

Measures Package

Identification of measures that may help to increase household waste recycling levels in the city of Oslo

48 international articles linked with waste sorting and published between 2002 and 2015 have been read and reviewed. 282 findings have been derived from these. The findings are categorised into one of ten categories, grouped further and assessed in relation to the effect on the recycling level. The results are summarised and presented for each individual category. Of the findings which fall within the scope of things that REN can influence, 74 are deemed to have a direct increased effect on the recycling level. The greatest potential for increasing the recycling level is linked with the development of the service offering for the collection scheme. Increasing the number of pure waste types collected, reducing the service offering linked with residual waste, closing refuse chutes in high-rise buildings and utilising the waste sorting criteria identified in the categories Communication, User experience, Laws/regulations, Demographics and Knowledge are recommended. The category Incentives is used in the formulation of a fee system that will encourage households to use the new solutions as intended. Continuation of the drop-off scheme as planned is recommended due to limited potential for development. The limitations apply to the development of the service offering itself as a result of the fact that the findings are largely being followed, but also with a view to raising the waste types in the waste hierarchy. The recommendations of the report are used as a basis for further development of the system dynamics model and simulation of the effects of the measures.

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1. Summary

The purpose of this work has been to identify measures that could help to increase the recycling level and that are documented in international articles. 282 findings have been identified in a review of 48 articles relating to sorting of waste that were published between 2002 and 2015. 74 of these findings have been deemed to fall within the jurisdiction of the authority, have a direct impact on the recycling level and increase the effect of the recycling level.

The door to door collection scheme works better than the drop-off scheme. The collection frequency and the number of waste types for the collection of sorted waste types should be high. The collection frequency and container size for residual waste should be low. Refuse chutes in high-rise buildings should be closed, and the most important waste container should be green in colour.

For the drop-off scheme, accessibility such as short distances from homes to drop-off location, tidy surroundings, cleanliness and factors perceived as offering good functionality are important. Good accessibility of manned drop-off locations – as accessibility is described here – will generally increase sorting of waste. This conclusion has less validity in multicultural environments.

The perception that sorting waste at home is difficult and time-consuming reduces waste sorting activities. Other negative perceptions also reduce waste sorting activities. Positive perceptions increase waste sorting activities. Positive and negative perceptions of the environment, which do not affect waste sorting, are the exception.

It is indicated that older people sort waste more than younger people, and older women appear to be the best. If these people live in individual houses, waste sorting increases still further. However, the amount of waste generated by these households is limited due to the fact that there are few people in them. Of larger households, women who stay at home with children are most likely to sort their waste. In a multicultural city like Oslo, cultural differences will probably influence waste sorting activities in different ways. In addition, high status individuals appear to be more likely to sort waste than lower status individuals.

Pay as you throw will probably help to increase the amount of waste sorted and reduce residual waste volumes if the scheme is organised correctly. The same is probably true of other financial incentives, but the emphasis should be on “inner motivation” when devising the incentive.

High skills levels among employees and users linked with waste disposal will increase the sorting of waste. Whether the general level of education affects the sorting of waste is less certain, but the sorting of waste will probably increase if a high level of education is combined with a high awareness of waste disposal.

Where possible, communication should be clear and distinct and communicated as directly as possible to households in a form suited to the recipient’s waste system. Using bin lorry drivers for direct communication with households may be effective.

Waste sorting programmes and sorting equipment should be mandatory, with clear allocation of responsibility for ownership and maintenance of the equipment. Applicable rules must be communicated clearly to households.

Being able to measure correctly as a prerequisite if we are to be able to discuss the effects of various waste solutions. The measurement parameters must be based on valid, objective data viewed in relation to the object to be assessed. Explanatory variables and coefficients have been identified that may be useful when using valid data from various sources to compare waste systems and businesses both nationally and internationally. It may be sensible to use a number of different methods for one and the same problem.

Possible effects on recycling levels should be simulated in order to identify and quantify likely effects before potentially implementing them in Oslo. We recommend using the following as a basis for further development of the authority's system dynamics model apparatus and for simulation of effects:

1. The number of sorted waste types in the door to door collection scheme must be increased as much as possible. This will be dependent on the space for setting out more containers. New containers beyond the current two-container system are primarily intended for a new waste type/new waste types that are currently included in residual waste but are covered by the drop-off scheme (category *Door to door collection scheme*).
2. The collection frequency for sorted waste types is sufficiently high to ensure that overfilling of containers is avoided (category *Door to door collection scheme*).
3. The collection frequency for residual waste containers and/or the volume of residual waste containers will be reduced. The current solution involving visual sorting must not be phased out at present. Food waste and plastic packaging is sorted into their coloured bags, as well as residual waste discarded in the same container, should be one of the solutions simulated. It is assumed that REN's Control apparatus will maintain control over the problem of littering (category *Door to door collection scheme*).
4. Refuse chutes in High-rise buildings will be closed (category *Door to door collection scheme*), and households in high-rise buildings will have to go and drop off their waste in waste areas.
5. The category *Communication* aims to encourage the positive waste sorting findings and reduce the negative waste sorting findings in the category *User experience* and to utilise the categories *Laws and regulations*, *Demographics* and *Knowledge*.
6. The category *Incentives* will be formulated so that these incentives provide support to the changes in the service offering so that this is used as intended to the greatest extent possible.
7. The drop-off scheme will continue as planned (category *Drop-off scheme*).

2. Background

One target of a waste disposal plan for the municipality of Oslo for 2006-2009 (case 239/06) was for a minimum of 50% of household waste to be recycled by 2014. The primary measure for achieving this target was to introduce sorting of plastic packaging and food waste (KiO). KiO began in parts of the city in 2009, and all households in Oslo had been offered this type of sorting in 2012. 2013 was the first full year of operation. The recycling level in 2013 reached 37%, and in its budget for 2014, REN's attainment of its targets was postponed from 2014 to 2018 as the year for attainment of the target (case 1 – 2014).

The report “Materialgjenvinning, en systemdynamisk tilnærming. Simulering av måloppnåelse i 2018” (MGM)¹, describes the development of a system dynamics model which simulates future recycling levels based on the activities and results achieved by REN between 2009 and 2015. The report concludes that *“The model and its criteria indicate current operations and likely development with the continuation of the current packages of measures, with no new measures. The current measures do not address the challenge, and attainment of the recycling target is unlikely without implementing new measures”*.

Among other things, the report recommends that *“in the formulation of a new package of measures, a thorough investigation of studies published internationally and linked with sorting waste should be carried out in order to find out about measures that work and avoid any pitfalls”*.

This report describes procedures, results and recommendations in efforts to identify measures aiming to increase household waste recycling levels in the municipality of Oslo.

3. Objective and purpose

The purpose of this work has been to identify measures that could help to increase the recycling level. The work and activities that are ongoing or have previously been carried out at REN have not been taken into account when identifying these measures. The objectives of the work are as follows:

1. Measures for increasing recycling in the municipality of Oslo are to be identified and taken from published international studies. Documented international experience will be evaluated by means of a set of new measures that the authority may elect to implement after 2015.
2. These measures must be summarised in appropriate manner so that potential effects on the recycling level can be simulated before they are implemented in the municipality of Oslo, where applicable.
3. Identification and summarising of measures are to be regarded as collation of data and knowledge with a view to increasing the authority’s understanding and expertise with regard to how the recycling level can be increased.

Simulation and quantification of effects on the recycling level do not form part of this report, but implementation of these is planned on the basis of the recommendations of this report.

4. Procedure

The starting point has involved looking for proven international experience from which REN can learn. This includes measures that have helped to improve the waste sorting results, but also measures that have had the opposite effect or measures with no documented effect. The criteria for selection of the articles in question are presented below, along with what information and data are linked with the individual articles. This is the result of this systematisation used as a basis for results, assessments and recommendations.

¹ REN file case 15/00725-2

4.1 Identification of articles

Searches were executed on the websites Elsevier², Springer³ and Sagepub⁴. Searched terms used are: “recycling”, “household waste”, “solid waste management”, “intention behaviour gap” and “attitude action gap”. The search terms were used individually and in various combinations. The period for publication of the articles was limited to 2002 – 2015. The results of the individual searches were reviewed by reading through the summaries of the articles. The articles that appeared to be most relevant in terms of purpose and objective were selected. A total of 48 articles have been printed and saved, and these have been reviewed and systematised.

4.2 Recording of information

The following information was recorded when reading through the articles:

Standard information. Title, author, year of publication, the nation (country) referred to in the article, a unique article number, and a case manager who read through the information in the article and recorded it.

Investigation method. The type of data on which the article/survey is based. This includes the following:

- *Interviews.* The article is based on data taken from interviews with users.
- *References.* The article is based on data taken from other published articles. All articles have a review and summary of current references of relevance to the survey carried out. This form of summary is *not* included in this datatype.
- *Official statistics.* The article is based on data taken from official sources, such as Statistics Norway or equivalent.
- *Produced volumes.* The article is based on data taken from waste volumes actually produced. Many articles base their studies on interviews and surveys and come up with conclusions on the basis of the responses given. These responses are generally reported by users themselves, and so a certain element of subjective bias has been built in. The studies in the category Produced volumes may also include interviews and questionnaires, but the results are controlled against actually produced volumes and so the studies in this category are deemed to be of greater validity than the other categories.
- *Questionnaire.* The article is based on data taken from surveys that vary in structure.
- *Questionnaire and interview.* The article is based on data taken from both surveys and interviews.

Findings. Situations in the article that can be linked with waste sorting activities, waste sorting solutions or other situations that may be of significance to how REN organises or implements its activities. These situations are named “*Findings*”. The findings have been translated from English into Norwegian and summarised to make them as brief and precise as possible. The findings are numbered from 1 to 282, and they are also labelled so that they can be found in the articles from which they were taken.

Categorisation. The findings have been categorised into one of the following 10 categories:

² <http://www.sciencedirect.com>

³ <http://www.springer.com/gp>

⁴ <http://online.sagepub.com/>

- *Door to door collection scheme*. Includes situations that affect the structure of the collection scheme. This may include collection frequency, the number of waste types collected, container sizes, etc.
- *Drop-off scheme*. Include situations that influence how recycling stations, return points, etc. should be organised. This may include distances to drop-off points, accessibility and orderliness.
- *Communication*. How the waste sorting message is communicated to households, and via which channels, provide a guideline for this category. Attempts have been made to keep what the message should include out of this category, and this is mainly covered by the other categories.
- *User experience*. This is a category that attempts to collate user perceptions linked with the use of various waste sorting solutions.
- *Demographics*. Includes gender, age, the number of residents in households, housing types, etc.
- *Incentives*. Includes reward and sanction schemes of various types.
- *Knowledge*. Includes the general level of knowledge and knowledge related to waste sorting, particularly among users and employees.
- *Laws and regulations*. Includes how the regulation of waste sorting influences the end result.
- *Quantify/measure*. Includes the information in the articles and can be used to calculate various effects or compare effects and figures across companies and countries. The findings in this category cannot be used to increase the recycling level to any great extent, but they have been included as this information can be used in connection with other work done by the authority. Therefore, it was appropriate to include these findings when the articles were read and reviewed.
- *Method*. Includes how different methods are used in efforts to find waste sorting solutions and identify the advantages and disadvantages linked with the solutions. The findings in this category cannot be used to increase the recycling level to any great extent, but they have been included as this information can be used in connection with other work done by the authority. Therefore, it was appropriate to include these findings when the articles were read and reviewed.

The findings in the individual categories are grouped further if the findings include the same conditions. These groups are unique, and these are what are used as a basis when the findings are assessed, summarised and formulated to provide recommendations.

Effects. “*Findings*” are assessed in relation to effects after they have been categorised. Effects in this context are threefold and include both efficiencies and opportunities for influence.

- *Firstly*, the findings in the article are assessed in relation to *effectiveness*. How does the finding influence the volume of sorted waste types? If this volume increases as a consequence of the finding, a (+) is given for effectiveness. If this volume of sorted waste types is reduced, a (-) is given for effectiveness. If there are findings where the influence on the volume of sorted waste types is unclear, a (0) is given for effectiveness.
- *Secondly*, findings are assessed in relation to *influence*. Do the findings have a direct or indirect influence on the sorted waste types? Not all findings influence sorted waste types. The criterion for the “Direct” designation is that the finding has to have been assessed to have a direct effect on sorted waste types. For example, findings that extend the door to

door collection scheme to include more waste types that at present are classified as “Direct”. Findings that claim there is a discrepancy between individuals’ claimed and actual waste sorting are an example of indirect influence, which is then classified as “Indirect”: This comes about due to individuals reporting more extensive waste sorting behaviour than is actually the case. Findings that can be classified as neither direct nor indirect are classified as “Data”.

- *Thirdly*, findings are assessed in relation to *authority*. To what extent does REN have – or not have – the authority to influence the findings? The example above, with the expansion of the number of waste types in the collection scheme, is classified as being “Within” as a result of this being within the scope of action of the authority. The second example, where individuals error-reports their own waste sorting activity, is “Outside” as a result of the authority experiencing difficulty with influencing individuals’ anonymous personal reporting.

5. Results

A total of 282 findings were recorded during the review of the collection of articles. The individual findings are categorised into one of ten possible categories, and three effect targets are linked.

The first effect target describes the *effectiveness* of the finding. 137 of the findings have been deemed to have positive effectiveness and are defined in the text as having increased effect. 50 of the findings are negative, and 95 findings have no effectiveness or neutral effectiveness and thereby have reduced or no effect on waste sorting.

In the second effect target, *influence*, 151 findings were found to have a direct influence on the sorting of sorted waste types, 78 findings were found to have an indirect influence and 53 were assigned the “data” characteristic. Data are findings that do not influence waste sorting but include information that may be of use to REN in other contexts. This may, for example, include comparisons between companies across national borders, weight loss for the waste as a consequence of evaporation, etc.

In the third effect target, *authority*, 158 of the findings were deemed to fall within REN’s field of authority and 124 fell outside REN’s field of authority.

Figure 1 summarises the effect targets. Findings that are deemed to have reduced or no effect on waste sorting are merged together in the presentations below, and should not be implemented in REN except under special conditions.

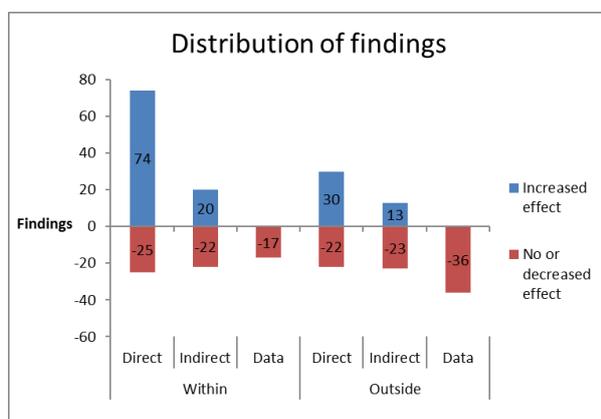


Figure 1 – Summary of effectiveness findings

The most important findings for REN will probably be the ones that offer the combination of being within REN’s field of authority, having a direct influence and having an increased effect on waste sorting. 74 findings are compliant with this combination. The same combination with the exception of findings with reduced or no effect accounts for 25 findings. A finding that may have increased effect in one article may have reduced or no effect in another. Depending on the article, one and the same finding may appear as both a blue and a red column due to questioning, survey methods, survey samples, national backgrounds and generally different preferences in the areas in which the surveys have taken place. In an assessment, the number of findings and the type of survey methods on which the findings are based will be emphasised in such a situation; see section 4.2.

In addition to the effectiveness criteria described above, all findings are categorised into one of ten categories. Figure 2 summarises the ten categories in relation to effectiveness.

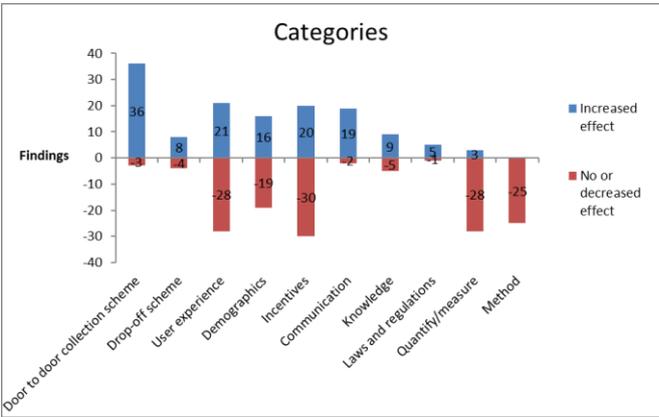


Figure 2 – Number of findings by category

The further analysis is summarised and presented in the categories “Door to door collection scheme”, “Drop-off scheme”, “User experience”, “Demographics”, “Incentives”, “Knowledge”, “Communication”, “Laws/regulations”, “Quantify/measure” and “Method”. These are further divided into groups, and figures are linked to these groups where deemed appropriate for passing on information.

5.1 Door to door collection scheme

The category *Door to door collection scheme* is made up of 39 findings, all of which – with the exception of three – help to increase waste sorting behaviour (Figure 3). When reviewing the findings, common denominators are identified that can be found throughout the articles. These findings are grouped according to these common denominator is and include how the collection scheme works versus a drop-off scheme, the number of waste types collected, the collection frequency for waste types, container size and a collective item for technical adaptations.

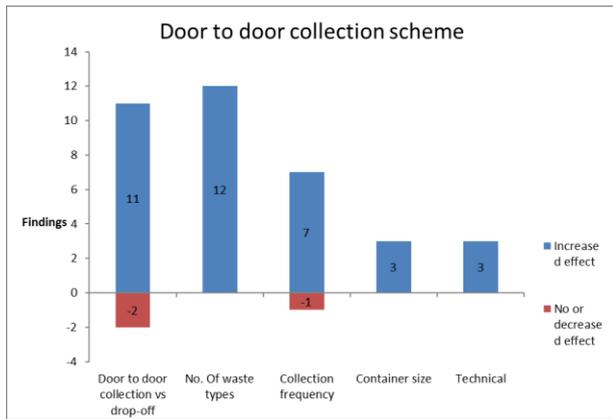


Figure 3 – Distribution of findings, Door to door collection scheme

Door to door collection scheme versus drop-off scheme. Of the group’s 13 findings, 10 findings (19, 145, 156, 211, 117, 178, 239, 253, 270, 271) give increased effect (Figure 4), with the conclusion that the door to door collection scheme gives better results and is more effective than the drop-off scheme when the intention is for households to sort as much as possible of their waste into clean, neat waste types. Two findings (59, 278) give reduced or no effect, with the conclusion that just as much dry sorted waste will be sorted irrespective of whether a door to door collection scheme or a drop-off scheme is implemented and that accessibility alone is not sufficient to increase sorted waste volumes. All these findings fall within REN’s jurisdiction.

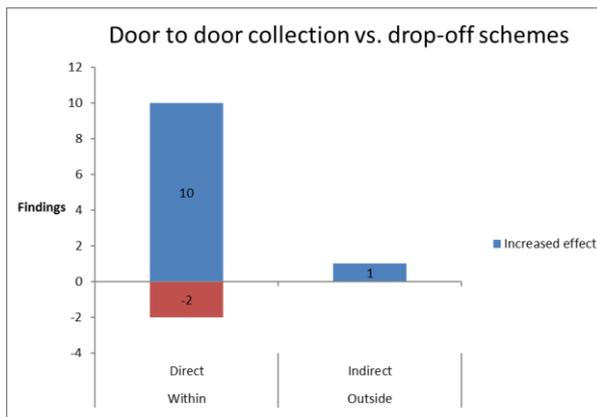


Figure 4 - Door to door collection and Drop-off

Only one finding (201) is both outside REN’s jurisdiction and has an indirect influence. This finding concludes that attitudes to waste sorting are correlated with the accessibility of door to door collection schemes, and this confirms the findings resulting in increased effects in the section above.

Number of waste types. Of the group’s 12 findings, 11 findings (13, 155, 5, 125, 151, 52, 110, 152, 229, 237, 279, 280) conclude that the number of waste types collected on household premises have an increase effect on waste sorting. All these findings fall within REN’s jurisdiction and have a direct influence (Figure 5). The greatest effect is recorded in areas where the door to door collection scheme has been introduced to replace a previous drop-off scheme. In areas with an established door to door collection scheme which is then extended to include more waste types, sorting of the types of waste that are new to the scheme increases, as well as the sorting of the types of waste that were part of the scheme previously. The effect increases according to the number of new waste types included in the door to door collection scheme. These findings are largely based on articles

based on produced volumes. This is interpreted to mean that the more waste types that are collected, the better the results.

This is confirmed in part by finding (280), which has an indirect influence, concluding that the introduction of extended door to door collection schemes reduces residual waste volumes.

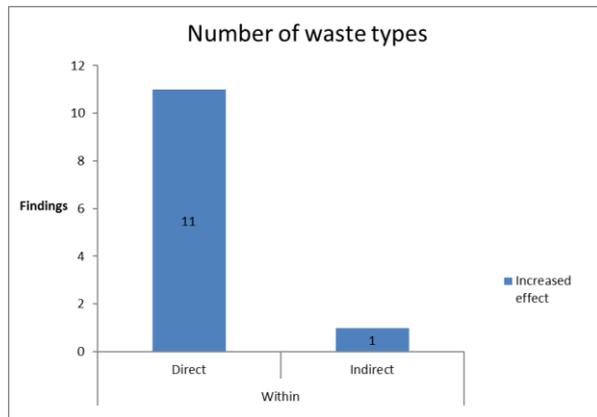


Figure 5 – Number of waste types.

Collection frequency. Of the group’s eight findings, seven (157, 112, 153, 111, 235, 236, 238) conclude that the door to door collection frequency results in an increased effect on sorted waste types. The collection frequency should be high for sorted waste types. The collection frequency should be low for residual waste. This is interpreted to mean that the service level for sorted waste types should be high and increasing, and that the service level for the waste that REN is hoping to reduce should be low and falling. The findings that give an increased effect are based on articles based on produced volumes.

One finding (225) deviates from the pattern and concludes that increasing the door to door collection frequency does not result in people sorting more waste. The survey arriving at this conclusion is based on a survey. All these findings fall within REN’s jurisdiction and have a direct influence.

Container sizes. Of the group’s three findings, all of which are within REN’s jurisdiction (Figure 6), two of the findings (146, 113) conclude that the volume of the residual waste container should be reduced. This corresponds to the service level referred to in “*Door to door collection frequency*” above. It is concluded that a smaller volume for residual waste will result in less residual waste and more sorted waste. One of the findings (147) has an indirect influence, and concludes that deployment of smaller residual waste containers does not have any unwanted political or administrative side-effects. All findings are based on articles based on produced volumes.

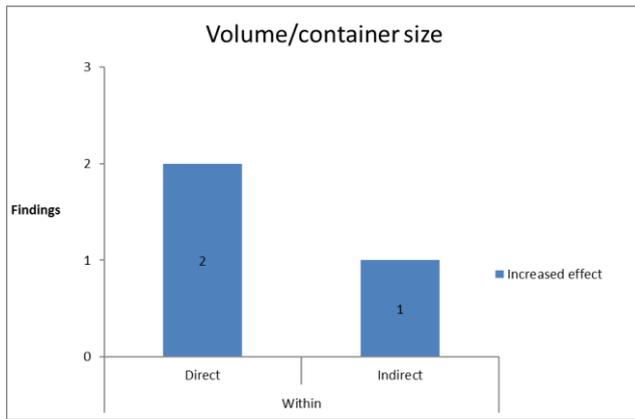


Figure 6 – Volume/container size

Technical adaptation. This group includes three findings (Figure 7). Closure of refuse chutes in high-rise buildings, rendering them inaccessible to residents, is recommended (119) in order to increase waste sorting from buildings of this kind. There is not much chance of waste sorting behaviour increasing while the refuse chutes are accessible to households. Closing refuse chutes means a lower service level for the waste which REN is aiming to reduce, and this corresponds to the findings linked with collection frequency and container volume for residual waste. Closing refuse chutes will *not* make a positive contribution to people’s perception of waste sorting – see finding (118) under user experience – but it will nevertheless improve and increase waste sorting behaviour wherever the measure is implemented.

Another study looks at the colour the waste container should be to encourage people to use it as much as possible. The colour should be green (205).

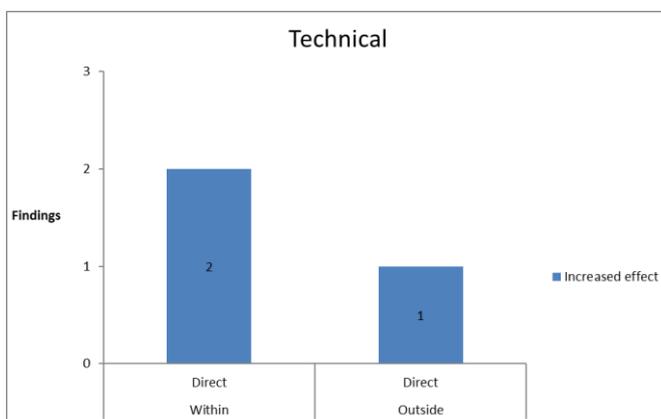


Figure 7 – Technical

Finding (165) concludes that the collection unit must be adapted to the logistics system used by users and falls outside REN’s jurisdiction but has a direct influence.

Summary

The door to door collection scheme works better than the drop-off scheme. The door to door collection frequency and the number of waste types for the collection of sorted waste types should be high. The collection frequency and container size for residual waste should be low. The most important waste container should be green in colour, and refuse chutes in high-rise buildings should be closed.

5.2 Drop-off scheme

The category *Drop-off scheme* is made up of 12 findings, all of which – with the exception of four – help to increase waste sorting behaviour (Figure 8). Ten of the findings are grouped under “accessibility”, and two come under “Miscellaneous”.

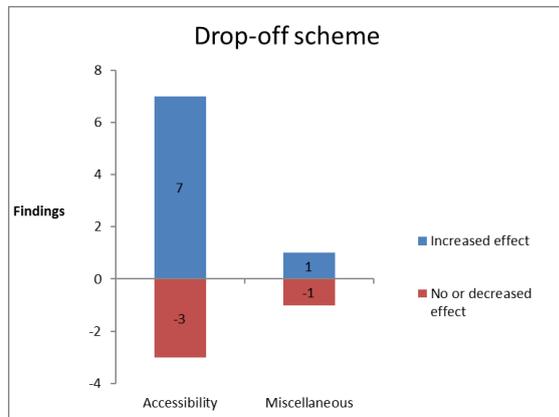


Figure 8 – Distribution of findings, Drop-off scheme

Accessibility. Nine of the group’s findings have a direct influence and fall within REN’s jurisdiction (Figure 9). Six of the findings (24, 82, 164, 23, 65, 68) conclude that good accessibility to the drop-off location increases waste sorting. Good accessibility means short distances from homes to the drop-off location, tidy surroundings, cleanliness and factors perceived as offering good functionality at the drop-off location.

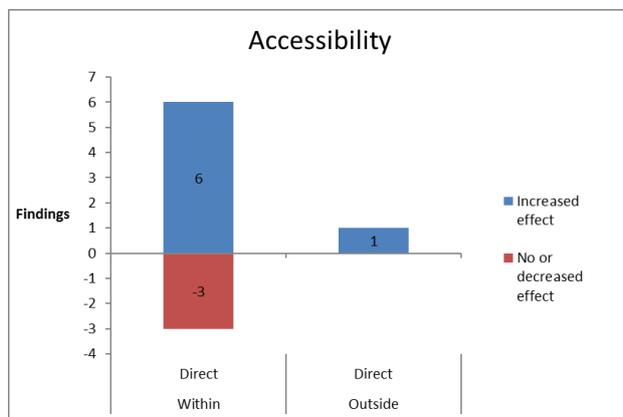


Figure 9 – Accessibility

The above findings that increase waste sorting are confirmed in part by one (63) of the three findings that give reduced or no effect, and conclude that the poor accessibility of drop-off schemes reduces waste sorting. Other findings conclude that satisfaction with drop-off options at the facility (103) and simplification of sorting and drop-off (83) have no effect on waste sorting, thereby contradicting the majority of the findings. (103) in particular may be of interest to REN as this survey involved multicultural people from Järva in Stockholm who live in high-rise buildings.

Finding (166) falls outside REN’s jurisdiction, but it confirms the above in that closeness to the drop-off location is important, particularly for people who do not have interim storage space for waste at home. See finding (163) under the category Model on p. 24, which divides waste sorting in the home into three different logistics solutions.

Miscellaneous. A study from the United States concludes that areas with developed reuse markets (126) collect more sorted waste than those without. Finding (114) concludes that unmanned drop-off locations lead to dumping grounds for waste and unhygienic conditions.

Summary

Good accessibility of manned drop-off locations – as accessibility is defined here – largely increases sorting of waste. This conclusion has less validity in multicultural environments.

5.3 User experience

There are 49 findings in the category *User experience*. One thing these findings all have in common is that they are mainly concluded from studies based on surveys, interviews, other references or a combination of these survey forms. Questionnaires and interviews in particular can easily provide a form of self-reporting from respondents taking part in the surveys. Self-reporting may lead to perception of people’s own behaviour deviating from their actual behaviour. This is confirmed by the findings (6, 256, 267, 275), which conclude that there is a discrepancy between the individual’s intention, the claimed and expressed willingness to sort waste on the one hand and actual behaviour measured in terms of waste sorted on the other.

Expressions such as attitudes, trust, feelings and hope are also used. These are expressions that may be perceived to mean different things depending on personal perceptions and preferences. The combination of survey forms and the use of not very clear terms may help to render findings imprecise, thereby leading to the validity of the findings being questioned.

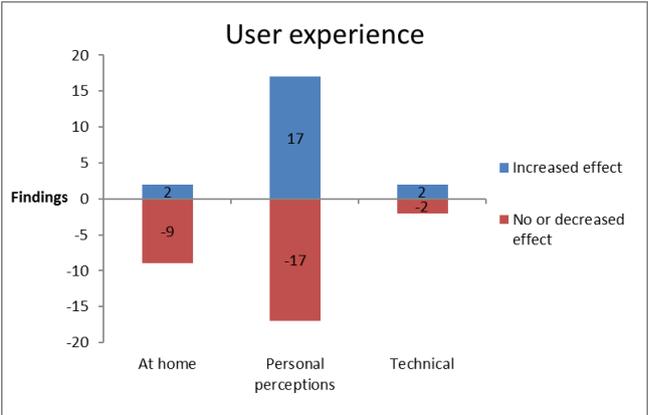


Figure 10– Distribution of findings, user experience

The category *User experience* is divided into the groups “at home”, “personal perceptions” and conditions of a “technical” nature (Figure 10).

At home. All 11 findings are deemed to fall outside REN’s jurisdiction and to have a direct influence.

Two of the findings (224, 227) give an increased effect, and conclude that there is no problem with storing waste at home until the collection day, and also stating that they want to sort waste themselves even if this requires cleaning of the waste.

Nine of the findings (70, 72, 107, 120, 121, 122, 158, 228, 246), linked mainly with waste sorting conditions in the home and reasons as to why people do not sort waste, head in the opposite direction. These causes are specified as “worried about bad smells”, “don’t have time” and “don’t have room”, all of which help to reduce waste sorting behaviour.

Personal perceptions. Includes 34 findings that are more psychological in nature (Figure 11). One of the findings (79) has a direct influence and falls within REN’s jurisdiction. This concludes that if residents feel that waste sorting is difficult, the effect will be reduced.

19 of the findings fall outside REN’s jurisdiction but have a direct influence. Of these 19, 12 findings (67, 80, 106, 127, 169, 171, 212, 214, 215, 218, 231, 247) give an increased effect. This includes statements and perceptions such as positive attitudes towards waste sorting, level of environmental awareness, waste sorting is convenient and norms in terms of morality and social behaviour. High personal perception of these statements/perceptions increases waste sorting activity, compared with people who have lower perceptions.

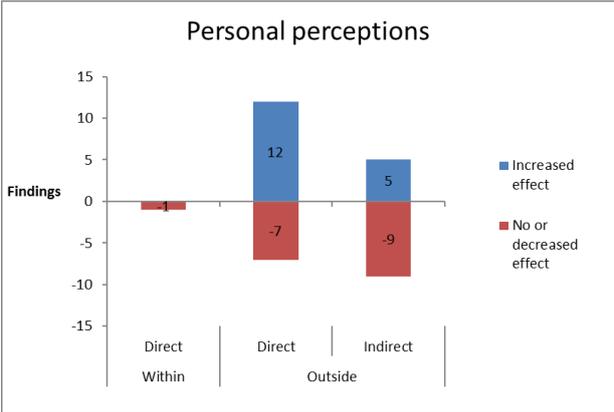


Figure 11– Personal perception

The seven findings (71, 73, 78, 104, 105, 217, 230) that give reduced or no effect include statements and perceptions such as little interest, indifference, lack of attention and experience of amount of effort required for the waste sorting activity. The stronger these perceptions are, the more they reduce waste sorting activities. Personal trust that the waste will be processed correctly has no effect, either.

14 of the findings are deemed to fall outside REN’s jurisdiction and are deemed to have an indirect influence. Of these 14 findings, five findings (186, 188, 199, 200, 233) give an increased effect. These includes statements and perceptions such as feelings of hope and pleasure in the environment, combined with high levels of concern and attitude towards waste sorting correlating with behaviour and knowledge on the subject. This has an increased effect on waste sorting.

Nine findings (6, 102, 170, 175, 187, 219, 256, 267, 275) give reduced or no effect and state that the expressed desire and intention to sort waste are more extensive than the actual behaviour. Previous behaviour/experience has no impact on waste sorting, and there is a discrepancy between individuals’ claimed waste sorting and waste sorting carried out. In other words, users find it easy to overestimate their own waste sorting behaviour in relation to actual behaviour. It is also concluded that a high level of environmental preferences and focus has a negative or no link with waste sorting behaviour. These environmental preferences contradict the findings described above.

Technical. Four findings (29, 27, 28, 118) involve situations that are more technical in nature. These conclude that if “management, cooperation and coordination between stakeholders in the region” and “technical structure of collection equipment and vehicles” are perceived as appropriate, waste

sorting behaviour increases. Closing refuse chutes in high-rise buildings has no positive impact on people’s perception of waste sorting, but despite this it will help to increase waste sorting; see finding (119) in the category Door to door collection scheme.

Summary

The perception that sorting waste at home is difficult and time-consuming reduces waste sorting activities. Other negative perceptions also reduce waste sorting activities. Positive perceptions increase waste sorting activities, with the exception of perceptions relating to the environment, which result in indifference.

5.4 Demographics

The category *Demographics* is made up of 35 findings and includes the groupings “age, “gender”, “housing”, “status”, “size”, “minimisation of waste” and a “miscellaneous” item (Figure 12). Of these findings, only two (198, 204) fall within REN’s jurisdiction. These both involve minimising waste, an activity contradictory to waste sorting. If REN encourages one of these two activities, this will have less effect on the other and so falls within REN’s jurisdiction. The extent to which the various findings have a direct or indirect influence on waste sorting is dependent to an extent on the articles and the interpretation of these. This is deemed to be of less significance as all findings – with the exception of the two referred to – fall outside REN’s jurisdiction. Lack of influence means that REN made shoes to take the findings into account, but there is not much chance of the findings been implemented on REN’s part.

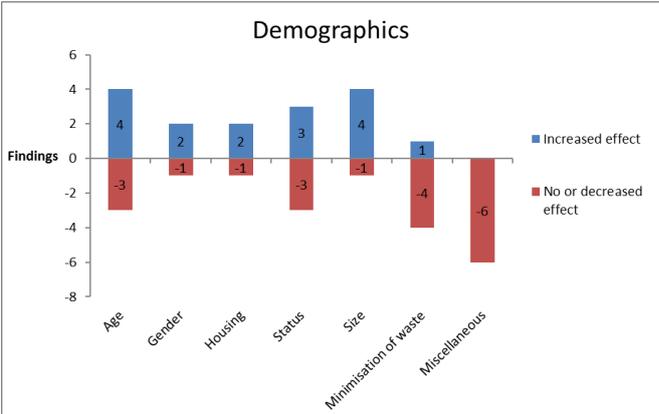


Figure 12 – Distribution of findings, Demographics

Age. Four of the findings (37, 57, 194, 206) conclude that the age of the individual increases the effect on the waste sorting behaviour. Older people sort more waste than younger people. This is confirmed by finding (123), which concludes that young people sort less waste than older people. Findings (34) and (245) conclude that “age is not strongly related to attitudes on recycling”, and so no link is demonstrated between the age composition of households and waste sorting behaviour.

Gender. Two of the findings (58, 168) Conclude that gender is of significance to waste sorting behaviour and that women sort more waste than men in the home. This contradicts (209), which concludes that gender does not influence waste sorting behaviour.

Housing. Two of the findings (36, 208) conclude that households living in individual houses sort more waste than people living in apartments. This is confirmed in (234), Which concludes that it is “more difficult to have high recycling levels in apartment buildings and apartments”.

Status. Includes the explanatory variables finance, education, employment status and degree of stability in the local district. Three of the findings (124, 207, 248) distributed over three articles conclude that well-established adults with high levels of education and high income levels influence waste sorting behaviour more than people who fare worse with regard to these explanatory variables. Three other findings (32, 38, 39) from a single study in Sweden conclude that the same explanatory variables have no effect on waste sorting behaviour. All the articles are based on surveys and literature and are taken from countries in and outside Europe.

Size. The explanatory variables include household composition, and four of the findings (33, 35, 87, 195) conclude that households with multiple occupants, with children and where people are at home during the daytime sort more waste than households with fewer of these explanatory variables. In addition, finding (8) concludes that few participants in the scheme are one reason for low levels of sorted waste.

Minimisation of waste. Finding (202) concludes that “minimisation of waste increases with age, and pensioners are best”. This is confirmed by (203), which concludes that “people with no children living at home minimise waste the most”. Three of the findings (190, 198, 204) conclude that minimising waste and sorting waste are two activities that are contradictory to one another. Hence the people who minimise waste extensively do not sort much waste.

Miscellaneous. Three of the findings (45, 101, 274) focus on multicultural populations in blocks of flats in Sweden, and parts of the findings deviate from other findings with other population structures, and (274) concludes that “differences in culture, climate and finances influence the generation of waste”. Finding (249) concludes that “people who live in towns sort less waste than other people”, and this may be linked with housing types. The findings are linked with segments of residents, (149) grouping the population according to how much waste they produce and (222) showing the size of the two biggest segments sorting waste in the United Kingdom.

Summary

It is indicated that older people sort waste more than younger people, and older women appear to be the best. If these people live in individual houses, waste sorting increases still further. However, the amount of waste generated by these households is limited due to the fact that there are few people in them. Of larger households, women who stay at home with children are most likely to sort their waste. In a multicultural city like Oslo, cultural differences will probably influence waste sorting activities in different ways. In addition, high status individuals appear to be more likely to sort waste than lower status individuals.

5.5 Incentives

The category *Incentives* is made up of 50 findings and includes the groups “Pay as you throw”, “Finance” and “Other incentives”; see Figure 13.

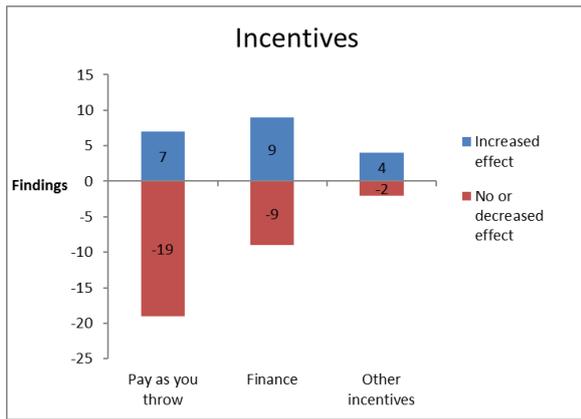


Figure 13 – Distribution of findings, Incentives

Pay as you throw. Refers to different types of scheme where users have to pay directly to dispose of their waste. All these findings are deemed to fall within REN’s jurisdiction (Figure 14).

Seven findings (40, 154, 242, 268, 269, 272, 282) are deemed to have a direct influence and lead to an increased effect. These conclude that pay as you throw increases waste sorting due to the fact that more waste is sorted and the volume of residual waste is reduced.

Six findings (128, 141, 148, 213, 244, 277) have a direct influence but have reduced or no effect. These conclude by saying that weight-based pricing or marginal pricing of residual waste neither reduces residual waste volumes nor increases waste sorting, and leads to more incorrect sorting or fly tipping.

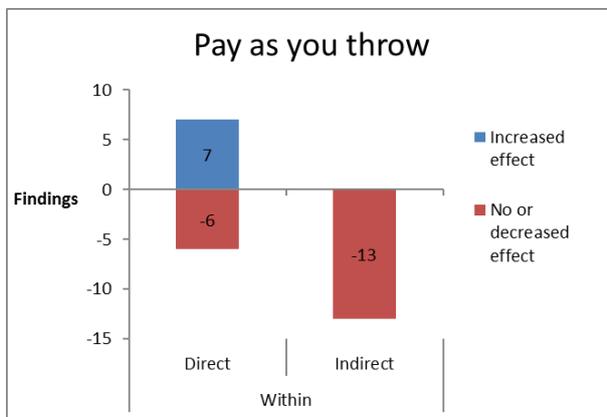


Figure 14– Pay as you throw

All 13 findings with indirect influence, five of the findings (161, 257, 259, 261, 263) conclude that the residual waste volume is reduced and there is less bulky waste in the residual waste, but waste sorting does not increase. Six of the findings (258, 262, 264, 265, 266, 281) indicate that the residual waste volume declines as a consequence of pay as you throw, but where this waste goes is not certain. Burning, dumping, disposal at work and disposal at recycling stations are explanatory variables. The last two findings (243, 260) conclude that if recycling requires a lot of effort, pay as you throw does not work as a measure. One municipality made an attempt but returned to its old scheme. It is worth noting that 10 of these findings (257-266) come from an article from Sweden, with data based on produced volumes.

Finance. This group includes more indirect use of financial means compared with the pay as you throw group.

Of the findings that fall within REN’s jurisdiction, nine have a direct influence (Figure 15). Six of the findings give an increased effect, and of these four (15, 75, 172, 232) conclude that financial incentives, charges and reward systems increase waste sorting. Finding (193) concludes that financial incentives should be implemented together with other measures. Finding (115) concludes that cost increases due to collection are financed by more sorted waste and lower incineration expenses.

Three of the findings (129, 197, 240) with direct influence have reduced or no effect, and conclude that the benefit of introducing financial incentives barely exceeds the costs in areas that already have a range of waste sorting options. Financial incentives for individuals, including discount coupons, do not encourage increased recycling, with the exception of tax cuts.

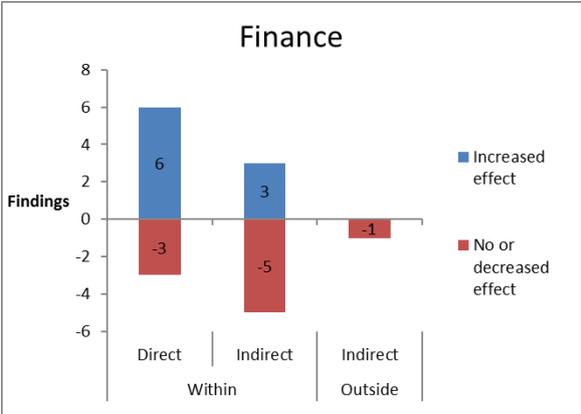


Figure 15 - Finance

Three findings (3, 25, 160) have an indirect influence and give an increased effect. These conclude that fees and operating costs must fall within an accepted level and that the recycling level can be increased by 2% if you spend 1\$ per person and year on training people how to sort waste.

Of the five indirect measures with reduced or no effect, four of the findings (250, 252, 254, 273) conclude that “inner motivation” may be weakened by using financial incentives, and so the structure is important. The fifth (251) concludes that people who sort waste in order to save money do not sort more waste than other households.

The finding (150) outside REN’s jurisdiction and with an indirect influence concludes that tax linked with improvement of recycling schemes has an uncertain effect.

Other incentives. The four findings that increase waste sorting activities (159, 182, 241, 255) are receipt of free containers, more frequent door to door collection, simple rewards, positive feedback and awareness that society is gaining by sorting waste. Contrary to this, (84, 85) conclude that material, moral and other types of incentive do not work.

Summary

Pay as you throw will probably help to increase the amount of waste sorted and reduce residual waste volumes if the scheme is organised correctly. The same is probably true of financial incentives,

but the emphasis should be on “inner motivation” when devising the incentive. Whether the findings grouped under *Other incentives* will have an effect is less certain.

5.6 Knowledge

The category *Knowledge* is made up of 14 findings and includes the groups “skills” and “education”; see Figure 16.

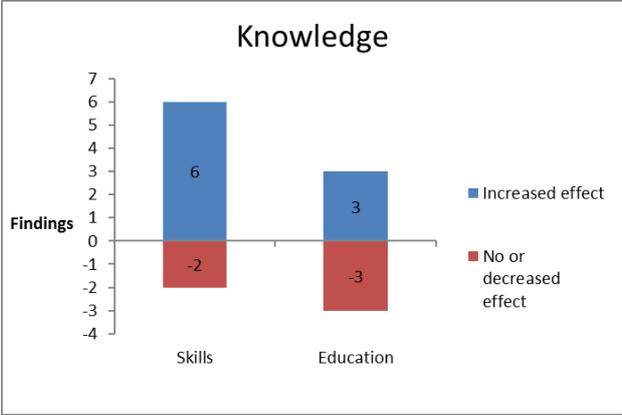


Figure 16 – Distribution of findings, Knowledge

Skills. Includes eight findings which describe skills levels relating to waste disposal in the population and among REN employees. With the exception of one finding, all are deemed to fall within REN’s jurisdiction and have a direct influence (Figure 17).

Five of the findings (66, 69, 76, 81, 174) conclude that people with a good knowledge of waste disposal throughout the entire value chain sort most waste. High levels of professional knowledge among employees who assess and provide guidance in connection with waste solutions also help to increase waste sorting.

The findings in the section above are confirmed by the two findings (74, 226), which give a reduced effect, and conclude that having little knowledge about what is to be sorted or where waste can be dropped off reduces waste sorting. In addition, a lack of skills with regard to what can and cannot be sorted leads to incorrect sorting of waste.

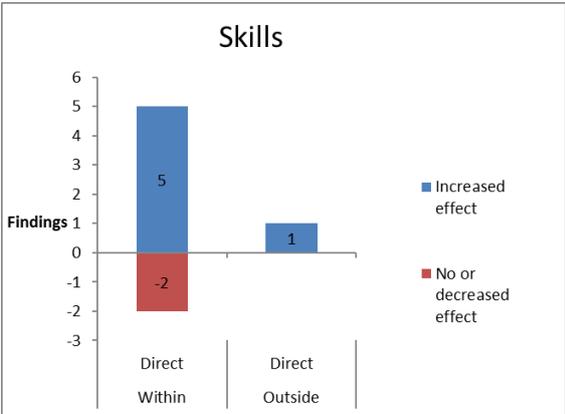


Figure 17 - Skills

The measure outside REN’s jurisdiction concludes that if waste is sorted at work, sorting of waste at home increases (196).

Education. Includes six findings focused mainly on a general education level. All these findings have an indirect influence, and only one (31) falls within REN’s jurisdiction (Figure 18). This concludes that an education programme – in schools, for example – increases waste sorting behaviour.

Two findings (30, 56) are outside REN’s jurisdiction and conclude that the level of education and awareness in respect of waste disposal increases the effect on waste sorting.

This contradicts the findings (130, 173, 210), where it is concluded that the education level has no effect on waste sorting. See the group “status” In the category Demographics, p. 16.

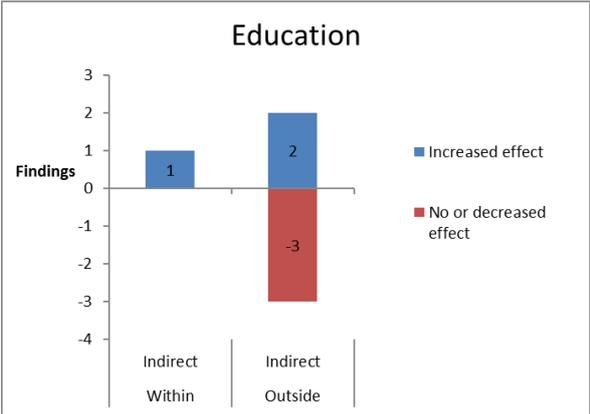


Figure 18 - Education

Summary

High skills levels among employees and users linked with waste disposal will increase the sorting of waste. Whether the general level of education affects the sorting of waste is less certain, but the sorting of waste will probably increase if a high level of education is combined with a high awareness of waste disposal.

5.7 Communication

The category Communication is made up of 21 findings and includes the groups “channel”, “clarity” and “formulation” (Figure 19).

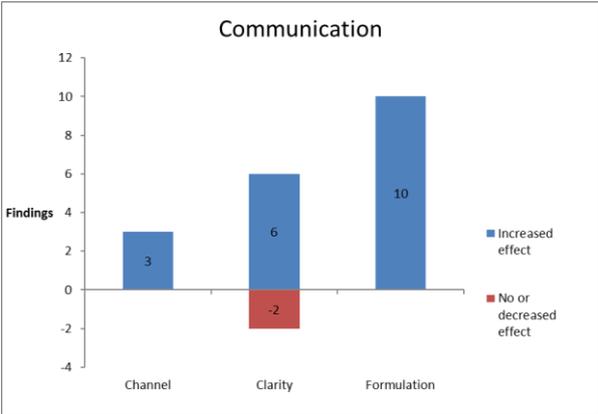


Figure 19 – Distribution of findings, Communication

Channel. All the findings fall within REN’s jurisdiction, have a direct influence on waste sorting and include the three findings (86, 177, 179). These findings conclude that direct information to households, direct marketing (B2C) and use of drivers for the door to door collection scheme as agents for information linked with waste sorting increase waste sorting behaviour.

Clarity. Includes a total of eight findings, all of which have a direct influence and fall within REN’s jurisdiction. Six findings (16, 20, 77, 109, 116, 216) give an increased effect and conclude that clarity in sorting instructions and written information that is simple and comprehensible and written in people’s native language help to increase waste sorting. In addition, information campaigns and education strategies must be clear and distinct. Segmentation and adaptation of messages and communication must be designed in relation to the waste system used by the recipient groups. This will increase waste sorting.

This is confirmed by the two negative findings (54, 64) which concludes that a lack of clarity with regard to what is to be sorted and how this is done, as well as a lack of attention to the obligation to drop off hazardous waste, have a negative effect on waste sorting.

Formulation. All the findings in this group have an increased effect on waste sorting (Figure 20). The three findings (18, 88, 89) fall within REN’s jurisdiction and have a direct influence. This includes measures such as showing households that sorting waste influences the environment positively, showing new products made from sorted materials and encouraging people to compost their own waste and offering equipment for such purposes.

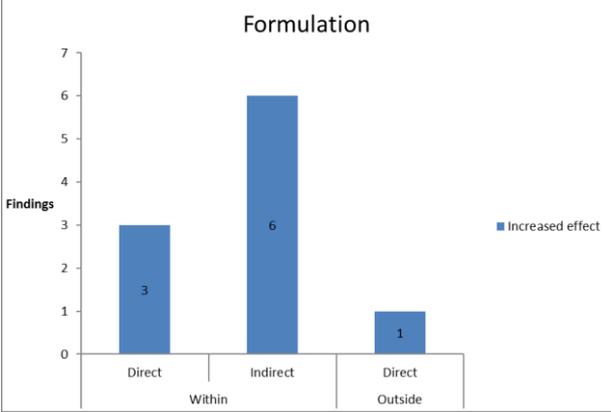


Figure 20 - Formulation

With the exception of (90) “Creating a waste sorting community that is increasing in scope – and presenting this outwardly”, which is deemed to fall outside REN’s jurisdiction, the remaining six findings (144, 167, 181, 183, 184, 185) fall within REN’s jurisdiction and have an indirect influence. This includes measures which conclude with “Waste sorting campaigns should focus on: the individual’s self-image, waste sorting targets, positive attitudes towards all waste types that can be sorted and the fact that individuals should sort all these waste types”. In campaigns, it may be appropriate to encourage a certain sense of anxiety in order to raise awareness of environmental problems among young citizens, but the anxiety aspect should be combined with messages that engender positive feelings and point out the links between behaviour on a day-to-day level and consequences for the environment. The aim of this is to avoid people feeling hopeless, which is not beneficial. In addition, the message should be divided up in respect of the waste activities carried out in the home. This may involve good guidance on the various logistics solutions in the home and activities such as sorting, washing, storage and dropping off the waste; see finding (163) under the category “Method”.

Summary

Where possible, communication should be clear and distinct and communicated as directly as possible to households in a form suited to the recipient's waste system. Using bin lorry drivers for direct communication with households may be effective. The factors described above should be taken into account when formulating the message.

5.8 Laws and regulations

The category *Laws and regulations* includes six findings in the groups "Mandatory" and "Equipment" (Figure 21). All these findings fall within REN's jurisdiction and have a direct influence.

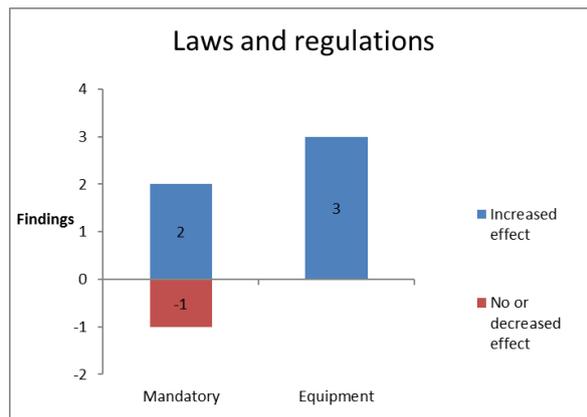


Figure 21 – Distribution of findings, Laws and regulations

Mandatory. Includes three findings, where two findings (14, 108) conclude that mandatory waste sorting programmes work more effectively than voluntary ones. In multicultural areas, the most important reason for participating is the fact that people are required to do so by law. This contradicts (220), which concludes that legal norms have no effect on waste sorting.

Equipment. Includes the three findings (17, 21, 22) which concludes that regulations/orders concerning the use of indoor and outdoor sorting equipment and clear and distinct ownership and cleaning responsibility for containers in the collection scheme increase waste sorting.

Summary

Waste sorting programmes and sorting equipment should be mandatory, with clear allocation of responsibility for ownership and maintenance of the equipment. Applicable rules must be communicated clearly to households.

5.9 Quantify/measure

The category *Quantify/measure* comprises 31 findings and includes information which helps to change waste sorting behaviour and target attainment to a limited extent, but it can be used to compare waste disposal between countries, businesses, the waste product mix and ratios. A decision has been made to combine the common denominators into the following groups; "measurement requirement", "explanatory variable" and "coefficient" (Figure 22). These articles should be reviewed in order to use the information in practical work. The text below shows the type of information found in the articles.

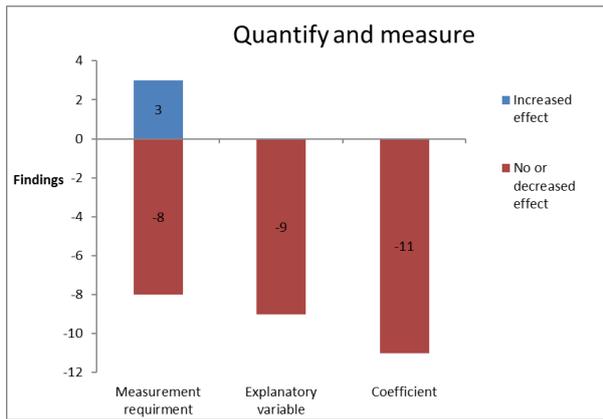


Figure 22 – Distribution findings, quantify and measure

Measurement requirement. Includes 11 findings (Figure 23). It is obvious that the industry has faced challenges on an international level relating to quantification of factors such as production and effectiveness. Of the five findings (2, 4, 7, 9, 140) That fall within REN’s jurisdiction and are classified as “data”, it is concluded that it must be possible to measure actions regardless of how waste disposal is organised, and valid, objective data must be used. In addition, benchmark indicators that can be used jointly by all countries are presented.

The three findings (1, 26, 136) Which all have indirect influence conclude that if private contractors are used, waste volumes must be recorded and checked by a responsible authority, and clear and distinct objectives should be used. This has an increased effect on waste sorting.

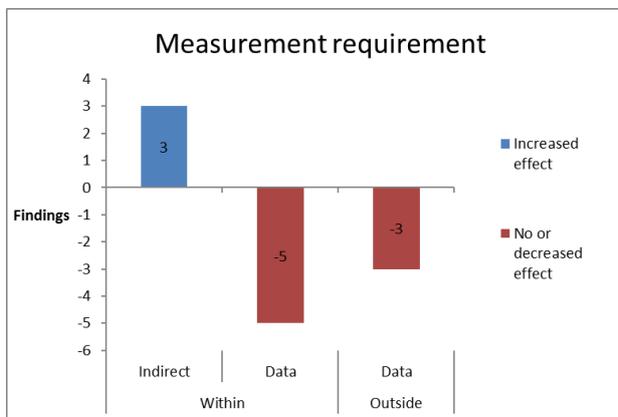


Figure 23 - Measurement requirement

Of the three findings (98, 142, 143) that fall outside REN’s jurisdiction, targets, measurement methods and strengths and weaknesses among individuals are discussed.

Explanatory variable. Includes nine findings, all of which are classified as data. Three findings (10, 60, 62) fall within REN’s jurisdiction and conclude that changing sorting behaviour is one of three explanatory variables with regard to why results in waste sorting systems are changing. In addition, there is a comparison between the effect of waste sorting versus incineration, and it is concluded that incineration without waste sorting has a significant adverse impact on the environment even if this incineration replaces fossil-intensive energy.

Of the six findings outside REN’s jurisdiction, two of the findings (11, 12) conclude that private consumption and product design are numbers two and three of three explanatory variables as to

why results in waste sorting systems are changing. These two findings (46, 221) indicate that there is little seasonal variation in the composition of waste throughout the year. A study from the United Kingdom shows historical development in sorted materials. Finding (97) gives the definitions of household waste in Flanders, Belgium. One definition which deviates from the Norwegian definition as a consequence of the fact that street litter, beach litter, etc. are included in the definition. Finding (100) Provides explanatory variables with regard to what influences the volume of household waste as a function of three variables.

Coefficient. Includes 11 findings (42, 43, 44, 47, 48, 49, 50, 51, 53, 55, 61), all of which are classified as data. All the findings include advance figures such as proportions of materials in residual waste, proportions of impurities in pure waste types, the proportion of food waste in the total amount, the proportion of sorted dry waste, the proportion of weight loss as a result of evaporation, waste generation in kg per capita and year, etc. The spreadsheet file containing the base data provides a good overview of the various findings, with good referrals to the appropriate article.

Summary

Being able to measure correctly as a prerequisite if we are to be able to discuss the effects of various waste solutions. The measurement parameters must be based on valid, objective data viewed in relation to the object to be assessed. Explanatory variables and coefficients have been identified that may be useful when using valid data from various sources to compare waste systems and businesses both nationally and internationally.

5.10 Method

The category *Method* comprises 25 findings and includes the groups “model” and a “miscellaneous” item (Figure 24).

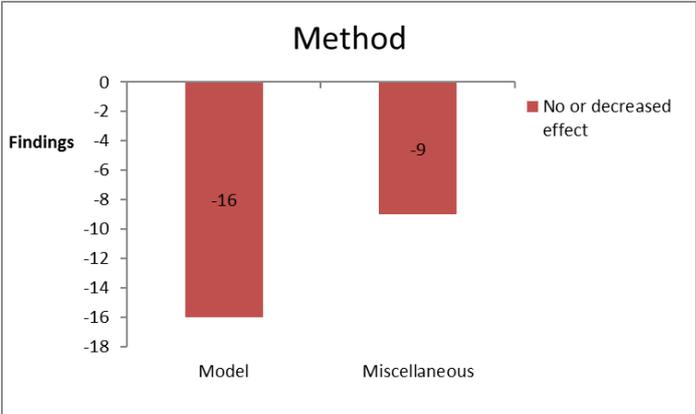


Figure 24 – Distribution of findings, Method

Model. Of the 16 findings, four fall within REN’s jurisdiction (Figure 25). These four findings (137, 138, 139, 189) conclude that several analysis methods should be used on the same assessment, and analyses included must consider all direct and indirect influences, and it may prove effective to establish a mass balance between the input and the output of the waste flows.

Of the 12 findings outside REN’s jurisdiction, the nine findings (91, 92, 93, 95, 134, 135, 162, 176, 192) describe the use of various models such as linear programming, multi-target analyses, life cycle analyses, system dynamics, a segmentation model, a waste minimisation model and a model for behavioural change. Finding (94) points out limitations in the use of models. One finding (276) is

linked with waste analyses and concludes that the deficient standard of waste analyses impedes comparisons of these.

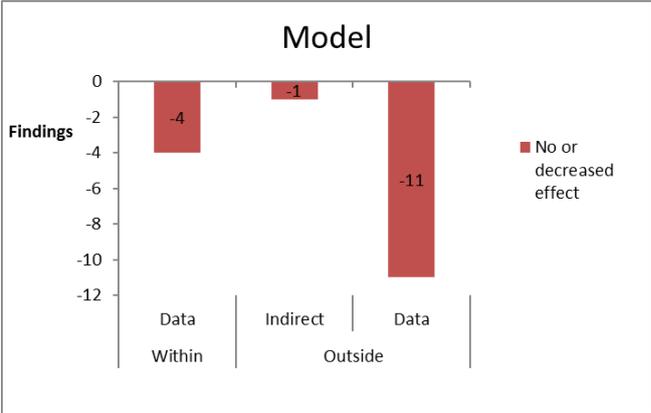


Figure 25 - Model

Finding (131), which has an indirect influence, looks at how research can be arranged for better use in political decisions.

Miscellaneous. Includes nine findings, three of these (41, 132, 133) falling within REN’s jurisdiction (Figure 26). These argue for use of the expression “waste sorting level” and not “recycling level”. Three different waste solutions in Montenegro are described, and (133) discusses how smartphone apps can help to persuade people to sort their waste.

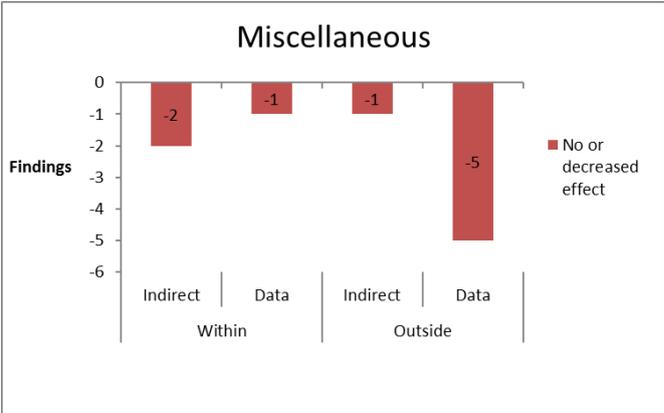


Figure 26 - Miscellaneous

Of the six findings outside REN’s jurisdiction, finding (96) shows a model that presents the dynamic link between the various processing forms and use of the model for establishment of targets. Finding (99) defines minimisation of waste, while finding (180) provides useful input on questions in surveys and summarised explanations of various psychological parameters. Finding (163) divides waste sorting in the home into three different logistics solutions depending on how much space each individual household has for storage of waste; see finding (166) under the category Drop-off scheme on p. 13. Finding (223) shows a model that takes into account positive and negative “spillovers” when people sort waste.

Finding (191), which is deemed to have an indirect influence, concludes that there is no consensus as regards theoretical models for behavioural change.

Summary

This category provides a good overview of methods used in assessment of waste solutions. It may be sensible to use a number of different methods for one and the same problem. There may be some handy hints to apply if surveys are to be formulated.

6. Assessment of findings

The categories can be grouped into three different main groups indicating which REN activities are affected.

6.1 Service offering

Main group one includes REN's service offering and how this can be formulated. The categories *Door to door collection scheme* and *Drop-off scheme* are included here. The findings linked with the category *Door to door collection scheme* are fairly and ambiguous. Of 39 findings, 29 of these are based on articles that use produced volumes as a basis, and only three of the findings have reduced or no effect on sorted waste types. In our opinion this gives the findings a great deal of validity, and it is concluded – among other things – that door to door collection schemes are more effective than drop-off schemes. It will be difficult not to take into account findings in the category *Door to door collection scheme* when assessing changes to the service offering. In addition, approx. 70% of the residual waste currently sent for energy recovery from the door to door collection scheme is waste that can be sent for recycling⁵ and for which REN has established logistics solutions. This reinforces the effect of the survey's findings.

As regards the category *Drop-off scheme*, the findings are less unambiguous due to the fact that the articles largely use survey forms other than produced volumes, and also the fact that a number of findings appear to be negative. Despite this, along with the fact that door to door collection schemes are more effective than drop-off schemes, REN wishes to maintain, and if possible extend the drop-off offering in the foreseeable future. However, given the findings the potential for development of the drop-off scheme is significantly smaller than for the door to door collection scheme. This is applicable to the formulation of the service offering itself, but also to the effect of the waste types on recycling, to a certain degree. As regards the formulation of the drop-off scheme's service offering, REN is currently making strenuous efforts to follow the findings that have been identified, and so the potential for development is limited. As regards the processing form, it has proven difficult to take the waste types received at REN's recycling stations which currently pass materials on for energy recovery and landfill, and move these up in the waste hierarchy. We therefore conclude that the door to door collection scheme has greater potential for development than the drop-off scheme; as regards both development of the service offering and delivering waste types for recycling.

6.2 Communication

Main group two includes all aspects related to communication. The main group includes more than the category *Communication*. The findings in the category *Communication* focus on *how* the waste sorting message should be communicated and in which *channels*. The main group context also includes *what* the message should include and *to whom* it should be addressed. This includes findings from all the categories, with the exception of main group three. In such a situation, communication is dependent on how the service offering is formulated and the structure of the demographic and other

⁵ Municipality of Oslo, Kommunerevisjonen – report 8/2015, Waste sorting, p. 23

waste sorting criteria in the catchment area in question. Differentiation of the service offering beyond the current provision will probably be necessary in order to increase the recycling level. Such differentiation will help to make the overall picture more complex in terms of communication. As a result of this complexity, the formulation of messages and dissemination of communication will become more complicated, increasing the likelihood of users receiving incorrect information.

Despite what is specified above, in our opinion it would be wrong to fail to implement changes to the authority's service offering that would have a positive effect on recycling levels, even if communication work is made more difficult and there is an increase in incorrect information. The unwanted effects in this context are to be regarded as a cost that REN has to deal with in order to increase the recycling percentage.

6.3 Residuals

Main group three includes categories that initially have no direct or indirect influence on the service offering or recycling. The categories *Quantify/measure* and *Method* are included here. No further comment will be made on these two categories in the report, but they are provided for information that can be used in connection with other work within the authority.

7. Error sources

The above rests on a number of assumptions and interpretations that may help to skew the representation and ultimately undermine the validity of findings and conclusions. The error sources with which we ourselves are familiar are described below:

- Excerpts from articles. We assume that both search terms and collation of articles provide a representative view of experiences with waste sorting solutions. It is possible that interesting findings have been omitted due to the fact that correct articles have not been identified, printed and reviewed.
- Findings. The findings have been identified by reading through the articles and then translating them from English and formulating them concisely in Norwegian. Lack of identification, incorrect or distorted translation and missing nuances in the definition of findings worded in Norwegian are all error sources linked with this work.
- The structuring of the findings into categories, groups and effects may be incorrect, with the results being skewed and the recommendations being less valid as a consequence.

In our opinion, the biggest risk is associated with the first bullet point, lack of identification of articles. On the other hand, the search was initially stopped when the search terms were unable to identify new articles with new topics within the period 2002-2015. Older articles were deemed to be too old.

Quality assurance has been carried out for some of the findings for bullet point two, but not all have been reviewed. For the ones that have been double-checked, not much has been changed in relation to the substance of the findings.

For bullet point three, changes were made to the original categorisations, effectiveness assessments and groups for many of the findings when the results were summarised. Quality assurance has corrected a number of defects.

This quality assurance is not all-encompassing, and we are unable to guarantee that all errors have been rectified. Despite this, we are of the few that the findings are valid in instances where the summing-up of the findings is clear and distinct.

8. Status objective

As regards section 1 of the objective, it can be concluded that a set of new measures has been identified and taken from international published studies.

As regards section 2 of the objective, in our opinion the measures are summarised appropriately. It remains to be seen the extent to which these can be used as input in the system dynamics simulation model.

As regards section 3 of the objective, a spreadsheet has been compiled in which articles and all data linked with individual articles have been recorded and hence documented in greater detail than has been possible in this report. It should be possible for other people to use this when doing other work within the authority.

9. Recommendation

Insofar as it is possible to implement and simulate effects in the system dynamics model, we recommend assuming the following:

1. The number of sorted waste types in the door to door collection scheme must be increased as much as possible. This will be dependent on the space for setting out more containers. New containers beyond the current two-container system are primarily intended for a new waste type/new waste types that are currently included in residual waste but are covered by the drop-off scheme (category *Door to door collection scheme*).
2. The door to door collection frequency for sorted waste types is sufficiently high to ensure that overfilling of containers is avoided (category *Door to door collection scheme*).
3. The door to door collection frequency for residual waste containers and/or the volume of residual waste containers will be reduced. The current solution involving visual sorting must not be phased out at present. Food waste and plastic packaging is sorted into their coloured bags, as well as residual waste discarded in the same container, should be one of the solutions simulated. It is assumed that REN's Control apparatus will maintain control over the problem of littering (category *Door to door collection scheme*).
4. Refuse chutes in High-rise buildings will be closed (category *Door to door collection scheme*), and households in high-rise buildings will have to go and drop off their waste in waste areas.
5. The category *Communication* aims to encourage the positive waste sorting findings and reduce the negative waste sorting findings in the category *User experience* and to utilise the categories *Laws and regulations*, *Demographics* and *Knowledge*.
6. The category *Incentives* will be formulated so that these incentives provide support to the changes in the service offering so that this is used as intended to the greatest extent possible.
7. The drop-off scheme will continue as planned (category *Drop-off scheme*).

Appendix 1 – Findings

Findi ng no.	Finding	Art. no.
1	When using private contractors, waste volumes must be recorded and checked by a responsible authority	1
2	It must be possible to measure actions (1)	1
3	Fees per household should not exceed 2% of household income in “middle-income” countries (2)	1
4	Benchmark indicators the same for all countries, Table 1 (3)	1
5	Door to door collection scheme for pure waste types, duplicate sorting in the home (10)	2
6	There is a discrepancy between individuals’ claimed and actual waste sorting (1)	2
7	It must be possible to measure actions (2)	2
8	Not much waste is sorted due to the fact that there are few participants (3)	2
9	It must be possible to measure actions in an unambiguous way so that they can be evaluated (4)	2
10	Change in sorting behaviour (5) No. one of three explanatory variables as to why output is changed in a waste sorting system	2
11	Change in private consumption (5) No. two of three explanatory variables as to why output is changed in a waste sorting system	2
12	Change in product design (5) No. three of three explanatory variables as to why output is changed in a waste sorting system	2
13	Number of waste types collected individually – better to have more than fewer (11)	2
14	Voluntary or mandatory waste sorting programme – mandatory is more positive than voluntary (11)	2
15	Formulation of fees systems and financial incentives – works more positively than without (11)	2
16	Information strategies and clarity in sorting instructions have a positive impact (11)	2
17	Regulations/orders concerning the use of indoor sorting equipment, where applicable list the type of equipment – has a positive influence (11)	2
18	Encouragement for private composting and offer of equipment – has a positive influence (11)	2
19	Convenience and simplicity for users as regards the formulation of the door to door collection scheme – has a positive influence (11)	2
20	Container and bag types collected through the collection scheme – clarification has a positive influence (11)	2
21	Provisions relating to container and bag types that constitute approved equipment in the collection scheme – clarification has a positive influence (11)	2
22	Ownership and cleaning responsibility for containers in the collection scheme – clarification has a positive influence (11)	2
23	Readily accessible drop-off schemes (distance, along transport routes, etc.) Simplicity has a positive influence (11)	2
24	Good functionality and attractive drop-off schemes have a positive influence (11)	2
25	Accepted operating cost/fee levels have a positive influence (11)	2
26	Clear objectives have a positive influence (11)	2
27	Technical design of collection equipment and vehicles – if these are perceived as appropriate, this has a positive influence (11)	2
28	Accessibility of alternative ways of dropping off waste (11)	2
29	Management, cooperation and coordination between stakeholders in the region (11)	2
30	Level of education and awareness with regard to waste disposal (11)	2
31	Education programmes, e.g. in schools, etc. (11)	2
32	Household finances (11)	2
33	Household size (number of residents) (11)	2

Findi ng no.	Finding	Art. no.
34	Household age composition (11)	2
35	Number of people in the household at home during the day (11)	2
36	Property type (individual house, terrace, block, etc.) (11)	2
37	Age composition in the area (tenure?) (11)	2
38	Stability and cooperation in the local area (11)	2
39	Employment status (in work/unemployed) (11)	2
40	Weight-based fees reduce the amount of waste (6)	2
41	Designation of waste sorting (7)	2
42	Proportions of materials in residual waste (8)	2
43	Proportions of impurities in pure waste types (9)	2
44	Waste generation share (9) (kg/res. year)	2
45	Multicultural population in apartment blocks (7)	3
46	Little seasonal variation in the composition of waste throughout the year (1)	3
47	Food waste accounted for approx. 30% of the total amount of waste in the area (2)	3
48	The paper/cardboard waste type is a large waste type, in addition to food waste (3)	3
49	Does not constitute recycling waste types approx. 21% of total waste (4)	3
50	Sorted dry recyclable waste constitutes approx. 26% (5), the paper being the major driver at approx. 75%	3
51	Food waste is reduced by approx. 5% in weight in plastic bags per week (6)	3
52	Ability to sort hazardous waste in the door to door collection scheme increases the sorting of hazardous waste (7)	3
53	Weight loss as a result of the evaporation of water (8)	3
54	Lack of clarity with regard to what should be sorted has a negative influence (9)	3
55	Sorted waste makes up approx. 33% of the total (10)	3
56	Level of education and awareness with regard to waste disposal influences waste sorting (11)	3
57	Age affects waste sorting (waste sorting increases with age) (11)	3
58	Gender affects waste sorting (11)	3
59	Accessibility alone is not enough to increase the amount of sorting (12)	3
60	Incineration without waste sorting has a significant negative environmental impact, even if incineration replaces fossil-intensive energy (1)	4
61	60% of environmental effects from waste sorting come from metal packaging and plastic alone (2)	4
62	Effect of waste sorting versus incineration	4
63	Long distances to the drop-off points have a negative influence (1)	5
64	Lack of attention to drop-off obligations for HW has a negative influence (2)	5
65	Increased accessibility of recycling stations increases the sorting of hazardous waste (3)	5
66	Good knowledge of downstream solutions has a positive influence (4)	5
67	Increased environmental awareness increases waste sorting (5)	5
68	Increased facilitation/accessibility of facilities, etc. increases waste sorting (5)	5
69	Increased awareness and knowledge of waste disposal increase waste sorting (5)	5
70	Insufficient space in houses/apartments for sorting waste reduces waste sorting (5)	5
71	Sorting/dropping off HW not suiting the individual reduces waste sorting (5)	5
72	Having insufficient time to sort/drop off HW reduces waste sorting (5)	5
73	Having little interest in sorting/dropping off HW reduces waste sorting (5)	5

Findi ng no.	Finding	Art. no.
74	Knowing little about what is to be sorted or where HW can be dropped off reduces waste sorting (5)	5
75	Reward system when dropping off HW increases waste sorting (6)	5
76	High levels of professional knowledge among employees who assess and provide guidance in connection with waste solutions increase waste sorting (7)	5
77	Segmentation and adaptation of messages and communication in respect of waste systems in relation to recipient groups increase waste sorting (8)	5
78	Indifference of residents has a negative influence (1)	41
79	Residents perceiving waste sorting to be difficult has a negative influence (1)	41
80	Positive attitude being more important than incentives to participate in waste sorting has a positive influence (1)	41
81	Well informed households with good drop-off points have a positive influence (2)	41
82	Good accessibility and tidiness at drop-off points have a positive influence (2)	41
83	Simplification of sorting and drop-off does not work (3)	41
84	Receiving material or moral incentives does not work (3)	41
85	Cooperation and support from other incentive types does not work (3)	41
86	Direct information to households has a positive influence (4)	41
87	Households with children sort more waste than households without children (5)	41
88	Showing households that waste sorting influences the environment positively has a positive influence (6)	41
89	Showing households new products made from sorted waste has a positive influence (7)	41
90	Creating a waste sorting community that is increasing in scope – and presenting this outwardly has a positive influence (8)	41
91	Models – Linear programming models for simulation of waste systems (1)	6
92	Models – multi-target approach (2)	6
93	Models – Life Cycle Analysis – LCA (3)	6
94	Limitations in the use of models (4)	6
95	Benefits of using SD models (5)	6
96	Objectives of the study (6)	6
97	Household waste definition (7)	6
98	Targets in the waste plan (8)	6
99	Minimisation of waste – definition (9)	6
100	Household waste as a function of three variables (10)	6
101	Multicultural population in apartment blocks	7
102	High environmental focus does not influence waste sorting (1)	7
103	Satisfaction with drop-off facilities does not influence waste sorting (2)	7
104	Personal trust that the waste will be processed correctly does not influence waste sorting (2)	7
105	Identifying with the community, etc. does not influence waste sorting (2)	7
106	Positive attitude towards waste sorting has a positive influence (3)	7
107	The biggest obstacle to waste sorting was “a lack of space” at home (4)	7
108	The most important for participation was acceptance of the fact it was required by law (5)	7
109	Written information, clear, simple, comprehensible and written in the native language – has a positive influence (6)	7
110	Increase the number of waste types in the door to door collection scheme (1)	8

Findi ng no.	Finding	Art. no.
111	Increase the door to door collection frequency for clean sorted waste as part of the door to door collection scheme (1)	8
112	Reduce the frequency of residual waste door to door collections (1)	8
113	Set out fewer residual waste containers (1)	8
114	Unmanned drop-off points result in dumping grounds and unsanitary conditions (2)	8
115	Cost increases due to collection are financed by more sorted waste and lower incineration expenses (3)	8
116	Good, accurate information is important – in connection with new system rollout (4)	8
117	A door to door collection scheme is more effective than a drop-off scheme for waste sorting	9
118	Closing refuse chutes does not contribute positively to people’s perception of waste sorting (5)	10
119	Closing refuse chutes in apartment blocks helps to increase waste sorting (1)	10
120	I do not have time to sort/drop off waste (2)	10
121	I do not have the space at home to sort waste (2)	10
122	I am worried about unwanted odours (2)	10
123	Young people sort less than older people despite intending more widely to do so (3)	10
124	Adults, well established people and people with high levels of education sort more waste than people who are not in such a position (4)	10
125	The door to door collection scheme for pure waste types increases sorted waste by 116.33 kg per res. per year compared with people who do not have such a service available (1)	11
126	Counties with a developed “recycling product market” collect 66.45 kg more sorted waste per res. per year than people who do not have such a market (2)	11
127	Households that are concerned with the environment sort more waste than households that do not have this focus (3)	11
128	Pay as you Throw does not work as regards waste sorting (4)	11
129	Recycle Bank does not work as regards waste sorting (5)	11
130	Level of education and party affiliation have no impact on waste sorting (6)	11
131	Use of research results in respect of decisions	13
132	Description of 3 waste solutions	14
133	Use of a mobile app linked with waste sorting	15
134	Different analysis methods	16
135	Brief description of 13 analysis methods – Table 1 (6)	16
136	Clear targets are important (1)	16
137	Use several analysis methods in the same assessment (2)	16
138	Comprehensive analyses must include all direct and indirect influences (3)	16
139	Establish a mass balance between input and output in the waste flows (4)	16
140	Use valid and objective data (5)	16
141	Weight-based pricing of residual waste – does NOT work	18
142	The article indicates methods for measuring waste minimisation (1)	17
143	The article indicates strengths and weaknesses of the individual measuring methods (2)	17
144	Message/influence of households to sort more waste should be divided up in relation to the activities involving waste that are carried out in the home. E.g. sorting, washing, storage, drop-off (1)	19
145	The door to door collection scheme for sorted waste will influence households in the “right” direction BUT will not affect people who have strong “anti waste sorting” attitudes (2)	19
146	Fewer residual waste containers mean less residual waste and more sorted waste (1)	20

Findi ng no.	Finding	Art. no.
147	Setting out fewer residual waste containers does NOT result in unwanted political and adm. side-effects (2)	20
148	Volume-based marginal pricing of residual waste does NOT reduce residual waste (3)	20
149	Segmentation of households into 11 categories with regard to production of waste volume	21
150	Tax related to the improvement of return schemes	22
151	The recycling level increases with the number of sorted waste types (1) + (11)	37
152	If waste sorting is increased by one waste type, this results in better sorting for the other waste types (7)	37
153	Weekly door to door collection of sorted waste seems more positive than less frequent collections (2)	37
154	Municipalities that have always had pay as you throw sort more waste, but municipalities that introduce this during the survey period do NOT increase waste sorting (10)	37
155	Single-flow door to door collection is better than multi-flow door to door collection (2) + (11)	37
156	The door to door collection scheme improves the recycling level more than the drop-off scheme (3)	37
157	A door to door collection scheme for sorted waste with the same frequency as door to door collection of residual waste ensures that users find it “convenient” to sort waste (4)	37
158	A lack of storage space (at home) and inappropriate materials to sort make a negative contribution (5)	37
159	People who do not participate in waste sorting should be identified so that they can receive free containers and more frequent collection (6)	37
160	The recycling level can be increased by 2% if you spend 1\$ per person and year on training people how to sort waste (8)	37
161	Pay as you throw helps to reduce waste volumes but not increase recycling (9)	37
162	Segmentation model – see REN	34
163	The article categorises and describes how waste sorting in the home can be carried out under 3 different logistics systems	32
164	It should be possible to transport sorted waste to good, hygienic collection points (1)	32
165	The door to door collection unit must be adapted to the logistics system used by users (2)	32
166	Close proximity to the drop-off point is important, especially for the “just in time” solution (3)	32
167	Good guidance on the three logistics solutions could import sorting in the home (4)	32
168	Women sort more waste in the home than men (5)	32
169	A positive attitude towards waste sorting has a positive influence (6)	32
170	A positive attitude towards environmental conservation is not linked with waste sorting behaviour (7)	32
171	Individualists sort more waste than collectivists (8)	32
172	Financial incentives work (9)	32
173	Education level has no impact on waste sorting (10)	32
174	The best informed people sort waste most extensively (11)	32
175	Environmental behaviour is independent of stated environmental preferences	35
176	The article looks at how multi-criterion analysis methods are used in the waste industry	25
177	Use direct marketing B2C (1)	30
178	Introduce and expand the door to door collection scheme (2)	30
179	Use the collection scheme’s drivers as agents for info related to waste sorting (3)	30
180	Explanation of how psychological variables are defined in the questionnaire (4) Table 2	30
181	Campaigns for waste sorting should focus on individuals’ self-image and waste sorting targets (1)	33

Findi ng no.	Finding	Art. no.
182	Reminders of individuals' waste sorting identity can be given by means of simple "rewards" such as fridge magnets or post-it notes on containers (2)	33
183	Campaigns for waste sorting should focus on positive attitudes towards all waste types that can be sorted and that individuals should sort all these waste types (3)	33
184	In information campaigns, it may be appropriate to encourage a certain sense of anxiety in order to raise awareness of environmental problems among young citizens (1)	31
185	The anxiety aspect in (184) above should be combined with messages that engender positive emotions and point out the link between behaviour on a day-to-day basis and consequences for the environment in order to avoid a sense of hopelessness (2)	31
186	A sense of (joy) with regard to environmental problems affected waste sorting more positively than a sense of worry with regard to environmental problems (3)	31
187	A sense of hope for the environment combined with low worry has a negative impact on waste sorting (4)	31
188	A sense of hope for the environment combined with high worry has a positive impact on waste sorting (5)	31
189	Behaviour change model (1)	12
190	Minimising waste and sorting waste are two activities that are contradictory to one another (2)	12
191	There is no consensus as regards theoretical models for behavioural change (3)	12
192	Models – models are presented for method use, focus areas, analytical framework, etc. (4)	12
193	Financial incentives should be implemented together with other measures in order to increase waste sorting (1)	42
194	Age affects waste sorting (1) – Older people sort more waste than younger people	43
195	Households with several/many people sort more waste than households with few people (1)	43
196	If people sort waste at work, sorting of waste increases in the home (1)	43
197	The benefits of introducing financial incentives barely exceed the costs in areas that already offer waste sorting (2)	43
198	Sorting waste and minimising waste are two different dimensions that can work "against" one another (1)	44
199	Attitude towards waste sorting correlates with behaviour (2)	44
200	Attitude towards waste sorting correlates with knowledge of the subject (2)	44
201	Attitude towards waste sorting correlates with the availability of a door to door collection scheme (2)	44
202	Minimisation of waste increases with age, and pensioners are best (3)	44
203	People without children at home minimise their waste the most (3)	44
204	Waste minimisation and waste sorting are two behaviours that correlate to a small degree (1)	45
205	Green containers are better than grey, red or blue	46
206	Age has a positive effect on waste sorting (1)	47
207	Income level has a positive effect on waste sorting (1)	47
208	People living in individual houses sort more waste than people who live in apartments (1)	47
209	Gender has NO influence on waste sorting (2)	47
210	Education level has NO influence on waste sorting (2)	47
211	Door to door collection schemes increase waste sorting in both high-rise buildings and individual houses (3)	47
212	People who feel that waste sorting is convenient sort waste more extensively (4)	47
213	Unit pricing does not influence waste sorting (5)	47
214	High moral standards have a positive influence on waste sorting (6)	47
215	The degree of environmental awareness has a positive influence on waste sorting (7)	47

Findi ng no.	Finding	Art. no.
216	Information campaigns and educational strategies have a positive influence on waste sorting when they are clear and distinct (8)	47
217	Personal effort to sort waste has a negative influence on waste sorting (9)	47
218	Norms of social behaviour have a positive influence on waste sorting (10)	47
219	Past behaviour has NO influence on waste sorting (11)	47
220	Legal norms have NO influence on waste sorting (12)	47
221	Historical development in sorted materials (1)	48
222	Table 1 shows the size of the two biggest segments responsible for waste sorting in the UK	48
223	Figure 2 shows a model that takes into account positive and negative “spillovers” when people sort waste	48
224	Most people believe that storing recycled waste until collection day is not a problem (14.2-14.4)	23
225	Most people believe that increasing the door to door collection frequency does not lead to people recycling more (13.1-13.3)	23
226	Incorrect sorting due to a lack of knowledge of what can/cannot be recycled (15.1,18.1-18.2)	23
227	Most people sort waste even if it requires cleaning (16)	23
228	Half of all respondents believe that they would not have recycled more even if they had had more space (14.1)	23
229	An extended door to door collection scheme is of significance when it comes to persuading residents to recycle more (12.1-12.3)	23
230	People who do not care about recycling use the drop-off scheme much less than committed people (17)	23
231	Non-committed people recycle to a greater extent due to orders and because others do it (21.1-21.3)	23
232	Young, non-committed people in urban areas will sort more waste if given an incentive (22.1-22.2)	23
233	Committed people recycle in order to help improve the environment (20/21.1)	23
234	More difficult to have a high recycling level in apartment buildings and apartments (1)	24
235	Higher collected tonnage of garden waste when door to door collection takes place weekly (2)	24
236	Increase the door to door collection frequency for recycled waste (3 – appendix)	24
237	Extended door to door collection scheme has a positive effect (4 – appendix)	24
238	Reduced the door to door collection frequency for residual waste (5 – appendix)	24
239	Improved door to door collection scheme gives more encouragement than financial incentives (1)	26
240	Financial incentives for individuals do not encourage increased recycling (2.1) Exception: tax cuts	26
241	Increased motivation to recycle if the community is rewarded for it (2.1 and 2.2)	26
242	Weight-based pay as you throw leads to reduction in residual waste and increased recycling (4.2)	26
243	If recycling requires a lot of effort, pay as you throw does not work as a measure (4.3)	26
244	Weight-based pay as you throw can lead to increased illegal dumping of residual waste (4.4)	26
245	Age is not strongly related to attitudes towards recycling (3.1)	26
246	Alternative cost for time has a negative effect on recycling (4)	27
247	People recycle because it is their civic duty and they want to contribute to a better environment (3)	27
248	Recycling effort increases with income, the number of people in the household, the property type and how long people have lived in a location (4)	27
249	People who live in towns recycle less than others (4)	27
250	Differentiated fees may signal that it is fine to pay rather than recycling. May weaken inner motivation (1)	27

Finding no.	Finding	Art. no.
251	People who recycle in order to save money recycle no more than other households (5)	27
252	The design for financial incentives is extremely important so as to avoid weakening inner motivation for recycling (8.2)	27
253	The door to door collection scheme for recycled waste has a significant effect (5)	28
254	Inner motivation is more important for recycling than financial incentives (1.1)	28
255	External influence can strengthen inner motivation by means of positive feedback on behaviour (1.2)	28
256	Expressed willingness to recycle does not match the actual behaviour (2)	28
257	Growth-based pay as you throw has in some cases led to reduced waste volumes, but not in other cases (3)	28
258	Unknown what influence weight-based pay as you throw has on the residual waste flow (4)	28
259	Reduced waste volumes with weight-based pay as you throw. Cannot be explained by increased recycling (kg/c*y). (6.1-6.2)	28
260	One municipality went back to its old solution after having tried weight-based pay as you throw (7)	28
261	Less bulky waste among residual waste in the case of weight-based pay as you throw (8)	28
262	Reduced collection frequency in the case of weight-based pay as you throw (8)	28
263	Reduced waste volumes initially, gradually increased in the case of weight-based pay as you throw (8)	28
264	Residual waste dropped off by mistake at recycling stations in the case of weight-based pay as you throw (8)	28
265	Private incineration of waste in the case of weight-based pay as you throw (8)	28
266	Residual waste dropped off at the workplace in the case of weight-based pay as you throw (8)	28
267	Intention is not a significant variable for recycling behaviour (1)	29
268	Households with weight-based pay as you throw recycle and compost more waste than households with fixed fees (1)	36
269	Increased information and education are not enough to achieve the same effect as with weight-based pay as you throw (3)	36
270	50% more recycling of metal, plastic and paper by means of a door to door collection scheme rather than a drop-off scheme (3) (kg/cap*y)	39
271	Less recyclable waste among residual waste in the case of the door to door collection scheme. The biggest impact is on food. (4.1-4.2)	39
272	Reduced waste volumes and increased recycling with weight-based pay as you throw (1, 2.1-2.2)	39
273	Financial incentives lead to weakening of inner motivation for recycling (7)	39
274	Differences in culture, climate and finances affect waste generation (8)	39
275	Expressed willingness to sort waste is greater than the actual waste sorting behaviour (5)	39
276	Lack of standard for waste analyses, thereby impeding comparison	40
277	More incorrect sorting with weight-based pay as you throw (2)	40
278	Just as much dry recycled waste is sorted regardless of whether a door to door collection system or a drop-off system is used 100 kg/cap*y (5)	40
279	Sorting of food waste reduces the residual waste volume and increases recycling (7)	40
280	Introduction of an extended door to door collection scheme reduces the residual waste volume (kg/c*y). Greatest impact with weight-based pay as you throw (1)	40
281	Unclear whether weight-based pay as you throw changes attitudes or whether this waste is dumped (4)	40
282	Sorting of food waste with weight-based pay as you throw increases waste sorting more than without pay as you throw (0)	40

Appendix 2 – Bibliography

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