores are often located in unlit carparks making signage difficult to

see. It was also highlighted that there is no ownership over the bins so they become unmanaged and messy.

Contamination costs LA11 £75,000 per year from the rejected material at the MRFs. The authority benefits from monthly reports from their MRF listing the materials found in samples taken from wagons as they drop off the waste. 3 x 60kg samples are taken from the front, middle and rear of a load and analysed for contaminants. The LA knows which round it comes from, the day it was collected and therefore whether their own staff were working that day or agency staff. This information feeds into the training sessions held with the Waste Operatives and can highlight areas to receive targeted communications. LA12 also explained that they have a coloured bin hanger system for contaminated bins; first offense receives a yellow hanger and the bin is emptied, the second offence receives a red hanger, the bin is not emptied and a postcard is sent through the post providing further information on how to recycle. If the issue continues the recycling bin is removed.

5.8.6. Political influence

Both LAs have contracts with waste management companies and this has influenced their recycling performance. LA11 changed the materials they collect for recycling, removing some which has confused residents resulting in increased contamination. LA12 explains that their long contract dictates the range of materials they can collect.

Recycling credits were discussed by LA11, explaining that they receive £40/tonne for dry recyclates and £30/tonne for food waste. These credits are put towards the cost of the waste contract that is worth £3 million to the WCA.

The interviewee explained that due to the drive to recycle plastics in recent years, their plastics are sent to Turkey. The interviewee suggested that this was not the most sustainable option and that, after reducing use, they should incinerate what is left producing energy and saving financial and environmental costs associated with transportation.

Budgets

The theme that traversed both interviews were budgetary concerns from staffing levels to service delivery. LA12 had recently employed a consultant to determine the best collection scheme. The report explained that the 'kerbside sort', where source separation occurs in the home and then a secondary sort is carried out by the Waste Operatives into the vehicle, would produce the best quality material, however the authority deemed this too slow and would cost too much to implement.

Despite a continued expression of interest from schools, educational visits are no longer offered by both LAs due to staffing resources. LA11 explained that there was a restructure currently under way and soon there were going to be further job losses in their department which will undoubtably impact the service delivery and therefore recycling performance.

Customer satisfaction

LA12 mentioned that some residents would like a kerbside glass collection.

5.8.7. Summary

The summary of positive and negative factors influencing recycling performance in Group 6 is shown in Table 5.7. Training for Waste Operatives, frequent updating of website information and re-evaluating the additional bins for larger households are examples of the best practice taken from Group 6. Austerity and reduced resources, contractual range of materials collected for recycling, and the national press confusing residents are factors out of the control of the LAs. Examples considered poor practice from Group 6 include Waste Operatives contaminating the dry recycling with textiles and insufficient communication for self-confident recyclers, and for the recent changes in materials collected for recycling.

		LA11 PR, LD, BP	LA12 PR, LD, PP
Context	Positive	Affluent population No language barriers	
Context	Negative	High tonnages	Flats increasing
Infrastructure & Service delivery	Positive	**Broad range of materials collected** Food waste service 1 Officer **Hire temps when needed**	In-house collections **Large family re-evaluation** 3 Officers **Training for waste operatives**
Infrastructure & Service delivery	Negative		'Trapped' in contract 5 materials collected kerbside
Education & Interventions	Positive	Annual communications mailed Social media **Website updated frequently** **Best practice from previous campaigns** **Door knocking** Evening talks to local groups **6 temp staff for door knocking**	Nudge theory **Nag factor (intergenerational)** **Network of communications** Consistent messaging Bin stickers and leaflets successful **Training for waste operatives**
Education & Interventions	Negative	No resource for school visits National press confusing messages Change in service needed more comms	No resource for school visits Flats an issue Self-confident recyclers an issue
Website content	Positive	User friendly Downloadable documents	User friendly **Cartoon character/images** School resources Reduce/reuse Why materials cannot be recycled
Website content	Negative	Service information only No composting No reduce/reuse/repair No school resources Lacked images	
Contamination	Positive		**Monthly reports from MRF** **Waste operative training** Bin hanger system Bin removal
Contamination	Negative	Crew adding textiles to dry recycling Costs LA £75,000 per year	
Political Influence	Positive	**Recycling credits** Did not sent waste to China so unaffected	**Consultant determined box/kerbside sort most effective, not adopted due to. costs**
Political Influence	Negative	Contract change - contamination Staff cuts due to Austerity Plastic sent to Turkey - public perception.	Long contract, not adapted over time Staff cuts due to Austerity Consultant recommendations not adopted

Bold - Best practice
Red - Poor practice
Blue - No control
SFW - Standardised food and waste collections

Table 5.7: Group 6 summary of influences on recycling performance

5.9. Chapter summary

This chapter aimed to present the results of the case studies, providing an intra group summary to inform the next discussion Chapter 6, and to contribute to Objective 3: exploring the difference between the best and poorest performers.

Despite grouping LAs with similar GSE characteristics, further factors that influence recycling performance that are not in control of the LA were uncovered such as more subtle differences in location, for example coastal or close to motorways, and political influences such as using bin collection frequency for votes or by having a senior leadership team fully engaged with the service who protect budgets against austerity.

Performing against the backdrop of continual budget cuts has resulted in rationalised service provisions and targeted communications. Lessons learnt from the LAs are presented in the summary tables as best and poor practices from each. These will be explored further in the following chapter, combined with the literature presented in Chapter 2, to fully address Objective 3: to distil good practice principles and the extent to which they may need to be tailored to local circumstances. Finally considering whether they could inform national policy or provide a guide to LAs when designing their waste and recycling services.

6. Factors influencing LA recycling performance

6.1. Introduction and chapter outline

This chapter presents a discussion of the factors found to influence recycling performance, distilled from the intra group comparisons presented in Chapter 5. Sections 6.2 to 6.7 present the themes identified during the analysis of the case studies. Following the discussion for each theme, Section 6.8 presents the best practices for each theme with identified tailored options for GSE characteristics and modifications for more constrained budgets.

6.2. Local authority context

This study aimed to separate the influence of factors on recycling performance that a LA has no control over, their GSE characteristics. The summary of LA contextual factors presented in Table 6.1 demonstrate that certain information can be missed when using the ONS Index of Multiple Deprivation. For example, LA4 has a small proportion of super rich residents that place the LA in the low deprivation group, but this is not a true reflection as most of the authority falls within the 20% of most deprived areas in England.

Table 6.1: Local authority context factors

		Predominantly Urban		Mixed Urban/Rural		Predominantly Rural	
Deprivation	High	**LA1 Best**	**LA2 Poorest**	**LA5 Best**	**LA6 Poorest**	**LA9 Best**	**LA10 Poorest**
		Unitary authority	Well connected		UA - short contracts	Space/less flats Less transient populations	Retirees Less transient populations
		Coastal - seagulls Less connected Transient population	WDA control materials	Increasing population Transient population Rural hard to access properties	Terraces with back streets Asian population (food waste)		Large distances between collection
	Low	**LA3 Best**	**LA4 Poorest**	**LA7 Best**	**LA8 Poorest**	**LA11 Best**	**LA12 Poorest**
		Lowest urban population density		Low population density		Affluent population No language barriers	
			Super rich distorting wealth Lots of high-rises Transient population Most populated LA	Very large area Collects high tonnages More high-rises Substandard roads		High tonnages	Flats increasing

Bold - Best practice
Red - Poor practice
Blue - No control
SFW - Standardised food and waste collections

Positive influence
Negative influence

LA4 is also a London borough with an extremely high population density unlike the other LAs in the study. This high population is mainly housed in high-rise buildings or houses

that have been converted in to several flats leaving no room for bin stores, confirming Roberts et al. (2015) observation that having less storage for bins will result in lower recycling performance. In contrast, the experience of LA10 (rural, high deprivation, poorest performer) suggests that having large distances between collection points in the rural areas adds costs to a service, making food waste collections prohibitively expensive. The interviewee explained that collecting from rows of flats and terraced houses is easier, quicker, and cheaper, but failed to consider the lack of space restricting storage for bins.

Further positive considerations for high-rise residents include not needing to remember to place out bins on collection day and that those in urban areas are more likely to copy their neighbours than in rural areas due to proximity. Kirakozian (2016) discussed the influence of 'keeping up with the neighbours' but in respect to those living in houses and more rural areas; the study also described the negative impact neighbours can have when those who want to recycle feel that their efforts are pointless when their neighbours do not participate or if they incorrectly use shared facilities.

It was clear from the interviews that the LAs attributed shared waste and recycling facilities to high contamination rates. Reasons provided for this included purposeful contamination by the residents, inadequate lighting to see signage, and the inconvenience of storing and disposing of separated materials, confirming the findings of du Toit and Wagner (2020). The lack of individual ownership was highlighted as negatively influencing the recycling performance from shared facilities, a point also made by Calvin Lakhan (2016). The LA12 (rural, low deprivation, poorest performer) representative added that applying additional charges for removing contaminated bins and clearing overflowing bin stores were responsible for fraught relationships with both residents and managing agents who did not believe that it was their responsibility to present the waste as requested, despite on-going communications.

Transient populations were an issue for the more urban LAs, with a rolling number of new residents, students and tourists adding to the complexity of communicating how to use the local waste collection service. The coastal tourist area, LA1 (urban, high deprivation, best performer) interviewee described the seasonal challenges associated with a temporary increased population, which are also identified by Bashir and Goswami (2016) and Fennell and Bowyer (2020). Both rural, high deprivation LAs (LA9 and LA10)

representatives specifically mentioned that they had fewer transient populations and explained it as a positive influence on their recycling performances.

The positive contribution to recycling from more affluent and older populations highlighted in the literature (Schultz et al., 1995; Swamia et al., 2011) was reflected in the comments made by LA9 and LA10 representatives. They noted that their older populations with a high proportion of retirees have a greater propensity to recycle which positively influenced performance compared to urban areas. This non-transient population retain their knowledge of the local waste collection service too. The rural, low deprivation, best performing LA11 was also described as having few non-English speaking residents, avoiding communications challenges found in the more urban areas.

Location, being coastal and/or well connected by motorway links were contextual factors found to influence the types of material collected either because of the nature of wastes tourists produce (Seckin et al., 1997), seagulls ripping bags (Britten, 2019) or from having access to a greater number of material recycling facilities or reprocessors. The contract an authority has and the type of waste authority they are (UA or WCA) also influences the type or material they collect and the access to recycling facilities. The extent to which they have control over the nature of these relationships appears to vary from authority to authority.

LAs do have control over whether they combine with other authorities to manage their waste disposal, however once the contract has been signed the departments responsible for delivering the service must work within the terms of the contract. Both LA1 (best performer) and LA6 (poorest performer) explained that being a UA had a positive influence on their recycling performance as they could pick and choose their short-term contracts. An outdated, long-term contract was responsible for the small range of materials collected in LA12, confirming the criticism of 'locking-in' technologies associated with long-term waste contracts described by Corvellec et al. (2013). Whereas LA9's 28-year contract was described as having a positive impact on recycling performance given the time to build a solid, long-term relationship with the contractor supportive of achieving waste targets.

These contextual factors are mostly beyond the control of the LA but provide strong links to the local waste infrastructure and service delivery provided, which the LA can use as a tool for increasing the amount of material collected for recycling.

6.3. Infrastructure and service delivery

The infrastructure and service delivery provided by a LA is unique to that authority; historic commitments, agreements with contractors, budgetary cuts, and pressures from their GSE factors all influence the type and number of receptacles, range of materials collected for recycling, and the frequency with which they are collected. Table 6.2 summarises the infrastructure and service delivery factors that have a positive or negative effect on recycling performance distilled from this study.

Table 6.2: Infrastructure and service delivery factors influencing recycling performance

Deprivation		Predominantly Urban		Mixed Urban/Rural		Predominantly Rural	
		LA1 Best	**LA2 Poorest**	**LA5 Best**	**LA6 Poorest**	**LA9 Best**	**LA10 Poorest**
	High	**Fortnightly collections** Textile collections **2 - Stream collection** **Bulky waste from inside** Reuse shops in HWRC	Less high-rises Neighbours influence **Composite collections** **Food waste collection** Shared Officers WDA	**Fortnightly collections** Co-mingled (less) confusion Collect PTT **Team of officers**	**Fortnightly collections** **2-stream** Collects WEEE, PTT **2 stage MRF, hand and automatic**	**28-year contract with good relationship** **Targets for contractor** **Box collections** Free food & garden collection 3 recycling officers (& contract officer)	WDA shared resources 3 Contract officers
		Many high-rises Space restrictions No food waste	Weekly collection Co-mingled	Large residual bins Inaccurate MRF data Collection points for rural Reduced vehicles (austerity)	Textile collection often landfilled Inaccurate MRF data No mention of recycling officers	H&S issues with boxes Windblown litter IVC at capacity limited food collections (New IVC to be built)	Light weighting of materials No food waste Time/fuel distances Between properties
	Low	**LA3 Best**	**LA4 Poorest**	**LA7 Best**	**LA8 Poorest**	**LA11 Best**	**LA12 Poorest**
		Greater range of materials Training customer services **Residual capacity reducing**	**Wrapped bin stores** **Food waste trial** Generous bulky waste **3 communications officers**	**2 box collections** **Source and kerbside sort** Food waste collection Free garden waste collection **4 Officers secured with contract**	Co-mingled (less) confusion Change garden for recycling in winter Free garden waste collection **Mobile MRF (trial finished)**	**Broad range of materials collected** Food waste service 1 Officer **Hire temps when needed**	In-house collections **Large family re-evaluation** 3 Officers **Training for waste operatives**
		Weekly collections Removal of recycling credits Confusion (changes to service) No food waste	Twice weekly collections due to space restrictions No cars for HWRC	H&S concerns with boxes No end markets More reprocessors needed	MRF 45 mins away No AD locally for food No recycling officers		'Trapped' in contract 5 materials collected kerbside

Bold - Best practice
Red - Poor practice
Blue - No control
SFW - Standardised food and waste collections

Positive influence
Negative influence

According to Boskovic et al. (2016), 70% of the total costs of service delivery is in the collecting and transportation of material. For this reason, precise models are used for route optimisation, taking into account the amount of waste collected and the amount of

fuel the vehicles use, as described by Wu et al. (2020). Occasionally contracts will be counterintuitive and determine which facilities LAs use, such as the wagons servicing LA8 (mixed, low deprivation, poorest performer). They travel 45 minutes to a MRF outside of their area rather than use the facility located on the same road as the yard where they are based. This adds mileage, wear and tear to the vehicles, and increases the chances of accidents, all resulting in increased costs.

A lack of local reprocessors was also mentioned by LA8 and by LA7, the poorest and best performing LAs from Group 4 (mixed, low deprivation). Both explained that the range of materials collected for recycling was limited by the availability of reprocessors nearby, specifically a lack of an anaerobic digester (AD) for food waste in LA8. The LA6 representative also explained that despite collecting textiles, they often landfill the material as there is no market for it. A different reason for restricted material was given by the LA12 representative, who explained that the range of materials collected by their authority are limited by the PFI contract, and unlike the study conducted by Gregson and Foreman (2020) who found some LAs did not collect plastic due to producing low tonnages, LA12 does not collect glass at the kerbside which is a much heavier material giving quick wins with regards to weight of collected materials. Unlike several other LAs in this study who have removed bring banks due to low quality material from contamination, corroborating the study carried out by Butler and Hooper (1999), the LA12 interviewee explained that glass bring banks contribute to their recycling performance exceeding that of neighbouring LAs. Despite this, the move to a kerbside collection for glass is imminent which may provide a more convenient service for some residents and reduce the contamination that may be contributing to LA12 being a low performer in their category (Okonta and Mohlalifi, 2020).

The best performers from Group 4 and Group 6, LA7 and LA11 respectively, collect the greatest range of materials for recycling and both provide a 2-stream service using boxes. All LAs that provide a box collection for the dry recyclate were best performers for their category, explained by the fact that non target materials, or contamination, is easily spotted, especially when there is an additional sort from the box into the vehicle by the Waste Operatives. The LAs are aware of the issues with using boxes, however, from windblown litter to Waste Operative manual handling concerns as highlighted in the

study comparing musculoskeletal disorders between different collection systems by D Thomas et al. (2019). Boxes are also seen to hinder recycling performance for rural areas with collection points as they are more difficult to carry to the end of a lane, such as with properties in LA9, although at the time of the interview the LA was using a box and bag system that was giving them a 100% quality rate.

A fortnightly recyclate collection is offered by the rural LAs, and 3 out of 4 of the mixed LAs. Only 1 urban LA collects recyclate fortnightly with the other 3 collecting either weekly or biweekly. The residual waste followed the same pattern apart from LA7 where recyclate is collected weekly and the residual waste fortnightly. Despite the evidence finding increased recycling performance from a decreased frequency of residual waste collection (Williams and Cole, 2013), some urban environments are too populated for residents to store waste. The LA must balance public health, their statutory responsibility to remove waste and cleanse streets with providing a service that promotes recycling. The London based LA4 provides biweekly collections and must remove all bags, even if contaminated, as there is no space for them on the pavements and they would otherwise cause a health and safety issue.

Decreased frequency equates to a decrease in capacity and many LAs have not only reduced the frequency of residual waste collections they have also decreased the size of the bin with a view to encouraging improvements in recycling performance. LA5, however, offer a fortnightly collection but provide a large wheelie bin in comparison to the rest of the LAs using wheelie bins. Despite this, they are a best performer for their category with a Quality Rate of 99.7% and a Quantity Rate of 51.6% and are one of the best performers in the whole study. A possible explanation of this is size of the team that works entirely on education to increase recycling and to reduce contamination, indicating education could outweigh bin size when considering which factors influence recycling rates the most.

Williams and Cole (2013) found that residents recycle more when they are offered only one bin for recycling – a comingled service. LA5 confirms this, being the only best performer to offer a comingled service compared to the 2-stream service offered by the poorest performer in their group. This LA is the one exception to the general observation that 2-stream services make for more effective recycling as the best performers in 4 of

the remaining 5 groups provided a 2-stream service in contrast to the poorer performers in their groups. The remaining group offered comingled in both the best and poorer performing LAs. It would appear that source separation, that is separation by residents, provides a cleaner, higher quality recyclate. Down-stream separation technologies, such as those in a MRF will dictate what materials can be collected together. However, most LAs are seeing an increase in demand for higher quality materials synonymous with source separation.

Additional stages of material separation were seen either at the kerbside as the materials are being loaded into various compartments in the wagon, or as in LA6 where they have a 2-stage MRF. Firstly, the materials are hand separated before going on to be automatically separated using automated MRF technologies. This labour intensive and costly service gives the LA an opportunity to remove non-target materials without whole wagon loads being rejected.

Although UAs have autonomy over their waste contracts, this does not necessarily equate to better data. For example, a UA may share a MRF with several other UAs or a WDA where contamination data is often allocated proportionately between the users. Also, LA6, a UA, sends their residual waste to a facility that alternates the quantities going to either EfW or landfill, clearly having an impact on the environment and disposal costs. The benefit of short contracts can be outweighed by the availability of local waste and recycling facilities often made possible with the investment associated with long-term contracts, although they do offer flexibility should a new market or reprocessor become available.

Two representatives of the of the urban LAs suggest that the recycling performance of urban areas are equal to those in rural areas, and that it was the green waste that accounted for the difference. The calculations used for determining the Quantity Rate included material presented for dry recycling, reuse and compositing (both food and garden waste) (Figure 6.1). By removing the weight of material sent for compositing, the differences between the quantity of waste sent for recycling reduces between the best and poorest performers (Figure 6.1). However, it can still be seen that the best performers capture more for recycling than the poorer performers. LA9 and LA10 are the

only pair to level up after removing the material sent for composting, although LA9 still outperforms LA10 on Quality Rate by 16%.

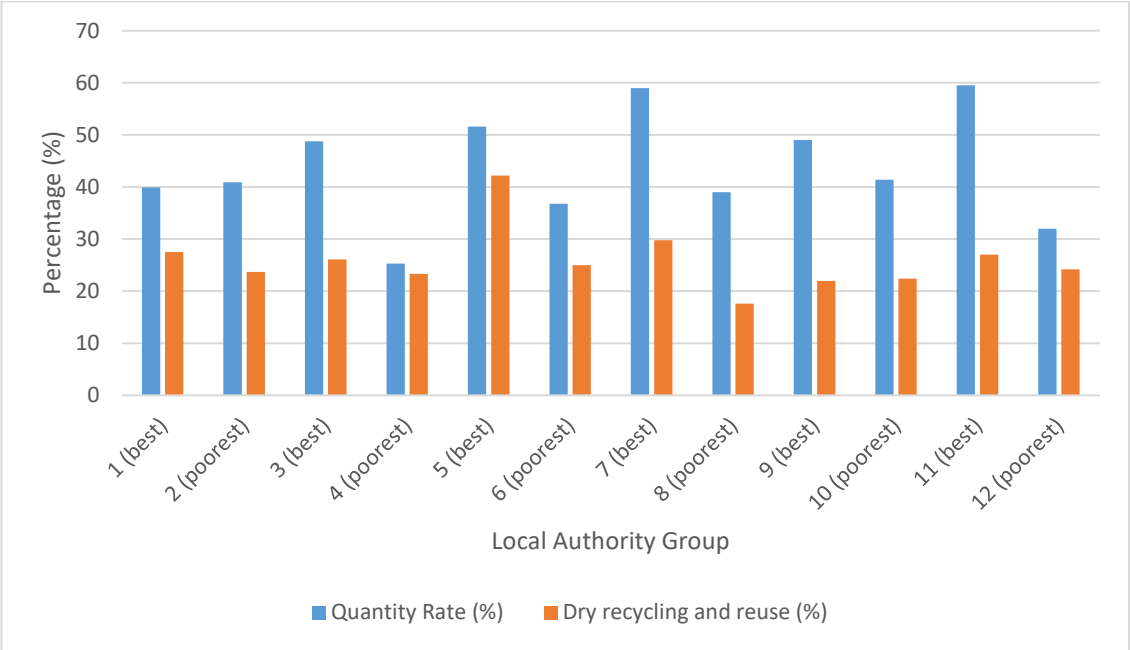

Figure 6.1: Quantity Rate (%) and Quantity Rate minus composting (%)

Once composting is removed from the Quantity Rate (Figure 6.1), LA5 becomes the highest performer with respects to dry recycling and reuse. This further confirms that their approach to dealing with contamination, 'Operation Contamination', is resulting in high yields of dry recycling. Figure 6.2 also shows that LA5 and LA4, the London authority, collect the least amount of material for composting and that the better performing LAs in the rural groups collect more than the poorest performers.

LA4 have trialled a doorstep food waste collection from high-rises and Houses of Multiple Occupation (HMOs) to try to increase the amount of compositing waste. Although it was successful, the service was too expensive to continue.

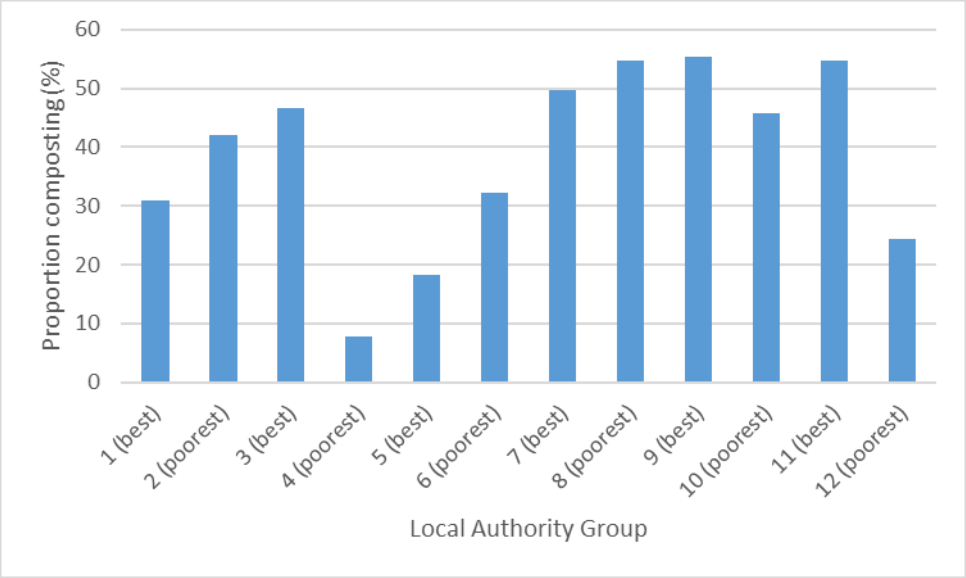

Figure 6.2: Proportion of Quantity Rate that is composting (%)

A mobile HWRC service provided by LA1 to capture the waste from residents who do not have a car, again had a positive influence on recycling performance but budgetary cuts also meant that the service was removed.

The number of staff allocated to working on a waste and recycling team, above those involved in the operational side, had been reduced in most LAs due to austerity. The best performers in this study, however, had more officers than the poorest performers hinting at an offset between the expense of paying salaries against earnings from higher recyclate tonnages and savings from contamination. Some LAs trained their customer service teams to answer questions about the service to reduce the workload on the shrinking teams, and others provide training to their Waste Operatives to provide education when on their rounds. It is acknowledged that staff are needed to provide education and facilitate interventions to help residents increase their recycling habits, providing the staff at a time of budget cuts and job losses is clearly a fundamental challenge.

6.4. Education and interventions

The importance of education was mentioned by all LAs as a key to increasing recycling performance, echoing findings by Peng et al. (2021) and Jamal et al. (2019). Table 6.3

summarises the factors, from the case studies, that have positive or negative influences on recycling performance. Providing education and interventions to change behaviour has suffered the most during times of austerity. Many of the LAs have ceased providing school visits, therefore losing the 'nag factor' or the intergenerational influence so positively observed by Cunningham-Scott (2005), Maddox et al. (2011) and Rybova and Slavík (2017). Other LAs have seen their teams eroded so that one officer is left, making it impossible to respond to all queries let alone carry out proactive campaigns.

Table 6.3: Education and interventions factors influencing recycling performance

Deprivation		Predominantly Urban		Mixed Urban/Rural		Predominantly Rural	
		LA1 Best	**LA2 Poorest**	**LA5 Best**	**LA6 Poorest**	**LA9 Best**	**LA10 Poorest**
	High	**Targeted comms** **Door knocking** Leaflets, hangers **In-house collections** Keep Britain Tidy messaging Campaign stunts Repair workshops	Categorises residents School bus investment	**Door knocking** Positive reinforcement **Operation** **contamination** Recycling champions MRF visits LA APP School visits/ Exhibitions	**Implements nudge** **theory** Positive reinforcement Annual recycling pack **Contamination** **campaign** **Football and faith** **messengers**	**£25k budget** Calendars 2 mailed/yr Digital comms School visits Reduce/reuse Large number of campaigns	**£25k budget** Targeted comms WRAP branding Campaigns Annual event
		Stickers are messy Reduced staff numbers	Incentive schemes 'pointless'	Relies on APP for calendar 100 languages spoken Language barriers	No door knocking No social media Language barriers No budget/resources	Confusion - incorrect tweets from central LA communications team	No lasting effect from campaigns No monitoring and evaluation No reduce/reuse (not financially lucrative for WCA)
		LA3 Best	**LA4 Poorest**	**LA7 Best**	**LA8 Poorest**	**LA11 Best**	**LA12 Poorest**
	Low	WDA manages comms Calendar mailed **Face to face most** **effective** Resident forums (WDA) School visits (WDA)	Calendar mailed Blue Planet effect **Door knocking** **Normalising recycling** **Graphics (language** **barrier)**	**3-year strategy/annual** **goals** **Healthy budget** **Targeted comms** Calendars mailed	Website	Annual comms mailed Social media **Website updated** **Best practice used** **Door knocking** Evening talks to groups **Temp staff**	Nudge theory **Nag factor** **Network of comms** Consistent messaging Bin stickers and leaflets **Training for staff**
		Material confusion (plastics) Austerity budget cuts	Transient population No social media Language barriers No contamination education Green fatigue	No door knocking	No comms-only website No budget therefore eroded service Reduced 3/4G networks Difficult to find rural Properties	No resource for school visits National press confusing messages Change in service needed more comms	No resource for school visits Flats an issue Self-confident recyclers an issue

Bold - Best practice
Red - Poor practice
Blue - No control
SFW - Standardised food and waste collections

Positive influence
Negative influence

Through these years of austerity, however, the LAs have adapted and become smarter with the resources that are available to them. Most no longer send annual collection calendars through the post and rely on digital content such as websites, APPs and social media. Those that do send the calendars or annual recycling packs believe that they represent good value as they have more of an impact than digital media, the same conclusion that Willman (2015) made. However, it is worth noting that not all LAs have the budget to pay for such communication and as the interim manager in LA8 has found,

concentrating solely on digital communications is the easiest way to cut costs. He also discussed the term 'self-help education' where residents seek out information on the recycling service. This option, however, suits the already motivated recyclers rather than the, as per the Dreyfus model of skill acquisition (WRAP, 2008b), the unconsciously incompetent or the consciously incompetent recyclers.

For those that do not use the self-help methods, most of the LAs find that education should be delivered frequently as recommended by Evison and Read (2001) and Rispo et al. (2015). Likening the role to painting the Forth Bridge; communication for behaviour change is never ending, as soon as the job is finished it needs to start again due to transient residents and to remind those that fall into bad habits.

Most of the authorities have adopted a targeted communications strategy rather than blanketing the whole area with messages. This uses less resources and can have more of an impact, as explained by the LA12 representative when citing the example of nappies, and the targeted communications directed at primary care givers. However, as they went on to explain education should be regarded as a 'network of communication' that may see someone reading a leaflet that leads them to the website, or a newsletter that leads the resident to downloading the council APP. To promote this network, consistent messaging is used to link different media by using standard messaging from Keep Britain Tidy or WRAP as a guide.

Combining targeted communication with nudge theory, as mentioned by LA4, LA6 and LA12 interviewees, aims to change recycling behaviour using subconscious cues. Whether using local residents as messengers to normalise behaviour or, as LA6 has found effective, using faith leaders to speak to their congregations. This corroborates the idea of using faith or community leaders by Lakhan (2018) who demonstrated it successfully among ethnic minorities. Nudge theory uses the theory of planned behaviour to predict recycling intention (Aboelmaged, 2021) and can help design communications. Message framing using positive reinforcement is found to be a positive factor used by two best performing LAs. In contrast, Yang and Liu (2021) found that negative frames are more effective in influencing behaviour when using the example of an incompetent recycler to highlight the negative consequences of their actions and thereby stimulate more positive recycling activity. Overall, these points illustrate the importance of tailoring frames of reference to

the specific recycling performance issues of an area. Most of the LAs avoid using enforcement actions, although one of the more successful LAs have made use of the first stage enforcement with no intention of taking further legal action. This first enforcement step, serving an official notice, is serious enough for most residents to change their behaviour for the better.

All LAs acknowledged that face-to-face communication had the greatest impact on recycling performance, although it requires a significant budget that most do not have. Instead, leafleting and bin hangers were found to have the next biggest impact. The best practice case described by the LA5 representative, however, highlighted the savings that can be made from reducing the contamination costs from paying for a team of recycling officers that are dedicated to changing behaviour. The LA10 interviewee argued that the cost savings from increased material recovery and reduced contamination only covered the increased expenditure associated with communication campaigns. Such revenue neutral activity requires that LAs are willing to support increased expenditure in the hope of seeing cost reduction benefits from the ensuing changes to behaviour. Accepting this form of risk requires a leadership team who are motivated by sustainability rather than one simply focused on minimising expenditure, highlighting the need for not only educating residents but the council leaders and employees too. If Councillors or Members of Parliament consistently tell residents that they will ensure a weekly residual collection in areas that might otherwise have fortnightly collections, then the residents will believe that is a superior service. Whereas, if the leaders understood the wider environmental concerns, they might project a more sustainable option as the superior service.

Contrary to Starr and Nicolson (2015), wider environmental or sustainability education was not seen as important to LA10. Being a WCA they profit from the weight of recyclate, not on overall reduction in waste and so neglect to include the Reduce and Reuse message used by other authorities. Incentive schemes and campaigns were also branded as ‘pointless’ by LA2 and LA10 representatives, believing they had no lasting effects; although LA10 did mention that with no resources to carry out the monitoring and evaluation before and after it would be tricky to identify an influence anyway.

National messaging such as the Blue Planet effect (Males and Van Aelst, 2021) and the future standardised garden and food waste collection were mentioned as having positive

effects on recycling performance, especially helping with the consistent messaging required for the standardised service, reducing costs and confusion. There were examples, however, where national messaging has resulted in contamination and residents questioning their service compared to others. One authority even had their own central communications team sending the wrong message via social media.

The majority of LAs used a combination of leaflets, bin stickers, bin hangers, newsletters, social media, and community events. The one form of communication that was consistent across the whole study was the use of a website as the main driver of education.

6.5. Website content

Every case study LA has a waste and recycling section included in their main website. It is often called 'Recycling and Waste' or 'Bins and recycling' and has, over the years, become the main tool to communicate with residents. The factors that could potentially influence recycling performance, with regards to the website, found during this study are listed in Table 6.4.

Table 6.4: Website content factors influencing recycling performance

		Predominantly Urban		Mixed Urban/Rural		Predominantly Rural	
Deprivation	High	**LA1 Best**	**LA2 Poorest**	**LA5 Best**	**LA6 Poorest**	**LA9 Best**	**LA10 Poorest**
		Concise Home composting **User friendly**	What happens after collection Home composting	Reuse & repair Charity links Thorough details	**Fun, user friendly** Cartoons with videos and games What happens after collection **Landlord/new tenant information**	User friendly Reduce/Reuse Charity links What happens after collection **Resident participation (recycling tips)**	User friendly
		No school resources No Charity links No reuse/repair No What happens after collection	No school resources No Charity links No reuse/repair Not concise or user friendly	Front loaded (43 links) Not as user friendly	No reduce/reuse/repair		Service information only No composting No reduce/reuse/ repair No school resources
		LA3 Best	**LA4 Poorest**	**LA7 Best**	**LA8 Poorest**	**LA11 Best**	**LA12 Poorest**
	Low	**User friendly** What happens after collection	A2Z material recycling What happens after collection Reuse & repair MRF tours Charity links	Detailed recycling facts Reduce/Reuse Charity links What happens after collection	User friendly Reduce/Reuse Charity links What happens after collection	User friendly Downloadable documents	User friendly **Cartoon character** School resources Reduce/reuse Why materials cannot be recycled **Images**
		No reuse/repair No graphics	Not as user friendly Too much information Too many documents	Lacked images, lots of text	Lacked images No school resources	Service information only No reduce/reuse/ repair No school resources Lacked images	

Bold - Best practice
Red - Poor practice
Blue - No control
SFW - Standardised food and waste collections

Positive influence
Negative influence

During the analysis it became apparent that different websites have different intentions. Some provide information solely on the service, others use it to provide further information designed to increase general environmental awareness and more positive behaviours. All of the LAs provide a basic reference guide on how to use their waste and recycling services, this specific knowledge being the primary predictor of recycling behaviour according to Schultz et al. (1995). However, some websites include further information such as detailing what happens to the materials after they are collected. According to a questionnaire carried out by WRAP, 86% of their respondents indicated that they would recycling more if they could see the practical impact of the recycling in the area (WRAP, 2008c). This study found that 4 best performing LAs and 5 poorest performing LAs included this type of information, suggesting that this provision may not have sufficient impact on behaviour to consistently influence recycling performance.

Some websites contained further environmental awareness information such as a history of plastics or some gave links to external sites that provide more detail such as the Recycle Now website, promoting the idea that awareness and attitude are fundamental factors in whether a person will recycle or not (Schultz et al., 1995). The messaging of Reuse, such as using links to charities or sites such as Facebook marketplace and eBay to sell goods for reuse, was included in 6 out of the 12 websites and those that did include it were split between 3 best and 3 poorest performers, again tentatively indicating a lack of consistent influence on recycling performance. There is also an even split between the LAs providing school resources, with 2 of the best and poorest performers making such provision, with the remaining 8 LAs making no resources for schools available. This would appear to be a missed opportunity to take advantage of the 'nag factor' or intergenerational influence on recycling rates identified in studies by Cunningham-Scott (2005), Maddox et al. (2011) and Rybova and Slavík (2017).

Information on home composting was present on all websites apart from 2 of the poorest performing LAs. Composting reduces the amount of green waste collected by the authority and gives the residents an opportunity to reduce their costs should their green waste collection have a service charge, as seen in Malta (Briguglio, 2021). Further information on reducing food waste was found through the compositing links. This was the only waste reduction measure present in any of the websites.

Website content that stood out as efforts to encourage engagement beyond simply providing answers to simple queries, such as what goes in which bin, included encouraging residents to provide their own recycling tips on social media (LA9), providing downloadable packs for both landlords and new tenants (LA6) and using cartoon characters to make the website fun and piquing interest in the recycling agenda (LA12). Once the resident visits the website, making it easy to use is key to getting them to explore the site beyond the original purpose of the visit, which may have been to find out their collection day or what materials can be accepted for recycling.

From the analysis, the websites broadly fell in to two categories; those that had been planned and purpose built, or those that started small and have grown over time with add-on pages as and when they became relevant. This then gave an indication as to how easy it was to navigate the website and to access specific information, generally the former was easier to use than the latter.

The number of options on the first page of the site was the primary predictor of how easy it was to find basic information such as the collection day or what materials are accepted for recycling. Although, this would become easier once a resident becomes familiar with the site, it could present a barrier to some, and if the intention of the website is to primarily act as a reference guide to the service, ease of information retrieval should be the priority. Some of the websites that provided details on wider environmental issues contained a plethora of information and felt more like a depository of documents rather than a resource for residents.

The use of graphics or visual aids are not just more appealing, but they can help navigate the language barrier, indicated as a negative influence on recycling performance in the urban and mixed urban/rural LAs. However, the content of many of these LA websites was mainly text based.

Despite Willman (2015) finding that literature posted through the door has a greater impact on recycling performance than relying on websites, given the impact of austerity, the LA website has become the mainstay of waste and recycling education. Providing a resource bank for the service provision and for wider environmental information, if they are to be effective the sites must be concise, well designed and updated regularly.

6.6. Contamination

For the majority of LAs, contamination is a costly problem, for example LA11 pays £75,000 per year to dispose of their rejected material, others such as LA5 have used these costs to make a case for a team of officers to tackle the contamination in their area. Table 6.5 details the factors regarding contamination, identified during this study, that have a potential influence on recycling performance.

Table 6.5: Contamination factors

Deprivation		Predominantly Urban		Mixed Urban/Rural		Predominantly Rural	
		LA1 Best	**LA2 Poorest**	**LA5 Best**	**LA6 Poorest**	**LA9 Best**	**LA10 Poorest**
	High	**Reruns at MRF** Consistent messaging **Trained extra officers**		**Operation contamination** **Door knocking** **Enforcement** Not emptying contaminated bins	**Contamination campaign**	**Boxes - easy to spot contamination** Non target materials left with card Contractor has increased education	
			Increased quality demand Purposeful contamination		Lack of resources Political influence re emptying bins		No direct costs from contamination No appetite to reduce contamination
		LA3 Best	**LA4 Poorest**	**LA7 Best**	**LA8 Poorest**	**LA11 Best**	**LA12 Poorest**
	Low	Bin hangers **Door knocking**	**Clear bags** Removal of service	**Kerbside sort = no contamination** Non target material left Notice explaining left materials			**Monthly reports from MRF** **Waste operative training** Bin hanger system Bin removal
		Bins hard to spot contamination Closed MRF with 12 pickers	Contamination collected Removal of doorstep collection flats-costs	H&S concerns with boxes	Increase quality demand	Crew adding textiles to dry recycling Costs LA £75,000 per year	

Bold - Best practice
Red - Poor practice
Blue - No control
SFW - Standardised food and waste collections

Positive influence
Negative influence

Infrastructure has a large impact on the level of contamination found in materials collected for recycling, from the type of bin provided by the LA to the receiving MRF and reprocessor. An increase in demand for higher quality recyclate from the MRFs has been noted by LA2 and LA8, explaining although it seems that contamination is increasing, it is in fact the level of acceptable contamination that is decreasing.

MRF data is key for a LA to track their contamination, however, many are given a proportional tonnage that is shared between all the users of that facility. In contrast, LA12 is provided with a monthly report that samples a load each month and provides a detailed list of the materials found, informing any directed communications as the specific round and Waste Operatives can be identified. LA10 was the only LA that did not make specific payments for the contamination, instead they have annual gate fees calculated on

material audits and contamination levels with no details of when or where the contamination was found, therefore providing little to no incentive to improve contamination rates.

Rather than relying on the MRF to determine acceptance or rejection of material loads on the basis of a single contamination assessment, LA1 employs staff to remove non-target items from rejected loads and then reruns the load again, therefore increasing their capture rate (98%). Similarly, LA3 previously owned their own MRF with 12 'pickers' that removed non-target materials before loads were moved to a second MRF, unfortunately due to resources this facility has been closed.

Those LAs that provide boxes were more likely to spot non-target materials than those that used wheelie bins, whether through purposeful misuse of the service or through accidental contamination. The source separated box collections were often followed by a second stage sort by the Waste Operatives when loading the materials into the wagons, providing further assurance that only accepted materials were captured. However, it became apparent for LA11 that the Waste Operatives may be contaminating the loads themselves due to placing textiles in with the dry recycling when the textile container was full, something that could be resolved with training.

The poor practices highlighted in red in Table 6.5 could all be resolved with adequate training. With training, the council leadership teams and political leaders could be encouraged not to use emptying contaminated bins as a tool to obtain votes, which could in turn increase the appetite for education and interventions to reduce contamination. However, education for both internal staff and external residents requires resources that most LAs are lacking.

LA5 has succeeded in making a business case for employing a team of officers to carry out 'Operation Contamination', paid for by the cost savings from avoiding the disposal of rejected materials. Other LAs have increased training for their Waste Operatives so that they not only collect the material but also provide advice to residents when they are on site. Most LAs have also provided training for the customer services teams who can answer frequently asked questions, relieving the workload of the recycling officers.

Various methods of communication are used to help tackle contamination issues with face-to-face contact regarded as by far the best tool for changing behaviour, with bin hangers and leaflets through doors regarded as the next best thing. Monitoring and evaluation of schemes involving bin hangers and leaflets have resulted in a substantial reduction in contamination and increased recyclate tonnages in a couple of the case studies; however, resources for evaluation are not available to all LAs making it difficult to provide concrete evidence of any impact from campaigns, as noted by LA10.

The importance of consistent messaging was acknowledged by most LA representatives; however, messaging from the national press has confused some residents resulting in unintentional contamination. Findings by Coltro et al. (2008) suggest that including other recycling systems in communications, such as the on-pack recycling labels found on packaging, can aid the correct identification of materials. However, this does not take in to account the regional differences as the range of materials collected for recycling is determined by the LA's contracts, waste management facilities and availability of downstream reprocessors which is not standardised in England, something that the Government is currently working towards.

6.7. Political influence

Political influence can vary from local councillors using the waste and recycling service as a tool to gain votes by offering favourable collections schedules, or by national changes in policy, such as the proposed introduction of a standardised separate green and food waste collection. Table 6.6 summarises the political factors found to influence recycling performance in this study.

Overwhelmingly, the subject of austerity and budget cuts dominated the interviews, from job losses to fewer resources for vehicles and communication materials. Table 6.7 demonstrates how many topics referred to budgets during the interviews.

Table 6.6: Political and budgetary factors influencing recycling performance

Deprivation		Predominantly Urban		Mixed Urban/Rural		Predominantly Rural	
		LA1 Best	**LA2 Poorest**	**LA5 Best**	**LA6 Poorest**	**LA9 Best**	**LA10 Poorest**
	High	Councillors contribute financially **Selective licencing scheme**		**Political leadership backing**			SFW scheme easier communications
		Financial loss from FPI Austerity High deprivation indices	Weekly collections gain votes	Austerity Savings offset by increased housing	Austerity Emptying contaminated bins during election periods	Lack of infrastructure Austerity Too costly to change to wheelie bins	Light weighting Austerity Cost dictates service
		LA3 Best	**LA4 Poorest**	**LA7 Best**	**LA8 Poorest**	**LA11 Best**	**LA12 Poorest**
	Low	SFW will reduce confusion		**3-yr strategy/annual goals** **£150k contractual budget** **Budget matched by contract (safe)** Leadership buy-in Customer satisfaction surveys inform strategies	**Mobile HWRC successful** although due to funding service removed	**Recycling credits** Did not sent waste to China so unaffected	**Consultant determined box/kerbside sort most effective not adopted due to costs**
		Austerity Lost recycling credits MRF removal Budget cuts to comms Move to wheelie bins	Cost dictates service SFW not feasible		No budget Austerity eroded service Uncertain futures-changes in political leadership Lack of infrastructure (AD)	Contract change - contamination Staff cuts- austerity Plastic sent to Turkey - public perception	Long contract, not adapted over time Staff cuts-austerity Box/kerbside sort not adopted

Bold - Best practice
Red - Poor practice
Blue - No control
SFW - Standardised food and waste collections

Positive influence
Negative influence

It was clear that the influence of austerity and budget cuts on recycling rates had mainly been negative, with 41 specific references. There were positive topics, although fewer with only 11 references to positive budgetary influences, which included examples such as using savings to pay for a team of recycling officers in LA5 and having a political leadership team that prioritises and funds the sustainability agenda in LA7. As LA8 explains, however, changes in political leadership can change the direction of decisions, such as with funding the successful mobile HWRC.

Table 6.7: Frequency of reference to budgetary topics in LA interviews

		Predominantly Urban				Mixed Urban/Rural				Predominantly Rural				
Deprivation Index		High		Low		High		Low		High		Low		
Performer		Best	Poorest	Best	Poorest	Best	Poorest	Best	Poorest	Best	Poorest	Best	Poorest	
Local Authority		LA1	LA2	LA3	LA4	LA5	LA6	LA7	LA8	LA9	LA10	LA11	LA12	Total
Context	Positive											1		1
Context	Negative				1						1			2
Infrastructure & service delivery	Positive													0
Infrastructure & service delivery	Negative	1		1		1			1		1			5
Education & Interventions	Positive					1		1		1	1			4
Education & Interventions	Negative	1		1			1	1	2		2	1	1	10
Website content	Positive													0
Website content	Negative													0
Contamination	Positive													0
Contamination	Negative			1	1		1				1			4
Political Influence	Positive	1				1		3				1		6
Political Influence	Negative	3		4	1	2	1		2	2	2	1	2	20
	Total	6	0	7	3	5	3	5	5	3	8	4	3	52

The political leadership can influence collections, such is the case in LA2 where weekly collections have been maintained for political reasons, as councillors perceive residents are happier with weekly collections and so promote them in an attempt to capture/retain votes. Politically, this could be making future changes difficult as residents have been given the message that weekly collections are the gold standard. It is worth noting that the joint interview with LA2 representatives was the only one where budgets were not discussed, which may have been due to the WDA being present. It is worth noting that a customer satisfaction survey from LA1 showed a high level of satisfaction with their fortnightly collections, which may suggest that the preference for weekly collections may not be as strong as perceived by some local politicians

Contracts had a mixture of positive and negative influences on recycling performance. Long contracts can be non-PFI, such as LA9's 18-year contract, which has allowed them time to build good working relationships with the contractor resulting in improved performance. Conversely, LA6 is a UA and feels that short term contracts give them greater control of the materials they can collect for recycling. The contract in LA7 was used to protect the healthy £150,000 communications budget by making it contractually binding for the contractor to pay half this amount and the LA to match it.

Austerity has eroded education and interventions in all LAs, as a result the importance of clear national messaging has increased. Sometimes this messaging can have unintended and potentially negative consequences as in the case of the Blue Planet effect changing public opinion on plastics (Males and Van Aelst, 2021) making recycling seem like the more sustainable option. This has encouraged the LA11 to send their plastic to Turkey for recycling, which in the opinion of their representative was causing greater environmental harm than if it was sent to their local energy from waste plant.

The introduction of the standardised separate green and food waste collection was welcomed with respect to combating confusion and lowering communication costs, however the lack of regional processors for waste was a concern. In a number of the case study LAs, a lack of infrastructure and reprocessors was seen to impede the type and quantity of material that can be collected. This issue appears to have been acknowledged

by the Government in the Environment Bill where commitments are made to strengthen the UK-based recycling market and to accept responsibility for the domestic waste, rather than sending it abroad (DEFRA, 2020a).

Unintended consequences for recycling performance are also linked to extended producer responsibility which has encouraged 'light-weighting' of packaging that is lowering the tonnages for LAs, reducing the number of recycling credits equating to a budget cut. The LA10 representative explained that the increase in tonnages collected from increasing the range of materials for recycling has been offset by the reduction in the weight of individual items.

A positive optional policy adopted by LA1 has been the Selective Licencing Scheme that has been successful in tackling the 'rogue' landlords and the negative impact on the recycling from transient residents.

These results both negative and positive consequences from statutory requirements, political influence and budgetary cuts, make designing a waste and recycling service difficult. Unfortunately, as LA4 and LA10 explained 'costs dictate service' and it is clear to see that imposition of austerity measures by central government and thus a political decision, has changed the service provided by the LAs beyond recognition.

6.8. Best practice with tailored options

This section lists the best practice factors within the control of the LAs and how they might be tailored for their certain GSE characteristics and budgetary constraints. For ease of reference these are listed in a table per theme to include the 'model' factor' (the best practice that is considered to yield the greatest recycling performance), a tailored option for specific GSE characteristics, where applicable, and modifications for more constrained budgets. The latter has been added as the results from the interview analysis showed the influence of austerity to be significant with many LAs needing to tailor responses to accommodate reductions in resourcing.

6.8.1. Infrastructure and service delivery best practice

Table 6.8 lists the model factors associated with higher performance infrastructure and service delivery, such as the type of bin or frequency of collection, factors that are noticeable to residents and therefore give an impression of good quality service. A fortnightly collection using boxes for a 2-stream recyclate collection offers a higher recycling performance, particularly increasing quality. Factors such as the size of the recycling team or number of staff at the MRF, to provide an additional hand sort, are less apparent but no less important.

Table 6.8: Model infrastructure and service delivery factors with tailored options

Theme	Model Factor	Tailor for GSE Characteristic	Tailor for reduced Budget
Infrastructure & Service delivery	Fortnightly collections	Increase frequency for areas with high population	-
	Box collection	Clear bags for areas with high population (to remove obstacles from busy pavements)	Wheelie bins
		Wheelie bins for rural collection points	-
	2-stream recyclate collection	-	-
	2-stage sort (source and kerbside)	-	Only source separation
	Wide range of recyclate collected	-	Reduce range
	Bulky waste collection from inside property	-	Kerbside collection
	Doorstep collection in high-rises	-	Bin store collection
	Update 'large family' service	-	Self-assessment
	Mobile HWRC	-	-
	Team of Recycling Officers	-	Hire temporary staff when needed
	2-Stage MRF (hand then automatic sort)	-	1 stage MRF (automatic sort)

To address issues associated with high occupancy dwellings, a collection from the doorstep would yield greater material, and to increase the potential for reusing bulky waste, a service that collects from inside the property is ideal. Mobile HWRCs for those residents without vehicles offers yet more opportunity to increase material recycling and reuse.

6.8.2. Education and intervention best practice

Table 6.9: Model education and intervention factors with tailored options

Theme	Model Factor	Tailor for GSE Characteristic	Tailor for reduced Budget
Education & interventions	Continual education	-	Targeted communications
	Set strategy and annual goals	-	-
	Door knocking	-	Bin hangers and post leaflets
	Face-to-face (community groups)	-	-
	School visits	-	School resources on website
	Mailed annual recycling pack	-	Digital versions
	Network of communications	-	-
	Use local messengers (e.g. faith leaders)	-	-
	Communications budget	-	Protect via contract
	Staff training	-	Include customer service teams and waste operatives

Table 6.9 displays the factors associated with education and communication interventions, these factors are relevant to all groups and therefore have no tailored options for GSE characteristics. Educating residents to use the specific service correctly and consistently is the primary communication goal of all LAs. Beyond educating the residents, the interviews highlighted a need to provide training and education to the council and political leaders. This is to increase the profile of the waste and recycling service within the council, making it a priority during budget allocations, and to also discourage the use of the service for vote catching, especially using factors that negatively impact recycling performance for this purpose.

6.8.3. Website best practice

The best practice taken from the websites has no need to be tailored for GSE characteristics or for budgets (Table 6.10). Producing a concise, easy to use and well-

planned site is the key for a successful website no matter the GSE or budgetary context. A top page with limited options and graphics, to quickly direct the visitor to the information they need, should then entice them to stay and explore the site further. Providing resources for landlords, new residents and schools can help with transient populations and stimulate the 'nag factor' that positively increases recycling performance.

Table 6.10: Model website factors

Theme	Model Factor	Tailor for GSE Characteristic	Tailor for reduced Budget
Website	5 top menu options	-	-
	Reference guide to service	-	-
	Use of graphics/photographs	-	-
	Landlord/new tenant information	-	-
	School resources	-	-
	Composting/food waste reduction	-	-
	Reuse information and links	-	-
	Downstream processing information	-	-
	Interactive	-	-
	Frequent review of structure/content	-	-
	Continually updated	-	-

6.8.4. Contamination best practice

Some factors associated with contamination link with those in infrastructure and service delivery and those from education and interventions (Table 6.11). Targeted communications, delivered via door knocking is the most effective tool for education, with bin hangers and leaflets for the tailored budget option. Box collections provide opportunities for spotting non-target materials, as do clear bags, wheelie bins are popular with residents, though, and importantly provide a safer working environment. Training Waste Operatives so that they can identify contamination and provide education whilst on-site is an effective tool when dealing with contamination in wheelie bins.

Table 6.11: Model contamination factors with tailored options

Theme	Model Factor	Tailor for GSE Characteristic	Tailor for reduced Budget
Contamination	Targeted communication campaigns	-	Bin hangers & leaflets
	Monitoring and evaluation	-	-
	Box collections	Clear bags for areas with high population	Wheelie bins
	2-stage sort (source and kerbside)	-	Source separation only
	2-stream recyclate collection	-	-
	Training for Waste Operatives	-	-
	MRF contamination report	-	-
	2-stage MRF (hand and automatic)	-	1-stage MRF
	Training for leadership teams	-	-

Monitoring and evaluating the impact of campaigns provides data to inform subsequent campaigns, and accurate, regular data from MRFs will also provide important information on contamination hot spots. Data is key to continually improving the service.

6.8.5. Political best practice

The political factors within the control of the LA shown to enhance recycling performance are presented in Table 6.12, again there are factors that traverse other themes such as training for leadership teams to increase the visibility of the service and to prevent it being used as leverage for votes. Having senior management buy-in could result in higher resourcing through increased budget allocation or by 'locking in' a level of investment through commitments in waste contracts. Using government initiatives, such as the Selective Licencing Scheme to monitor rogue landlords, can combat issues with transient populations. Finally, writing strategies and setting annual goals for communications provides a framework for all stakeholders to work from and towards.

Table 6.12: Model political factors with tailored options

Theme	Model Factor	Tailor for GSE Characteristic	Tailor for reduced Budget
Political influence	Training for leadership team	-	-
	Lock in budget to waste contract	-	-
	Selective Licencing Scheme	-	-
	Set strategy and annual goals	-	-

6.9. Chapter summary

This Chapter has presented the distillation of best practice principles and the extent to which they may need to be tailored to local circumstances fulfilling Objective 3. To maximise good quality recyclate from residents using the current infrastructure, LAs need to provide on-going, face to face education. LA5 serves as an example having the highest recycling performance for material recycling attributed to an on-going education campaign involving face to face communication. The increased recycling performance is rewarded with an increased income that funds the team, providing confidence for further investment by budget holders. Education appears to be as important as infrastructure and service delivery in influencing recycling performance yet has suffered from dis-investment as a result of austerity measures. These findings imply that budgets need to be increased and protected if English LAs are to maximise their recycling performance using the current infrastructure.

There are a wide range of factors that influence recycling performance, varying in impact and often interrelated. The case studies have demonstrated the overarching impact of austerity measures and provided insights into how the LAs have responded, the adaptations they have made, and how they will respond to further policy changes.

It would be easy to suggest that increasing budgets would result in better recycling performance, however attention would still need to be given to the finer detail, such as what to include in a contract or deciding what resources could be used for different types of buildings, for example.

Not all factors need to be tailored for different circumstances and it must also be noted that not all factors can be implemented. This can be due to arrangements with contractors, restrictions such as the type of collection vehicle, and of course the budget required for changing the service. What these best practices can provide, however, is a guide should funding become available, or old contracts expire. Changes in national policy could force the introduction of new services and open new material markets, or as technology advances a greater range of material recycling could become available.

Despite a decade of budget cuts, the kerbside waste and recycling service provided by English LAs has continued to manage increasing amounts of waste, handling 6.3 million tonnes in April to May 2020 alone. To capture the recyclate incorrectly disposed of in residual waste will not only ensure England meets their recycling targets, it will also provide the income that the LAs need to deliver a service that goes beyond their statutory duty.

7. Conclusions

7.1. Introduction and chapter outline

The principal aim of this study was to establish critical success factors for effective intervention tools, to be used by English LAs, designed to enhance public participation in recycling. To achieve this, three research objectives were completed.

Objective 1: Establish the key influences on LA recycling performance

Presented in Chapter 2, the literature review and subsequent research demonstrated that factors that influence recycling performance fall in to 2 categories; they are either within or they are outside of the control of a LA. Factors that were inherent, or outside of their control, were described as their geo-socio-economic characteristics.

Objective 2: Develop a LA classification framework using geo-socio-economic factors and a method to compare both the quality and quantity of recycling performance across LAs to allow for their grouping and ranking.

Presented in Chapter 4, the study removed, or separated, the influence from factors outside of the LAs control, thereby theoretically enabling the focus to be on those that are within their control to explain the difference in recycling performance between better and poorer performers. This was achieved by categorising LAs into 6 groups of similar GSE characteristics and then selecting exemplar 'best' and 'poorest' performing LA pairs from the range of recycling quantity and quality identified. The range of performance demonstrated across these GSE groupings clearly showed that recycling performance increased with decreasing deprivation and increasing rurality.

Objective 3: Explore the core attributes that explain the difference between best and poorest performers within the novel LA groupings, and distil good practice principles and the extent to which they may need to be tailored to local circumstances

Presented in Chapters 5 and 6, an exploration of the core attributes that explain the difference between LA recycling performance was fulfilled by selecting examples from the extremes of the recycling performance ranges highlighted in Chapter 4 to subject to in-

depth case studies. These were presented in Chapter 5 against themes emerging from the interviews and literature, with those themes the focus of the horizontal analysis presented in Chapter 6. The best practices for each of the factors within the control of the LAs and how they might be tailored for their specific GSE characteristics and budgetary constraints were also presented in Chapter 6.

The key outcomes of the study include;

- Education, especially face to face communication, appears to be as important as infrastructure and service delivery in influencing recycling performance.
- Increasing and protecting education budgets is necessary for LAs to maximise their recycling performance using current infrastructure.
- Confirmation of the influence GSE factors have on recycling performance and the positive relationship between quantity and quality of recyclate.
- Unintended consequences from policy changes such as material light weighting are having a negative impact on LAs.
- Lack of downstream infrastructure could inhibit standardised waste collection schemes throughout England.

Section 7.2 presents the contribution to knowledge made by the research and implications for policy and practice. A critique of the study and identification of further research is presented in Section 7.3, and a list of conferences, papers and publications are presented in Section 7.4

7.2. Contribution to knowledge and policy implications

This research provides several contributions to knowledge. The review of the literature established key influences on LA recycling performance, interventions used to change recycling behaviour and waste infrastructure, part of this review has been published, the details are given in Section 7.4.

One of the main novel outcomes and contributions to knowledge offered by this thesis is the development of a method to assess recycling performance based on both the quality and quantity of recyclate. Several studies have used recycling performance defined only as the quantity of collected recyclate (Wilson and Williams, 2007; Abbott et al., 2011;

Andreasi Bassi et al., 2017), however at the time of writing this thesis the researcher was not aware of any study that had incorporated quality of the recyclate to calculate a LAs recycling performance. This method provided evidence that there was a positive statistical significance to the relationship between quality and quantity rates.

However, the amount of contamination in England is growing, therefore so is the importance of a method that incorporates both measures. This in turn can inform interventions to minimise contamination as LAs seek to include a wider range of materials in recycling systems to help in achieving waste diversion and material recovery targets set by government.

Calculating the costs of implementing service changes in a LA has previously made use of best practice taken from other LAs with similar GSE factors. GSE classifications have been used widely in the social sciences (Lake et al., 2012; Lymperopoulou, 2020), however the unique element of this thesis was the expansion of an existing GSE classification scale to incorporate recycling performance, both quantity and quality of recyclate, for all 287 waste collection and unitary authorities in England. It must be noted that the GSE classes are not perfectly homogenised as some subtle differences in the distribution of population and affluence in individual circumstances will be lost in averaging, such as the 'dumbbell' population of LA4 where the presence of the superrich is offset by areas of deprivation giving an average impression of affluence that does not reflect the actual communities present.

Nevertheless, categorising LAs into 6 groupings of GSE characteristics allowed for the comparison of seemingly similar LAs and to identify best and poorest performers to use in contrasting pairs as case studies to explore the reasons for the difference in recycling performance. One other study attempted to explain the variations in household recycling rates across the UK and concentrated on infrastructure and service provision (Abbott et al., 2011). This study, through the in-depth case studies using interviews with the LAs, identified other factors that the LAs have autonomy over, and extracted the best practice from each.

Finally, distilled from the in-depth case studies, good practice principles and the extent to which they may be tailored to local circumstances are presented. The literature

demonstrated a wealth of studies that have concentrated on single factors such as the shape of a bin (Jiang et al., 2019), service charges (Collinson, 2019), and the importance of intergenerational influence (Cunningham-Scott, 2005; Maddox et al., 2011). In contrast, this study did not set a limit to the scope of the factors that influence recycling rates, it aimed to extract the best practice and to identify areas of improvement. In particular it provides a better insight into austerity and how these best practice factors can be tailored in the resourced constrained environment.

The results of this study can be used and applied practically by LAs and policy makers when designing interventions or implementing changes to service. As an example, the introduction of the standardised garden and food waste collection needs to be carefully monitored as it will act as a test bed for consistent collections across the country. Reducing confusion over what can be recycled and in which bin the material goes will benefit recycling performance, but as this study shows, flexibility is needed so that changes can be tailored to suit local circumstances. Extending the consistent collections to the remaining materials would standardise the downstream facilities and may see improvements in contamination.

Quality Rate (contamination) is calculated by the amount of waste rejected by the MRFs due to non-target material in the collected recyclate. However, it is also a factor of the thresholds of acceptable limits placed on the LA by the MRFs and their reprocessors. Standardising material collections will go some way to reduce the influence on contamination rates arising from differences in acceptable limits as the 'system' should be similar across the country.

Whilst using current infrastructure and downstream technologies, the only option for increasing recycling rates is to focus on the behaviour of residents if more material is to enter waste recovery routes. As more LAs rely on passive communications, such as websites, marginal improvements in the performance of those already recycling may be realised. However, this method will not reach the less motivated resident and could see a stagnation or even a reduction in recycling performance over time. Thus, the trend towards reliance on more passive forms of communication may be insufficient to achieve the targeted levels of recycling.

Budget commitments from leaders for continual education appears to be rewarded both in the quantity and quality of material. Despite this, as austerity was introduced in the UK, resources for education were the first to be reduced and have eroded the service for many LAs to the bare minimum. As education appears to be as important as infrastructure to recycling performance, budgets for this activity need to be protected either through statutory requirements or ring fencing during LA budget setting.

Unfortunately, the financial returns that could support increased investment in educational initiatives may be being undermined by the unintended consequences of policy changes. Impacts from the light-weighting of material in packaging and the soon to be implemented deposit return scheme look set to reduce recycling tonnages with negative financial implications for LAs. To counter this, greater credit could be given to the harder to recycle materials and thereby stimulating a broader materials market in the UK.

7.3. Study critique and further research

One advantage of travelling to the LAs to conduct the interviews was that the interviewer could observe the locality first-hand. Differences between LAs that were not apparent during the desk study were visible during the visits such as the number of high-rises in London and the remote nature of some coastal areas. Although GSE factors are frequently used for studies such as this, it is worth noting it is not a fail-safe method to compare groups of LAs and contrasting pairs therein. It may have been valuable to increase the case study sample size, however due to purposeful sampling using robust data, as describe by Kvale and Brinkmann (2015), the 12 LAs are an acceptable sample size for a study such as this.

Accessibility to interviewees was problematic for some, so the service manager was not always interviewed which may have affected the results. The interviewee's experience and length of service in the authority may have influenced the results too, expanding the number of and employee types may have countered these issues. Some LAs did not respond at all, resulting in several attempts to find an exemplar LA in some groups, for example it took four attempts to secure LA12.

The empirical data represents a snapshot in time, a reflection of the resources available for the study; however, the benefit of more longitudinal study cannot be ignored (Kalof et al., 2008). This limitation is offset somewhat by the slow pace of change in GSE characteristics, and the recycling performance achieved by the LAs. However, it would be of value to conduct a long term study to increase monitoring and evaluation of interventions, similar to that conducted by Cole et al. (2014). It was also evident from the case studies that austerity measures had affected the resources available and thus the extent and nature of the interventions designed to enhance recycling performance. A greater appreciation of these temporal changes would have offered further insights, but interview time limited the issues that could be explored.

Although anonymity to foster openness was adopted, the interview with LA2 was influenced by the presence of the WDA. In hindsight it would have been valuable to conduct the interview without the WDA, not just to be consistent with the other WCA representative interviewed in the study, but also to provide the LA with the opportunity to discuss any negative aspects of the contract and relationship. That is not to say the input from the WDA was not valuable, in fact this could lead to further research.

During the study, the identified areas for further research include;

- To investigating the influence of the WDAs on the waste and recycling services provided by LAs; to understand the strengths and weaknesses of different contract specifications and the impact on the resulting relationship between the WCA and the WDA. This could inform a best practice guide for waste management contracts.
- To evaluate and monitor the impact on LAs arising from the introduction of standardised food and green waste collections. The study could include the changes in service provision and infrastructure and also the impact of using consistent messaging in communications, both locally and nationally.
- To map waste management and reprocessing facilities to inform the Government's resolution to invest in the UK waste and recycling infrastructure as set out in the Environment Bill (DEFRA, 2020a). Also, to better understand the logistics and movement of waste so that nonsensical use of infrastructure is avoided, as evidence by LA8 travelling 45 minutes to a MRF.

7.4. List of conferences, papers, and publications

Conference presentations

- Provoking Discourse, MMU, March 2018. Poster title *A comparison of the recycling performance of English local authorities.*
- Symposium on Urban Mining and Circular Economy, Italy, May 2018. Presentation and conference paper titled *A comparison of the recycling performance of English local authorities*. Also chair of a session 'Paper Recycling'.
- International Waste Management and Landfill Symposium, Sardinia, October 2019. Presentation and conference paper titled A *qualitative look at English local authority recycling rates* and *An Erasmus+ Waste Education Initiative*.
- Institute of Environmental Sciences 'Women and Girls in Science' Webinar, February 2020.

Paper in preparation

Comparing English Local Authority recycling performance: the role/influence of socio-economic factors and population density (in preparation). Resources, Conservation and Recycling (impact factor 6.699).

Published paper

A comparison of waste education in schools and colleges across five European cities. International Journal of Sustainable Development & World Ecology (impact factor 3.716). DOI https://doi.org/10.1080/13504509.2021.2019138 (Lee et al., 2021)

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Appendices

Appendix 1: Waste and recycling data with recycling rate and quality rate

Local Authority	WRAPS Rurality/Deprivation Scale	Authority type	Total local authority collected waste (tonnes)	Household - total waste (tonnes)	Household - waste sent for recycling /composting /reuse (tonnes)	% of Household waste sent for recycling/ composting/ reuse	% of Estimated accepted Household waste from Household dry recycling/reuse	Household dry recycling/reuse (tonnes)	Household - estimated rejects (tonnes)
Adur District Council	2) Predominantly urban, lower deprivation	Collection	**24,000**	21,555	6,892	32.0	91.2	5,039	442
Allerdale Borough Council	5) Predominantly Rural, higher deprivation	Collection	**44,513**	39,030	15,341	39.3	97.3	7,849	214
Amber Valley Borough Council	5) Predominantly Rural, higher deprivation	Collection	**47,382**	45,490	14,952	32.9	96.0	10,715	433
Arun District Council	4) Mixed urban/rural, lower deprivation	Collection	**53,189**	52,876	19,802	37.5	91.7	13,194	1,096
Ashfield District Council	1) Predominantly urban, higher deprivation	Collection	**47,641**	46,146	15,002	32.5	93.0	9,999	702
Ashford Borough Council	5) Predominantly Rural, higher deprivation	Collection	**40,301**	40,296	22,296	55.3	95.0	12,816	637
Aylesbury Vale District Council	6) Predominantly Rural, lower deprivation	Collection	**59,591**	54,874	28,208	51.4	96.1	16,433	647
Barking and Dagenham LB	1) Predominantly urban, higher deprivation	Collection	**94,672**	89,955	21,071	23.4	81.1	10,561	2,000
Barnet LB	2) Predominantly urban, lower deprivation	Collection	**162,435**	146,292	55,525	38.0	95.2	32,602	1,555
Barrow-in-Furness Borough Council	3) Mixed urban/rural, higher deprivation	Collection	**26,814**	26,676	9,052	33.9	97.2	5,368	150
Basildon District Council	2) Predominantly urban, lower deprivation	Collection	**79,368**	76,491	39,562	51.7	95.3	19,655	918
Basingstoke and Deane Borough Council	4) Mixed urban/rural, lower deprivation	Collection	**61,417**	59,854	14,724	24.6	91.3	12,891	1,126

Bassetlaw District Council	5) Predominantly Rural, higher deprivation	Collection	**43,267**	41,664	8,017	19.2	92.4	7,671	584
Bath and North East Somerset Council	6) Predominantly Rural, lower deprivation	Unitary	**86,159**	74,528	37,555	50.4	91.9	19,964	1,623
Bedford	4) Mixed urban/rural, lower deprivation	Unitary	**82,769**	74,867	28,341	37.9	91.3	15,577	1,348
Bexley LB	2) Predominantly urban, lower deprivation	Unitary	**119,806**	97,239	52,548	54.0	99.0	30,114	304
Birmingham City Council	1) Predominantly urban, higher deprivation	Unitary	**486,663**	376,521	100,205	26.6	96.4	65,179	2,323
Blaby District Council	4) Mixed urban/rural, lower deprivation	Collection	**37,469**	36,676	17,912	48.8	94.7	10,150	534
Blackburn with Darwen Borough Council	3) Mixed urban/rural, higher deprivation	Unitary	**63,659**	55,464	20,411	36.8	77.9	13,839	3,052
Blackpool Borough Council	1) Predominantly urban, higher deprivation	Unitary	**71,460**	63,470	25,339	39.9	97.8	17,474	385
Bolsover District Council	5) Predominantly Rural, higher deprivation	Collection	**33,143**	31,742	13,098	41.3	90.8	6,077	561
Bolton MBC	3) Mixed urban/rural, higher deprivation	Collection	**98,936**	93,263	36,287	38.9	93.9	19,171	1,163
Boston Borough Council	5) Predominantly Rural, higher deprivation	Collection	**28,392**	27,230	12,120	44.5	92.6	6,906	513
Bournemouth Borough Council	2) Predominantly urban, lower deprivation	Unitary	**95,234**	86,694	43,272	49.9	96.9	20,595	632
Bracknell Forest Borough Council	4) Mixed urban/rural, lower deprivation	Unitary	**55,110**	51,991	20,455	39.3	84.8	12,501	1,905
Bradford City MDC (MBC)	3) Mixed urban/rural, higher deprivation	Unitary	**225,646**	197,455	101,808	51.6	99.7	83,243	245
Braintree District Council	5) Predominantly Rural, higher deprivation	Collection	**61,418**	57,071	30,992	54.3	97.6	14,048	336
Breckland Council	5) Predominantly Rural, higher deprivation	Collection	**49,974**	49,702	18,515	37.3	83.5	10,789	1,776
Brent LB	1) Predominantly urban, higher deprivation	Collection	**107,491**	99,913	35,177	35.2	79.8	19,280	3,888
Brentwood Borough Council	4) Mixed urban/rural, lower deprivation	Collection	**31,303**	28,474	13,839	48.6	96.0	8,772	353
Brighton and Hove Council	1) Predominantly urban, higher deprivation	Unitary	**107,174**	104,433	26,358	25.2	93.8	22,535	1,397

Bristol City Council	1) Predominantly urban, higher deprivation	Unitary	**177,414**	166,701	72,575	43.5	99.8	44,541	85
Broadland District Council	6) Predominantly Rural, lower deprivation	Collection	**49,014**	48,626	22,762	46.8	84.2	10,808	1,711
Bromley LB	2) Predominantly urban, lower deprivation	Unitary	**144,634**	123,303	59,213	48.0	98.3	33,985	580
Bromsgrove District Council	4) Mixed urban/rural, lower deprivation	Collection	**39,594**	38,055	16,654	43.8	90.0	9,943	990
Broxbourne Borough Council	4) Mixed urban/rural, lower deprivation	Collection	**39,873**	36,941	12,939	35.0	74.6	5,597	1,419
Broxtowe Borough Council	4) Mixed urban/rural, lower deprivation	Collection	**40,157**	38,566	15,041	39.0	95.8	9,753	408
Burnley Borough Council	3) Mixed urban/rural, higher deprivation	Collection	**29,777**	28,989	9,176	31.7	100.0	5,847	0
Bury MBC	3) Mixed urban/rural, higher deprivation	Collection	**69,968**	65,453	30,479	46.6	92.7	15,459	1,124
Cambridge City Council	2) Predominantly urban, lower deprivation	Collection	**52,820**	46,155	19,905	43.1	94.7	10,618	561
Camden LB	1) Predominantly urban, higher deprivation	Collection	**114,684**	82,371	21,627	26.3	95.2	17,494	842
Cannock Chase Council	5) Predominantly Rural, higher deprivation	Collection	**39,194**	38,757	19,427	50.1	92.1	10,518	834
Canterbury City Council	4) Mixed urban/rural, lower deprivation	Collection	**57,160**	54,214	26,256	48.4	93.8	11,492	711
Castle Point Borough Council	2) Predominantly urban, lower deprivation	Collection	**32,541**	32,541	16,976	52.2	95.4	9,281	431
Central Bedfordshire	4) Mixed urban/rural, lower deprivation	Unitary	**123,353**	117,728	57,129	48.5	93.2	33,379	2,285
Charnwood Borough Council	4) Mixed urban/rural, lower deprivation	Collection	**60,834**	60,346	29,227	48.4	95.3	17,651	835
Cheltenham Borough Council	2) Predominantly urban, lower deprivation	Collection	**50,471**	47,067	21,445	45.6	100.0	11,657	4
Cherwell District Council	6) Predominantly Rural, lower deprivation	Collection	**59,274**	59,163	32,404	54.8	94.4	13,651	760
Cheshire East	5) Predominantly Rural, higher deprivation	Unitary	**194,549**	181,268	102,983	56.8	97.5	56,857	1,413
Cheshire West and Chester	4) Mixed urban/rural, lower deprivation	Unitary	**171,193**	160,597	94,926	59.1	100.0	47,839	10

Chesterfield Borough Council	3) Mixed urban/rural, higher deprivation	Collection	**44,651**	40,871	17,293	42.3	88.7	8,047	912
Chichester District Council	6) Predominantly Rural, lower deprivation	Collection	**48,845**	42,344	16,263	38.4	91.8	11,801	964
Chiltern District Council	6) Predominantly Rural, lower deprivation	Collection	**34,795**	34,676	19,910	57.4	98.4	11,105	174
Chorley Borough Council	5) Predominantly Rural, higher deprivation	Collection	**44,109**	44,007	21,010	47.7	93.5	10,447	681
City of London	2) Predominantly urban, lower deprivation	Unitary	**3,987**	3,771	1,297	34.4	90.9	1,192	108
Copeland Borough Council	5) Predominantly Rural, higher deprivation	Collection	**28,958**	27,813	9,509	34.2	99.7	4,471	13
Corby Borough Council	3) Mixed urban/rural, higher deprivation	Collection	**26,740**	25,399	10,825	42.6	90.2	5,879	575
Cornwall	5) Predominantly Rural, higher deprivation	Unitary	**267,606**	254,777	87,507	34.3	98.8	58,095	704
Cotswold District Council	6) Predominantly Rural, lower deprivation	Collection	**37,522**	37,468	21,734	58.0	99.6	8,645	34
County Durham	5) Predominantly Rural, higher deprivation	Unitary	**248,108**	224,924	95,839	42.6	89.2	62,085	6,705
Coventry City Council	1) Predominantly urban, higher deprivation	Unitary	**161,354**	125,803	42,845	34.1	93.4	26,092	1,715
Craven District Council	6) Predominantly Rural, lower deprivation	Collection	**25,509**	21,191	8,922	42.1	99.3	6,029	40
Crawley Borough Council	2) Predominantly urban, lower deprivation	Collection	**32,726**	31,010	8,258	26.6	90.9	6,906	625
Croydon LB	2) Predominantly urban, lower deprivation	Unitary	**158,836**	129,148	51,526	39.9	91.8	27,129	2,211
Dacorum Borough Council	6) Predominantly Rural, lower deprivation	Collection	**58,978**	54,813	25,395	46.3	96.4	10,917	395
Darlington Borough Council	3) Mixed urban/rural, higher deprivation	Unitary	**54,255**	43,872	16,006	36.5	94.2	12,588	725
Dartford Borough Council	4) Mixed urban/rural, lower deprivation	Collection	**34,801**	34,559	9,533	27.6	96.5	8,075	281
Derby City Council	1) Predominantly urban, higher deprivation	Unitary	**114,800**	101,252	33,322	32.9	94.6	24,919	1,336
Derbyshire Dales District Council	6) Predominantly Rural, lower deprivation	Collection	**30,460**	28,190	15,574	55.2	99.0	7,119	74

Dorset Waste Partnership		Unitary	**217,183**	194,984	106,166	54.4	70.2	55,940	16,656
Dover District Council	5) Predominantly Rural, higher deprivation	Collection	**33,898**	32,869	13,931	42.4	85.2	8,581	1,272
Dudley MBC	2) Predominantly urban, lower deprivation	Unitary	**139,781**	125,591	52,999	42.2	98.4	27,970	439
Ealing LB	1) Predominantly urban, higher deprivation	Collection	**133,905**	95,287	38,218	40.1	99.9	26,592	31
East Cambridgeshire District Council	6) Predominantly Rural, lower deprivation	Collection	**32,241**	32,041	18,148	56.6	96.1	8,013	316
East Hampshire District Council	6) Predominantly Rural, lower deprivation	Collection	**36,079**	35,972	11,724	32.6	88.9	10,242	1,139
East Hertfordshire District Council	4) Mixed urban/rural, lower deprivation	Collection	**56,293**	54,081	26,764	49.5	99.0	12,413	128
East Lindsey District Council	5) Predominantly Rural, higher deprivation	Collection	**56,195**	55,762	25,912	46.5	83.5	12,013	1,980
East Northamptonshire Council	6) Predominantly Rural, lower deprivation	Collection	**26,740**	26,317	11,754	44.7	88.9	8,048	891
East Riding of Yorkshire Council	5) Predominantly Rural, higher deprivation	Unitary	**193,188**	171,888	98,866	57.5	87.5	47,760	5,952
East Staffordshire Borough Council	5) Predominantly Rural, higher deprivation	Collection	**46,399**	45,848	23,717	51.7	97.2	11,510	319
Eastbourne Borough Council	2) Predominantly urban, lower deprivation	Collection	**37,174**	36,892	12,798	34.7	93.7	7,610	483
Eastleigh Borough Council	4) Mixed urban/rural, lower deprivation	Collection	**43,625**	39,998	16,235	40.6	86.2	9,981	1,378
Eden District Council	5) Predominantly Rural, higher deprivation	Collection	**24,176**	22,437	9,966	44.4	97.9	5,195	108
Elmbridge Borough Council	4) Mixed urban/rural, lower deprivation	Collection	**52,959**	52,785	26,878	50.9	94.3	14,309	814
Enfield LB	1) Predominantly urban, higher deprivation	Collection	**136,975**	123,083	47,344	38.5	94.0	27,201	1,631
Epping Forest Borough Council	5) Predominantly Rural, higher deprivation	Collection	**53,242**	53,222	31,142	58.5	96.2	14,935	575
Epsom and Ewell Borough Council	4) Mixed urban/rural, lower deprivation	Collection	**30,680**	29,336	13,728	46.8	95.2	7,230	347
Erewash Borough Council	4) Mixed urban/rural, lower deprivation	Collection	**47,242**	45,158	17,549	38.9	79.5	7,950	1,627

Exeter City Council	3) Mixed urban/rural, higher deprivation	Collection	**40,476**	37,899	12,816	33.8	92.2	10,057	784
Fareham Borough Council	4) Mixed urban/rural, lower deprivation	Collection	**38,955**	34,923	12,024	34.4	87.4	8,330	1,054
Fenland District Council	5) Predominantly Rural, higher deprivation	Collection	**43,033**	41,631	21,129	50.8	94.6	8,830	475
Forest Heath District Council	6) Predominantly Rural, lower deprivation	Collection	**28,782**	26,549	12,369	46.6	94.8	6,017	312
Forest of Dean District Council	5) Predominantly Rural, higher deprivation	Collection	**30,890**	30,845	14,775	47.9	99.8	5,396	8
Fylde Borough Council	6) Predominantly Rural, lower deprivation	Collection	**34,477**	31,709	15,863	50.0	98.1	8,382	162
Gateshead MBC	3) Mixed urban/rural, higher deprivation	Unitary	**93,033**	84,421	30,315	35.9	94.7	20,088	1,059
Gedling Borough Council	4) Mixed urban/rural, lower deprivation	Collection	**46,198**	43,734	15,846	36.2	94.1	11,002	650
Gloucester City Council	2) Predominantly urban, lower deprivation	Collection	**47,511**	44,956	16,177	36.0	99.9	8,017	7
Gosport Borough Council	2) Predominantly urban, lower deprivation	Collection	**23,758**	23,732	5,579	23.5	86.0	5,286	739
Gravesham Borough Council	3) Mixed urban/rural, higher deprivation	Collection	**35,298**	31,881	10,899	34.2	96.5	6,657	231
Great Yarmouth Borough Council	3) Mixed urban/rural, higher deprivation	Collection	**37,715**	36,450	9,723	26.7	82.8	7,701	1,321
Greenwich LB	1) Predominantly urban, higher deprivation	Unitary	**114,846**	107,260	36,828	34.3	71.8	21,151	5,975
Guildford Borough Council	4) Mixed urban/rural, lower deprivation	Collection	**55,918**	50,286	28,544	56.8	95.7	15,161	656
Hackney LB	1) Predominantly urban, higher deprivation	Collection	**116,472**	84,286	21,291	25.3	95.1	16,051	783
Halton Borough Council	3) Mixed urban/rural, higher deprivation	Unitary	**60,895**	56,692	26,516	46.8	92.9	18,621	1,319
Hammersmith and Fulham LB	1) Predominantly urban, higher deprivation	Collection	**74,848**	52,229	10,827	20.7	82.9	10,395	1,779
Harborough District Council	6) Predominantly Rural, lower deprivation	Collection	**40,050**	36,510	20,991	57.5	96.4	9,206	328
Haringey LB	1) Predominantly urban, higher deprivation	Collection	**108,985**	87,412	32,627	37.3	95.0	25,078	1,250

Harlow District Council	2) Predominantly urban, lower deprivation	Collection	**26,073**	25,688	11,783	45.9	95.3	8,369	394
Harrogate Borough Council	6) Predominantly Rural, lower deprivation	Collection	**64,153**	58,067	23,994	41.3	98.6	12,977	177
Harrow LB	2) Predominantly urban, lower deprivation	Collection	**97,953**	87,017	39,283	45.1	94.3	19,423	1,110
Hart District Council	4) Mixed urban/rural, lower deprivation	Collection	**30,861**	30,836	11,454	37.1	87.5	8,649	1,080
Hartlepool Borough Council	3) Mixed urban/rural, higher deprivation	Unitary	**46,985**	41,586	15,795	38.0	86.1	9,421	1,312
Hastings Borough Council	1) Predominantly urban, higher deprivation	Collection	**31,787**	31,678	8,882	28.0	94.5	7,049	386
Havant Borough Council	3) Mixed urban/rural, higher deprivation	Collection	**38,192**	37,771	11,016	29.2	83.9	8,940	1,438
Havering LB	2) Predominantly urban, lower deprivation	Collection	**109,241**	100,897	32,715	32.4	91.8	16,989	1,396
Herefordshire Council	5) Predominantly Rural, higher deprivation	Unitary	**85,277**	75,911	30,331	40.0	88.9	22,028	2,452
Hertsmere Borough Council	6) Predominantly Rural, lower deprivation	Collection	**40,895**	38,556	16,683	43.3	98.2	8,014	142
High Peak Borough Council	5) Predominantly Rural, higher deprivation	Collection	**40,915**	36,616	15,676	42.8	95.3	8,289	389
Hillingdon LB	3) Mixed urban/rural, higher deprivation	Collection	**108,500**	95,122	41,695	43.8	97.0	23,753	718
Hinckley and Bosworth Borough Council	4) Mixed urban/rural, lower deprivation	Collection	**45,080**	43,241	22,807	52.7	97.3	10,298	283
Horsham District Council	6) Predominantly Rural, lower deprivation	Collection	**56,690**	53,748	23,916	44.5	87.8	11,853	1,452
Hounslow LB	2) Predominantly urban, lower deprivation	Collection	**98,610**	89,462	30,836	34.5	96.1	19,259	760
Huntingdonshire District Council	6) Predominantly Rural, lower deprivation	Collection	**69,651**	68,935	39,253	56.9	95.9	17,524	713
Ipswich Borough Council	2) Predominantly urban, lower deprivation	Collection	**56,350**	51,720	21,168	40.9	94.2	11,084	644
Isle of Wight Council	5) Predominantly Rural, higher deprivation	Unitary	**76,424**	71,948	35,368	49.2	95.3	19,693	920
Islington LB	1) Predominantly urban, higher deprivation	Collection	**96,033**	59,965	19,671	32.8	95.2	15,178	724

Kettering Borough Council	4) Mixed urban/rural, lower deprivation	Collection	**40,444**	38,971	18,837	48.3	95.3	9,216	431
Kings Lynn and West Norfolk Borough Council	5) Predominantly Rural, higher deprivation	Collection	**58,855**	55,301	23,192	41.9	82.3	11,418	2,018
Kingston-upon-Hull City Council	1) Predominantly urban, higher deprivation	Unitary	**120,901**	103,738	46,639	45.0	72.2	27,488	7,643
Kirklees MBC	3) Mixed urban/rural, higher deprivation	Unitary	**206,325**	171,465	47,378	27.6	76.3	33,824	8,003
Knowsley MBC	1) Predominantly urban, higher deprivation	Collection	**58,420**	54,869	20,164	36.7	95.6	11,963	528
Lambeth LB	1) Predominantly urban, higher deprivation	Collection	**122,381**	85,319	24,135	28.3	84.6	18,134	2,799
Lancaster City Council	3) Mixed urban/rural, higher deprivation	Collection	**54,344**	49,530	21,254	42.9	97.7	10,774	248
Leeds City Council MBC	3) Mixed urban/rural, higher deprivation	Unitary	**323,967**	305,618	131,032	42.9	91.2	86,830	7,677
Leicester City Council	1) Predominantly urban, higher deprivation	Unitary	**126,434**	116,165	40,237	34.6	98.0	26,204	535
Lewes District Council	5) Predominantly Rural, higher deprivation	Collection	**31,430**	29,516	7,268	24.6	99.7	6,102	20
Lewisham LB	1) Predominantly urban, higher deprivation	Unitary	**129,260**	107,033	18,297	17.1	82.9	17,431	2,978
Lichfield District Council	6) Predominantly Rural, lower deprivation	Collection	**44,620**	43,327	23,636	54.6	93.9	11,821	724
Lincoln City Council	1) Predominantly urban, higher deprivation	Collection	**36,515**	36,443	14,839	40.7	94.0	8,773	526
Liverpool City Council	1) Predominantly urban, higher deprivation	Collection	**180,364**	173,541	51,443	29.6	95.3	33,182	1,571
Luton Borough Council	1) Predominantly urban, higher deprivation	Unitary	**93,465**	81,241	27,909	34.4	96.9	19,170	589
Maidstone Borough Council	4) Mixed urban/rural, lower deprivation	Collection	**56,392**	55,834	27,420	49.1	95.4	14,887	686
Maldon District Council	6) Predominantly Rural, lower deprivation	Collection	**22,931**	22,931	10,561	46.1	99.4	4,871	28
Malvern Hills District Council	6) Predominantly Rural, lower deprivation	Collection	**25,810**	24,640	9,398	38.1	90.6	7,470	701
Manchester City Council MBC	1) Predominantly urban, higher deprivation	Collection	**172,896**	165,926	54,436	32.8	92.3	28,782	2,215

Mansfield District Council	3) Mixed urban/rural, higher deprivation	Collection	**45,094**	42,434	15,171	35.8	90.2	8,235	809
Medway Borough Council	3) Mixed urban/rural, higher deprivation	Unitary	**130,280**	122,840	56,686	46.1	91.7	31,062	2,575
Melton Borough Council	6) Predominantly Rural, lower deprivation	Collection	**20,398**	20,134	9,380	46.6	94.4	5,768	324
Mendip District Council	5) Predominantly Rural, higher deprivation	Collection	**40,273**	39,990	17,101	42.8	100.0	10,845	5
Merton LB	2) Predominantly urban, lower deprivation	Unitary	**84,439**	72,406	27,135	37.5	97.4	19,546	515
Mid Devon District Council	5) Predominantly Rural, higher deprivation	Collection	**33,589**	30,949	14,926	48.2	100.0	4,494	2
Mid Suffolk District Council	6) Predominantly Rural, lower deprivation	Collection	**70,172**	66,139	28,485	43.1	94.5	18,876	1,039
Mid Sussex District Council	6) Predominantly Rural, lower deprivation	Collection	**47,765**	47,654	18,834	39.5	95.5	13,274	603
Milton Keynes Council	4) Mixed urban/rural, lower deprivation	Unitary	**129,697**	119,408	61,907	51.8	91.5	34,468	2,917
Mole Valley District Council	6) Predominantly Rural, lower deprivation	Collection	**33,204**	32,838	18,259	55.6	94.0	9,866	590
New Forest District Council	6) Predominantly Rural, lower deprivation	Collection	**60,609**	58,690	17,474	29.8	88.8	14,606	1,634
Newark and Sherwood District Council	5) Predominantly Rural, higher deprivation	Collection	**46,171**	43,512	11,767	27.0	92.9	9,759	694
Newcastle-upon-Tyne City Council MBC	3) Mixed urban/rural, higher deprivation	Unitary	**138,534**	110,811	45,236	40.8	99.3	25,306	181
Newham LB	1) Predominantly urban, higher deprivation	Collection	**124,006**	116,711	20,023	17.2	83.0	15,464	2,631
North East Derbyshire District Council	5) Predominantly Rural, higher deprivation	Collection	**42,486**	40,578	17,835	44.0	91.1	7,988	711
North East Lincolnshire Council	3) Mixed urban/rural, higher deprivation	Unitary	**79,113**	76,658	24,437	31.9	99.7	11,020	34
North Hertfordshire District Council	4) Mixed urban/rural, lower deprivation	Collection	**52,141**	48,612	28,453	58.5	99.8	13,067	27
North Kesteven District Council	6) Predominantly Rural, lower deprivation	Collection	**45,265**	45,086	21,304	47.3	85.3	10,507	1,549
North Lincolnshire Council	5) Predominantly Rural, higher deprivation	Unitary	**94,191**	84,041	42,104	50.1	96.7	22,079	730

North Norfolk District Council	5) Predominantly Rural, higher deprivation	Collection	**45,525**	41,934	17,340	41.4	84.4	9,391	1,467
North Tyneside Council	3) Mixed urban/rural, higher deprivation	Unitary	**103,649**	91,210	34,156	37.4	99.9	22,894	25
North West Leicestershire District Council	5) Predominantly Rural, higher deprivation	Collection	**41,888**	39,506	18,395	46.6	99.8	7,858	18
Northumberland	5) Predominantly Rural, higher deprivation	Unitary	**163,108**	149,207	59,077	39.6	90.8	36,705	3,366
Norwich City Council	1) Predominantly urban, higher deprivation	Collection	**44,933**	44,277	15,483	35.0	84.4	10,217	1,596
Nottingham City Council	1) Predominantly urban, higher deprivation	Unitary	**156,533**	110,938	36,478	32.9	87.7	22,866	2,820
Nuneaton and Bedworth Borough Council	3) Mixed urban/rural, higher deprivation	Collection	**48,796**	48,439	21,763	44.9	96.8	9,825	312
Oadby and Wigston Borough Council	2) Predominantly urban, lower deprivation	Collection	**16,113**	16,109	7,867	48.8	100.0	4,197	1
Oldham MBC	3) Mixed urban/rural, higher deprivation	Collection	**82,950**	73,130	27,043	37.0	89.6	14,350	1,487
Oxford City Council	2) Predominantly urban, lower deprivation	Collection	**56,717**	46,076	21,117	45.8	96.2	13,732	518
Pendle Borough Council	3) Mixed urban/rural, higher deprivation	Collection	**34,859**	32,186	11,016	34.2	97.9	7,837	164
Peterborough City Council	3) Mixed urban/rural, higher deprivation	Unitary	**87,943**	82,578	38,495	46.6	95.0	21,572	1,076
Plymouth City Council	1) Predominantly urban, higher deprivation	Unitary	**125,779**	107,972	38,152	35.3	97.4	26,903	692
Poole Borough Council	4) Mixed urban/rural, lower deprivation	Unitary	**81,822**	70,481	32,315	45.8	97.5	20,974	527
Portsmouth City Council	1) Predominantly urban, higher deprivation	Unitary	**82,471**	77,904	17,696	22.7	90.9	13,061	1,188
RB of Kensington and Chelsea	2) Predominantly urban, lower deprivation	Collection	**80,139**	54,574	13,810	25.3	84.3	12,733	2,004
Reading Borough Council	2) Predominantly urban, lower deprivation	Unitary	**74,278**	63,521	23,499	37.0	85.2	16,381	2,427
Redcar and Cleveland Borough Council	5) Predominantly Rural, higher deprivation	Unitary	**71,804**	57,598	27,275	47.4	97.0	16,953	517
Redditch Borough Council	3) Mixed urban/rural, higher deprivation	Collection	**28,303**	28,029	8,446	30.1	90.0	8,446	844

Reigate and Banstead Borough Council	4) Mixed urban/rural, lower deprivation	Collection	**51,715**	48,205	25,339	52.6	97.4	13,392	348
Ribble Valley Borough Council	6) Predominantly Rural, lower deprivation	Collection	**23,227**	22,406	8,648	38.6	98.7	5,040	67
Richmond upon Thames LB	2) Predominantly urban, lower deprivation	Collection	**88,617**	74,753	30,793	41.2	96.5	20,188	708
Richmondshire District Council	6) Predominantly Rural, lower deprivation	Collection	**18,446**	18,048	6,807	37.7	100.0	3,998	0
Rochdale MBC	3) Mixed urban/rural, higher deprivation	Collection	**69,955**	68,866	22,993	33.4	92.7	13,731	1,008
Rochford District Council	4) Mixed urban/rural, lower deprivation	Collection	**33,609**	33,609	21,920	65.2	92.0	8,946	712
Rossendale Borough Council	3) Mixed urban/rural, higher deprivation	Collection	**24,866**	23,727	7,794	32.8	96.4	5,313	193
Rother District Council	5) Predominantly Rural, higher deprivation	Collection	**34,656**	34,328	15,595	45.4	95.1	8,171	398
Rotherham MBC	3) Mixed urban/rural, higher deprivation	Unitary	**118,607**	110,411	41,558	37.6	96.0	22,295	899
Rugby Borough Council	4) Mixed urban/rural, lower deprivation	Collection	**47,146**	43,680	20,086	46.0	84.0	9,040	1,442
Runnymede Borough Council	4) Mixed urban/rural, lower deprivation	Collection	**29,042**	26,354	11,527	43.7	94.3	7,000	399
Rushcliffe Borough Council	6) Predominantly Rural, lower deprivation	Collection	**44,517**	44,386	21,750	49.0	95.2	10,073	487
Rushmoor Borough Council	2) Predominantly urban, lower deprivation	Collection	**30,842**	30,816	7,979	25.9	85.7	6,082	867
Rutland County Council	6) Predominantly Rural, lower deprivation	Unitary	**20,840**	19,734	11,665	59.1	94.3	6,118	348
Salford City Council MBC	1) Predominantly urban, higher deprivation	Collection	**91,451**	81,129	33,395	41.2	95.9	17,440	709
Sandwell MBC	1) Predominantly urban, higher deprivation	Unitary	**138,479**	123,672	50,556	40.9	74.3	29,334	7,544
Scarborough Borough Council	5) Predominantly Rural, higher deprivation	Collection	**52,855**	47,065	19,174	40.7	94.1	10,809	635
Sedgemoor District Council	5) Predominantly Rural, higher deprivation	Collection	**40,651**	40,047	18,561	46.3	100.0	10,809	0
Sefton MBC	3) Mixed urban/rural, higher deprivation	Collection	**108,831**	106,598	43,852	41.1	98.9	22,070	238

Selby District Council	6) Predominantly Rural, lower deprivation	Collection	**38,855**	36,632	16,027	43.8	100.0	6,455	0
Sevenoaks District Council	6) Predominantly Rural, lower deprivation	Collection	**47,232**	43,767	14,603	33.4	97.8	9,880	218
Sheffield City Council	3) Mixed urban/rural, higher deprivation	Unitary	**197,094**	185,301	55,543	30.0	97.7	46,729	1,058
Shepway District Council	5) Predominantly Rural, higher deprivation	Collection	**41,560**	39,347	18,716	47.6	90.0	10,602	1,061
Shropshire	5) Predominantly Rural, higher deprivation	Unitary	**159,637**	152,444	75,062	49.2	99.1	33,485	305
Slough Borough Council	2) Predominantly urban, lower deprivation	Unitary	**57,300**	51,641	15,059	29.2	94.0	10,416	622
Solihull MBC	4) Mixed urban/rural, lower deprivation	Unitary	**96,608**	92,003	36,638	39.8	79.0	17,015	3,571
South Bucks District Council	6) Predominantly Rural, lower deprivation	Collection	**23,173**	22,852	11,583	50.7	97.6	6,908	166
South Cambridgeshire District Council	6) Predominantly Rural, lower deprivation	Collection	**63,532**	60,819	35,321	58.1	97.9	15,680	327
South Derbyshire District Council	6) Predominantly Rural, lower deprivation	Collection	**41,155**	39,673	19,446	49.0	97.9	7,648	159
South Gloucestershire Council	4) Mixed urban/rural, lower deprivation	Unitary	**126,020**	120,015	56,982	47.5	72.3	28,918	8,016
South Hams District Council	5) Predominantly Rural, higher deprivation	Collection	**37,698**	34,599	18,461	53.4	99.6	8,011	28
South Holland District Council	5) Predominantly Rural, higher deprivation	Collection	**30,281**	30,169	9,301	30.8	88.7	9,029	1,016
South Kesteven District Council	6) Predominantly Rural, lower deprivation	Collection	**53,238**	53,174	25,294	47.6	88.7	15,296	1,732
South Lakeland District Council	6) Predominantly Rural, lower deprivation	Collection	**45,330**	45,093	19,772	43.8	100.0	9,035	0
South Norfolk Council	6) Predominantly Rural, lower deprivation	Collection	**48,531**	47,941	19,354	40.4	83.8	11,095	1,794
South Northamptonshire District Council	6) Predominantly Rural, lower deprivation	Collection	**40,437**	38,628	23,144	59.9	96.0	9,808	389
South Oxfordshire District Council	6) Predominantly Rural, lower deprivation	Collection	**50,139**	50,054	33,698	67.3	95.0	17,781	883
South Ribble Borough Council	4) Mixed urban/rural, lower deprivation	Collection	**44,942**	42,908	21,197	49.4	94.2	10,459	611

South Somerset District Council	5) Predominantly Rural, higher deprivation	Collection	**56,238**	55,691	25,118	45.1	100.0	15,518	0
South Staffordshire Council	6) Predominantly Rural, lower deprivation	Collection	**46,460**	46,263	25,042	54.1	93.3	11,770	790
South Tyneside MBC	1) Predominantly urban, higher deprivation	Unitary	**76,895**	66,674	26,158	39.2	95.3	17,117	803
Southampton City Council	1) Predominantly urban, higher deprivation	Unitary	**110,474**	94,600	24,686	26.1	83.3	16,604	2,776
Southend-on-Sea Borough Council	2) Predominantly urban, lower deprivation	Unitary	**75,899**	72,854	37,426	51.4	97.8	22,609	498
Southwark LB	1) Predominantly urban, higher deprivation	Unitary	**118,814**	111,262	38,475	34.6	90.8	29,378	2,714
Spelthorne Borough Council	2) Predominantly urban, lower deprivation	Collection	**33,943**	33,505	14,459	43.2	93.8	9,098	567
St Albans City and District Council	4) Mixed urban/rural, lower deprivation	Collection	**52,036**	51,363	25,897	50.4	97.0	12,150	366
St Edmundsbury Borough Council	6) Predominantly Rural, lower deprivation	Collection	**52,577**	46,073	23,842	51.7	94.4	10,676	601
Stafford Borough Council	6) Predominantly Rural, lower deprivation	Collection	**53,475**	53,475	28,213	52.8	94.8	14,056	726
Staffordshire Moorlands District Council	5) Predominantly Rural, higher deprivation	Collection	**40,058**	38,204	21,091	55.2	95.4	8,376	386
Stevenage Borough Council	2) Predominantly urban, lower deprivation	Collection	**34,299**	32,168	12,289	38.2	96.1	6,142	240
Stockport MBC	3) Mixed urban/rural, higher deprivation	Collection	**103,366**	102,268	62,035	60.7	94.6	25,913	1,387
Stoke-on-Trent City Council	1) Predominantly urban, higher deprivation	Unitary	**116,708**	103,275	34,806	33.7	91.4	20,751	1,788
Stratford-on-Avon District Council	6) Predominantly Rural, lower deprivation	Collection	**54,837**	54,680	32,956	60.3	90.9	13,762	1,247
Stroud District Council	6) Predominantly Rural, lower deprivation	Collection	**37,831**	37,662	11,446	30.4	99.6	11,303	43
Suffolk Coastal District Council	6) Predominantly Rural, lower deprivation	Collection	**57,124**	49,382	27,888	56.5	94.7	13,310	711
Sunderland City Council	1) Predominantly urban, higher deprivation	Unitary	**134,297**	123,114	37,656	30.6	94.8	23,684	1,234
Surrey Heath Borough Council	4) Mixed urban/rural, lower deprivation	Collection	**29,611**	29,429	18,629	63.3	95.3	11,907	556

Sutton LB	2) Predominantly urban, lower deprivation	Unitary	**81,731**	73,350	27,557	37.6	96.7	20,096	666
Swale Borough Council	5) Predominantly Rural, higher deprivation	Collection	**51,875**	49,985	20,164	40.3	93.5	13,669	883
Tameside MBC	1) Predominantly urban, higher deprivation	Collection	**78,840**	70,968	28,938	40.8	92.3	15,795	1,213
Tamworth Borough Council	2) Predominantly urban, lower deprivation	Collection	**29,761**	29,252	14,411	49.3	93.2	8,461	574
Tandridge District Council	6) Predominantly Rural, lower deprivation	Collection	**29,438**	29,010	14,990	51.7	94.8	9,226	483
Telford and Wrekin Council	3) Mixed urban/rural, higher deprivation	Unitary	**85,823**	79,774	37,975	47.6	98.0	21,280	418
Test Valley Borough Council	6) Predominantly Rural, lower deprivation	Collection	**40,363**	39,903	12,765	32.0	88.1	9,666	1,154
Tewkesbury Borough Council	6) Predominantly Rural, lower deprivation	Collection	**34,416**	32,947	16,692	50.7	90.6	8,515	801
Thanet District Council	3) Mixed urban/rural, higher deprivation	Collection	**47,048**	46,787	15,873	33.9	87.4	9,406	1,183
Three Rivers District Council	4) Mixed urban/rural, lower deprivation	Collection	**37,403**	34,900	22,048	63.2	100.0	9,033	1
Thurrock Council	3) Mixed urban/rural, higher deprivation	Unitary	**70,996**	67,865	27,449	40.4	94.1	15,002	892
Tower Hamlets LB	1) Predominantly urban, higher deprivation	Unitary	**110,245**	71,649	20,146	28.1	92.7	19,147	1,405
Trafford MBC	2) Predominantly urban, lower deprivation	Collection	**88,073**	81,935	50,755	61.9	93.9	20,685	1,263
Tunbridge Wells Borough Council	6) Predominantly Rural, lower deprivation	Collection	**46,375**	46,305	21,632	46.7	99.9	9,834	14
Uttlesford District Council	6) Predominantly Rural, lower deprivation	Collection	**31,656**	29,308	14,731	50.3	92.0	9,389	747
Vale of White Horse District Council	6) Predominantly Rural, lower deprivation	Collection	**41,644**	41,608	27,281	65.6	94.8	14,808	773
Wakefield City MDC	3) Mixed urban/rural, higher deprivation	Unitary	**169,377**	148,579	57,639	38.8	98.6	33,814	467
Walsall MBC	1) Predominantly urban, higher deprivation	Unitary	**122,234**	112,515	47,228	42.0	92.3	27,671	2,128
Waltham Forest LB	1) Predominantly urban, higher deprivation	Collection	**109,616**	99,518	35,292	35.5	95.1	24,279	1,193

Wandsworth LB	2) Predominantly urban, lower deprivation	Collection	**102,521**	95,081	19,680	20.7	85.1	18,960	2,827
Warrington Borough Council	4) Mixed urban/rural, lower deprivation	Unitary	**94,323**	89,763	45,337	50.5	97.3	24,732	656
Warwick District Council	4) Mixed urban/rural, lower deprivation	Collection	**49,825**	49,825	27,300	54.8	99.7	12,429	35
Watford Borough Council	2) Predominantly urban, lower deprivation	Collection	**32,720**	32,668	13,611	41.7	98.0	7,523	148
Waveney District Council	5) Predominantly Rural, higher deprivation	Collection	**54,718**	50,846	26,330	51.8	94.9	11,903	602
Waverley Borough Council	6) Predominantly Rural, lower deprivation	Collection	**42,705**	42,287	21,856	51.7	92.3	14,117	1,086
Wealden District Council	6) Predominantly Rural, lower deprivation	Collection	**60,697**	60,236	29,476	48.9	94.2	15,076	880
Wellingborough Borough Council	5) Predominantly Rural, higher deprivation	Collection	**30,742**	29,999	12,060	40.2	86.1	6,645	921
Welwyn Hatfield Council	4) Mixed urban/rural, lower deprivation	Collection	**45,338**	43,256	20,771	48.0	95.6	9,067	395
West Berkshire District Council	6) Predominantly Rural, lower deprivation	Unitary	**84,622**	80,856	41,933	51.9	97.9	21,351	442
West Lancashire Borough Council	5) Predominantly Rural, higher deprivation	Collection	**48,466**	45,636	20,679	45.3	97.2	9,901	274
West Lindsey District Council	5) Predominantly Rural, higher deprivation	Collection	**40,535**	40,023	21,707	54.2	94.8	9,838	516
West Oxfordshire District Council	6) Predominantly Rural, lower deprivation	Collection	**47,228**	44,099	26,218	59.5	99.2	11,900	91
Westminster City Council	1) Predominantly urban, higher deprivation	Unitary	**188,643**	90,621	17,325	19.1	87.2	17,243	2,213
Wigan MBC	3) Mixed urban/rural, higher deprivation	Unitary	**143,642**	135,157	61,243	45.3	94.5	37,816	2,085
Wiltshire	6) Predominantly Rural, lower deprivation	Unitary	**257,718**	225,559	104,898	46.5	93.9	57,226	3,507
Winchester City Council	6) Predominantly Rural, lower deprivation	Collection	**43,405**	37,261	13,170	35.3	85.6	8,333	1,197
Windsor and Maidenhead BC	4) Mixed urban/rural, lower deprivation	Unitary	**70,861**	68,132	30,995	45.5	96.4	20,542	733
Wirral MBC	3) Mixed urban/rural, higher deprivation	Collection	**123,362**	119,375	42,937	36.0	93.6	30,263	1,925

Woking Borough Council	4) Mixed urban/rural, lower deprivation	Collection	**37,259**	37,088	21,671	58.4	97.3	10,822	298
Wokingham Council	4) Mixed urban/rural, lower deprivation	Unitary	**76,904**	72,836	30,230	41.5	86.8	19,751	2,613
Wolverhampton MBC	1) Predominantly urban, higher deprivation	Unitary	**125,940**	107,314	47,280	44.1	92.9	23,911	1,707
Worcester City Council	2) Predominantly urban, lower deprivation	Collection	**33,438**	30,977	11,647	37.6	89.8	10,035	1,023
Worthing Borough Council	2) Predominantly urban, lower deprivation	Collection	**41,901**	37,614	13,033	34.6	91.3	8,382	733
Wychavon District Council	6) Predominantly Rural, lower deprivation	Collection	**45,099**	42,863	18,430	43.0	89.6	13,209	1,380
Wycombe District Council	6) Predominantly Rural, lower deprivation	Collection	**65,583**	64,819	34,013	52.5	98.4	15,168	242
Wyre Borough Council	4) Mixed urban/rural, lower deprivation	Collection	**43,225**	42,878	21,913	51.1	99.4	10,869	69
Wyre Forest District Council	5) Predominantly Rural, higher deprivation	Collection	**37,406**	36,694	11,713	31.9	89.9	10,058	1,015
York City Council	4) Mixed urban/rural, lower deprivation	Unitary	**96,458**	89,876	38,206	42.5	99.8	21,752	51

Appendix 2: First stage desk study

LA Name	
Descriptor (e.g. PU,HD,GP)	
Opposite LA (e.g. PU, HD, PP)	
Authority type (collection/disposal/unitary)	
Address	
Telephone No	
Website	
Twitter handle	
Contact Name	
Job Title	
Total HH Waste (tonnes)	
Quality Rate (% and tonnes)	
Quantity Rate (% and tonnes)	
Rural/Urban Classification	
Deprivation Index	
Population size	
Land area	
Waste Contractor	
Year recycling started	
Useful Documents	

Appendix 3: Example waste and recycling collection scheme

Schemes (Number)	No.	Type	Number of Households	Materials Collected	Container	Collection Frequency	Notes
Dry Recycling (1)	1 – Kerbside	Co-Mingled	160000	Glass Mixed cans Aerosols Foil Card	Wheeled bin 181-240l	Fortnightly	
	2 - Flats	Multi streamed	33000	Plastic bottles Mixed plastics Paper Composites	Wheeled >240l	Fortnightly	
Garden Waste Recycling (1)	1 - Kerbside	For houses with gardens	160000	Garden Waste	Wheeled Bin 181-240l	Fortnightly	Chargeable £25 annual
Separate Food Recycling Scheme (1)	1 – Kerbside	Separate food waste collection	160000	Food Waste	Kitchen caddy (7l) Kerbside caddy (23l)	Weekly	
Residual Waste (1)	1 – Kerbside	-	160000	Residual Waste	Communal wheeled bin >360l, wheeled bin 141-180l	Fortnightly	
Bulky service (1)	1 – Kerbside	Chargeable		Large items including WEEE		On demand	1 to 3 items £25

Appendix 4: Example Interview Invitation Email

Dear

I have been given your details by the contact centre as someone who may be able to help with my research.

I am a PhD student at Manchester Metropolitan University. Through a series of interviews with English Local Authorities, my research aims to find out what works and what doesn't work when it comes to waste and recycling educational initiatives. I am not only looking at the quantity of recycling but also the quality.

It would be of great benefit if you or a colleague could spare me an hour to discuss your experience as a council. Ideally the person would have knowledge of previous initiatives including budgets and waste data. All information would be kept strictly confidential and LA'S name would be anonymised in all written work. I have attached a participant information sheet that has more information.

If you agree or you have any further questions, please do not hesitate to get in touch.

Thank you for your time and kind regards,

Sheryl

Sheryl Lee

Research Assistant
PhD Researcher
Waste 2 Resource Innovation Network
Faculty of Science and Engineering
Chester Street
Manchester M1 5DG

Appendix 5: Participant Information Sheet

Participant Information Sheet

Educational interventions to improve municipal recycling rates achieved by UK Local Authorities

1. Invitation to research

I would like to invite you to take part in an interview which is to be included in a research study based on Local Authority recycling rates. Please take the time to read the following information and to ask questions if any part is unclear or if you would like further details.

2. Why have I been invited?

Data from the WasteDataFlow database has been analysed as part of this study. Your Local Authority has been selected so we can learn from your recycling and waste education initiatives to help develop an educational intervention specific to a LA type similar to yours.

3. Do I have to take part?

It is up to you to decide. We will describe the study and go through the information sheet, which we will give to you. We will then ask you to sign a consent form to show you agreed to take part. You are free to withdraw at any time, without giving a reason.

4. What will I be asked to do?

If you agree, the interview will take no longer than one hour and will be digitally recorded, audio only. The purpose of the interview will be to gather information around educational initiatives the local authority has used which has had an influence on recycling rates, whether positively or negatively. It could help to be prepared with any leaflets or documents you feel may aid the discussion.

5. Are there any risks if I participate?

There are no foreseeable risks associated with this interview.

6. Are there any advantages if I participate?

The interview will be a useful contribution to the research in designing recycling initiatives and interventions. There are no direct advantages to participating, however feedback can be provided at the end of the PhD if requested.

7. What will happen with the data I provide?

When you agree to participate in this research, we will collect from you personally identifiable information.

The Manchester Metropolitan University ('the University') is the Data Controller in respect of this research and any personal data that you provide as a research participant.

The University is registered with the Information Commissioner's Office (ICO), and manages personal data in accordance with the General Data Protection Regulation (GDPR) and the University's Data Protection Policy.

We collect personal data as part of this research (such as name, telephone numbers or age). As a public authority acting in the public interest we rely upon the 'public task' lawful basis. When we collect special category data (such as medical information or ethnicity) we rely upon the research and archiving purposes in the public interest lawful basis.

Your rights to access, change or move your information are limited, as we need to manage your information in specific ways in order for the research to be reliable and accurate. If you withdraw from the study, we will keep the information about you that we have already obtained.

We will not share your personal data collected in this form with any third parties.

If your data is shared this will be under the terms of a Research Collaboration Agreement which defines use and agrees confidentiality and information security provisions. It is the University's policy to only publish anonymised data unless you have given your explicit written consent to be identified in the research. **The University never sells personal data to third parties.**

We will only retain your personal data for as long as is necessary to achieve the research purpose. The data obtained during the interview will be kept strictly confidential.

If you agree, the interview will be recorded and stored on a password protected computer that only myself and my supervisory team will have access to. The recordings will be destroyed at the end of the PhD (approximately April 2022). You may be quoted to support the study, however this will be anonymous and with your permission. In the final thesis, the interviewees and the Local Authority will be anonymous except being identified using broad characteristics e.g. population density/number of bins/predominantly rural etc.

For further information about use of your personal data and your data protection rights please see the University's Data Protection Pages.

8. What will happen to the results of the research study?

The results of the study will be included in the PhD thesis and will also be disseminated via a relevant conference and paper publication.

9. Who has reviewed this research project?

This is a part-time PhD project which is in the 4th year out of 6. The project has been through two reviews (the project proposal and the conversion from an MPhil to a PhD). These reviews were carried out by two MMU reviewers and the projects three supervisors. The project also gained ethical approval at the project proposal stage.

10. Who do I contact if I have concerns about this study or I wish to complain?

If you have any questions about this study, please contact me, Sheryl Lee, by email at sheryl.lee@stu.mmu.ac.uk, leave a message on 0161 247 6951 or in writing to; Sheryl Lee c/o Research Degrees, Faculty of Science & Engineering, John Dalton Building, Chester Street, Manchester, M1 5DG.

Alternatively you can contact my supervisor: Professor Paul Hooper either by email p.d.hooper@mmu.ac.uk, Tel. 0161 247 6197 or in writing; Chair in Environmental Management and Sustainability, Head of Enterprise Development School of Research,

Enterprise and Innovation, Faculty of Science & Engineering, John Dalton Bldg., Chester Street, Manchester, M1 5GD.

Should you have any questions regarding the ethics please contact Dr Gethin Evans by email ethics-scieng@mmu.ac.uk, by phone on 0161 247 1208 or in writing to Physiological & Reconstructive Sciences, Faculty of Science & Engineering, John Dalton Building, Chester Street, Manchester, M1 5GD.

If you have any concerns regarding the personal data collected from you, our Data Protection Officer can be contacted using the legal@mmu.ac.uk e-mail address, by calling 0161 247 3331 or in writing to: Data Protection Officer, Legal Services, All Saints Building, Manchester Metropolitan University, Manchester, M15 6BH. You also have a right to lodge a complaint in respect of the processing of your personal data with the Information Commissioner's Office as the supervisory authority. Please see: https://ico.org.uk/global/contact-us/

THANK YOU FOR CONSIDERING PARTICIPATING IN THIS PROJECT

Appendix 6: Consent Form

Sheryl Lee
PhD Researcher
Science & Engineering
John Dalton
Manchester Metropolitan University
Tel: 07958783296
Sheryl.lee@stu.mmu.ac.uk

Consent Form

Title of Project: Educational interventions to improve municipal recycling rates achieved by UK Local Authorities

Name of Researcher: Sheryl Lee

Participant Identification Code for this project:

	Please initial box
1. I confirm that I have read and understood the information sheet Dated 01/02/2019 for the above project and have had the opportunity to ask questions about the interview procedure.	☐
2. I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason to the named researcher.	☐
3. I understand that my responses will be sound recorded and used for analysis for this research project.	☐
4. I give/do not give permission for my interview recording to be archived as part of this research project, making it available to future researchers.	☐
5. I understand that my responses will remain anonymous.	☐
6. I agree to take part in the above research project.	☐
7. I understand that at my request a transcript of my interview can be made available to me.	☐

Name of Participant	Date	Signature
Researcher	Date	Signature

To be signed and dated in presence of the participant

Once this has been signed, you will receive a copy of your signed and dated consent form and information sheet by post.

Appendix 7: Interview Code Table

Theme	Sub-themes
Context	
Infrastructure & Service delivery	Dry recycling Food & garden waste Residual waste HWRCs Personnel
Education & interventions	Methods of communication Campaigns Challenges Workshops & training School visits
Website content	Number of pages Menu options Reuse information Composting Interactive Downstream processing information
Contamination	
Political influence	Budgets Customer satisfaction

Appendix 8: Example Website Content Table

Top page (Waste and Recycling)	1st Sub page	2nd Sub page	3rd Sub page
Bin collections	Apply for Garden waste collection	• Costs • What is/isn't collected • Times • Moving home • Alternative options; home composting, the tip, grey bin. • Collection of unwanted bin.	
	Bin collection day	• Postcode search • When to present your waste for collection (times)	
	Help with your collection	• Apply	

	What goes in my bin	• Return to normal collections
		• What goes in which bin?
		  • Blue lid bin
		  • Green lid bin
		  • Brown bag
		  • Textile sack
		  • Grey lid bin
		  • Refuse sack
		  • Seagull sack
			Number of example materials accepted (Yes)/not accepted (No) for each colour bin.
			• Yes x 15, No x 5
			• Yes x 5, No x 5
			• Yes x 8, No x 4 (Apply for bags)
			• Yes x 6, No x 3 (Apply for sack)
			• No x 7 (FPN threat for additional sacks)
			• Red bag collection for hard to reach props

Top page (Waste and Recycling)	1st Sub page	2nd Sub page	3rd Sub page
			• No x 4 (no charge, reusable)
	Order a replacement, new or repair to a bin	• Brown recycling bag • Grey, blue or green bins • Swaps • New builds and conversions • New resident • Extra grey lidded bins • Request a Family Waste Audit	
	Book a textile collection	• Textile recycling • What goes in my sack (Yes x 6, No x 4) • Request textile sack	
Collection of bulk items	Order a bulky waste collection	• Collection of bulky items (Yes x 6) • Cost of service • Amendments	Link to acceptable items.
	What we can collect	• Acceptable items (Yes x 85, No x 30)	
Tip and recycling centres	[Name of tip]	• Tip and household waste recycling centre • Address • Opening hours • Queueing • Tip shop (closed)	

Top page (Waste and Recycling)	1st Sub page	2nd Sub page	3rd Sub page
		• Restrictions • Waste accepted (Yes) x 25, no accepted (No) x 8. • Private waste contactors	• You can check their vehicle online (link to DEFRA)
	Tip shop	• Items for sale • Opening times (closed atm) • Donate unwanted items (Yes x 11, No x 8)	
	Waste restrictions	• Hardcore and rubble (permit) • Gas bottles (15kg petroleum only) • Oxygen, air and brewery cylinders (no) • Asbestos (only small quantities of cement bonded) • Fire extinguishers (last resort) • Car parts and tyres (No) • Petrol, diesel and paraffin (No)	
	Rover – mobile recycling unit	• Acceptable items Yes – 14, No – 11 • Collection locations • Collections Mon - Fri	
	Permit schemes	• Permit types; Hardcore, soil & rubble	

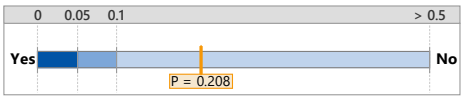
Top page (Waste and Recycling)	1st Sub page	2nd Sub page	3rd Sub page
		• Applying for a permit	
Home composting	• Why compost • Getcomposting.com		

Appendix 9: Regression Summary Reports

1 Predominantly Urban, Higher Deprivation
Regression for QR vs RR Summary Report

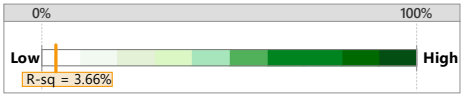
Y: QR
X: RR

Is there a relationship between Y and X?



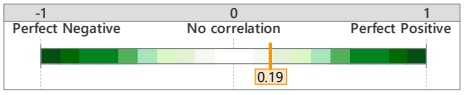
The relationship between QR and RR is not statistically significant (p > 0.05).

% of variation explained by the model



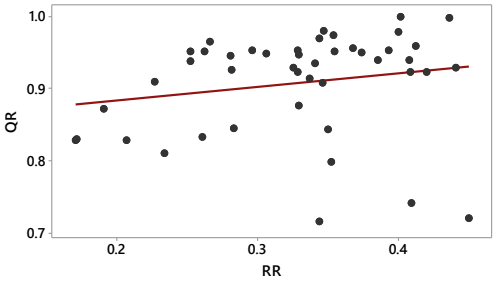
3.66% of the variation in QR can be explained by the regression model.

Correlation between Y and X



The correlation between QR and RR is not statistically significant (p > 0.05).

Fitted Line Plot for Linear Model
Y = 0.8471 + 0.1863 X



Comments

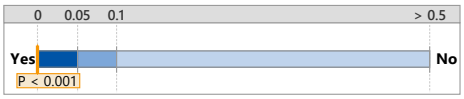
The fitted equation for the linear model that describes the relationship between Y and X is:
Y = 0.8471 + 0.1863 X
If the model fits the data well, this equation can be used to predict QR for a value of RR, or find the settings for RR that correspond to a desired value or range of values for QR.

A statistically significant relationship does not imply that X causes Y.

2 Predominantly Urban, Lower Deprivation
Regression for QR vs RR Summary Report

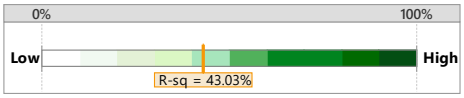
Y: QR
X: RR

Is there a relationship between Y and X?



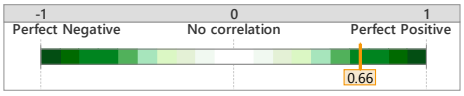
The relationship between QR and RR is statistically significant (p < 0.05).

% of variation explained by the model



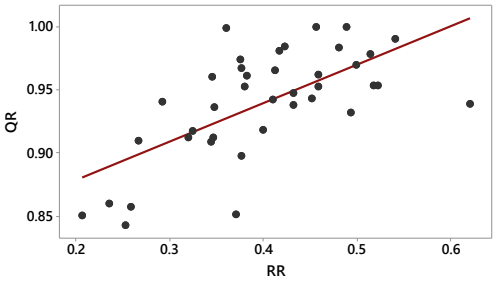
43.03% of the variation in QR can be explained by the regression model.

Correlation between Y and X



The positive correlation (r = 0.66) indicates that when RR increases, QR also tends to increase.

Fitted Line Plot for Linear Model
Y = 0.8175 + 0.3057 X



Comments

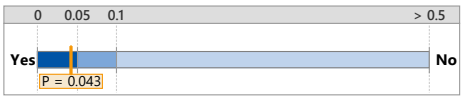
The fitted equation for the linear model that describes the relationship between Y and X is:
Y = 0.8175 + 0.3057 X
If the model fits the data well, this equation can be used to predict QR for a value of RR, or find the settings for RR that correspond to a desired value or range of values for QR.

A statistically significant relationship does not imply that X causes Y.

3 Predominantly Mixed, High Deprivation
Regression for QR vs RR Summary Report

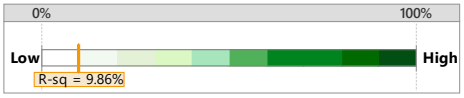
Y: QR
X: RR

Is there a relationship between Y and X?



The relationship between QR and RR is statistically significant (p < 0.05).

% of variation explained by the model

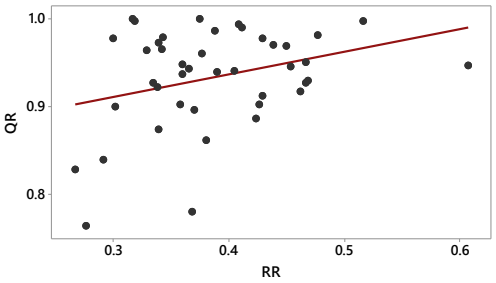


9.86% of the variation in QR can be explained by the regression model.

Correlation between Y and X

The positive correlation (r = 0.31) indicates that when RR increases, QR also tends to increase.

Fitted Line Plot for Linear Model
Y = 0.8341 + 0.2557 X



Comments

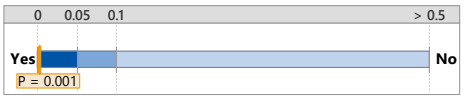
The fitted equation for the linear model that describes the relationship between Y and X is:
Y = 0.8341 + 0.2557 X
If the model fits the data well, this equation can be used to predict QR for a value of RR, or find the settings for RR that correspond to a desired value or range of values for QR.

A statistically significant relationship does not imply that X causes Y.

4 Predominantly Mixed, Lower Deprivation
Regression for QR vs RR Summary Report

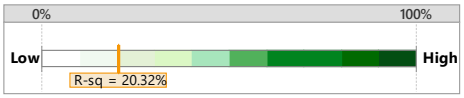
Y: QR
X: RR

Is there a relationship between Y and X?



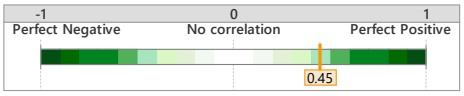
The relationship between QR and RR is statistically significant (p < 0.05).

% of variation explained by the model



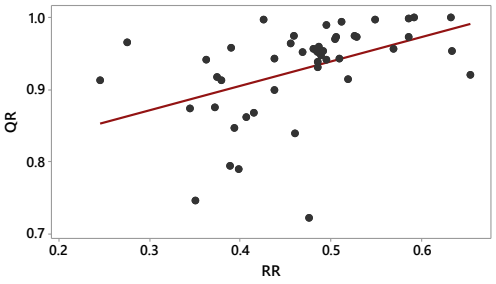
20.32% of the variation in QR can be explained by the regression model.

Correlation between Y and X



The positive correlation (r = 0.45) indicates that when RR increases, QR also tends to increase.

Fitted Line Plot for Linear Model
Y = 0.7706 + 0.3369 X



Comments

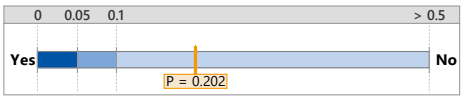
The fitted equation for the linear model that describes the relationship between Y and X is:
Y = 0.7706 + 0.3369 X
If the model fits the data well, this equation can be used to predict QR for a value of RR, or find the settings for RR that correspond to a desired value or range of values for QR.

A statistically significant relationship does not imply that X causes Y.

5 Predominantly Rural, Higher Deprivation
Regression for QR vs RR Summary Report

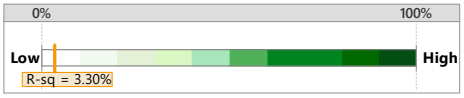
Y: QR
X: RR

Is there a relationship between Y and X?



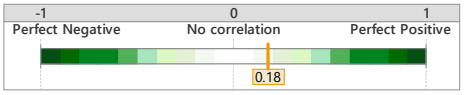
The relationship between QR and RR is not statistically significant (p > 0.05).

% of variation explained by the model



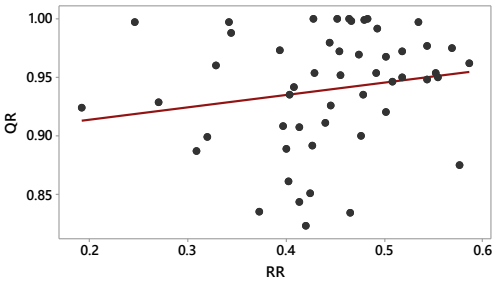
3.30% of the variation in QR can be explained by the regression model.

Correlation between Y and X



The correlation between QR and RR is not statistically significant (p > 0.05).

Fitted Line Plot for Linear Model
Y = 0.8921 + 0.1070 X



Comments

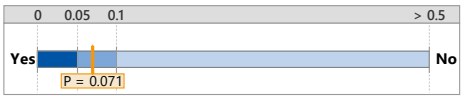
The fitted equation for the linear model that describes the relationship between Y and X is:
Y = 0.8921 + 0.1070 X
If the model fits the data well, this equation can be used to predict QR for a value of RR, or find the settings for RR that correspond to a desired value or range of values for QR.

A statistically significant relationship does not imply that X causes Y.

6 Predominantly Rural, Lower Deprivation
Regression for QR vs RR Summary Report

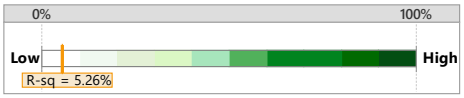
Y: QR
X: RR

Is there a relationship between Y and X?



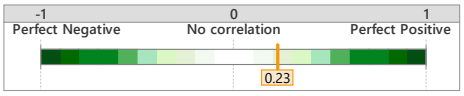
The relationship between QR and RR is not statistically significant (p > 0.05).

% of variation explained by the model



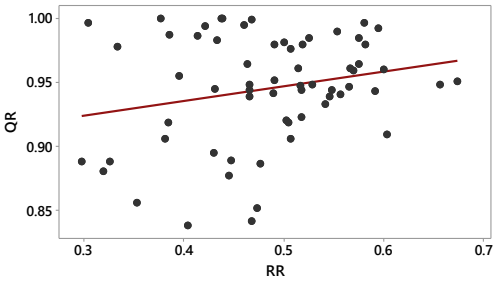
5.26% of the variation in QR can be explained by the regression model.

Correlation between Y and X



The correlation between QR and RR is not statistically significant (p > 0.05).

Fitted Line Plot for Linear Model
Y = 0.8893 + 0.1151 X



Comments

The fitted equation for the linear model that describes the relationship between Y and X is:
Y = 0.8893 + 0.1151 X
If the model fits the data well, this equation can be used to predict QR for a value of RR, or find the settings for RR that correspond to a desired value or range of values for QR.

A statistically significant relationship does not imply that X causes Y.

Appendix 10: Published paper

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A comparison of waste education in schools and colleges across five European cities

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ABSTRACT

The European Union produces over 200 million tonnes of municipal waste each year with 47% being recycled or composted. With the EU reuse and recycling targets set at 55% by 2025 and the introduction of the EU's Circular Economy Action Plan there has never been more importance placed on waste and recycling education. A three-year transnational project 'An Erasmus+ Waste Education Initiative' set out to investigate the level of waste and recycling education (WE) that is currently being delivered in five European cities with a view to develop a range of materials to be used in the classroom extracting the best practice from each. This paper highlights the responses from a questionnaire sent to schools and colleges to determine the baseline of WE currently being delivered in Bucharest, Hamburg, Manchester, Tallinn and Zagreb. Factors such as the local waste and recycling infrastructure and population density were also considered to determine the extent of their influence on the type and availability of WE in the classroom. The findings indicate a wide variation in the amount of WE currently being delivered in the five cities. Increased recycling rates and level of infrastructure have an inverse effect on the level of teacher engagement and involvement in waste management projects does not have an impact on the amount of WE that is present in the curriculum or number of registered Eco-Schools. Time constraints due to other curriculum topics, awareness and lack of resources were the main reasons for not including WE in the classroom.

ARTICLE HISTORY

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KEYWORDS

Waste, recycling, circular economy, environmental education

1. Introduction

The reduction of waste generation through prevention, reuse and recycling are part of the Sustainable Development Goals (Nations 2021) and fundamental to a Circular Economy. The EU produces approximately 200 million tonnes of municipal waste each year with 47% currently recycled (Eurostat 2021); however, the target for 2025 is 55%. In order to meet these goals, behaviour change and education is vital to produce a waste aware and motivated generation of young people who will improve the quality and quantity of valuable resources available for recycling. This will also prepare them for 'green' sector opportunities resulting from the decoupling of economic growth from material consumption central to the Circular Economy principles (Stahel 2016). It is estimated that the expansion of the Circular Economy has the potential to create 1.2 to 3 million jobs and reduce unemployment by 520,000 in the EU member states by 2030 (WRAP 2015b).

To design teaching resources that include waste management and introduce concepts such as the Circular Economy and the Waste Hierarchy it is important to understand the baseline of material currently used in the classroom. This paper presents the findings of a questionnaire sent to teachers in schools and colleges across five European cities; Bucharest, Romania; Hamburg, Germany; Manchester, UK; Tallinn, Estonia; and Zagreb, Croatia. Combining these empirical data with factors that influence recycling performance within each region, an analysis of available waste education, materials used and factors that influence Waste Education (WE) uptake in the classroom are presented.

Integrating sustainability education (SE) in schools has attracted significant academic research over the years, for example, teacher knowledge (Green and Somerville 2015), integrating SE in to the school day (Meersdom and Vandelacluze 2018; Pereira da Silva et al. 2020) and evaluating SE present in primary textbooks (Andersen Katja, 2018). However, few studies are specifically concerned with WE in schools and colleges. This finding was echoed by a study based on Danish schools seeking to overcome shortcomings of habitual behaviour (Jørgensen et al. 2018). Those that do involve WE tend to examine a single project or initiative in one school or class (Cunningham-Scott 2005; Maddox et al. 2011; Stöckert and Bogner 2020). This paper contributes to the literature by providing a comparison of WE across five European cities and examining the influence of the local waste management infrastructure (Butler and Hooper 1999) and population density (Rispo et al. 2015) on the WE provided in junior and secondary schools and colleges.

Before analysing the results of the questionnaire sent to teachers, it is first important to understand the impact of waste education and the role it has played in the five regions.

1.1. Waste education

Factors such as policy and availability of recycling facilities all influence the variation in recycling rates; however, along with access to facilities, education and ongoing environmental awareness campaigns are found to be one of the biggest influences on recycling rates within the control of Local Authorities (Starr and Nicolson 2015). Schultz et al. (1995) carried out a literature review of studies into the determinants of environmental behaviour. They concluded that awareness and attitude were fundamental factors in whether a person will recycle or not. Their review found it was specific knowledge of the recycling scheme available, rather than general environmental knowledge that was the predictor of positive recycling behaviour. Further to this, a study carried out on five deprived high-rise estates in the London Borough of Haringey concluded that continued communication to change behaviour over time is required to increase recycling performance (Rispo et al. 2015).

The idea of continual communication and education was echoed in a study carried out in Texas, USA where the LA, waste contractor and a primary school worked in partnership to determine the effects of recycling education (Cunningham-Scott 2005). The study found

that recycling rates increased during the term time and fell dramatically during the summer months, increasing again once the children had returned to school and to the recycling education. The Taking Home Action on Waste (THAW) project was conducted in Rotherham, United Kingdom to determine the effects of intensive education in infant and primary schools (Maddox et al. 2011). The project centred around the 3'R's (Reduce, Reuse and Recycle) and involved assemblies, workshops and homework to complete with parents. The results were overwhelmingly positive with residual wastes falling by 4.5%, paper recycling increasing by 4.3% and glass, cans and textiles by 8.7%. The project concluded that as well as producing a waste aware cohort of children there was also evidence that intergenerational influence can have substantial effects on waste and recycling rates.

Environmental Education has been building importance on the global stage for many years. In 1994 'Eco-Schools' was set up by the Foundation for Environmental Education. This voluntary, pupil led programme empowers young people to develop an environmentally conscious world (FEE 2020). This seven-stage programme guides young people through forming an eco-committee, carrying out Environmental Reviews, making action plans linking to the curriculum and producing an eco-code for the school. Initially, Eco-Schools were European based but the scheme now has over 59,000 schools in 68 countries around the world (EcoSchools 2020).

Although schemes such as Eco-Schools are available, in this case, to all five cities, not all schools become an Eco-School. The influence of socio-economic factors (Valenzuela-Levi 2019) and population density on a school's propensity to arrange extra-curricular activities is varied within a country and certainly between countries.

1.1.1. United Kingdom

The education system in the United Kingdom has incorporated environmental education (EE) at certain points over the years. It was introduced as a cross-curriculum topic 'the built and natural environment' in 1990 but was removed from classrooms in 1994. In 2000 the Education for Sustainable Development introduced environmental education as a non-statutory topic, this was updated in 2006 by the Sustainable Schools Strategy which included a 'Purchasing and Waste' module, but again this was removed in 2010 (NAEE(UK) 2015). Since 2014 there has been little formal environmental education and specifically waste and recycling education in schools although it is mentioned as a small element within the Science subject in Key Stage 3 (DfE 2014). Organisations such as the National Association for Environmental Education, a UK-based charity, and Waste Watch who later merged with Keep Britain Tidy, provide support to teachers wanting to teach EE in their classrooms, this heavily relies on the interests of teachers and their willingness to incorporate EE into their classroom activities.

1.1.2. Romania

In Romania, waste education is not adopted as a topic in the basic curriculum in schools, colleges or universities. Only environmental disciplines teach waste topics in higher education, and only since 1997. Pilot educational activities related to waste started in 2000 in schools and are often supported by environmental associations and NGOs. In primary and secondary schools, only dedicated teachers are introducing the waste topic within environmental education, this is done voluntarily with not too much interest from the authorities. Today, these educational activities do not have continuity and only occasionally involve waste contractors for marketing purposes or public authorities to reach the legal recycling targets. Without public policy and legal constraints for waste educational activities included in the national curriculum, combined with the awareness for Circular Economy, the Romanian waste challenge will continue preponderantly targeting landfilling or incineration.

1.1.3. Germany

In Germany, schools in different states are starting to incorporate the subject of sustainability into their syllabus. A committee of stakeholders from the political arena, academia and non-governmental organisations is responsible for advising Germany's education ministers on the inclusion of sustainability in the curricula. The environmental movements of the 1970s played a major role in the development of the current approaches. In the 1980s, numerous concepts with very different orientations and objectives were developed in the German-speaking countries, for which various designations were introduced, such as environmental education, ecological learning, and eco-pedagogy. Since the late 1980s, environmental education actors have existed in all educational sectors, from early childhood education, school, university, vocational and general (further) education to informal learning. Following Agenda 21 at the 1992 World Conference in Rio de Janeiro, environmental education developed further in the context of the Education for Sustainable Development (ESD) campaign (UNESCO 2013). Without the guiding principle of sustainable development, environmental education is now obsolete. This model not only applies to ecology, the environment and nature but also integrates other dimensions such as social and economic issues and often also to politics/participation and culture. This has now been accepted by nearly all actors in the former environmental education field, in all areas of education and in science and politics.

1.1.4. Estonia

Environment education is one of the priorities for Estonia and traditionally it has focused on biodiversity, natural heritage and species conservation. Starting from 2000, Environmental education has been incorporated in the wider topic of Education for Sustainable Development (ESD), being implemented in Estonian schools' curriculum. According to the National Curricula, sustainable development was recognized at all school

levels as a cross-curricular objective in 2002. Based on sustainable development requirements, study programmes have been developed which included topics such as waste management, mining of mineral resources, and other economic and cultural aspects affecting the state of the environment. With support of Estonian government and European Structural Funds the EDS got a new leap, especially during the financial period from 2007 to 2013. During this time two measures were supported: 'Development of the infrastructure of environmental education' with 22.3 million euros by the European Regional Development Fund and 'Development of Environmental Education' with 3.2 million euros by the European Union Social Fund (Henno 2016). Today ESD in Estonia covers formal and informal learning.

1.1.5. Croatia

The national body responsible for the education system in Croatia is the Ministry of Science and Education (MSE). The Croatian education system provides education services at four different levels: pre-school, primary school, high-school and higher education levels, as well as for adult education. They are trying to enable every user to develop his/her potential optimally, aiming at their personal development and entry into the labour market, including their preparedness for lifelong learning. Environmental education (EE) is not separately enrolled in the Curriculum, but it is touched within cross-curriculum topics as sustainable development (MSES 2019). Sustainable development encompasses all three dimensions of sustainability – environmental, social and economic sustainability and their interdependence; these topics prepare students to act appropriately in society for personal and general well-being. According to the provisions of the Environmental Protection Act, in 2004 an Environmental Protection and Energy Efficiency Fund was established to secure additional resources for the financing of projects, programs and similar activities in the field of conservation, sustainable use, protection and improvement of the environment. The Fund provides funding and organizes events for different levels of education and communities at the local, regional or national level can participate in various projects to develop an awareness of the application of waste management principles, 3 R concepts, our environmental footprint and sustainable use of resources among others. Whether or not the Curriculum has this type of education or it is provided by the Fund or other sources, the main goal of environmental education (EE) is to implement awareness among communities as early as possible that waste, if adequately managed, can bring economic and ecological benefits.

The last two decades have seen schools in all five regions introduce Environmental Education and, to an extent, Waste Education (WE), whether this is through the formal curriculum or via extra-curricular activities.

2. Methodology

Figure 1 provides an overview of the framework used for the study.

Figure 1. Study framework.

To determine the baseline of waste education being delivered in the schools and colleges within the five cities; Bucharest, Hamburg, Greater Manchester (Manchester), Tallinn, and Zagreb, a questionnaire containing open and closed questions was developed and sent to all schools in the local areas, the number of responses received is shown in Table 1. During the development of the survey further education providers were identified including local authorities, waste contractors, and universities, the responses from these are not included in the scope of this paper. Although it is worth noting that the education they provide to schools and colleges should be picked up in the survey results from the schools and colleges, however this is not guaranteed.

Table 1. Number of questionnaire responses (Table view)

City	Primary School	High School (College)	Total
Manchester	11	5	16
Hamburg	7	12	19
Tallinn	13	10	23
Bucharest	16	6	22
Zagreb	17	13	30

The questionnaire had two foci; the first to gather information on the waste facilities/infrastructure within the school such as whether there is a recycling system, material segregation and whether the school is a registered Eco-School. The second was on the amount of WE provided in the school and if it is taught as part of the curriculum or whether it is a voluntary extra. If WE is provided, information was sought on the type of materials used, how often and who supplies the resources. The teachers were also consulted about where and how they felt WE could be improved.

The five regions, although all European, have varying socio-economic profiles. Population density and the availability of a waste and recycling infrastructure can influence the topics taught in the classroom. Relevance and interest significantly increases long-term learning (Stöckert and Bogner 2020) so material separation, for instance, is not appropriate in a country that does not have a recycling infrastructure. A desk study and informal consultation with the local waste authority for each city to determine the local collections offered to residents and limitations to increasing their recycling performance was carried out to provide a picture of each local area and how they compare with each other.

3. Results and discussion

3.1. The five cities

The five regions included in this project and the project partners are shown in Figure 2, the cities were chosen based on the broader project with which this study lies, the consortium that made up the members of the Erasmus+ Waste Education Initiative (Thewastecitizen 2020). The diverse locations promoted transnational cooperation when sharing best practice and aimed to increase regional development whilst tackling common environmental issues.

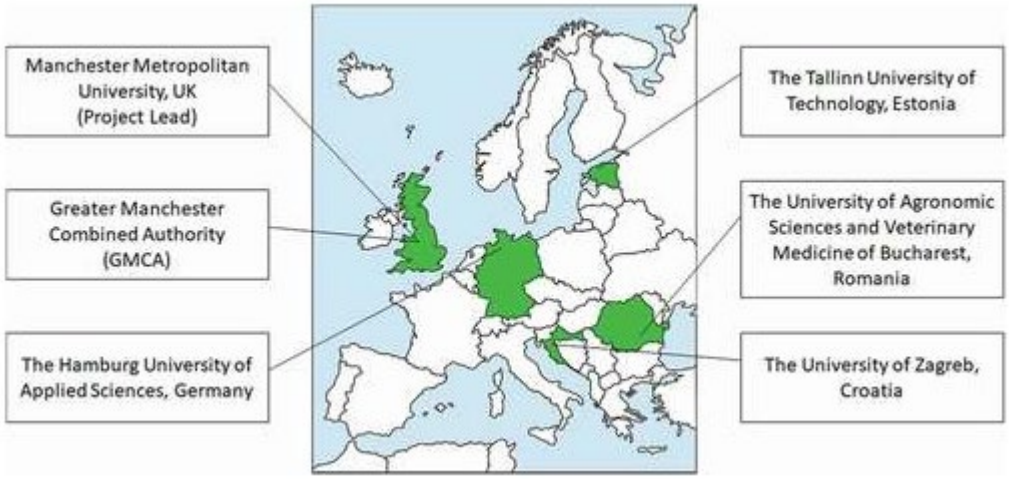

Figure 2. Map of regions in study.

The regions covered by the partnership represent approximately 7 million residents and 5 million tonnes per annum of Municipal Solid Waste (MSW), with varying approaches to waste management.

Figure 3 summarises the population size and geographical area of each region for comparison. It is well documented that these two factors have an impact on the way waste and recycling is collected and treated (Rispo et al. 2015). For instance, whilst Greater Manchester has the largest population at 2.79 million with a geographical area of 1,277 km^2, Bucharest has a population of 2.12 million in a geographical area of just 238 km^2, or in other words there are 2.2 people/m^2 in Greater Manchester and 8.9 people/m^2 in Bucharest. Tallinn and Hamburg have 2.8 and 2.4 people/m^2 respectively and Zagreb has the least with 1.3 people/m^2. A large majority of the population of Bucharest reside in high-density housing such as apartments in high-rise buildings. High-density housing can have significant impacts on recycling levels and can hinder kerbside recycling schemes (Rispo et al. 2015). Rispo et al.'s study concluded that residents in highly populated areas require intensive and ongoing recycling services and awareness campaigns to promote material segregation, resources that most Local Authorities are lacking.

Kerbside collections of recyclate consistently capture larger tonnages of material than alternative schemes such as bring sites in local recycling centres or supermarket carparks (Butler and Hooper 1999). Table 2 provides a summary of the kerbside waste infrastructure provided to residents in each region. Hamburg and Greater Manchester both have recycling rates of 47%, see Figure 4, and have a similar kerbside waste infrastructure with containers for green waste, food, bottles, glass, cans, paper and card. They both have fortnightly and monthly residual waste collections.

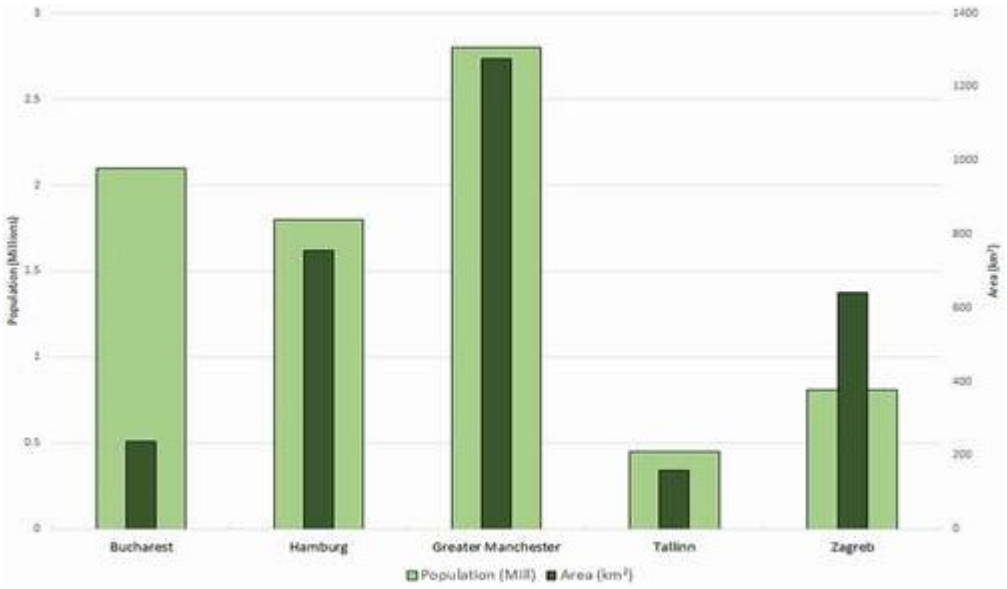

Figure 3. Population and geographical area each city.

Tallinn also has a kerbside waste collection scheme and has a slightly lower recycling rate of 44%. The residual collection in Tallinn is collected once or twice a week; this could be an obstacle to increasing the recycling rate as there is little incentive for residents to recycle. Abbott et al. (2011) found that there is an inverse relationship between recycling participation and the frequency of the residual waste collection; that is, many Local Authorities saw an increased recycling rate when changing from a weekly to a fortnightly residual waste collection (Abbott et al. 2011).

Table 2. Summary of kerbside waste collection frequency in each partner region

	Bucharest	Hamburg	Manchester	Tallinn	Zagreb
Residual	2 to 3/week	Fortnightly	Fortnightly	1 to 2/week	2/week
Paper/card	-	Monthly	Fortnightly	1 to 2/week	-
Metal/plastic	-	Fortnightly	Fortnightly	-	-
Glass*	-	Monthly	Fortnightly	-	-
Bio waste	-	Fortnightly	Weekly	1 to 2/week	-

*Glass is collected with metal and plastic in Manchester

Tallinn has a Deposit Return Scheme (DRS) for plastic and glass bottles and Hamburg has one for glass and cans, which runs alongside its kerbside collection. A DRS is due to be introduced to the UK in 2023 (DEFRA 2019); however, the cost of implementation has come under criticism due to the already comprehensive kerbside collection offered and that the estimated €1.1 billion set up costs could be better used to reduce the litter associated with the on-the-go bottles (Snowden 2019).

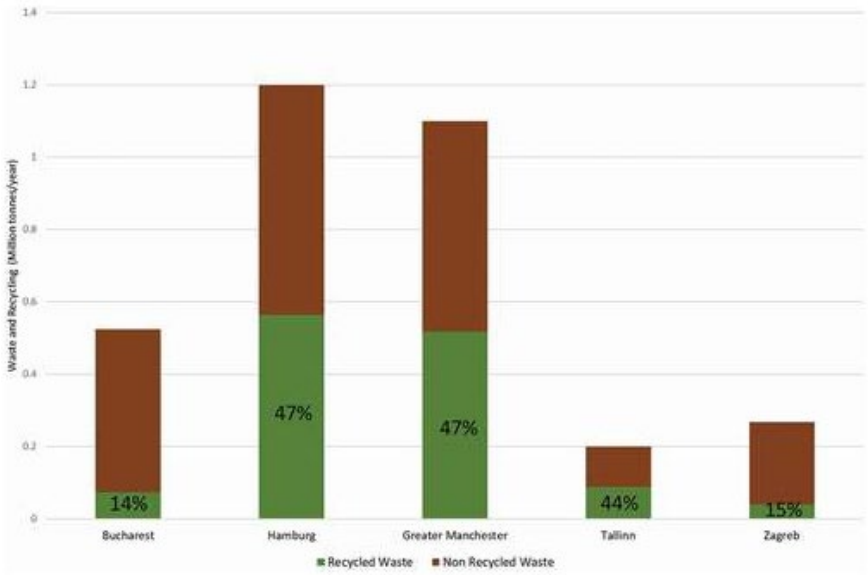

Figure 4. Quantity of waste collected and recycled in each region.

Zagreb has a similar recycling rate as Bucharest at approximately 15%. Both of these countries currently have little to no downstream processors for recycling materials and the majority of waste is landfilled, though both countries are currently investigating energy from waste plants. Zagreb is also in the early stages of implementing a kerbside recycling scheme, however there are no plans for Bucharest to implement one at the time of writing this paper.

When Local Authorities were asked about obstacles to current recycling performance, contamination was mentioned in the three regions offering a kerbside scheme. Contamination presents issues from the point of collection by taking up space in the vehicles, to damaging machinery leading to costly repairs and downtime. A local authority in England reports to spending €276,000 annually on rejected material due to contamination (WRAP 2015a). Lack of infrastructure and a reliance on overseas markets were noted as being major obstacles to current performance with Greater Manchester collecting only plastic bottles and Hamburg finding the adaption of the Circular Economy, especially WEEE, lacking. Manchester also highlighted the need for disposal routes for compostable and biodegradable alternatives to plastics as residents are incorrectly

placing them in the plastic recycling bins. As already discussed, Tallinn highlights frequency of collections and size of residual bins to be an issue and that packaging waste is not a kerbside collection, but collected via bring sites. Bring sites tend to contain high levels of contamination and tend to capture far less material than with kerbside collections (Butler and Hooper 1999).

The five regions show different approaches to managing their waste and recycling, to understand the influence these differences have on the WE provided in schools it is first important to understand the waste infrastructure within schools.

3.2. Waste infrastructure within schools

A separate waste infrastructure within schools can promote recycling behaviour and cement learning by using a real-life experience (Meersdom and Vandelacluze 2018). Noticeably, the two cities with the highest recycling rates, Manchester and Hamburg, had fewer schools with separate waste collections than Zagreb (44%) and Tallinn (44%) at 19% and 11%, respectively. Bucharest had the least with no schools having a separate waste infrastructure, which would be expected as there is minimal recycling infrastructure in the city.

The schools that did not have a separate waste collection scheme were asked if they would like to organise one. The majority of respondents, see Table 3, from Manchester and Hamburg did not want to participate with 63% from Manchester and 79% from Hamburg saying no. The majority of teachers in Bucharest, Zagreb and Tallinn said that they would be interested in organising separate waste collections in their schools. Bucharest, having no schools with separate collections were the most likely to want to organise the schemes with 82% of respondents saying yes, indicating that the lower the recycling rate of a region the more interested the teachers are at implementing a separate waste collection.

Table 3. % of respondents interested in organising separate waste collection at their school

	Yes	No	Already in place
Manchester	19	63	19
Hamburg	10	79	11
Tallinn	35	9	44
Bucharest	82	18	0
Zagreb	37	0	63

Financial support, permits from school administrations and active support from colleagues were factors highlighted to promote the organisation of a recycling scheme. All cities, especially Bucharest and Zagreb, indicated that material support such as separate

containers were required to set up the schemes, although this would also indicate a need for downstream processors of the collected recyclate.

When asked what could improve waste collection, prevention, reuse or recycling rates at their school the most popular answer from Manchester, Hamburg and Zagreb was more awareness of the topic. Tallinn also found awareness important being the second most popular answer after provision of appropriate containers, however Bucharest found awareness the least popular answer. Bucharest felt the biggest improvement could be made by the responsible handling of waste in the classroom, indicating that a separate waste collection scheme in the classrooms would improve the waste collection and recycling rates, less so the prevention or reuse of waste materials.

Less than half of teachers surveyed in all five cities had been involved in a waste management project with Manchester and Hamburg responding only 6% and 5%, respectively, responding positively. 17% of teachers in Tallinn had, 37% in Zagreb and 46% in Bucharest. The teachers were asked if they would like to be involved in a recycling or a circular economy project or hub in the future and a similar pattern is seen with 19% of Manchester teachers being interested, 26% in Hamburg, 44% in Tallinn, 73% in Bucharest and 80% in Zagreb. Once again indicating that the lower the recycling rate of a city the more likely a teacher had been involved in a waste management project or would like to be involved in one.

This emerging pattern of teachers in areas with higher recycling rates being less inclined to organise separate waste collections and be involved in waste management or circular economy projects could be explained by the presence of a robust waste and recycling infrastructure and therefore waste is not seen as a priority. Unlike a city with lower recycling rates where the majority of waste is being sent to landfill, the urgency to divert waste from landfill is clearly apparent and therefore requiring immediate action. Waste infrastructure within schools and the teacher's propensity to be involved in waste and circular economy projects will have an impact on the waste education that a child receives. It is therefore necessary to determine how much waste education is delivered as part of the curriculum or whether it is an extra-curricular component of school life.

3.3. Curriculum or extra-curricular

Teachers are required to cover all topics on the curriculum set by their governments. It is therefore clear that if waste education (WE) is included as a topic on the curriculum it will be taught by teachers. However, it is worth noting that not all topics are covered every year and therefore some teachers who teach certain age groups may not be aware of the curriculum for other age groups they do not teach, especially if waste education is covered as a sub topic of a broader subject such as environmental education. Figure 5 shows the percentage of respondents that have WE as part of the curriculum at their school. Bucharest (27%) and Manchester (31%) have the lowest rates of WE on the

curriculum, Hamburg has just over half at 53%, and Tallinn has 70% with Zagreb having the most at 83% of schools.

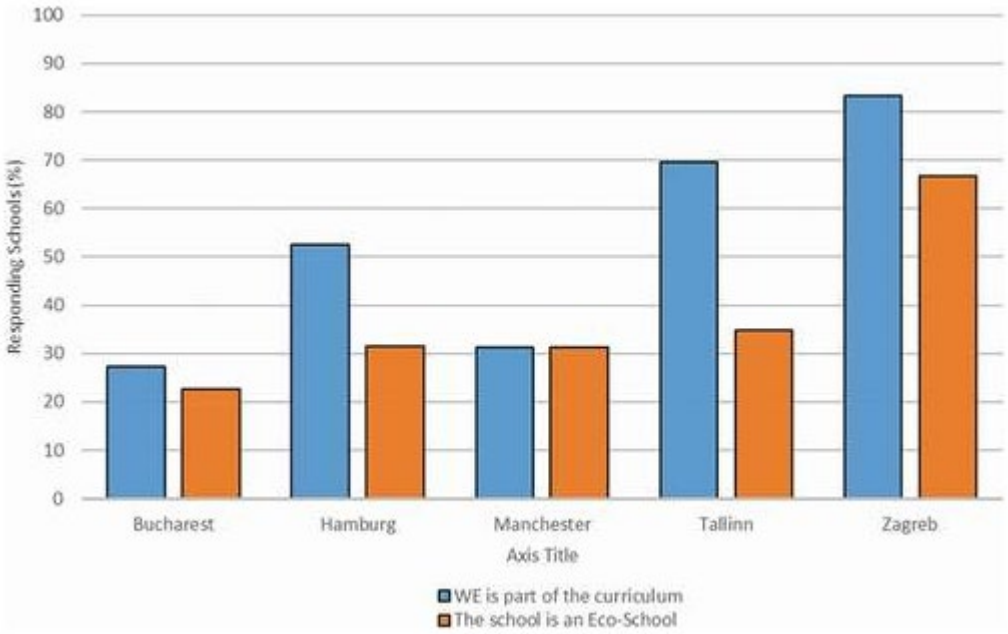

Figure 5. Percentage of respondents that have WE on the curriculum and or are an Eco-School.

These results could be explained by the reason already highlighted that the teachers who responded to the questionnaire did not teach the age group where WE is found on the curriculum and therefore produced a negative image of the current curriculum in some regions. Alternatively, if these results are indicative of the general level of WE in the curriculum, Manchester and Bucharest have the lowest formal WE; however, their recycling rates and infrastructure are polar opposites therefore finding an explanation for a lack of WE must go beyond infrastructure.

Zagreb and Bucharest have similar recycling rates, yet their level of WE are at opposite ends of the scale, again indicating that infrastructure has little influence over whether a curriculum contains WE. A presumption could be that a government's propensity to install recycling infrastructure would indicate their inclination to incorporate WE in the curriculum, but these results show this not to be the case. There are many reasons for a lack of infrastructure that are often complex and out of the control of an authority, however the ability to add WE to the curriculum may be something the authority has autonomy over.

Figure 3.21 also shows the number of schools who responded to the questionnaire that are certified Eco-Schools. Bucharest, Hamburg, Manchester and Tallinn all have between 23% and 35% of schools that are running the Eco-School scheme with Manchester equalling the number of schools that have WE on the curriculum. The other regions have less Eco-Schools than schools with WE on the Curriculum. Zagreb, as with the WE on the

curriculum, outperforms the other cities by having the most number of Eco-Schools at 67%. This indicates that not only are teachers required to teach WE but they also incorporate WE as extra-curricular activities within the schools.

The Eco-School certification is not the only method of teaching WE as an extra-curricular activity, so to fully understand the frequency that WE is taught in schools teachers were asked how often they used WE materials in their classes. Frequency of WE in the classroom will have an impact on compounding knowledge (Starr and Nicolson 2015), so the more frequent materials are used the greater the long-term knowledge. Figure 6 shows the frequency with which teachers said that they use educational materials based on waste management. Overall WE materials are rarely used by teachers across all cities daily. Although numbers start increasing, very few schools use WE materials once a week. Manchester and Hamburg are more likely to use materials from twice a year or less, noticeably over half of the teachers in Manchester and Hamburg said that they use WE materials less than once a year. More schools said they only use WE materials once a year in Tallinn than the other categories, however the numbers were more evenly proportioned with 26% saying they use the materials once a month and 21.7% saying that the use them once every 6 months. Bucharest and Zagreb mainly use materials between once a month and once every 6 months. Once again, these results indicate that the higher the recycling performance, the less WE are incorporated in the classroom.

The teachers were asked what prevents them from addressing the topic more often or with more detail; other requirements of the curriculum and time were the most popular category for all of the cities except Bucharest who highlighted insufficient suitable materials/not enough materials as being their main reason. It is worth noting that all teachers responded with both reasons. A small number of respondents in Bucharest and Tallinn also mentioned the interest of the children or their own interest prevented them from teaching WE more often. Finally, a small number of teachers in Zagreb responded that there were no reasons why they could not teach WE more often.

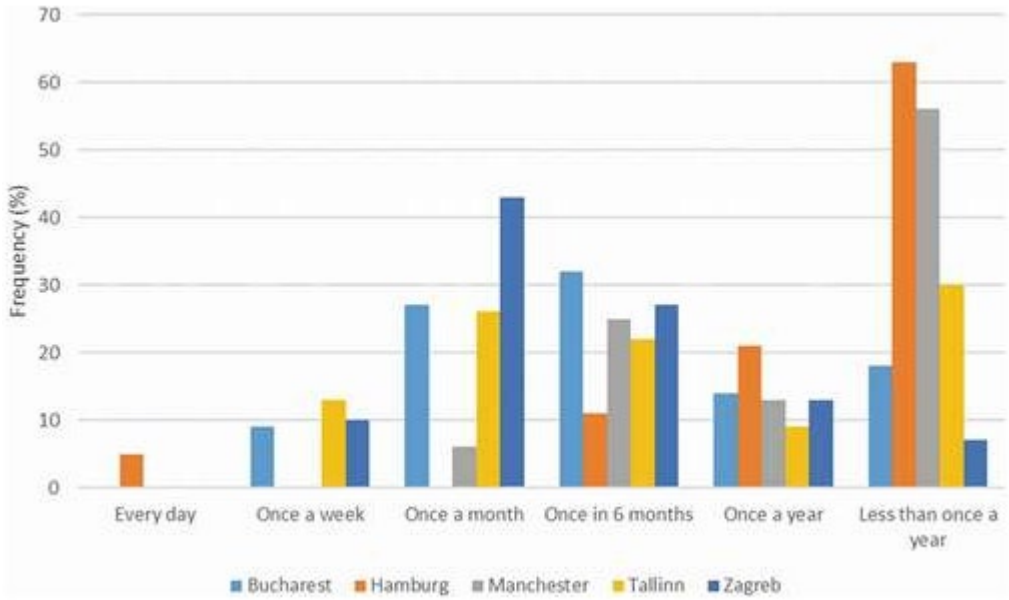

Figure 6. The frequency that waste management materials are used in schools (%).

Overall, formal and informal WE is still not prevalent in most of the schools in Bucharest and Manchester; Hamburg has just over half of schools with a formal WE education; and the majority of schools in Tallinn and Zagreb have WE on the curriculum. Across all cities the lack of time due to other requirements of the curriculum and access to materials are the main reasons for teachers not addressing the topic of waste, recycling and the circular economy more frequently. It could therefore be concluded that if WE was on the curriculum in more schools, time and materials would be less of a reason not to include it in the classroom.

3.4. WE materials

To investigate the current teaching practices and the materials that the teachers use with respect to WE, the questionnaire initially asked if the school, education authority, non-governmental organisations or similar provided educational material. Only 13% of responses said yes in Manchester, 42% said yes in Hamburg, 48% in Zagreb, 55% in Bucharest and 61% in Tallinn said that they did receive material provided by these institutions.

When asked who is responsible for providing the material/information on WE in their school, the teachers were able to provide multiple answers. Some mentioned that the school administration, local authorities and waste contractors were responsible; however all of the cities, including Manchester but less so, said that it is the responsibility of the individual teacher to provide the WE materials. Manchester's highest number of responses indicated that no one was responsible for providing the WE; many of the other schools also agreed that no one was responsible. It could be argued that if no one is responsible for supplying the teaching materials, then it would be up to the teachers to provide it should they wish to add the WE as a topic. With the lack of time to introduce

non-curriculum topics and the unclear source of WE material supply, these present further barriers to covering WE as a topic in the classroom.

Teaching methods for WE used by the respondents include lecturing (or teaching), individual and/or group classroom-based work, homework and excursions to waste sites or educational centres. Nearly half of the schools in Hamburg and around a third of schools in Manchester and Bucharest had been on an excursion. Approximately 20% of schools in Tallinn had been to a waste site or educational centre and no schools had in Zagreb. When asked if there are improvements seen in the student's knowledge when going on excursions instead of conducting classroom-based work, between 59% and 75% of respondents said that there were no improvements seen in all regions except Zagreb, interestingly the body of evidence shows that cognitive learning increases with personal experience (Stöckert and Bogner 2020). Approximately 77% of teachers did see improvements in students' knowledge after excursions in Zagreb; interestingly, the only city with no excursions to waste sites or educational centres, it should be noted that the respondents were probably basing their answers on experiences from other topics.

Despite not going on WE excursions, schools in Zagreb said that they receive the most amount of support from their local authority or waste contractor compared to the other regions with 67% of schools responding positively, see Figure 7. Tallinn respondents said that 35% did, and the remaining three cities had less than 25% of schools say they had support. Over half (57%) of the responding teachers in Tallinn said that they had received a visit from a waste expert, 43% in Zagreb had too. The remaining cities; Manchester, Hamburg and Bucharest saw around 31% to 32% of schools receive a visit from a waste expert. It is worth noting that it may not be a true representation of support provided by the local authorities or waste contractors, poor signposting to available resources could explain the results or the respondents are not teaching the relevant section of the curriculum and therefore have not been in receipt of the support or visit.

The two topics included most frequently in WE material are waste recycling and material separation. The idea that cognitive learning through the reflection of personal experience will influence long-term knowledge (Stöckert and Bogner 2020) is somewhat redundant with school children being taught material separation if there is no infrastructure, whether in the classroom or within the school. Other topics such as waste prevention are covered to some degree in all schools; however, this topic features heavily in Tallinn, as does waste treatment. Littering is also a significant topic for Manchester but topics such as the circular economy and the degradation of materials were not taught at all, an important factor in driving behaviour change through reduce, reuse and recycle of waste (Jørgensen et al. 2018). Principles such as the circular economy and the waste hierarchy were the least covered topics overall with landfill, waste treatment and material degradation also lacking in some regions. When asked if the material is adjusted for different age groups so that the material becomes meaningful to the students in each educational level (Pereira da Silva et al. 2020), the majority of respondents from

Bucharest, Tallinn and Zagreb said that it was. Manchester and Hamburg were less likely to adjust the material for different ages at 25% and 32%, respectively, saying that they do.

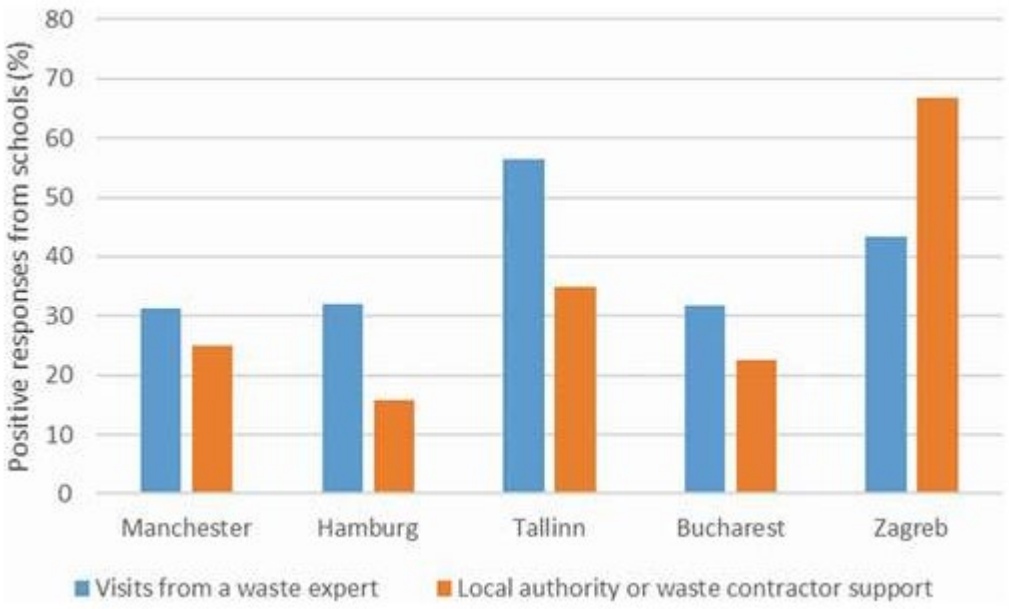

Figure 7. Schools with local authority or waste contractor support.

The method and content of teaching WE varies greatly between the cities and between the schools themselves. Reasons for this inter-city variation might be explained by a lack of recycling infrastructure making excursions difficult, lack of resources to transport children, no education centres or differences in the curriculum. Intra-city variation could be explained by poor signposting to resources, time restraints on teachers or lack of knowledge and/or interest in the subject. Despite this variation in teaching methods and materials, a clear gap in principles such as the circular economy and waste hierarchy was missing from WE across all cities.

4. Conclusions

The amount of waste education (WE), both formal and informal, within schools across the five cities varied. A general pattern emerged from the results showing that as the recycling rate increases the frequency with which WE is taught decreases. Teacher engagement and infrastructure within the schools repeat this pattern with the schools in areas with higher recycling rates less likely to engage in or have been involved in waste management projects. Across all regions, to increase the recycling performance of their school, teachers believed that more awareness of the topic was needed for both students and colleagues. The variation in the amount of WE on the curriculum was not consistent with the level of infrastructure in the city, although more students had been in receipt of excursions to waste/recycling sites in areas with higher recycling rates. Overall, the teachers from all five cities agreed that time pressures (other subjects on the curriculum)

and lack of resources were the two main factors that impacted the amount of WE in their classroom.

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