Two Measured Parameters Correlated to Participation Rates in Curbside Recycling

Schemes in the UK

shortened version of title:

Two Parameters Correlated to Participation Rates

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Abstract

Local authorities in the United Kingdom are currently changing their approach towards recycling as they attempt to meet legislative targets. An important part of this drive is the provision of an effective curbside recycling service, and it is vital to understand the parameters that influence the performance of the system offered. In this paper three primary data sets, collected from over 1,400 households each, are examined for parameters correlated to participation rates. Two measured parameters were found which are not commonly identified in previous studies of curbside recycling schemes, and are shown to merit further investigation as useful tools for planning purposes. One is the number of types of materials collected; participation rates are greater for schemes collecting more materials. The second is the number of households situated on the same road; the lower the number the higher the participation rate. In both cases evidence of the measured correlation is presented, justifying their usefulness for planning. The multiple underlying factors causing the correlations are not identified here, but suggestions are made for further studies.

Key words: Waste planning; Household Waste; Recycling targets; Curbside recycling; Participation rates

In 2001/02 the UK generated 25.6 million tonnes of household waste (Department for the Environment, Food and Rural Affairs, DEFRA 2003). This is defined in the UK and in this paper as material from household collection rounds and from services such as street sweeping, bulky waste collection, hazardous household waste collection, litter collections, household clinical waste collection, separate yard waste collection, civic amenity sites and those collected for recycling or composting through bring/drop off schemes, and curbside schemes (Great Britain 1990).

The majority of UK household waste is sent to landfill with only 12% being recycled or composted in 2002 (DEFRA 2003). This is despite a UK government target for recycling 25% of household waste by 2000 (Department of the Environment, DOE 1995), and the new Landfill Tax of 1996, intended to make landfill a more expensive form of disposal thereby increasing the viability of alternatives (Turner *and others* 1998).

The recycling target of 25% was not met, and the deadline was extended to the firm date of 2005 with step increases in interim years. This time, the responsibility for meeting the targets was placed directly on individual local authorities with new, statutory, recycling targets allocated based on their previous recycling achievements (Department for Environment, Transport and the Regions, DETR 2001). The penalties for failing to meet these targets could include fines or forfeit of duties (i.e. the enforced handing over of waste responsibilities to another body). Local authorities are also bound by new The Household Waste Recycling Act which requires them to provide, in most cases, curbside collections for all households for a minimum of two materials by 2010 (Great Britain 2003).

Local authorities throughout the UK are thus under great pressure to increase their recycling rates. They are revising their existing waste management structure, implementing recycling schemes where previously absent, and improving existing ones, to increase their recycling rates.

Curbside recycling schemes are seen as the main tool to do this, but they are complex systems with different parameters, each of which can influence overall performance. Quality data to assist such decision making is now becoming more widely and published. For example Folz (1999) identified mandatory recycling schemes as having higher levels of recycling and participation. Noehammer and Byer (1997) showed that economic incentives and a weekly collection were other variables found in high performing schemes. Gilitz (1989), Schmerling (1990) and Everett and Peirce (1993) found that recycling programs that supplied residents with curbside containers captured more materials. Further examples of variables that influence performance include the frequency of collection (Tucker *and others* 2000), type of collection vehicle (Jones and Read, 2001), public education and promotion of the schemes (Read 1999).

In this paper we re-examine existing data sets for the express purpose of uncovering correlated parameters with participation rates. In particular, three large primary data sets of over 1,400 households each were examined, and two parameters were found to be correlated to participation rates. They clearly merit further specific investigation as potential tools to improve recycling rates. One parameter is the number of materials collected in a scheme; a higher participation rate is found for those collecting more materials. The second parameter is the number of households situated on the same road; a negative correlation is found between it and the participation rate. Evidence for the correlations is provided, to justify their

use in planning. The multiple factors which together cause the correlations are not investigated here, as the emphasis is on providing useful planning tools rather than identifying complex contributory facets like education and income, whose complex interactions are more difficult to model for planning uses.

Curbside Recycling Schemes

Curbside schemes are those where recyclable materials are collected direct from households for recycling. Local authorities usually provide residents with appropriate containers, such as boxes, wheelie bins, sacks or bags, and collect materials weekly or fortnightly. The types of materials collected vary (see Figure 1); in some areas only paper is collected, in others a wide range of materials from glass to aluminium. In the UK participation by residents is voluntary.

INSERT FIGURE 1

The set out rate is defined as *"the number of households placing recyclable materials out for collection on a given day"* (DETR 1999). This metric is a quick and useful indicator of the number of households taking part in recycling, but is often wrongly interpreteted as the participation rate.

The participation rate, PR, is a quantity used to record levels of participation in a recycling scheme. In the UK it is *"the number of households that actively take part in recycling over a four week period"* (DETR 1999). Collections are typically weekly or every two weeks, but some households may not place recyclable materials out at each opportunity, as they may not generate enough or they may forget. The definition presumes that if the household actively recycles, materials will be set out at least once in a four-week period, which is why this period

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is used as a standard. Although PR is not a perfect standard for comparisons across different schemes, e.g. which have different collection frequencies, it is the most standardised quantity currently used. Set out rates have been related to PR, but with different factors. Everett and Peirce (1992) and Waite (1995) proposed conversions of 1.2–3.0 and 2.5 respectively for weekly collections. Tucker *and others* (1997) and Perrin (2002) suggest a value of 1.4 for fortnightly collections, compared to the range given by Everett and Peirce (1992) of 1.7-2.0. It should be noted that a high participation rate does not necessarily reflect a high overall recycling rate, as the measurement of participation does not take into account the quantity of material placed out by an individual (Wang *and others* 1997).

$$Participation\ Rate = \frac{(No.\ of\ households\ setting\ materials\ out\ for\ collection\ at\ least\ once\ in\ a\ four\ week\ period)}{(Total\ no\ of\ households)} \times 100\%$$

The preferred form of measuring participation rates is by directly surveying how many households set materials out for collection. However, many local authorities have used questionnaires or 'focus groups' to estimate participation, as they cost less. These approaches are not according to government guidelines (Department of Environment, Transport and the Regions, DETR 1999) and result in unreliable data as the claims of residents often do not reflect their actions (Perrin and Barton 2001). Participation rates of 90-100% are thus sometimes reported, which are very unlikely to reflect reality as UK schemes are not mandatory. Indeed, these rates are not reflected in the tonnage of material collected. Moloney (2002) conducted a survey of participation rates in 21 curbside recycling schemes operating in the UK, and the highest participation rates reported were based on reported participation

rather than by measured participation. Everett and Peirce (1992) conducted a survey of curbside recycling schemes operating in the USA. Of the 357 respondents only 34% actually appeared to directly measure participation.

A review of various published participation rates from the UK is presented in Table 1. Some clearly state that their rates have been measured by counting boxes set out, but for others it is unclear how they were obtained. It is interesting to note a trend in the data in Table 1 that schemes reporting participation of less than 50% appear only appear to collect paper whilst schemes reporting higher levels of participation collect a range of materials. This trend will be discussed further below. Although the data suggests a correlation, the studies were carried out with different methodologies, different household types and used different reporting methods, making it difficult to draw clear conclusions. In the section below, more appropriate data sets are used to investigate the trend further.

INSERT TABLE 1

Recent WERG Studies

The Waste & Energy Research Group (WERG) at the University of Brighton has monitored many curbside schemes for research, consultancy and public service (WERG 2000; 2001; 2002; Woodard *and others* 2001; 2002; 2004; 2005). In some cases these data sets included detailed information on participation rates, often sub-divided into information on each material type and demographic group, and with the data collected on a house-by-house basis.

It was therefore decided to re-examine appropriate studies from this data bank to investigate whether there were parameters not widely reported that were correlated with higher participation rates, and which could be used to help plan better schemes. An obvious one to start with, suggested by previous data, was the possible correlation of participation rates with

the number of materials collected. All of these WERG data sets had consistent methodologies, and in particular each set had participation rates which were *measured* rather than estimated. In this work three sets were chosen which each have a significant number of households, i.e. 1,400-2,000 each. They cover similar areas of population density averaging 20-40 people per hectacre (National Statistics 2004). Their demographics are also similar, with considerable overlapping ACORN profiling (CACI 2002). ACORN profiles were designed for marketing purposes, rather than demographics, and care must be taken not to use them as anything other than a general guide rather than a reliable indicator of demographics. However, broadly speaking, ACORN profile A designates typically higher income, higher educated household, through to profile F which typically denotes a lower income and household education. None of the measurements were taken at anomalous times of year, such as during major holiday periods. All of the sets were taken in similar parts of the country − Sussex − where unemployment rates are generally similar at around 3%, waste production is typically 900-1200 kg/(hh yr), and the residents live in towns rather than villages.

In each case data was collected on a house-by-house basis for each recyclable material group for each collection date, allowing not only the participation rate to be calculated (i.e. summing over four weeks) but also for the classification of individual households as high, low and non-recyclers. High recyclers set out materials at every opportunity; non-recyclers were those that did not particpate at all in the four week period. This earmarking of house residents in terms of their measured commitment to recycling proved to be a very useful tool, yielding information discussed below. The data was also able to be analysed on a road-by-road basis, which brought out interesting trends. Table 2 summarises general information about the three sets, labelled A, B, C.

INSERT TABLE 2

Ideally it would have been desirable to have all of the data sets collected at the same time and to vary only the parameters being investigated, but it is rare that such an opportunity to collect such data comes up. To arrange the necessary trials would imply great costs unless carried out on only a few households which would then make the data set weak in terms of sample number. The reasonable size of the data sets used and the fact that the same research group had carried out all three studies using consistent methodologies made them suitable for exploratory work looking for correlations. The first parameter investigated was the number of materials collected.

Variation of Participation Rates with number of material types collected

Whereas most of the earliest systems only collected newspapers, 24% of households in England are now provided with a service that collects 4 or more materials (Department for the Environment, Food and Rural Affairs 2003). Moreover, the inclusion of yard waste in curbside collections is also becoming common (15% of households in England). Yard waste can contribute up to 32% of the household waste stream (Woodard *and others* 2002), and has proved to be a material that householders are willing to recycle through curbside schemes. Further information on yard waste collection schemes has been reported in Woodard and others (2001), Jones *and others* (2001), Williams and Kelly (2003).

Schemes A, B, C summarised in Table 2 are used here to investigate a possible correlation of participation rate with the number of materials collected. Scheme A collected only 1 material type (newspapers & magazines) and reports the lowest participation rate of 38%. Scheme B collected 2 material types and reports a participation rate of 49%, and Scheme C collected 3

material types and reports a participation rate of 65%. The trend of increased participation rate with increasing number of collected materials holds. Moreover, Scheme C had the largest proportion of high recyclers at 29% (those who participate at every opportunity) and the least number of non-recyclers at 35% (those who did not participate). So what is the best explanation of this apparent correlation, and how robust is the suggestion that one way to increase an authority's participation rate is to collect more types of materials?

To answer these questions it is necessary to further unravel the different parameters involved. The data from Scheme C can be used to do this, as it contains more detail on which household set out which material types. Figure 2 indicates how the overall participation rate of 65% is made up of some households which set out newspapers and magazines only (9% contributions), some which set out cans and plastics only (17% contributing) and 39% setting out both, all within a given period of four weeks.

INSERT FIGURE 2

The percentage of households setting out newspapers and magazines only (48%) in Scheme C corresponds well with the number participating in Scheme A, where this is the only material type collected and 38% participate. Newspapers have the longest tradition of being recycled, are clean and easy to handle, and are usually kept segregated from other waste in households. For example, Sudol and Zach (1991) reported on a scheme in Newark after glass was collected as well as paper, and found that more recycled paper alone (47%) compared to those recycling both paper and glass (30%).

Of those in Scheme C setting out newspapers and magazines, most set out cans and plastics (39 out of 48). Of course, not all households may use enough cans and plastics for them to

feel it is worthwhile to sort and store them for recycling, but most of these households are doing so.

Conversely, as many as 17 of the 56% who recycle cans and plastics never seem to set out newspapers and magazines. One possible explanation is that many households do not take regular newspapers, or otherwise acquire enough to bother setting out - Tucker (1999) has shown that householders believe that curbside recycling schemes are of little use to low users of newspaper. On the other hand, McDonald and Oates (2003) have shown that 62% of those residents not participating in a curbside scheme may recycle through other mechanisms such as bring banks or civic amenity sites. Two reasons for this type of behaviour are possible. First, such households may have committed recyclers who segregate other materials (e.g. glass) not commonly collected at curbside which they transport regularly to bring-banks, and they prefer to take the newspapers then. Secondly, newspapers and magazine can be heavy and it is possible that the household relies on a particular person to be available to remove them; this person may find bring-banks more convenient as they can be accessed at most times of the week. All of these hypotheses could be feasibly tested, and will be the subject of future surveys by this research group.

It is interesting that in Scheme B mixed paper is collected. Households which do not subscribe to newspapers but which acquire paper e.g. from computer print-outs will be able to make use of this curbside collection service, which might contribute towards the higher participation rate of 49% (compared to 38% for Scheme A newspapers and magazines). In other words, mixed paper collections may widen the net and allow a wider spread of households to participate compared to newspaper-only collections.

The above data and analysis strongly indicate that participation rates are increased when a larger number of key material types are collected. However, there is another aspect which may be contributing, which we call the Stepwise Rise. When only 1-2 materials are diverted by householders from their waste for recycling, the emphasis is still on waste collection. When more significant amounts of the householders' waste is regularly segregated for recycling, e.g. 4-6 materials, the householder may shift their perception of the process to one of overall recycling, with minimal actual 'residual waste'. Their waste system could become dominated by recyclates. If that were the case, then schemes which facilitate this could benefit from a significant stepwise increase in both participation rates and in the amounts of recyclates collected from each household. Scheme C, which collects three key materials comprising a large fraction of the waste, could have a Stepwise Rise effect contributing to its PR of 65%.

Some authorities are moving towards this kind of recycling-dominated system by reducing the frequency of collection of residual waste to fortnightly only, and increasing the frequency and range of recyclates collected. For example, in the first week residual waste is taken and in the following week dry recyclable materials and yard waste might be collected. This approach is becoming increasingly popular throughout the UK, and the two authorities recording the highest recycling rates in the UK in 2002/03 used this system (Letsrecycle.com. 2004).

It would appear worthwhile and timely for further research to investigate the correlation of participation rates with number of material types further, and to see whether stepwise increases in recycling rates do occur in the UK when a comprehensive curbside recycling collection services are brought in, in the future. It certainly seems that in order for the

recycling rate in the UK to increase significantly emphasis needs to be placed on changing the public and local authorities' perception from a *garbage collection* to a *recycling collection*.

Variation of participation rates with number of houses on a given road

The data collected in Schemes A, B, C also includes house-by-house detail, which is not commonly collected. This allows a powerful matrix of data to be built up which can be interrogated in a variety of ways. It was due to this level of detail that a correlation could be found existing between the participation rate achieved and the number of houses on a given road. In other words, residents on short roads tend to participate in recycling more than those on longer roads. Although there are likely to be shifts in sizes of properties, the wealth and nature of the households going from small roads to longer ones in a UK town, all such effects appear to be contained within the envelope of this simple parameter. It is important to note that all houses considered were in similar urban areas; the effect may not be present for rural or metropolitan communities. The data from all three of the data sets A, B, C were used, totalling 5,351 households sited on 140 roads, and shown in Figure 3.

The data was analysed with respect to the participation rates of residents depending on the number of houses on each road. For example, roads with 1-20 households on them averaged a participation rate of 64%, disregarding the type of scheme or town. Households on roads with 161-180 households averaged a significantly lower participation rate of only 34%. The general trend indicates that as the number of houses on a road increases the participation ratio gradually reduces. Standard deviations are shown in Figure 3, as is the best fit. The number of houses on a road is correlated to the participation rate with a Pearson's correlation coefficient of $r = 0.30$, which for $n = 138$ is highly significant, giving $p < 0.01$.

Clearly, changes in participation rates are not caused by the number of houses on the road – the relationship is not directly causal. The number of houses on a road does not in itself change the participation rate. But there are linked factors which may be more directly related. The effect may be related to an individual's attachment to their neighbourhood (Folz 1999, Lyas 2002). On smaller roads there may be more of a community spirit and peer pressure to recycle. It is interesting that Noehammer and Byer (1997) also found that the lowest performing (mandatory) schemes were mainly in areas of large population density.

It is natural to expect that education and income might affect participation rates, and that these are significant contributors to the trends seen. Whether they are or not, the correlation shown here is valid over the three towns studied in England, suggesting that this parameter of road type or length could be directly useful for planning waste services in England.

However, in an effort to determine approximately the extent of the contribution of education and income on the participation rates, the data was checked for each Scheme A, B C separately for correlations of PR to ACORN groups. No clear pattern emerged, as shown in Figure 4. The correlations to road length were also examined for each individual Scheme A, B, C. The trend is significant in Scheme A but there is insufficient data in the individual data sets of the others to make a judgement.

The overall correlation seen for all three schemes combined, providing a larger sample, and as shown in Figure 3, is exciting, and further studies are planned to explore how significant it is, and to unravel its cause. One possibility is that the PR is linked to the size of the dwelling. A review of recycling worldwide has indirectly shown a general trend of higher recycling rates with larger dwellings (Resource Recovery Forum 2004), and also viewed by density of

population. It is also true that roads with only 0-10 houses along them tend to be cul-de-sacs in Schemes A, B, C, but this trend does not easily extend to the higher end. (Cul-de-sacs are small groups of houses on dead-end road spurs off from a through-road.) Further investigation on this topic will be interesting.

Regardless of its cause, the influence of road size on participation could have several implications for planning of curbside schemes. UK local authorities sometimes have standard education programs that are applied throughout their respective municipalities. In many instances these authorities have a shortfall of funding and resources for such schemes. This analysis suggests that resources could be better focused on different areas. For example, curbside schemes could be expanded and supported for residents in cul-de-sacs and crescents who are more likely to participate at higher rates. On the other hand, residents living on main roads with more traffic might be better served not by curbside schemes requiring collection vehicles which would cause more traffic congestion, but street-based mini-recycling centres of communal recycling bins which are emptied less often. Moreover, residents on these roads may benefit from a more intensive waste education and awareness program.

INSERT FIGURE 3

INSERT FIGURE 4

Further unravelling of this effect would be useful. For example, it would be of interest to see the relative contributions to this effect of factors such as property size, value, and demographics. Another important factor which should be investigated is the correlated link to capture rates, i.e. the percentage of material captured for recycling compared to that discarded. It does not follow that the areas with higher participation rates necessarily

correspond to those recycling the most materials, though the maximisation of this quantity is the ultimate aim of the local authorities. It would also be interesting to determine whether the main contributions to the effect due to road length are from high recyclers or not. High recyclers are targeted differently to low or non-recyclers by local authorities wishing to increase recycling, as the barriers to their further involvement are different. For example, non-recyclers need to be 'triggered' to begin, while low-recyclers may need reminding and encouragement. Further research will test these trends.

Conclusions

In this paper various data sets which contain house-by-house detail on recycling activity are examined and two parameters which are not commonly identified in other studies of curbside schemes are discussed; the number of types of materials collected, and the number of households on a given road.

By considering three large data sets that use consistent methodologies in directly measuring participation, it is seen that the number of households participating in curbside schemes increases as the number of key materials collected increases. For example, 38% participate monthly in recycling newspapers & magazines when that is the only material collected. However, participation was higher - 49% - on a scheme where mixed paper is also collected, and 65% on a scheme where cans and plastic are also collected. Further analysis detail showed that the number of high recyclers observed was 21% in the basic scheme, but as high as 29% in the scheme which had the additional collection of cans and plastics. Even the number of low recyclers were correlated, with 17% on Scheme A collecting one material but as high as 36% on Scheme C collecting four materials, implying that far fewer residents were still in the non-recycler category. It thus appears that one way to increase general participation

is to increase the number of types of material collected.   The detailed reason for this is not determined here, but a review of published participation rates also indicates that rates are seldom above 40% when only one material is collected, and are generally higher (e.g. 65%) when schemes collect more than 4 materials.

Secondly, data indicates a decrease of participation rate with an increase in the number of households situated on the same road. The underlying direct factors are not determined here. What is noted is that this correlation is useful from a practical point of view because it links participation rates and a measurable quantity - the number of houses on a road.   Such information is useful for planning purposes and is readily available to local authorities.

It may, for example, be better to focus curbside schemes on residential areas with small neighbourhoods and cul-de-sacs. On long roads, which are often main traffic roads, it may be best to use permanent banks of bins to capture recyclable materials or to implement a more intensive education and promotion campaign.

Acknowledgements

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Table 1. Reported participation rates in the UK

Case study	Partic-ipation rate	Data collection method	Detail	Number of materials collected
Bradford (Perrin and Barton 2001)	92%	Measured	Mixed multi material collection	6
Unknown (Moloney 2002)	90%	Measured	Alternate collection of yard waste and refuse and dry recyclables	Unknown
Bath & NE Somerset (FoE 2001)	76%	Measured	Co-mingled dry recyclables collected weekly in boxes.	4
Bournemouth (FoE 2001)	75%	Unknown	Co-mingled dry recyclables collected weekly in returnable blue bags	3
Havering, London (Lyas *and others* 2002)	71%	Measured	Survival bags	Unknown
Milton Keynes (Thomas 2001)	71%	Self reported	Dry recyclables collected weekly	5
Luton (Coggins 1994)	63%	Measured	Dry recyclables	Unknown
Milton Keynes (Coggins 1994)	58%	Measured	Co-mingled recyclables. Pilot scheme data	Unknown
Bristol (FoE 2001)	52%	Measured	Co-mingled dry recyclables collected weekly in boxes.	4
Fylde (Tucker *and others* 1997)	51%	Measured	Newspaper collection only	1
Sheffield (Coggins 1994)	40%	Measured	Pilot	Unknown
Wyre (Tucker *and others* 1997)	35%	Measured	Newspaper collection only	1
Glasgow (Tucker *and others* 1997)	33%	Measured	Newspaper collection only	1
East Dunbartonshire/N. Lanark (Tucker and others 1997)	28%	Measured	Newspaper collection only	1

Table 2. Summary of Characteristics of Three Data Sets Used

Case study	A	B	C
No. of Households	1,473	1,957	1,921
Participation rate (PR) (Overall)	38%	49%	65%
Materials collected (Brackets indicate those collected together in one container)	1 (newspapers & magazines)	2 (newspapers & magazines + mixed paper)	3 (newspapers & magazines) (Cans + plastic bottles)
Collection Frequency (recyclates)	Fortnightly	Fortnightly	Alternate weeks i.e., (news & mags) one week (cans + plastics) the next
Number of Recyclate collections Every 4 weeks	2	2	4
Container types	Box Baskets Bags	Reusable bag	Baskets
Collection Frequency (residual waste)	Weekly	Weekly	Weekly
Minimum PR on any given road	15%	1%	0%
Maximum PR on any given road	67%	80%	100%
Overall Recycling Rate (Over period of analysis)	10%	13%	13%
Percentage of high recyclers (Participating 2/2,3/4,or 4/4 opportunities)	21% (2/2)	28% (2/2)	29% (18% + 11%) (3/4 + 4/4)
Percentage of low recyclers (Participating 1/2,1/4,or 2/4	17% (1/2)	21% (1/2)	36% (19% + 17%) (1/4 + 2/4)

opportunities)

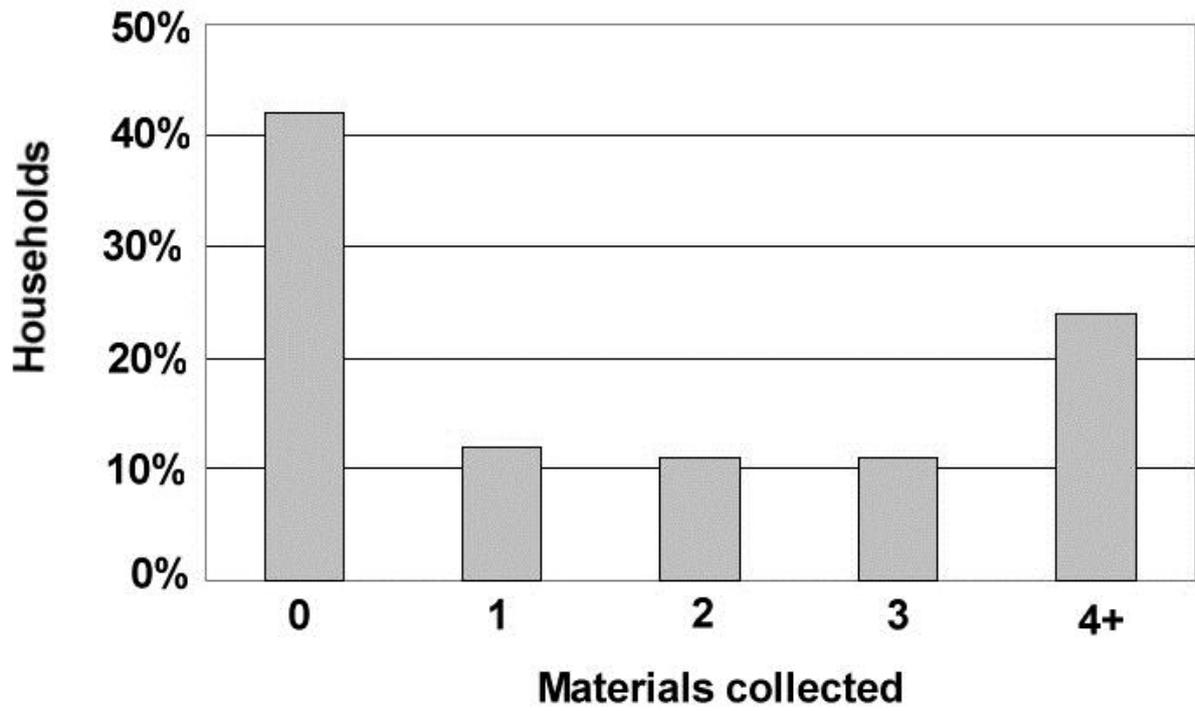|			
Percentage of non-recyclers (Participating in 0 opportunities)	62%	51%	35%
	(0/2)	(0/2)	(0/4)
Year of survey	2002	2001	2002

LIST OF FIGURES:

Figure 1. Number of materials collected in curbside recycling schemes in England

Figure 2 Participation rates for different material groups in Scheme C - the overall participation rate was 65%

Figure 3. Relationship between number of households on a road and participation rate

Figure 4. Participation Rates of Schemes A,B, and C versus the Number of households on the respective road, and the ACORN groups A-F (roughly corresponding to decreasing income and education).

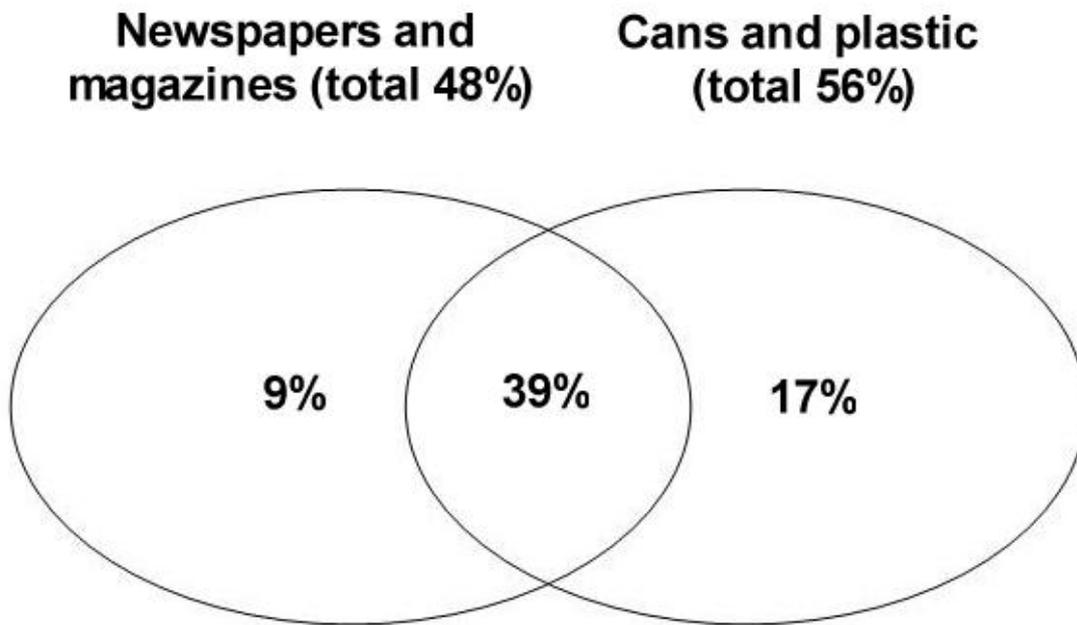**Figure 1. Number of materials collected in curbside recycling schemes in England**

Newspapers and magazines (total 48%) Cans and plastic (total 56%)

9%   39%   17%

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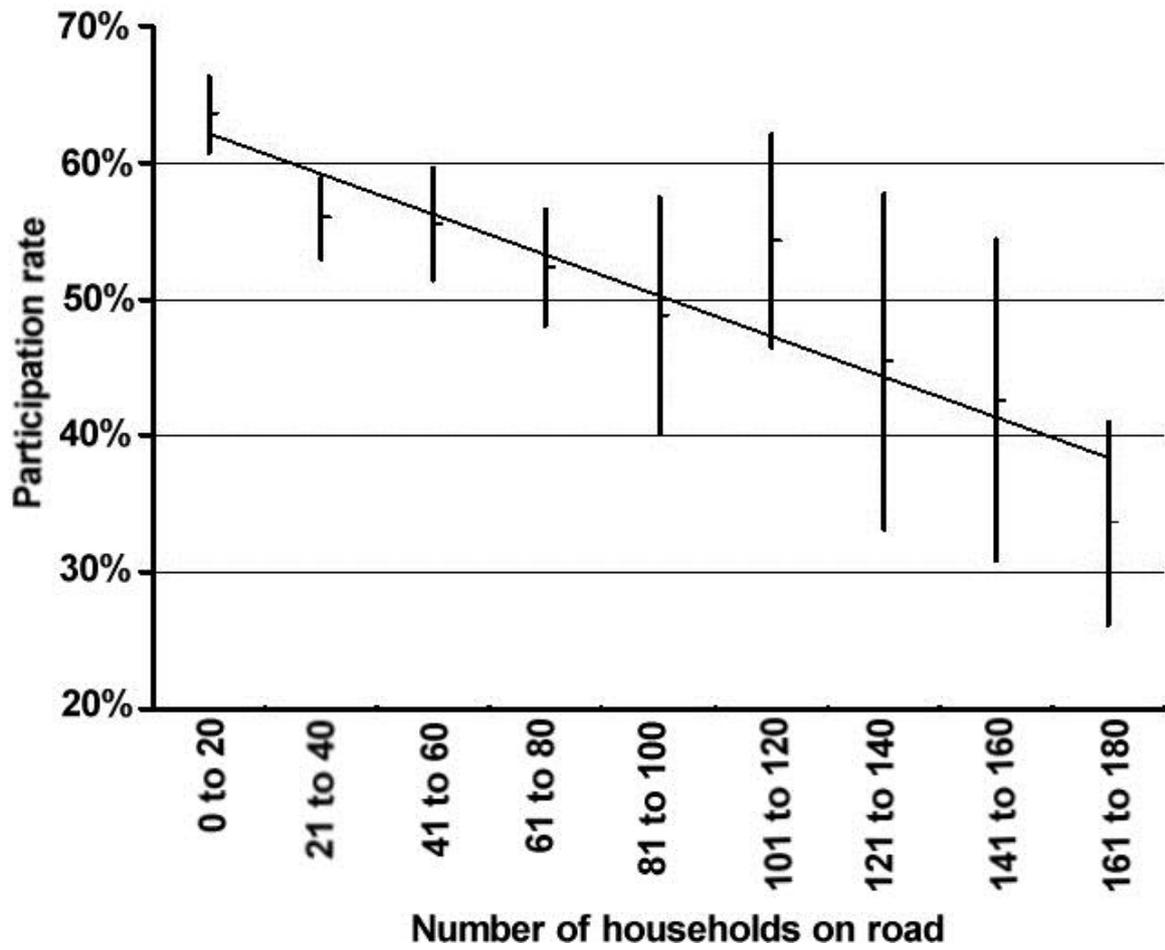
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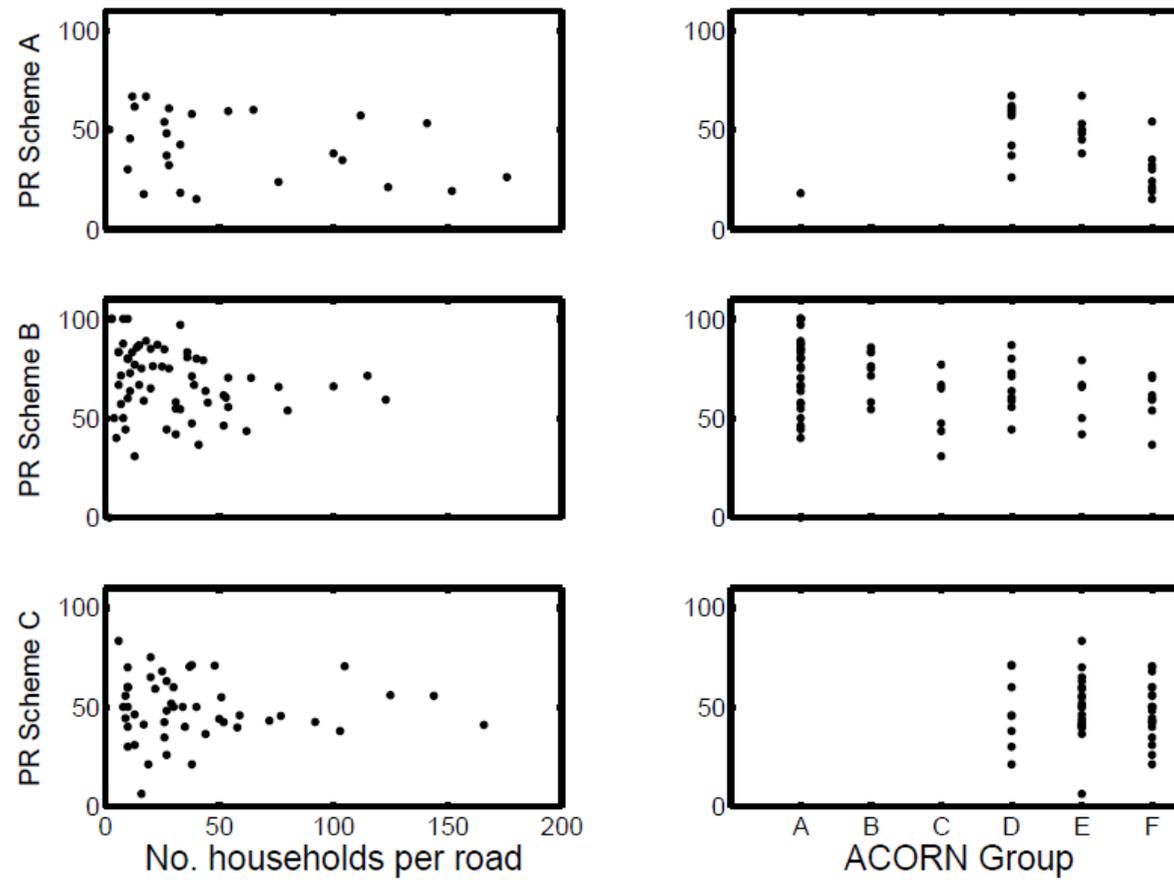
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