Information sheet

Factors affecting MF reject rates

Local Authorities (LAs) that collect dry recyclables as either a comingled or two stream collection send the mixed element to a Materials Recovery Facility (MRF) for sorting, and this is a key stage where rejects are identified.

LAs report on mixed recyclables sent to MRFs in questions 58 and 100 of Waste Data, the web based system for municipal waste data reporting by UK local authorities to government[1]. These questions require information on end destination of the materials and information on reject.

Rejected material can have an effect on recycling performance and may be identified and potentially removed at several points in the collection process. The maximum average percentage of reject in this study was 10.6% (average figure for England and Wales combined in 2015/16) which equates to nearly 361,000 tonnes.

Presently, the specific factors causing the high reject rates are unclear, as well as how much of this material could contribute to increased national recycling if rejects were removed or avoided. The following study aims to examine the potential factors that may affect reject, in order to help suggest areas to focus interventions on and also improve data quality. This is a short summary of the two phases of the study.

Trends in MF material quality are available in the quarterly commentaries on the MF portal home page.

Phase 1

The aim of phase 1 of the study was to test and quantify the effect of a series of predictor variables (describing the type of collection scheme and contextual factors) on variation in the reported quality of co-mingled recycling via MRFs in Waste Data Flow (WDF), in both England and Wales (the response variable).

Methodology – Response variable

The response variable tested was the annual reject rate from mixed recycling sent to

[1] (http://www.wastedataflow.org/).

MRFs reported in Waste Data Flow. This was expressed as a percentage of the MRF tonnage input. This information was taken from answers to questions 58 and 100 in Waste Data Flow in the years 2013/14, 2014/15 and 2015/16.

Authorities were selected for inclusion in the study if their dominant recycling scheme had a comingled element i.e. the scheme was either fully comingled, or two stream, and reported under either question 58 or 100 in Waste Data Flow. This represented 73.2 – 74.6% of all England and Welsh authorities over the three years of the study (2013/14, 2014/15 and 2015/16). England and Wales data were combined for each year to provide a larger sample, with the aim of producing more robust statistical outputs.

Methodology – Predictor variables

Unless stated otherwise the data for the majority of predictor variables, such as collection scheme data, were taken from Wrap's Local Authority Recycling Updater database[2]. The predictor variables were as follows:

- Effective weekly residual capacity (calculated using container volume and frequency of collection)
- Recycling frequency
- Mixed recycling collection contract status (in-house or through external contractor)
- Number of materials collected
- Glass collection (presence or absence)
- Pots, Tubs and Trays Collection (presence or absence)
- Food collection (presence or absence and frequency)
- Length of time mixed collection in place
- Rurality
- Deprivation

The predicator variables were selected on the basis of known influence on recycling performance from other studies and also where WRAP could obtain data and evidence on each relative to the Local Authority and MRF end-destination. For example, factors such as MRF processing, enforcement approach or quality of the communications materials issued could not be included.

Methodology – statistical analysis

Each year was modelled in turn to establish the impact of the predictor variables on the reject rate. The statistical package SPSS was used to perform a backwards stepwise regression so that the least significant variable was removed at each stage to reach the most parsimonious model.

Methodology – feedback from Waste Data Flow users

Feedback was sought from LAs who make up the Waste Data Flow user group in England. General questions were asked about how reject was reported in Waste Data Flow and what information was received from MRFs to feed into Waste Data Flow.

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[2] *http://larsu.wrap.org.uk/*

Outputs and conclusions

The regression models explained up to 23.7% of the variability in the annual reject rate. This is a relatively low figure and has highlighted that it is a complex issue and that there may be other factors influencing the level of reject.

Some variables were found to have a statistically significant association with the reject rate in each of the three models (deprivation, dry collection of 5 materials, absence of PTT collection, and absence of glass collection). The relative impact (positive or negative) is shown in the table below using an arrow. The significance (p-value) of the predictor is shown by the level of blue shading.

Feedback received by users of Waste Data Flow showed that data received from MRFs varied greatly between facilities and that authorities may be reporting reject in different ways. This may have had implications on the outcomes of the current study.

Phase 1 was an exploratory analysis and although it had low explanatory power, it has still highlighted some interesting results that warrant further investigation.

Table 1 Levels of significance

Level of significance	**What this means**	**Strength of evidence**
Highly significant ($p \leq 0.001$)	<0.1% chance of observing an effect size this large, or bigger, if there was truly no effect of the predictor on the response	Strong
Moderately significant ($0.001 < p \leq 0.01$)	0.1%-1% chance of observing an effect size this large, or bigger, if there was truly no effect of the predictor on the response	Moderate
Marginally significant ($0.01 < p \leq 0.05$)	1%-5% chance of observing an effect size this large, or bigger, if there was truly no effect of the predictor on the response	Weak
Non-significant ($p > 0.05$)	>5% chance of observing an effect size this large, or bigger, if there was truly no effect of the predictor on the response	None

Table 2 Impact on reject rate of predictor variables

Variable	Direction of impact on reject rate		
	2013/14	2014/15	2015/16
Deprivation	↑	↑	↑
Rurality			
External contract (Compared to internal contract)			
Number of materials collected - 1 (Compared to 6 materials collected)			
Number of materials collected - 2 (Compared to 6 materials collected)			
Number of materials collected - 3 (Compared to 6 materials collected)			↓
Number of materials collected - 4 (Compared to 6 materials collected)			↓
Number of materials collected - 5 (Compared to 6 materials collected)	↓	↓	↓
No PTT collection (Compared to presence of a PTT collection)	↑	↑	↑
Effective weekly residual capacity			
Mixed collection in place for 1-2 years (Compared to 5 years plus)		↓	↓
Mixed collection in place for 3-4 years (Compared to 5 years plus)			
Recycling collection frequency - Monthly (Compared to fortnightly)			
Recycling collection frequency - 3 weekly (Compared to fortnightly)			
Recycling collection frequency - weekly (Compared to fortnightly)		↑	↑
Recycling collection frequency - more than weekly (Compared to fortnightly)			
Fortnightly food and garden collection (Compared to no food waste collection)	↓	↓	
Weekly food and garden collection (Compared to no food waste collection)			
Separate food waste collection (Compared to no food waste collection)			
Two stream collection, glass separate (Compared to comingled with glass collection)		↑	
Two stream collection, glass in the mix (Compared to comingled with glass collection)			
No glass collection (Compared to comingled with glass collection)	↑	↑	↑
Percentage of reject variability explained by each model	18.1	20.1	23.7

Phase 2

Phase 2 of the analysis aimed to further investigate reject rate and attempt to establish what else may be influential in material quality. This was done by looking at further factors using a second regression analysis, by comparing Waste Data Flow reject data with MF portal reject data, and by investigating recycling and refuse collection scheme characteristics of authorities who exhibited characteristics that were shown to be important in the initial study. The study focussed on data from 2015/16.

Regression phase 2 - Methodology

The backward regression analysis from phase 1 was repeated with additional variables. The predictor variables were as follows (the majority of predictor variables from phase 1 of the study were also used in this study – new variables in bold):

- **Household estimate**
- **Percentage flats**
- **Effective weekly recycling containment capacity**
- **Organic collection (presence or absence)**
- **Paper collection (presence or absence)**
- **Card collection (presence or absence)**
- **Plastic bottles (presence or absence)**
- Effective weekly residual capacity (calculated using containment volume and frequency)
- Recycling frequency
- Mixed recycling contract status /(internal or external contractor)
- Glass collection (presence or absence)
- Pots, Tubs and Trays Collection (presence or absence)
- Food collection (presence or absence and frequency)
- Length of time mixed collection in place
- Rurality
- Deprivation

Regression phase 2 – outputs and conclusions

The regression model explained up to 19.2% of the variability in annual reject rate. The study has further shown that this is a complex issue and other variables are important in explaining contamination levels.

The factors shown to have a statistically significant association with reject were deprivation, absence of a PTT collection, mixed collection in place for 1-2 years (in comparison to one in place for 5 plus years), absence of glass collection and percentage of flats. The relative impact (positive or negative) is shown in the table below using an arrow. The significance (p-value) of the predictor is shown by the level of blue shading.

Table 3 Levels of significance

Level of significance	**What this means**	**Strength of evidence**
Highly significant ($p \leq 0.001$)	<0.1% chance of observing an effect size this large, or bigger, if there was truly no effect of the predictor on the response	Strong
Moderately significant ($0.001 < p \leq 0.01$)	0.1%-1% chance of observing an effect size this large, or bigger, if there was truly no effect of the predictor on the response	Moderate
Marginally significant ($0.01 < p \leq 0.05$)	1%-5% chance of observing an effect size this large, or bigger, if there was truly no effect of the predictor on the response	Weak
Non-significant ($p > 0.05$)	>5% chance of observing an effect size this large, or bigger, if there was truly no effect of the predictor on the response	None

Table 4 shows the predictor variables that are significant for each dataset and whether it has a positive or negative impact on the reject rate.

Table 4 Impact on reject rate of predictor variables

Variable	Direction of impact on reject rate
	2015/16
Deprivation	↑
Rurality	
External contract (Compared to internal contract)	
No PTT collection (Compared to presence of a PTT collection)	↑
Effective weekly residual capacity	
Mixed collection in place for 1-2 years (Compared to 5 years plus)	↓
Mixed collection in place for 3-4 years (Compared to 5 years plus)	
Recycling collection frequency - Monthly (Compared to fortnightly)	
Recycling collection frequency - 3 weekly (Compared to fortnightly)	
Recycling collection frequency - weekly (Compared to fortnightly)	↑
Recycling collection frequency - more than weekly (Compared to fortnightly)	
Fortnightly food and garden collection (Compared to no food waste collection)	↓
Weekly food and garden collection (Compared to no food waste collection)	
Separate food waste collection (Compared to no food waste collection)	
No glass collection (Compared to comingled with glass collection)	↑
Household estimate	
No organic collection (Compared to presence of an organic collection)	
Percentage of flats	↑
No paper collection (Compared to presence of a paper collection)	
No plastic bottle collection (Compared to presence of a plastic bottle collection)	
Percentage of reject variability explained by each model	19.2

MF portal/Waste Data flow comparison - Methodology

MF portal data for 2015/16 was used to compare with Waste Data Flow data for the same period. Local authorities were matched where possible. The original regression analysis was repeated with MF portal data. The study was used to make recommendations on improvements to data entry.

MF portal/Waste Data Flow – outputs and conclusions

It was often difficult to match LAs because a free text box is used to record supplier name, so there are frequent typos and iterations of names. LAs that use waste transfer stations could not be identified.

The reanalysis of the MF portal data, where LAs could be matched from Waste Data Flow, using the same methodology and variables as the first phase of the project, explained 18.8% variation in the reject. The results were similar to the original study, in that deprivation, and absence of glass and PTT collections were all important factors in relation to reject rates and were associated with an increase in reject. Again, collections consisting of 4 or 5 materials were associated with lower reject rates when compared to collections of 6 materials.

The study led to the suggestions for improvements to the MF portal to improve data entry and data quality.

Investigation of collection scheme characteristics

Collection schemes were investigated for all local authorities with a mixed collection in 2015/16 that had a characteristic that was shown to have an association with reject rate in all three years of the first phase of the study (absence of glass collection, absence of PTT collection, mixed collection of 5 materials, more deprived authorities).

Investigation of collection scheme characteristics – outputs and conclusions

Collection schemes are very similar for all groups (see Table 5), with similar recycling and residual collections. The majority do not have a food collection, which could account for some of the contamination. It would be useful to carry out a composition analysis of the contaminants to more fully understand what the issues surrounding reject.

Table 5 Summary of service profiles (showing characteristics of the **majority** of authorities)

Service detail	Characteristic of interest			
	No glass collection	**No PTT collection**	**Collect 5 materials**	**More deprived**
Recycling contract	In-house	In-house	In-house	In-house
Recycling frequency	Fortnightly	Fortnightly	Fortnightly	Fortnightly
Food collection?	None	None	None	None
Effective weekly residual capacity (litres/wk)	120	120	120	120
Garden collection?	Separate	Separate	Separate	Separate
Average percentage flats	13.2	15.0	13.2	14.8
Co-mingled/two stream recycling collection?	Co-mingled	Two-stream	Both	Co-mingled
Effective weekly recycling capacity (litres/wk)	120	120	120	120
Recycling container	181-240 litre wheeled bin	181-240 litre wheeled bin	181-240 litre wheeled bin	181-240 litre wheeled bin
Materials collected	Card, paper, plastic bottles, cans. Approximately half collect PTT	All collect plastic bottles and cans, approximately half collect paper and card.	All collect plastic bottles and cans, majority collect paper and card	All collect plastic bottles and cans, majority also collect paper, card and PTT.

Overall conclusions

Both stages of the study have shown there are clearly other factors that are important in influencing rejects. Given the consistency in results, just having a comingled collection appears to be an influential factor, meaning that you would expect some contamination regardless of any other factors. Without improvements in data quality (including increased sample sizes, more consistency with WDF and MF portal responses) and any new evidence for other predictor variables there is a natural limit on what further analysis can be undertaken to identify the more impactful factors on material quality.

Other influential factors could relate to the receipt of material and sorting process at the MFs themselves. Further work could be carried out, both to find out more about any differences in MF sorting processes, and to gain a better understanding of the mix received by MFs from different sources, e.g. whether bulking has taken place, or if a

particular type of commercial waste is included. Understanding the potential contributions from these factors would require increased information and associated participation from all MFs in providing further details around their facilities and processing.

The sampling regime at MFs could be having an impact and affecting data quality, as well as inconsistencies in the data reporting itself, both through the data submitted by MFs, and that reported by Local Authorities in Waste Data Flow. Improving the data quality to enable greater certainty of the influence of factors would require an increase in the MF sampling regime and enforcement undertaken by the Regulator and increased checks by Government and updated guidance in Waste Data Flow.