VANG

HOUSEHOLD WASTE

Samen geven we afval een nieuw leven

Improving waste separation in high-rise buildings

Increased source separation of organic waste in cities through behavioural change

Implementation programme VANG Household Waste
July 2020

'High-rise buildings and the separation of organic waste were long believed to be incompatible. Our participation in this project on Java-eiland in Amsterdam-Oost has demonstrated - partly thanks to the collaboration of residents - that this is indeed possible. Over the coming years, we will use the experiences we have acquired during this project to facilitate the separate collection of organic waste throughout all of Amsterdam. This helps preserve the raw materials we so desperately need and paves the road towards a waste-free city.'

Marieke van Doorninck
Alderman for Spatial Development and Sustainability,
Municipality of Amsterdam

'In Schiedam, we produce twenty-five percent less residual waste than in similar municipalities. We owe this success to the combination of source and subsequent separation that we utilise. Part of our residual waste still consists of fruit, vegetables, garden waste and food waste. In order to optimally process this waste material via composting, source separation is the best method to use. This study offers us guidelines to successfully utilise source separation in high-rise buildings as well.'

Jeroen Ooijevaar
Alderman, Municipality of Schiedam

'In Utrecht, as elsewhere, waste separation in high-rise buildings continues to pose a challenge, especially in built-up areas with limited public spaces. We can use the results of this project as starting points for the plans we intend to develop for the coming years in the form of our new Resources Memorandum. This project also demonstrates that you can make greater progress on the road towards a circular economy by working together.'

Klaas Verschuure
Alderman for Circular Economy, Municipality of Utrecht

'Never before has behavioural research into waste separation in high-rise neighbourhoods been conducted at this scale. That is both unique and highly relevant, because substantial environmental benefits can be achieved in these areas. It makes me proud to see so many members of the NVRD take part in this project and commit to taking their waste separation efforts to a higher level.'

Han Noten
President, Royal Dutch Waste Management Association (NVRD)

'In Rotterdam, where not every household has enough space to store multiple waste bins, it is a challenge to properly separate waste. As it makes up 40% of the total volume of household waste, we want to focus our efforts on properly separating organic waste. We will be successful in this. Especially because we will work together with the people of Rotterdam to make it as easy as possible to separate organic waste.'

Bert Wijbenga
Alderman, Municipality of Rotterdam

'The city of the future is a city without waste, where resources are reused. The necessary transition towards a circular economy is a responsibility that we all share. Research into the relationship between behavioural science and waste separation can bring this transition one step closer. I am therefore thrilled that Almere was able to take part in this project.'

Jan Hoek
Alderman for Sustainability, Mobility and Democratic Renewal, Municipality of Almere

'In The Hague, we make sure that all residents - even those living in high-rise buildings - can give their waste a second lease on life. Organic waste is composted, plastic is used to make e.g. roadside posts and old newspapers are turned into toilet paper. Our core principles are reuse, reduced use and recovery. That means repairing or recycling something, instead of simply throwing it out.'

Liesbeth van Tongeren
Alderman for Sustainability, Environment and Energy Transition, Municipality of The Hague

'Rijkswaterstaat has an important social mission; we envision the challenges, opportunities and possibilities for a future-proof country and work to make the Netherlands accessible, liveable and safe. The "Improved waste separation in high-rise buildings" project is a wonderful example of how we collaborate with our chain partners in municipalities, branch organisations and knowledge institutions on the Netherlands of (the day after) tomorrow.'

Michèle Blom
Director-General, Rijkswaterstaat

'The results of the high-rise project have certainly been worth the wait. It is wonderful to see that increasing and improving the collection of organic waste is also possible in high-rise buildings! We can use clean input materials to make the qualitative raw materials that the market demands. That not only goes for organic waste, but also for other waste streams such as PMD. The knowledge we have now acquired about organic waste can also be applied to other waste streams in order to extract even more invaluable resources from residual waste. However, we cannot do this alone.
Close collaboration with our chain partners is essential. We therefore invite municipalities and waste-collection organisations to join us in putting our newly acquired knowledge of possible interventions into practice in order to collect more qualitative organic waste from high-rise buildings. We can use that material to make high-quality compost, which is needed to preserve the healthy soil in which we grow our food. Together, we can pave the road towards a circular economy.'

Robbert Loos
Director, Dutch Waste Management Association

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Preface

Cities in the Netherlands have grown rapidly over the past decades. This growth is expected to continue for the foreseeable future. Despite this expansion, every city faces the challenge of reducing its environmental impact. An important strategy with which to achieve this goal involves using more waste as raw materials. In addition to the environmental benefits of this approach, it also contributes to the realisation of a circular economy.

The Netherlands strives to become a circular economy by the year 2050. It is therefore important that household waste is separated in a way that results in various qualitative waste streams. After all, the quality of the input waste stream partly determines the outcome of the recycling process.

In cities with a large number of high-rise buildings, it often proves difficult in practice for households to properly separate their waste. The “Improving waste separation in high-rise buildings” project is designed to help improve the source separation of organic waste from high-rise buildings. Properly separated organic waste can be used to produce sustainable energy and compost. At the same time, it also improves the quality of the remaining streams of household waste.

For this project, the national government, municipalities, businesses and the scientific community worked together to develop best practices for widely applicable behavioural interventions through various pilot programmes. Recent insights from the world of behavioural psychology were combined with practical experiences regarding waste separation. These insights have been summarised in the form of an accessible menu.

The collaboration has also resulted in the development of a platform for waste collection in cities, which the twenty-five most heavily urbanised municipalities in the Netherlands use to share knowledge and experiences. I am hopeful that future insights will quickly be implemented in practice, so they can make a concrete contribution to the realisation of our circular economy.

Ministry of Infrastructure and Water Management

Roald Lapperre
Director-General Environment and International

Summary

Motivation

In recent decades, the Netherlands' major cities have grown significantly. This growth is expected to continue in the foreseeable future. Despite this expansion, every city faces the challenge of reducing its impact on the environment and the climate. An important strategy to achieve this goal is transitioning towards a circular economy by using more waste as raw materials.

Major cities have to deal with the issue of residents living in high-rise buildings not properly separating their waste. Residual waste contains valuable resources. These resources need to be separated by residents to provide high-quality, clean recycling streams. However, many residents living in high-rise buildings do not separate their waste properly. Among other things, this is due to a lack of storage area for recycling bins, communal waste bins, and a general lack of social cohesion and control.

In the Netherlands, 62% of all household waste is currently being separated (2018). The national government wants to raise this figure to 75% by the year 2020. In addition to quantity, quality is also a key aspect of the transition towards a circular economy. Properly separated waste is easier to recycle into quality raw materials that can then be used for the production of new goods. Seperating material streams such as organic waste (fruit, vegetables and food waste), textile, glass and paper & cardboard is currently not a feasible option in the Netherlands. If these materials are not separated from the rest of the residual waste at the source, the potential raw materials are lost.

Objective

The objective of the project is ***to find effective instruments that cities can use to improve the source separation of organic waste in urban regions with many high-rise buildings***. In addition to determining what measures (do not) work, the project also considers why these measures (do not) work: it provides ***insight into the factors that determine people's behaviour with regard to waste separation and what factors are important when***.
A key result of this project is a menu that presents a range of interventions that have been tested in practice and which are designed to bring the realisation of the Netherlands' waste separation target one step closer. This menu was developed based on experiences covered in existing literature on the subject, field research and various pilot programmes.

Technique	Effectiveness	Budget	Practical feasibility
Facilitating store at home	★★★	★★☆	★★★
Changing the distance to the waste collection point	★★☆	★★☆	★☆☆
Setting personal coals & activating	☆☆☆	★☆☆	★☆☆
Influencing attitudes (the use of waste separation)	★★★	★★★	★★★
Strengthening social standard & activating	☆?☆	★★★	★★☆
Social modelling	★★☆	★★★	★★☆
Setting group goals & feedback	★★★	★★☆	★★☆
Promising reward	★★☆	★☆☆	★☆☆
Acknowledging & reducing resistance	★☆☆	★★★	★★★
Pre-emptive gift	★★☆	★★★	★★★
	* low effectiveness *** high effectiveness	* costly *** inexpensive	* limited feasibility *** high feasibility

Figure 1: The menu of interventions and their effectiveness, budget and practical feasibility.

The parties involved in this project are the municipalities of Almere, Amsterdam, The Hague, Rotterdam, Schiedam/Irado and Utrecht, HVC, the Ministry of Infrastructure and Water Management (IWM), NVRD, Rijkswaterstaat, the Dutch Waste Management Association and the Association of Dutch Municipalities (VNG). This project forms part of the VANG Household Waste programme.

Results and conclusions

Basic package

1) In all six pilot regions, organic waste was not collected separately prior to the start of the project. The introduction of a basic package, consisting of organic waste containers with keycard access, communication to residents and possibly a small organic waste container for use in the kitchen, has a visible effect: on average, one in five households makes frequent use of the organic waste containers. About half of the households have used the organic waste containers once. To get more households to separate their organic waste, additional (behavioural) interventions are needed.

Behavioural interventions

2) The menu presents an overview of the intervention techniques that were tested, along with scores for their respective effectiveness, budget and practical feasibility. The interventions that prove most effective are “facilitating storage at home,” “setting group goals & feedback” and “influencing attitudes (the use of waste separation).” It looks like all three are both practically and financially feasible.

3) The intervention(s) that are best suited to a specific area depends on local circumstances, such as the attitude of residents. A diagnosis must therefore be conducted before the right intervention(s) can be selected. “The devil is in the detail.” It is important to first test interventions in a smaller setting (“pre-testing”), before they are implemented on a larger scale. In this study, one intervention was not conducted effectively (“strengthening social standards & activating"). It should be noted that the menu was developed based on how the interventions were executed during the pilot programmes. A different target group or implementation may lead to different effects.

4) It is possible to combine interventions in a complementary manner. During the pilots, these complementary effects were identified, but no strengthening effects were found: no additional better (or worse) waste separation behaviour was found, compared to what each intervention was able to realise on its own.

5) The effects of the interventions deteriorate over time. The interventions that continue to have a significant effect after two to three months are characterised by some form of repetition. To achieve a stable behavioural change, it is therefore advisable to continue stimulating the desired behaviour for an extended period of time or execute interventions periodically.

Quality

6) When it comes to processing organic waste, the quality of the collected material is a key factor. For other waste streams, a low percentage of organic waste in the residual waste stream is also important: this prevents cross-contamination of recyclables. At the end of the intervention periods, the quality of the collected organic waste had improved to “sufficiently clean” for almost all pilot programmes. Maintaining the requisite level of quality will be a continuous point of attention.

Impact

7) In the Netherlands, separating the organic waste from high-rise buildings contributes 1.5 percentage point to the national waste separation percentage (based on the results of the most effective non-combined intervention). For a municipality such as Rotterdam, this figure is 4.7 percentage points. The focus on separating organic waste from high-rise buildings in the Netherlands therefore has a demonstrable impact on the country's transition towards a circular economy: the sparing use of natural resources, their reuse and maintaining a healthy soil.

8) It was not the goal of this study to achieve maximum effectiveness; it was primarily intended to determine which instruments work and which do not. The expectation is therefore that it will be possible to achieve even better results when multiple interventions are actually rolled out simultaneously. Furthermore, there are various ways in which the results from this study can be rolled out in a more comprehensive manner.

Survey analysis model

9) Since this study allows for the combination of observed separation behaviour and measurements of underlying psychological factors, it becomes possible to clarify what factors have the strongest impact on people's actual behaviour. The described behavioural model is robust and can be used to design new interventions by focusing on the factors with the strongest behavioural effects.

Process

10) The project represents a unique collaboration around multidisciplinary and constructive collaboration between governments, the scientific community, practical experts and businesses. To successfully realise improvements to waste separation, collaboration in the waste management chain and interaction with behavioural experts are critical factors. This research utilises a scientific approach based on the approach with the DOE-MEE tool, the theoretical substantiation, a clear phasing into a base period and an intervention period, the random division of participating households into an intervention group and a control group (randomised controlled trial) and the quantitative and qualitative measurement of results. The results have been carefully validated through the application of the best methods available and a deeper connection between waste and behaviour has been established.

Recommendations

1) **Get started** on organising the source-separated collection of organic waste from high-rise buildings on a larger scale, based on available scientific insights and practical experiences. In addition to a number of existing examples, this study has resulted in a clear basic package and a number of validated behavioural interventions. The focus on separating organic waste from high-rise buildings in the Netherlands has a demonstrated impact on the country's transition towards a circular economy: the sparing use of natural resources, their reuse and maintaining a healthy soil. Collecting more organic waste separately is an important factor in the ability of municipalities, the Dutch national government and Europe to achieve its environmental targets.

2) Explore the extent to which the behavioural interventions can be applied to other waste streams from high-rise buildings, such as paper and cardboard, and the collection of organic waste from low-rise buildings. Utilising the full potential of the insights from this study will bring us that much closer to the realisation of the Netherlands' national recycling target.

3) **Keep learning from each other.** This means close collaboration between municipalities, between municipalities and other chain parties and with experts from other fields, such as behavioural experts. The issue and the possible solutions are relevant to municipalities all over the world.

4) If necessary, **conduct pilot programmes/practical tests and additional in-depth research.** Both are essential in order to take further significant steps.

1 Introduction

This chapter explains the project's motivation, mission and organisation. It also includes a reading guide that clarifies how this report is structured.

1.1 Motivation

Major cities in the Netherlands have grown rapidly over the past decades. This growth is expected to continue for the foreseeable future. Despite this expansion, every city faces the challenge of reducing its impact on the environment and the climate. An important strategy with which to achieve this goal involves a transition towards a circular economy by using more waste as raw materials.

Major cities have to deal with the issue of residents living in high-rise buildings not properly separating their waste. Residual waste contains valuable resources. These resources need to be separated by residents to provide high-quality, clean recycling streams. However, many residents living in high-rise buildings do not separate their waste properly. Among other things, this is due to a lack of storage area for recycling bins, communal waste bins, and a general lack of social cohesion and control. High-rise buildings also face other issues, such as hindrance near communal waste bins (see figure 1.1 for an example).

In the Netherlands, 62% of all household waste is currently being separated (2018)[1]. The national government wants to raise this figure to 75% by the year 2020. In addition to quantity, quality is also a key aspect of the transition towards a circular economy. Properly separated waste is easier to recycle into quality raw materials that can then be used for the production of new goods. Seperating material streams such as organic waste (fruit, vegetables and food waste), textile, glass and paper & cardboard is currently not a feasible option in the Netherlands. If these materials are not separated from the rest of the residual waste at the source, the potential raw materials are lost. In less urbanised regions, there exist various examples of measures that can stimulate residents to improve their waste separation: a high level of service on raw materials, PAYT (Pay As You Throw) and reverse collection. For urbanised regions, no such good examples are available. Major cities therefore need successful interventions to help them utilise more waste as raw materials.

[1] This figure includes source and subsequent separation. CBS reports a figure of 58% for source separation in 2018 https://www.cbs.nl/nl-nl/nieuws/2019/26/nauwelijks-meer-afval-beter-gescheiden

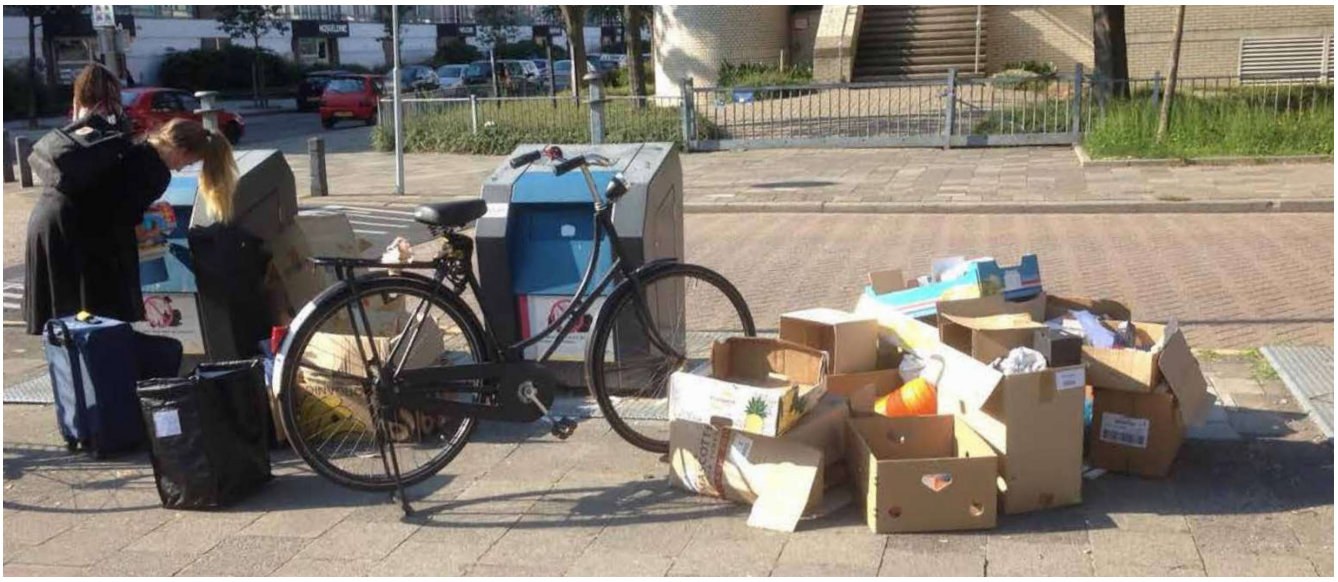


Figure 1.1: An example of hindrance near communal waste bins.

1.2 Mission

1.2.1 Objective

The objective of the project is **to find effective instruments that cities can use to improve the source separation of organic waste in urban regions with many high-rise buildings**. In addition to determining what measures (do not) work, the project also considers why these measures (do not) work: it provides **insight into the factors that determine people's behaviour with regard to waste separation and what factors are important when**. A key result of this project is a menu that presents a range of interventions that have been tested in practice and which are designed to bring the realisation of the Netherlands' waste separation target closer. This menu was developed based on experiences covered in existing literature on the subject, field research and various pilot programmes.

1.2.2 Scope

At the start, the project had a comprehensive scope that included the various material streams for which source separation is the preferred method, such as organic waste and paper & cardboard.
During the study, it was decided to focus on the waste separation of only a single material stream to make the results easier to compare. The focus of this study is food waste or organic waste. This focus was chosen because:

- Organic waste makes up circa one third of the residual waste stream, making the organic waste stream the largest waste stream that is not collected separately.
- It is harder for residents to separate their organic waste than their glass, paper or plastic. Organic waste is wet, dirty and attracts vermin.
- Organic waste contaminates other usable resources that are found in the residual waste stream.
- More effective source separation of organic waste can help reduce food wastage.

The scope of this project is limited to the source separation of waste streams because of this method's expected environmental benefits. Subsequent separation falls outside the scope of this project. Several pilot programmes also took the collection of source-separated PMD (plastic, metal and beverage cartons) into consideration.

This study focuses on (urban) high-rise buildings: residences without a garden that consist of at least three floors (or a garden that is not accessible from the street). Figure 1.2 shows a number of examples of residences in the pilot neighbourhoods.

1.2.3 Innovation

The innovations of this project are:

- The project represents a unique collaboration because of the solid and balanced organisation centred around multidisciplinary and constructive collaboration between governments, businesses and the scientific community. It shows that new forms of collaboration are needed in order to realise a circular economy.
- The six pilots programmes were developed in accordance with the best scientific research methods available. The pilots are conducted in various cities and in different types of neighbourhoods.
- The pilots test a number of simple behavioural interventions that can easily be implemented in other regions. The goal is to discover what works and why.

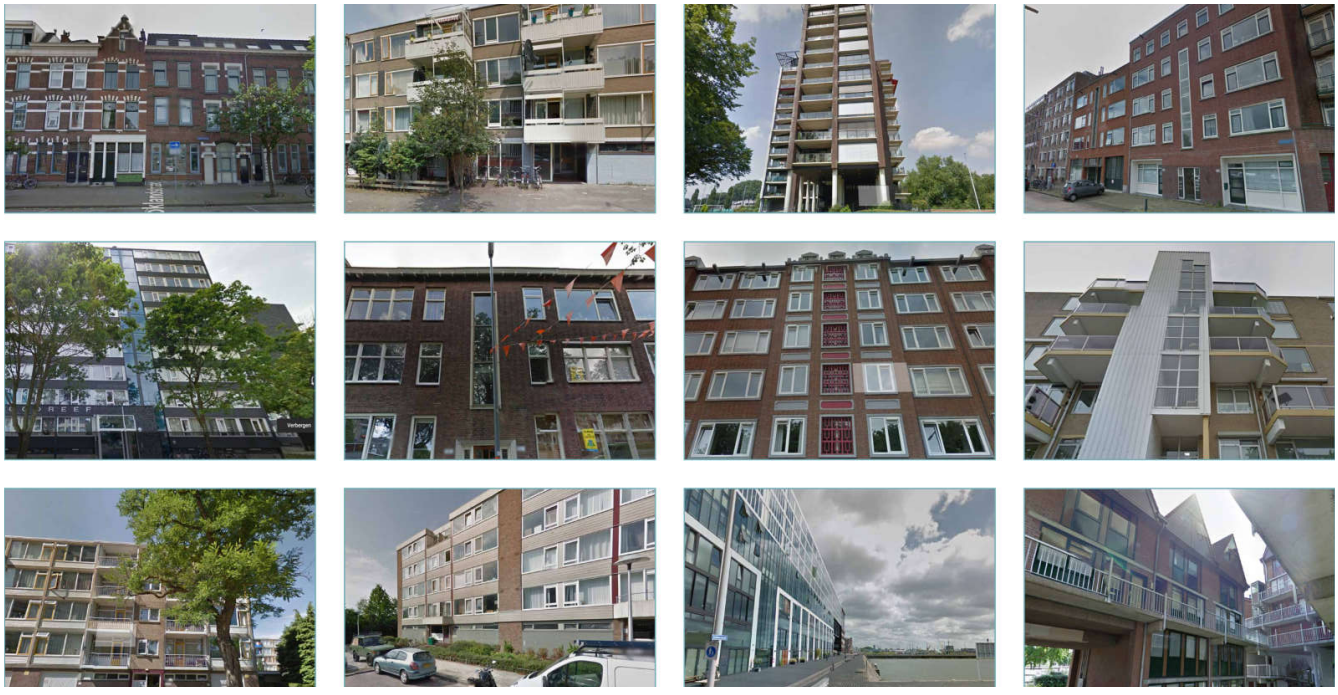


Figure 1.2: Examples of residences in the pilot neighbourhoods.

- There are no other known projects anywhere in the world that involve applied scientific research into the relationship between behaviour and waste separation in high-rise buildings on this scale.

1.3 Organisation

Figure 1.3 represents the organisation of this project. The **steering group** is the client. It makes decisions with regard to the project's progress, its quality and the financial aspects. The **think tank** is a team of behavioural experts that provides a number of partial products, safeguards the quality and serves as a sounding board during the process. The **project leaders** are responsible for the realisation of the pilots. The **triangle** provides coordination, communication and facilitation of and between the steering group, the think tank and the project leaders.

The parties involved in this project are the municipalities of Almere, Amsterdam, The Hague, Rotterdam, Schiedam/Irado and Utrecht, HVC, the Ministry of Infrastructure and Water Management (IWM), NVRD, Rijkswaterstaat, the Dutch Waste Management Association and the Association of Dutch Municipalities (VNG)[2]. This project forms part of the VANG Household Waste programme.

In part, the project was initiated and supported by IWM's Behavioural Insight Team (BIT). The think tank was also made up of professors from Tilburg University and Eindhoven University of Technology and researchers and practical experts with a background in behavioural change. The involved PhD candidate was supported by the Netherlands Environmental Assessment Agency (PBL).

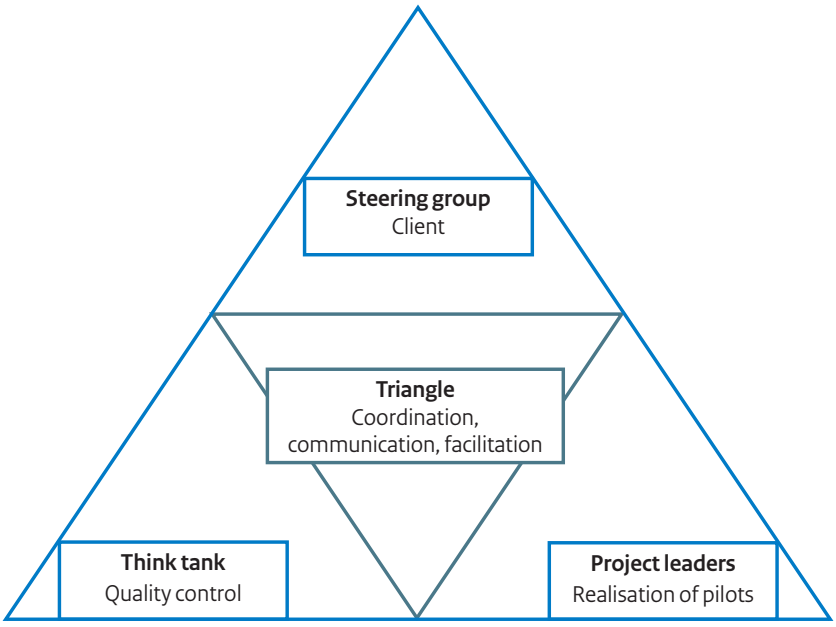


Figure 1.3: Project organisation.

[2] Avalex also took part in the first three steps of the project.

1.4 Approach and reading guide

The approach of this project follows the DOE-MEE tool that was developed by BIT. This approach was developed in collaboration with the think tank. Figure 1.4 illustrates this approach. After the design phase (step 1), the issue was tackled through understanding (step 2), development (step 3), experimentation (step 4) and monitoring and evaluation (step 5). This report is structured in accordance with the five steps of the project itself. Chapter 2 covers **the understanding**: the reality check, the literature study, the field research and promising instruments. Chapter 3 goes over the **development**: the research design, the definition of pilot areas, data processing and privacy and conditions. Chapters 4, 5 and 6 illustrate the results of the **experiments**: per pilot, as a synthesis of all pilots and translated into a menu. **Evaluation and monitoring** come last: chapter 7 reflects on the process and chapter 8 presents the key conclusions and recommendations.

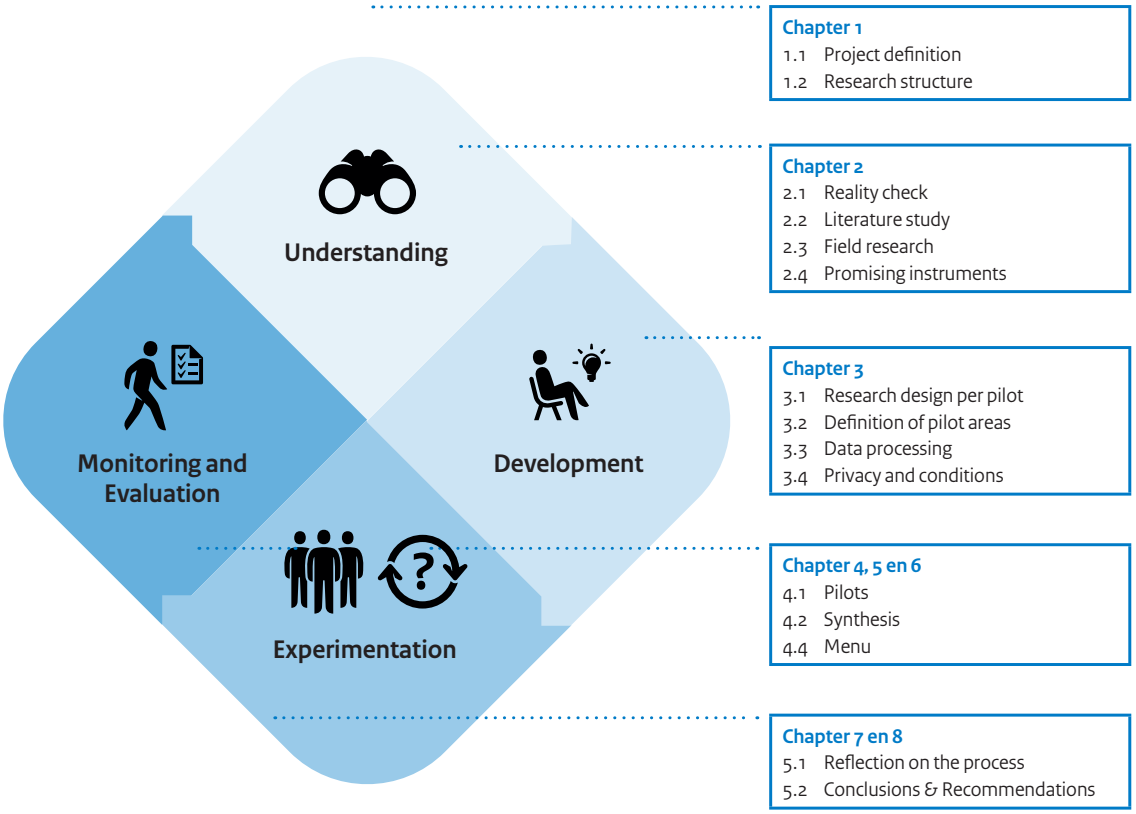


Figure 1.4: The DOE-MEE approach translated into project activities and chapters.

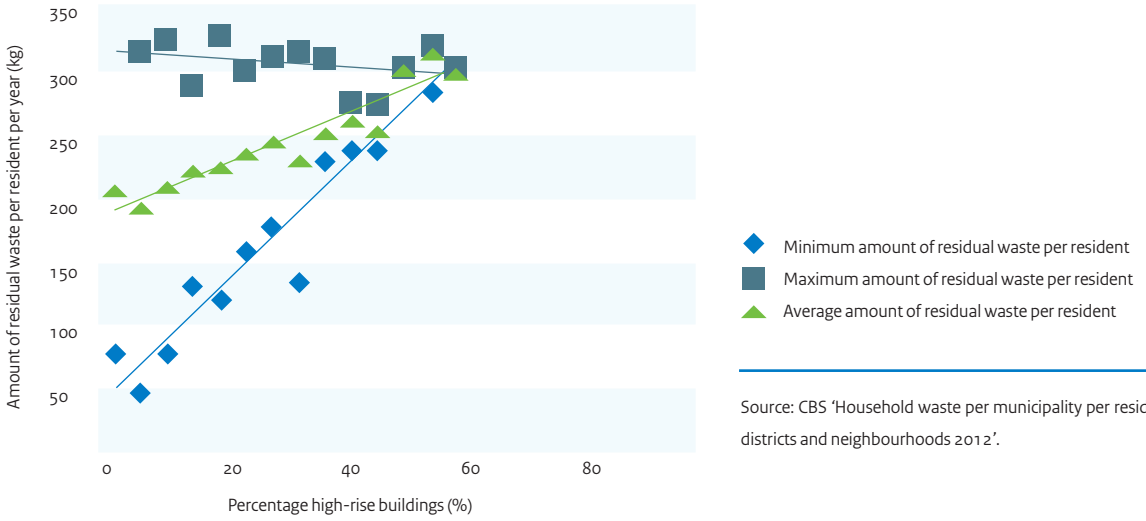
2 Understanding the issue

Chapter 1 introduced the issue and the research. This chapter will provide more insight into the issue at hand. It also clarifies the results of the reality check, the literature study and the field research. Lastly, the promising interventions are introduced.

2.1 Reality check

In 2015, CE Delft conducted a reality check to assess the relevance of the project beforehand. The key results are:

1. As the number of high-rise buildings in municipalities grows, so does the volume of residual waste per resident. See also figure 2.1.
2. The definition of "high-rise buildings" ("residences without a garden with at least three floors") can be used for the purpose of this project. It is advisable, however, to reconsider this definition at a later stage.
3. If we assume that residents of high-rise buildings can separate their waste in 2020 to a similar degree as residents of low-rise buildings in 2012, this represents an additional waste separation potential of 620 kt of waste in the Netherlands. This makes up seven percentage points of the target of the waste-to-resource programme (from 50% to 75%). See also figure 2.2.
4. If we consider the amount (in kilograms) of additional material to be separated and the environmental benefits that can be realised with it, three streams - i.e. organic waste, paper & cardboard and plastic/beverage cartons - are particularly interesting. It is unlikely that organic waste is representative of the collection of paper and plastic/beverage cartons. We recommend expanding the focus on organic waste to also include paper & cardboard, in order to develop a total overview of all behavioural aspects.
5. When it comes to the aforementioned focus streams of this project (organic waste, paper & cardboard and plastic), source separation is preferable for organic waste and paper from an environmental perspective. For these two streams, it is advisable to focus on source separation for high-rise buildings as well. For plastic and beverage cartons, subsequent separation is also a viable option. However, the choice for either method depends in part on various other considerations.



Source: CBS 'Household waste per municipality per resident 2012' and 'Key figures districts and neighbourhoods 2012'.

Figure 2.1: The correlation between high-rise buildings and the volume of residual waste in municipalities.

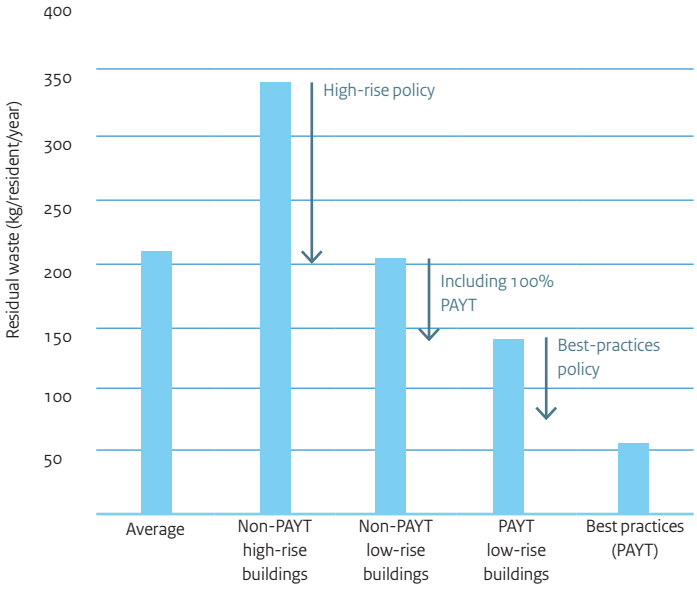


Figure 2.2: Volumes of residual waste per resident per type of municipality.

Based on the reality check, the steering group decided to continue the project. High-rise buildings offer tremendous potential for the increased collection of separated waste. It was decided to utilise the aforementioned definition of high-rise buildings and focus on organic waste.

2.2 Literature study

The next step is a literature study. This is done to assess what existing knowledge is available on behaviour, waste separation and high-rise buildings. To that end, Midden Research & Consultancy conducted an extensive analysis of a large number of international studies into waste separation behaviour in 2015.

2.2.1 Introduction

Over the past four decades, hundreds of studies have been conducted on the international level into the factors that impact waste separation behaviour and ways to influence said behaviour. Especially in the United States and Europe, extensive research has been conducted in this field.

Based on a review of published scientific literature on waste separation and recycling (Midden, 2016), it is possible to draw a number of general conclusions.

- Firstly, it can be said in a general sense that there is sufficient evidence of the fact that waste separation behaviour can be influenced. However, interventions do differ significantly with regard to their effectiveness. Interventions that specifically target the problems associated with high-rise buildings are relatively scarce.
- Secondly, there exists an enormous diversity in how the studies of waste separation are structured. Only a small percentage of the research involves specifically designed experimental (field) research with which to assess the effectiveness of behavioural interventions. Much of the research is descriptive in nature (What behaviour do people exhibit?). This is largely based on the analysis of surveys. Another large part of the research is local in nature and focused on assessing a specific intervention (How do people feel about a certain behavioural measure?).

2.2.2 A close examination of waste separation behaviour

The process of waste separation by citizens consists of a number of sub-behaviours:

- Recognising the waste stream to be separated when it is formed in the home, e.g. while peeling potatoes or emptying the plates after dinner;
- Separating and temporarily storing the waste stream to be separated, e.g. by disposing of the potato peels or leftover food in a bin on the kitchen counter (with or without a liner bag);
- Transporting the waste to be separated to a facility (means of collection) outside the home, e.g. a private mini-container or an above- or underground communal container in the neighbourhood;
- Disposing of waste in the relevant facility for the purpose of collecting and processing the separated waste, e.g. throwing the waste in the private mini-container or a communal container in the building or in a public space;
- Making the facility available for collection and processing. This step is necessary in situations involving the parcel-specific use of mini-containers or bags: putting them on the side of the road, ready for collection.

2.2.3 General framework

Various behavioural models and conceptual frameworks have been proposed to explain and predict waste separation behaviour, as well as sustainable behaviour in a broader sense. In many cases, these models are derived from more general theories on influencing behaviour drawn from, in particular, the fields of social psychology, economic psychology, communication science and behavioural economics. Among others, this tradition includes the Theory of Planned Behaviour (TPB) model[3], the Transtheoretical model[4], the Value Belief Norm theory[5], the Motivation-Opportunity-Ability model[6], the Health-Belief model[7], the Unified Theory of Acceptance and Use of Technology[8], the Influence model[9], the Com-B model[10], the Triade model[11] and Fogg's Behaviour model[12]. It falls outside the scope of this report to discuss each of these models in detail[13].

While each of these behavioural models has its own emphases - derived in part from the underlying scientific tradition - they all contain behavioural components that pertain to *capacity* (does someone possess the knowledge, strength and abilities to perform the behaviour?), *personal and social motivation* (is someone sufficiently motivated - either consciously or subconsciously - to display the behaviour at times when it is relevant and do they think the behaviour is socially acceptable?) and *opportunity* (are the circumstances, e.g. the physical context, such that they make it easy for someone to display the behaviour in question?). See also figure 2.3.

Capacity

Capacity, i.e. someone's knowledge, skills and personal aids (or lack thereof), pertains to people's personal opportunities to separate their waste; their ability to do it themselves[14]. This is about possessing specific knowledge on how to separate waste. It turns out that people only see a very tenuous connection between their own behaviour (waste separation) and the major environmental issues our society faces. For example, it can be difficult for users to dispose of products in the correct waste stream. People who separate their waste prove to possess more knowledge of the various available waste separation opportunities than people who do not separate their waste[15]. Various studies found that waste separators knew more than non-waste separators about how to separate, store and recycle the various waste streams (e.g. whether cans have to be cleaned before being recycled)[16].

People's thoughts and perceptions about the feasibility of the behaviour also play a role in waste separation behaviour. When people believe they do not know or cannot do something, chances are slim that they will exhibit the behaviour, regardless of their actual capacity to do so.

Personal motivation

Waste separation behaviour is stimulated at the level of personal motivation because citizens believe waste separation is useful and important for the environment, nature and the landscape: intrinsic motivation. Furthermore, people may feel morally

[3] Ajzen, I. (1991). The theory of planned behaviour. Organizational Behaviour and Human Decision Processes 1991;50:170–211. Ajzen, I. (2005): Attitudes, Personality and Behaviour; Open University Press – Second Edition, McGrawHill Education, ISBN 0335217036

[4] Prochaska, J.O., & DiClemente, C.C. (1982). Transtheoretical therapy: Toward a more integrative model of change (19) 3 Psychotherapy: Theory, Research &Practice, 276-288

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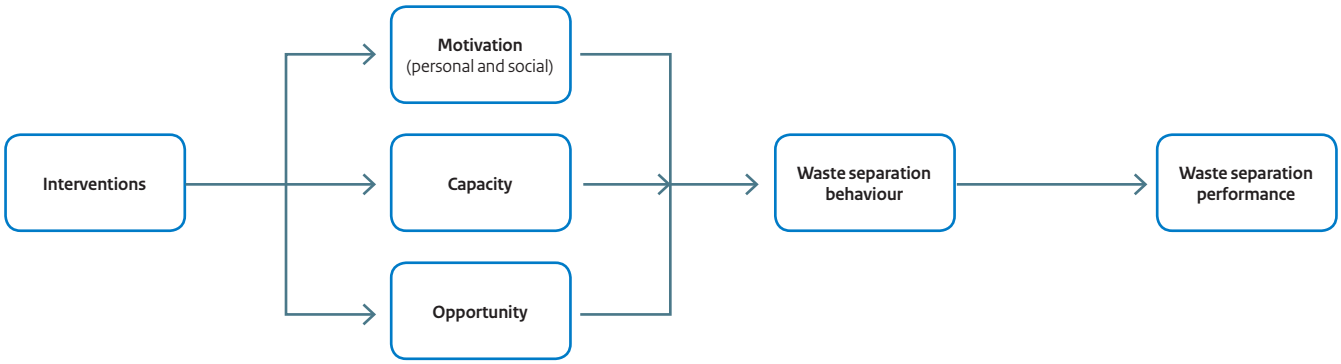


Figure 2.3: General framework.

obligated to separate their waste, which makes them willing to accept this responsibility. In both instances, people view waste separation as their personal standard. In this case, however, it is essential that waste separation is seen as comfortable, user-friendly, pleasant and easy (this has a strong connection to people's actual physical opportunity and capacity to separate waste).

Studies devote little attention to the routine-based, automatic components of waste separation behaviour. Behaviour is often subconsciously instigated by contextual triggers and cues. Although it is widely acknowledged that people's motivation and behaviour are influenced to a large extent by these subconscious processes, this has not been systematically studied in the context of waste separation.

Social motivation

In waste separation behaviour, social standards are less of a factor than personal standards.
It should be noted that waste separation behaviour is - at its core - a form of social behaviour. This is not only because much of the behaviour is exhibited in social environments, e.g. one's home, apartment building and neighbourhood, but also because the result of the behaviour is a collective achievement. People's individual performances are dependent on the contributions of others. Uncertainty about the contributions made by others can be reduced with social standards.

Information about the contributions made by other residents through communication or observation has a demonstrable and potentially significant positive effect on people's behaviour. Furthermore, active residents who give the right example can stimulate others to do their part. The tightness of a social system (cohesion), typified by the quantity and strength of social connections, determines the extent to which residents influence each other based on the exchange of information and the development of standards. In residential environments with high mobility and a large degree of heterogeneity, standards are developed less quickly and they are communicated to a lesser extent. Social influencing is therefore generally less effective in those environments.

Opportunity

Opportunity is about factors that allow people to separate their waste and which are not personal in nature. It concerns the environment and the available facilities. Think of e.g. space inside the home to temporarily store waste, opportunities to transport the separated waste streams to facilities outside the home and containers outside the home that are used to ultimately dispose of waste and make it available for collection. The choice of container can be a decisive factor for the success of a waste separation programme. The visibility, size and shape of the containers are important, as are the waste streams that are collected in them. The design of containers can offer residents physical and cognitive support and stimulation to efficiently, comfortably and effectively separate their waste. This can be done through the dimensioning of the containers and through suggestive designs, e.g. of lids and apertures, by calling attention to itself, by transferring knowledge about what waste streams should and should not be disposed in them and by activating people's standards and attitudes regarding waste separation at times when they have a separation task to perform. The facilities (opportunity) can therefore also be used as a means of communication to contribute to capacity and motivation.

In reality, opportunity is about the perceived opportunity: if people are unaware of the availability of waste separation facilities in their area, these facilities might as well not exist at all. This, in turn, reduces or even eliminates the chance of people exhibiting the desired behaviour.

To properly design containers and the associated infrastructure and logistics, more insight is needed into household practice(s), where waste is formed, e.g. in the kitchen, and the manner in which it can be stored and transported at various times and in various places in and outside the home. The analysis of this information depends on ergonomic, social and cultural factors, as well as the spatial situation and technical facilities.

The interplay of opportunity, motivation and capacity

A core principle of the current project is that waste separation behaviour is the result of the interplay of sufficient "scores" for each of these three behavioural components: opportunity, motivation and capacity. These factors can be seen as preliminary conditions for behaviour. The factors can also compensate for each other, e.g. by compensating for moderate personal motivation with strong facilities support and vice versa. However, a certain minimum "score" for each of the three factors is necessary. Behavioural interventions will lead to more significant behavioural change as all three preliminary conditions are met to a larger extent.

2.2.4 Specific behavioural framework as a foundation for the behavioural interventions

Based on the literature study (Midden, 2016), a range of promising intervention techniques was developed to stimulate waste separation in high-rise buildings. Intervention techniques activate one or more specific behavioural components (opportunity, motivation and/or capacity). Intervention techniques are theoretically substantiated and demonstrably effective techniques with which to instigate behavioural change in people. Intervention techniques must ultimately be translated into actual behavioural interventions (i.e. what text was written on a flyer, what bins were distributed, etcetera).

Figure 2.4 provides a general overview of the promising streams of intervention techniques. This is not an exhaustive or comprehensive list of intervention techniques: many more techniques can be developed based on the behavioural components. The interventions used in the pilot programmes are described in paragraph 3.2. The intervention techniques shown in figure 2.4 are briefly explained below[17].

Personal motivation

This mostly concerns cognitive techniques designed to improve people's personal motivation. Examples include setting goals, strengthening commitment, activating personal standards, influencing attitudes and boosting confidence. Some of these intervention techniques, such as influencing attitudes, setting goals and activating standards, have already resulted in a positive impact on waste separation behaviour in international studies.

Social motivation

Intervention techniques centred around social motivation are about activating people's social standards. Examples of concrete behavioural interventions are: informing people about descriptive social standards or making them visible (what are other residents doing?) and offering social comparative feedback that informs residents about their own waste separation performance in comparison with other residents.

Extrinsic motivation

Extrinsic motivational techniques are about orders and bans, rewards and punishments. This technique can be seen as a separate category of techniques focused on improving people's personal motivation. With these techniques, residents need not be convinced of the usefulness of waste separation; by offering them a reward, they can be pushed to separate their waste regardless. Studies of these techniques show widely varying results. Their success is largely dependent on the manner in which the punishments and rewards are utilised. A point of attention is that rewards are only effective as long as they are actually being given. Furthermore, rewards can have a negative impact on people's intrinsic motivation. The challenge is to move from extrinsic motivation to automatic or new habitual behaviour.

Subconscious motivation

This technique is about utilising people's automatic behavioural patterns. It concerns methods such as making desired behaviour easier (nudging) and utilising small reminders at smart locations (prompts). Furthermore, this category includes such techniques/ principles as reciprocity, commitment and consistency, self-conviction, scarcity and authority. Few studies have been conducted into the effects of subconscious motivation on waste separation behaviour. In Milan, however, a great form of public commitment and consistency was utilised by having the residents of an apartment complex sign a waste separation declaration and hanging it in a prominent location where all persons involved could clearly see it.

Capacity: knowledge, skills and personal aids

This category includes intervention techniques centred around the transfer of knowledge: how to recognise organic waste, how to separate it and how to make it available for collection. Knowledge on how to avoid or deal with hindrance (odours, fruit flies) is also interesting. With regard to capacity, it is possible to achieve results by supporting people and making them feel that waste separation is a manageable goal. This can be done by e.g. making personal aids (bins, bags) for use in the home available or by providing information about those aids so people can purchase these themselves. Note that these aids can also be utilised as communication channels via which to influence people's knowledge (what can they throw in the bin?) and motivation (e.g. with a "separating waste: good job" message or a smiley).

Opportunity

This concerns the actual availability of facilities to make it easier for people to separate their waste. The literature study shows that there exists relatively little knowledge on how to improve facilitation in and outside the home, while the availability of space and technical facilities can pose serious issues, especially

[17] A detailed explanation and references to sources per intervention technique can be found in the literature study, which is available online via https://www.vang-hha.nl/@148641/literatuurstudie/

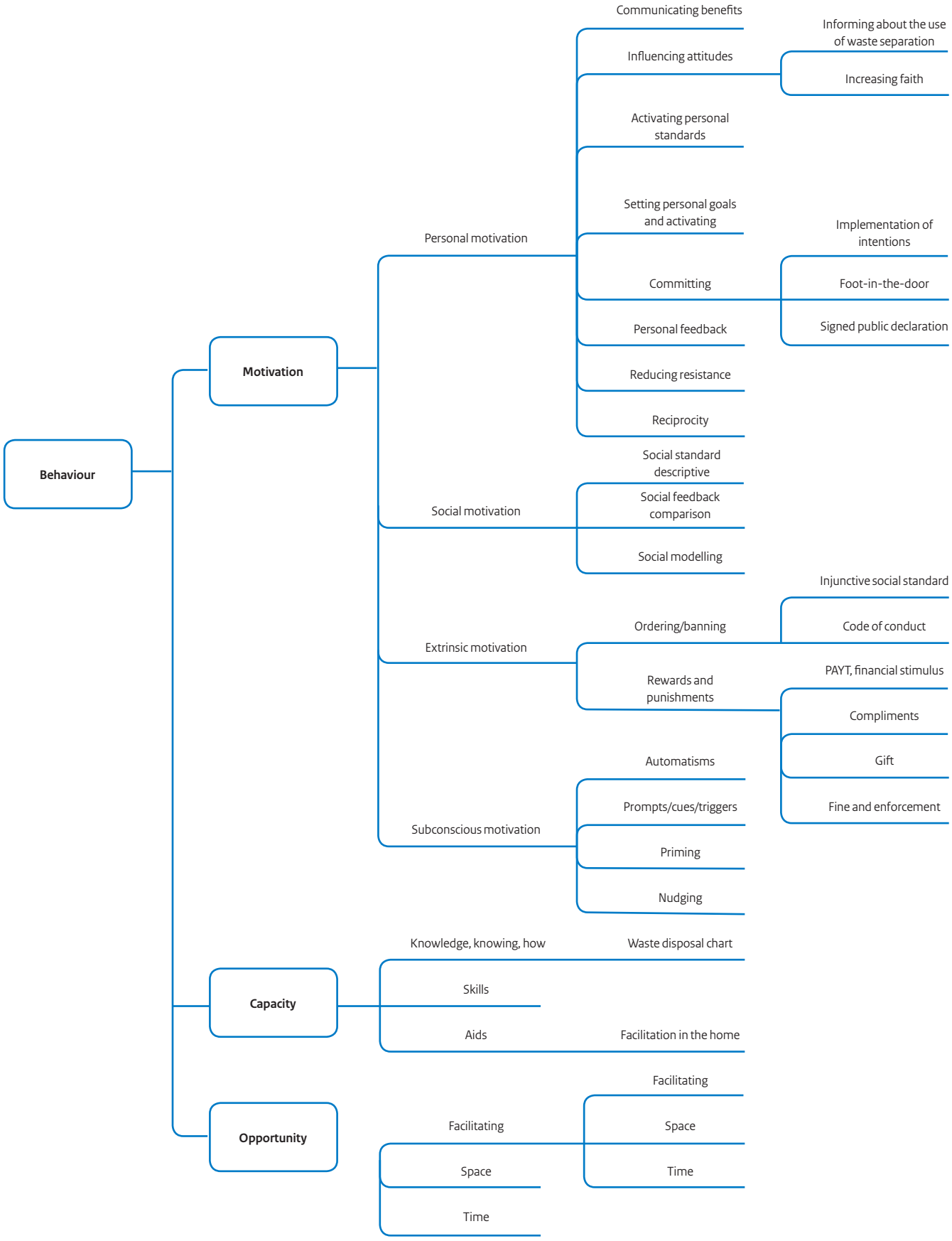


Figure 2.4: Promising intervention techniques: from factors to techniques/interventions.

in high-rise buildings. Examples of interventions centred around improving the spatial and technical facilities are: offering special waste storage facilities for use in the kitchen/home that make efficient use of the little available space, information about where the containers for the various waste streams are located and how to get there, making the containers more noticeable or reducing the distance to the waste collection point. Making the containers accessible and easy to operate and making sure they do not fill up and therefore remain available are also important aspects of the "opportunity" factor.

In conclusion, it can be stated that behavioural models and their translation into interventions are available. However, there is a lack of (scientific) studies that specifically focus on waste separation in high-rise buildings and on waste separation in the Netherlands. The added value of this study is that these gaps in the available knowledge are filled with insights into what behavioural measures (do not) work in high-rise buildings in the Netherlands. The full literature study is available online[18]. The first step of filling these knowledge gaps is conducting structured research into the behaviour that residents of high-rise buildings exhibit in their own homes. This field research is explained in more detail in the next paragraph.

2.3 Field research

Design Innovation Group has conducted generative and qualitative field research to determine how residents of high-rise buildings manage their waste. The key findings of this research are:

1. Exhibiting the "desired waste separation behaviour" consists of a series of actions, where the chain as a whole is only as strong as its weakest link. A person has to perform all actions in the right manner to exhibit the desired behaviour.
2. Many residents have very limited knowledge about waste separation in general. Similarly, it is unclear to many what happens to the separated waste stream once it has been collected. Furthermore, facts are made up and then shared during social gatherings as "urban legends."
3. Based on the interviews, four types of waste separators have been defined. Over time, people can exhibit more or fewer traits associated with the different personas. These shifts often occur as a result of changes in their living situation, e.g. a move, the birth of a child and changes to the municipality's facilitation of waste separation.
4. When municipalities help out with waste separation, people do more. At the same time, we find that there are many questions about the entire complex of behaviours, especially with regard to plastic.
5. The following are exclusive to high-rise buildings: (a) people hardly have any idea of how much residual and organic waste they produce (out of sight, out of mind), (b) residents can dispose of their waste in underground containers whenever they want (i.e. ad-hoc behaviour), (c) people use their balconies as collection points for residual waste before transporting it to the waste station (the container). During the summer - especially when it gets hot - people do not like leaving waste out in the heat because of the smell it produces.

The complete "Waste in high-rise buildings" study is available online[19].

2.4 Basic package

The basic package was designed based on the literature study and the field research. To assess the various instruments, the high-rise project provides a set of basic facilities.
These ensure that the desired waste separation behaviour can be exhibited in the first place. The basic package also helps create a uniform baseline situation, based on which scientifically sound conclusions can be drawn. The package includes the following:

- A letter with information about any changes made to the waste facilities and a brief explanation of the reasons for these changes, the importance of waste separation (environment, recycling, waste = resource, less waste incineration, resulting in new raw materials and lower waste charges in the future), a reference to a website where people can find more information about waste separation in their municipality.
- A flyer to accompany the letter, containing waste separation instructions: what streams are people expected to separate and where can they dispose of each stream?
- Containers for the various waste streams that are clearly visible, easy to find, located in logical areas, easily accessible, function well, look clean and clearly show for which waste stream they are intended.

[18] https://www.vang-hha.nl/kENNISBIBLIOTHEEK/@155217/STAPPENPLAN-HUIS/
https://www.vang-hha.nl/kENNISBIBLIOTHEEK/@155657/PUBLICATIE-INVLOED/
[19] https://www.VANG-HHA.NL/PUBLISH/PAGES/108759/VUILNISINDEFLATINZICHTENINGEDRAGAFVALSCHEIDINGINHOOGBOUWFASE1DIG2015.PDF

2.5 Promising interventions

Based on the literature study and the field research, an overview of the possible instruments was created, see figure 2.5. The most promising instruments are covered in more detail below.

1. **Setting goals and activating:** motivating people by linking the goals they set for themselves to their waste separation behaviour.
2. **Personal performance feedback:** motivating people to properly separate their waste by frequently letting them know how they are performing.
3. **Influencing attitudes:** informing people in order to positively influence their attitude.
4. **Strengthening their personal standard:** motivating people by communicating the importance of waste separation as the standard and a moral obligation.
5. **Facilitating storage at home:** facilitating waste separation where the waste is formed.
6. **Commitment:** having residents (publicly) declare their (intended) waste separation behaviour in a positive manner (i.e. making a commitment) creates a strong motivation to exhibit that behaviour.
7. **Strengthening the social standard:** making use of the principle "if many others are doing it, it must be okay."
8. **Social comparison:** motivating people by comparing their behaviour to that of others, preferably the group they feel most closely related to.
9. **Social modelling:** people are subconsciously motivated when they are shown that and how others separate their waste and that these people are proud of and appreciated for their waste separation behaviour.
10. **Distance to the collection point:** reducing the physical or mental distance to the waste collection point.
11. **Improving the recognisability and experience of the collection point:** making the collection point stand out more in the area and creating a positive experience when people look at it.
12. **Reward:** exterior stimuli (money, gifts, points, compliments) are a great motivator.

The complete information about the twelve promising instrument is available online[20].

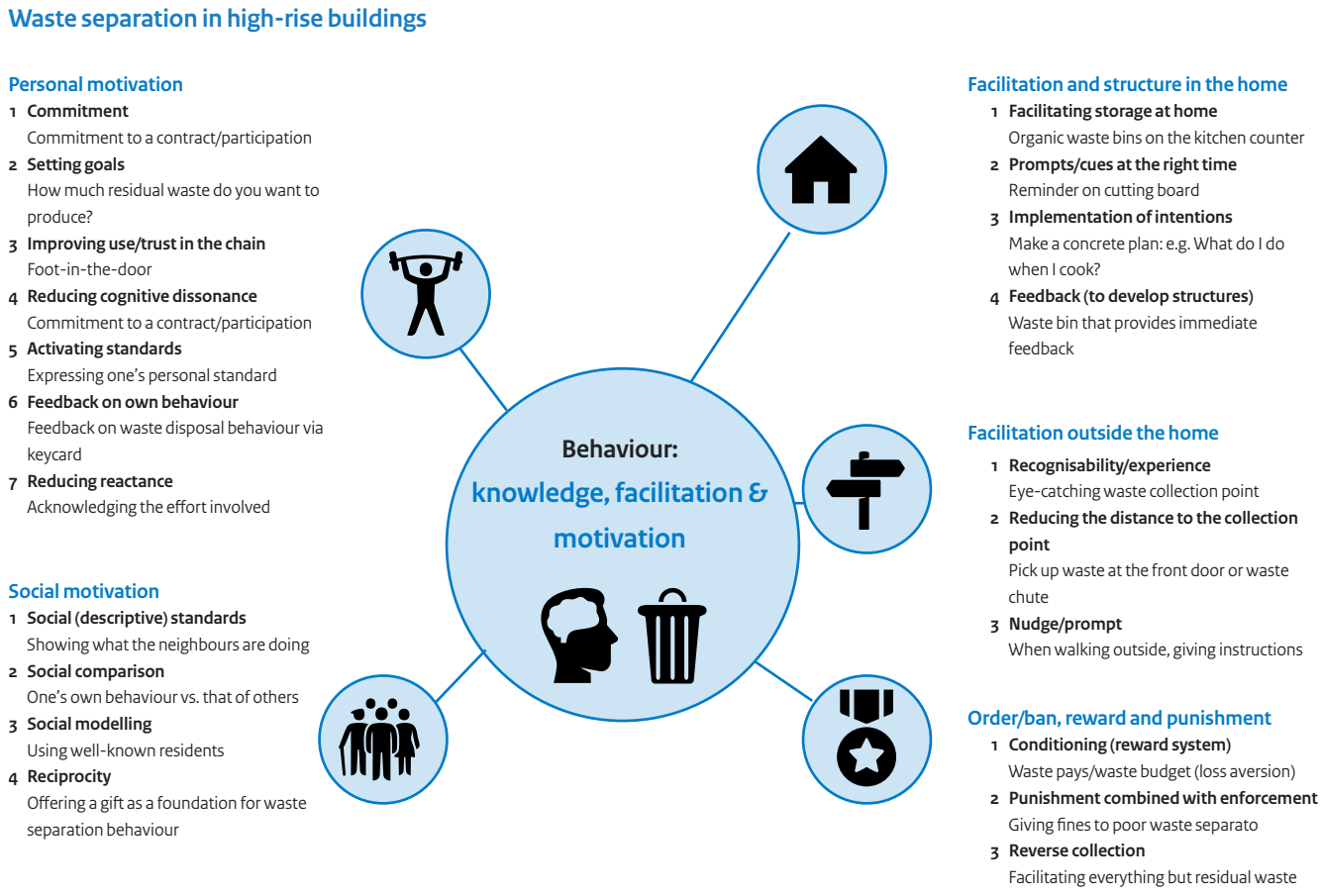


Figure 2.5: Overview of possible interventions.

[20] https://www.VANG-HHA.NL/PUBLISH/PAGES/112541/2017-10-26_PUBLICATIE_INSTRUMENTEN_AFVALSCHEIDING_HOOGBOUW.pdf

3 Research design

The issue at hand was clarified in chapter 2. In this chapter, the research structure will be explained in more detail. The intervention techniques that were utilised are also discussed. Lastly, the chapter covers the manner in which data are processed and privacy is safeguarded.

3.1 Research structure of the six pilots

3.1.1 Experimental field study – the best way to measure the effectiveness of behavioural interventions

To assess the effectiveness of the various behavioural interventions as well as possible, the pilot programmes were conducted in accordance with a strict scientific method. All pilots were structured in the form of an *experimental field study*, for which the participating households were randomly assigned to the various behavioural interventions. In other words, in every municipality, the households taking part in the pilot programme were randomly divided into multiple groups. Each group then received different information or materials. For example, some of the households taking part in the pilot in Amsterdam received a gift, others received a positive message and a third group only received the basic package. Below, we will explain why this method was chosen.

The amount of waste that a household produces varies over time. These variations occur on a weekly, seasonal and long-term basis. Over the years, the amount of waste produced displays a trend which may be related to a range of social developments: the increased consumption of goods as a result of economic growth, a stronger focus on reducing waste production by preventing food wastage or through more environmentally conscious purchasing behaviour (e.g. reducing the amount of packaging materials). As a result of these influences, a commonly used method to measure the effectiveness of interventions - the so-called before/after comparison - cannot produce reliable measurements of the effectiveness of interventions designed to stimulate waste separation. In other words, the frequency with which organic or residual waste is deposited in the months prior to the introduction of an intervention does not offer a reliable benchmark for the frequency of waste deposits in the months after its introduction. Likewise, comparing the frequency with which waste is deposited in one year to that of a different year does not produce a reliable measurement of an intervention's effectiveness. If a before/after comparison does not produce reliable effect measurements, how can we know whether there is any point in facilitating waste separation in households by e.g. distributing organic waste bins for people's kitchen counters? Similarly, how can we determine the effectiveness of an information campaign that reminds households of the importance of waste separation?

At first glance, the effectiveness of distributing the waste bins seems easier to measure than that of the information campaign. If organic waste bins are offered to all residents of an apartment complex, some households will accept the bin, while others will not. Could we not compare the amount of organic waste and/or the amount of residual waste produced by households that accepted the bin to the corresponding amounts produced by households that rejected the use of the bin? This approach would probably result in a gross overestimation of the effectiveness of the method of distributing waste bins. Households that understand the importance of waste separation will likely accept the bin. On the other hand, households that fail to understand the importance of waste separation will likely reject the bin. This means households that accepted the bin will likely do a much better job at separating their waste than households that rejected it - partly because using the bin makes waste separation easier and especially because they have a stronger motivation to separate their waste. Perhaps it was not even necessary to distribute the waste bins to many of the more motivated households; if they had not received one, they might have purchased one themselves.

It is therefore not possible to conduct a proper effect measurement by comparing the behaviour of households who received a bin to that of households who did not want it. When we consider the example of the information campaign, it is at least as difficult to measure the effectiveness of the intervention. If we were to roll out the information campaign to a group of households, we would want to compare that group's behaviour to that of a different group of households who did not receive the information. How can we find a group of comparable households? The most accurate (and easiest) method to measure the effectiveness of an intervention is to randomly assign the available households in the pilot region to different groups: a group of households for whom the intervention is conducted (the

intervention group) and a group for whom that is not the case (the control group). This research structure is known as an experimental field study or a *randomised controlled trail* (RCT). It is explained in more detail in the paragraph that follows.

3.1.2 Experimental field study – the details

For an experimental field study, it is important to use sufficiently large groups. If the intervention group(s) and the control group are sufficiently large, the law of large numbers states that the two groups are comparable in all respects - the same percentage of households that are highly motivated to separate their waste, the same percentage of single-person households, the same percentage of households with access to a balcony, etcetera. If we were to toss a coin for every household to determine whether to assign it to the intervention group or the control group (so-called random allocation), the chance of a disproportionately large number of single-person households being assigned to one group and far fewer to the other group becomes smaller as more households from the pilot region take part in the project. It is relatively easy to determine whether the random allocation of households to each of the two groups results in both groups being comparable with regard to all observable characteristics that influence waste separation behaviour (e.g. living area, gender, age and the availability of a balcony). If random allocation has resulted in the two groups being highly comparable with regard to all observable characteristics, it is of course very likely that the groups are also highly comparable with regard to all non-observable characteristics, such as the importance that the members of a household attach to waste separation, how unpleasant they believe it to be to have multiple waste bins in their home or how inconvenient they think it is to make more frequent trips to the waste collection points, etcetera.

If the two groups are (virtually) identical with regard to all possible observable and non-observable characteristics that affect people's willingness to separate their waste, we know that the groups will - on average - exhibit similar behaviour if they are treated the same; i.e. the average frequency with which each of the two groups makes use of the various waste bins will therefore be the same. This will be the case in the short term and in the long run; if, for example, waste separation is suddenly featured extensively on the (local) news, the two groups will - on average - exhibit a similar response to this development. This also means that if the intervention is conducted among one group and not among the other, the resulting difference in the average frequency of the use of the various bins can only be the result of the fact that one group underwent the intervention, while the other group did not.

Figure 3.1 provides an example in which the disposal behaviour of the control group and the intervention group are compared. In this case, the situation prior to the introduction of the intervention is comparable, which means the randomisation was conducted properly. The difference that occurs after the introduction of the intervention can be attributed to the intervention itself. Random allocation to intervention group(s) and a control group is therefore essential in order to gain insight into the effectiveness of behavioural interventions designed to stimulate waste separation.

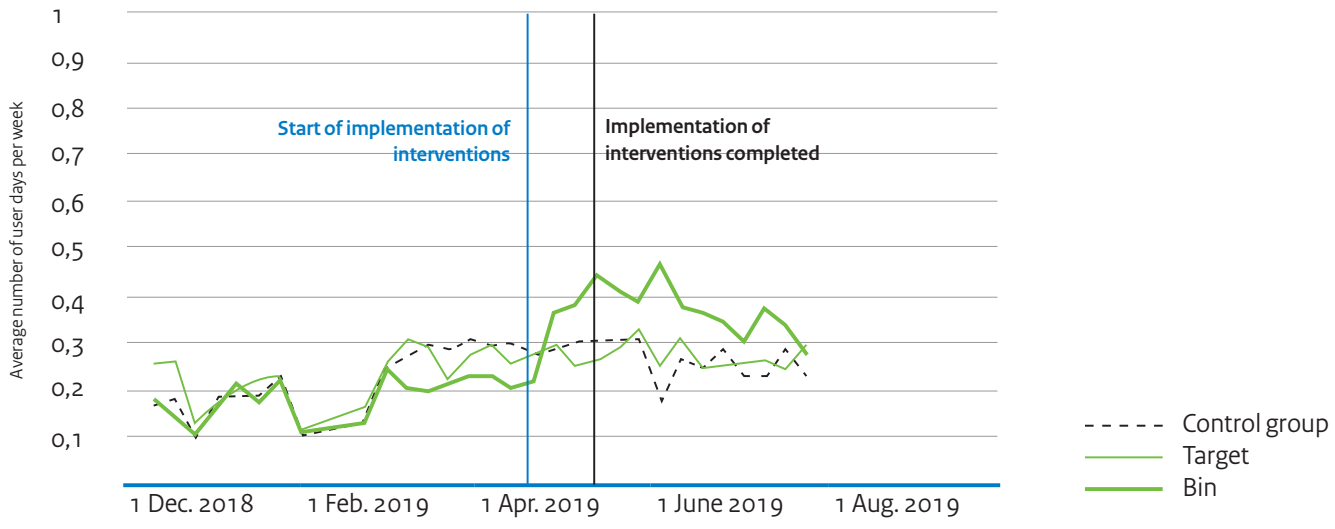


Figure 3.1: A comparison of the disposal behaviour of the control group and the intervention group over time (Rotterdam).

3.1.3 What do the effect measurements look like?

How can you measure exactly whether the behavioural interventions actually resulted in different behaviour? During the pilots, two different types of effect measurements were conducted. Before we describe these types of effect measurements, it is important to fully understand the complexity of the situation.

Behavioural interventions designed to stimulate waste separation are complex for several reasons. One reason is that not every selected household will undergo the intervention, e.g. by accepting the waste bin that is offered. A second reason is that an intervention is not necessarily unique. Organic waste bins, for example, can easily be purchased in shops. Households in the control group can still acquire a bin, even though they were not actively offered one as part of the project. This disrupts the effect measurement. These kinds of issues can be resolved by utilising two different types of effect measurements.

For the first type of effect measurement, the average behaviours of the intervention group and the control group are compared. This is the appropriate (and only possible) approach for e.g. information interventions, where we cannot be sure whether the households actually read the information that was offered to them. One example is the letter containing information about the useful products that can be made with organic waste, which was sent out in Amsterdam (an intervention designed to change the attitudes of households with regard to waste separation). Although we know which households received the letter in their mailbox, we cannot be sure whether everyone who received the letter actually opened it, let alone whether they then bothered to read it. The effect measurement based on the comparison of the average behaviour exhibited by all households in the two groups is therefore known as an Intention-to-Treat (ITT) estimate; it represents the average value of the intervention's impact on the study population.

The second type of effect measurement can be conducted when we know which households actually participated in the intervention. With regard to the distribution of the organic waste bins, that is fairly easy to determine; we register which households accepted a bin and which households did not. With the help of statistics, it is then possible to make a very accurate estimate of the impact of offering the bins on the behaviour of the households that actually accepted the bin. This accounts for the fact that not every household in the intervention groups will accept the bin and that some households in the control group will acquire a bin via different means. This is known as the effect of the Treatment-on-the-Treated (ToT).

Both types of effect measurements were conducted as part of the current pilot programmes and the results are described per municipality in chapter 4.

3.1.4 Dividing the households between the groups (intervention group versus control group)

The validity of the aforementioned effect measurements depends on the extent to which the intervention and control groups are similar; the more similarities there are, the more accurate the effect measurement becomes. How can you achieve this?

The number of households in the pilot regions lies between 450 and 750 households, with outliers of 1,200 and nearly 4,000 households. In each of these pilot regions, two or sometimes three interventions are tested (in comparison with a control group). Can we rely on the law of large numbers? Will the entirely random allocation of households to three or four different groups (two or more treatment groups and a single control group) result in groups that are identical in every relevant aspect - the same distribution of large and small families, the same distribution of highly motivated and unmotivated households, the same distribution of living area (large or small), the same distribution of distance to the waste collection point (living on the ground floor or on the top floor of an apartment building), etcetera? As that is unlikely, we decided to lend Lady Luck a helping hand. We did so by making sure that the intervention and control groups had a comparable composition with regard to family size, living area, etcetera. This method is known as *stratification* based on observable characteristics (in this case, characteristics that affect households' waste separation behaviour). Stratification increases the odds that the different groups are also similar with regard to non-observable characteristics (e.g. households' motivation to separate waste). We applied this method in each of the pilot regions. Depending on the specific situation in each region, we stratified based on different sets of variables.

3.2 Interventions

How were the behavioural interventions and the control group(s) selected and structured in the various behaviour pilots in the six municipalities? The behavioural framework, as described in chapter 2, forms the foundation for the choices that were made. This framework states that a person's behaviour is determined by their *capacity* (knowledge, strength and skills), personal and social *motivation* and the *opportunity* they have to easily exhibit the behaviour in question. All behavioural interventions and the structure of the control group(s), which were tested as part of the six pilot programmes, relate to one or more of these three behavioural components. In other words, they strengthen or activate people's knowledge, motivation and (perceived) opportunity in order to stimulate them to exhibit (more) waste separation behaviour. These three behavioural components can be activated via intervention techniques. These are theoretically substantiated and demonstrably effective techniques with which to instigate behavioural change in people. Intervention techniques must ultimately be translated into actual behavioural interventions (i.e. what text was written on a flyer, what bins were distributed, etcetera).

Below, we describe the intervention techniques that were used in the control group(s) and intervention groups during the six different pilot programmes. The appendices about the pilot programmes per municipality explain how these intervention techniques were ultimately translated into interventions that were deployed in the municipalities.

3.2.1 The basic package

In all six municipalities, all participating households (i.e. both the control groups and the intervention groups) received a so-called basic package. The households that only received this basic package formed the control group. The package included intervention techniques that affect all three components that determine people's behaviour: motivation, capacity and opportunity. As mentioned previously, all three components must be present within a household in order for its members to actually change their behaviour and - in this case - start separating their organic waste. The basic package is designed to provide a decent "baseline score" for all three behavioural components.

The basic package provides good waste separation facilities (opportunity), it explains how waste separation works and what products should be disposed of in which bin (capacity) and it lists the benefits of waste separation (motivation). Below, we will describe the ingredients of the basic package in more detail. For each item, we will indicate which of the three behavioural components it pertains to.

Realisation of the waste facilities (pertains to opportunity):
- Placing new containers or modifying existing containers.
- The facilities were easily accessible, in good condition, usable (not full) and fairly clean. The waste stream for which each container was intended was indicated with text, symbols and/or colours.
- Keycard feature for organic waste (preferably also for residual waste) to register how often households deposit their organic waste.

A letter containing:
- Information about the new approach (new containers, keycards) (pertains to capacity).
- Explaining the usefulness and benefits of waste separation (environment, recycling, less waste incineration, new raw materials and possibly lower waste charges in the future) (pertains to motivation).

A flyer accompanying the letter, which contains:
- Instructions/knowledge on how to separate waste (pertains to capacity).
- Information about where the waste containers are located (pertains to opportunity).

In Amsterdam, Utrecht and Schiedam, the basic package also included aids (bins and/or bags) for use in the home. In Schiedam, households were able to choose whether they wanted to receive these aids. These bins and bags were intended to give people more opportunities to separate their waste. Each municipality's report specifies the exact contents of its basic package.

The behavioural interventions that the intervention groups underwent complemented the basic package and were designed to assess the impact of a specific intervention on people's behaviour, via one of the behavioural components, as accurately as possible.

3.2.2 Applied behavioural interventions

Based on the literature study (see chapter 2), various promising intervention techniques were selected. Together with behavioural experts, municipalities selected the most promising and feasible variants to test during the pilot programmes. Figure 3.2 lists the intervention techniques that were utilised in each of the six municipalities. These intervention techniques mostly pertain to the behavioural components of *motivation* and *opportunity*. The basic package provides the necessary *capacity*.

In the following section, we will briefly explain the backgrounds of the ten intervention techniques that were tested. The concrete substantiation per pilot programme can be found in chapter 4.

Facilitating storage at home: The core principle of this intervention technique has to do with facilitating the first phase of waste separation behaviour: separating the different waste streams at the point where they are formed. This concerns handy, easy-to-use aids designed for the temporary storage and transport of waste to the container. Different types of aids are available, such as a *stand-alone* modular system with separate compartments for organic waste, paper, plastic and glass, a built-in version of the same system for use inside a kitchen cupboard and separate bins for use on the kitchen counter. It is not merely about whether people accept a bin in the first place; one type can also be deemed to be easier to use than a different type.

Changing the distance to the waste collection point (physical): Reducing the physical distance to the waste collection point makes the desired behaviour easier and stimulates it. This is a feasible option for municipalities that have not yet installed waste containers or which use above-ground containers that can be relocated. In that case, we propose to utilise "reverse collection" by positioning the containers a bit closer, thereby making them easier to access.

Setting personal goals & activation: The idea is to motivate people by linking the goals they set for themselves to their waste separation behaviour. Setting a clear goal for one's own behaviour helps residents aspire to that behaviour, especially when they actively keep the goal in mind. In setting the goal, a personal approach offers certain benefits. A neighbourhood spokesperson or waste management coach can go door to door to set personal waste management goals with residents. It is important to help residents set their goals: not too high and not too low. The script for this intervention explains how to draw up goals together with residents,

	Amsterdam	Almere	The Hague	Rotterdam	Schiedam	Utrecht
Opportunity						
Facilitating storage at home	0	1	1	1	0	0
Changing distance to waste collection point	1					
Motivation						
Setting personal goals & activating				1		
Setting group goals & feedback					1	
Influencing attitude (the use of waste separation)	1					
Strengthening social standard & activating		1				1
Social modelling					1	
Acknowledging & reducing resistance						1
Pre-emptive gift	1					
Promising reward	1					

* 0 in basic package; 1 in behavioural interventions; ** Facilitating storage at home: this concerns different variants (various types of bins and bags)

Figure 3.2: The intervention techniques that were tested in each municipality.

along with an instruction to present them with a sticker, which serves as a cue to repeatedly remind residents of the goals they set for themselves.

Setting group goals & feedback: The core principle of this intervention technique has to do with motivating residents to properly separate their waste by frequently informing them about their performance. To do so, residents are informed on e.g. a weekly basis about their personal waste separation performances or those of the group to which they belong (all residents who make use of the same waste container). Feedback is most effective when a goal is set beforehand to which the feedback is related. This clearly illustrates to residents how their performances relate to the predefined goal.

Influencing attitudes (the use of waste separation): At its core, an attitude is an evaluative judgement or feeling (good versus bad, positive versus negative) that is based on a number of pros and cons that an individual links to waste separation. Examples include the use of waste separation (everything just ends up in the same place to be incinerated), the effort it takes (takes a lot of time, heavy lifting), the side effects of waste separation (smell, flies, takes up space in the home) or the municipality (prejudice about city officials). These judgements can be based on correct or faulty information and assumptions, personal experiences or stories told by others. Negative attitudes demotivate the desired behaviour. Stimulating a positive attitude about waste separation is a promising method with which to motivate households to change their behaviour.

Strengthening social standards & activating: This method is centred around the pressure that people experience from the group they want to belong to. People can be influenced by the behaviour exhibited by (many) other people. The rule of thumb that we use (consciously or subconsciously) is "if many others are doing it, it must be okay." We can utilise this principle by communicating what most people are doing. The more concrete the standard is (e.g. the percentage of active waste separators), the more effective it becomes. Of course, it is important to make sure that the normative message accurately describes the behaviour of other residents.

Social modelling: People learn behaviour by observing how others (the model) behave in similar situations. When the model visibly experiences a positive effect, the observing individual will link that effect to the exhibited behaviour and become more motivated to exhibit similar behaviour themselves. The core of this instrument is that people are subconsciously motivated when they are shown that and how others separate their waste and that these people are proud of and appreciated for their waste separation behaviour. This method becomes even more effective when the people who are chosen resemble the test subject in some way, and when the latter recognises themselves in and has a positive association with the former.

Acknowledging and reducing resistance: Resistance is an emotional and natural response to a certain (undesired) change. Generally speaking, there are three types of resistance: reactance (you are taking away my freedom of action), scepticism (you can tell me more) and inertia (lacking the will, energy or priority to change). One way of dealing with this emotional resistance is by acknowledging it, followed by a refutation or a mitigation of the perceived effect.

Gift & reward: Rewarding is a form of extrinsic motivation - exterior stimuli (money, gifts, compliments) give an individual the motivation to change their behaviour. For this instrument, the

challenge is to make sure that the extrinsic motivation gradually turns into intrinsic motivation, which the individual can then maintain on their own. Extrinsic rewards can also have a sustainable effect because the behaviour becomes automated. In this manner, it can lead to structural behavioural change.

3.2.3 Surveys and the underlying conceptual framework

The ultimate goal of the behavioural pilots was to test whether the people in the intervention groups would begin to separate their organic waste better than those in the control groups. If we see any effects of the interventions on people's organic waste separation behaviour, the intervention was successful. However, it is also highly informative to examine the effects of the behavioural interventions on residents' thoughts, feelings, knowledge and attitudes. Do intervention techniques that are designed to strengthen people's motivation actually activate their motivation to separate waste? To gain more insight into these psychological processes, surveys were conducted among the participating households, especially towards the beginning and end of the pilots.

Figure 3.3 presents an overview of the core concepts of the survey. It describes a conceptual framework of the psychological processes that can factor into the development and change of behaviour. The framework is based on the literature study (see chapter 2). The framework describes the psychological processes in a greater level of detail than the three behavioural components (motivation, capacity and opportunity) that have thus far been the focus. The advantage is that this allows for intricate analyses of the effects of the applied intervention techniques on the psychological processes that factor into the development of behaviour. We will first explain the framework and then describe how it relates to the three behavioural components that lie at the core of the six pilots.

The framework clarifies the processes that lead to changes in people's waste separation behaviour and their behavioural intentions. Intentions indicate the extent to which residents plan to engage in waste separation in the near future. In the framework, these interventions are predicted most directly with four main motives.

1. The **attitude** with regard to waste separation, both at the personal level and in a more general sense, describes the extent to which a person feels positively or negatively about the waste separation behaviour. Attitudes can be influenced with new information about the assumed pros and cons of waste separation, e.g. about recycling products made of separated waste.
2. The **personal standard**, which describes the extent to which a person views waste separation as their moral obligation and a matter of principle. The personal standard can become stronger by activating it and bringing it to the top of a person's mind.
3. The **social standard**, which indicates the extent to which a person feels pressure from their social environment, e.g. their neighbourhood or household, to exhibit waste separation behaviour. Subjective social standards can be influenced via information on and activation of standards.
4. The **perceived feasibility**. Intentions will be inhibited if a person expects that exhibiting the behaviour is difficult on the grounds of personal, technical or physical limitations. Examples include storage space in the home, transport to the container, knowledge of the rules of waste separation. Physical and technical modifications can influence behaviour and behavioural interventions via this factor.

In addition to these direct intention factors, there are also four indirect factors:

1. **Trust** in the municipality is a factor that plays a role in the development of someone's attitude with regard to waste separation. It is about believing that the municipality does its best to stimulate waste separation and serve residents' best interests.
2. **Perceived pros and cons**, or beliefs, concern the set of relevant consequences or implications that a resident associates with the waste separation behaviour (e.g. it being "a dirty job") and which affect their attitude.
3. **Neighbourhood cohesion** or the bond people feel with their neighbourhood. As this gets stronger, social standards are felt more strongly and information, e.g. about how to separate waste, spreads easier. The pressure people feel to conform to the standard is stronger in a group to which people want to belong.
4. **Experiences with waste separation behaviour** that people have already exhibited and which may impact the perceived feasibility. It may also impact their behaviour directly, especially when the behaviour becomes habitual.
5. **Demographic and residential characteristics**, which can have an impact at several points within the framework, e.g. with regard to feasibility and social standards.

In general, it can be said that the extent to which an intervention technique was successfully able to activate the behavioural component of *motivation* can be measured by examining the survey answers to questions about attitude, personal standards, social standards, trust in the municipality, perceived pros/cons and neighbourhood cohesion. These factors all measure certain components of residents' motivation. The factor "perceived feasibility" not only provides insight into people's motivation, but also into the behavioural component of opportunity. A person's opinion on the feasibility of organic waste separation depends on the facilities that are actually available (opportunity) and on the ideas they have about feasibility and possible (dis)comforts (motivation).

When we take a closer look at the link between the behavioural factors from the conceptual framework of the survey, we can also link together the ten intervention techniques that were tested during the six pilot programmes. Figure 3.4 illustrates which behavioural factors from the conceptual model the intervention techniques that were utilised are expected to affect. For example, an (effective) intervention designed to influence people's attitudes will affect their attitude regarding waste separation and influence their behaviour in that manner.

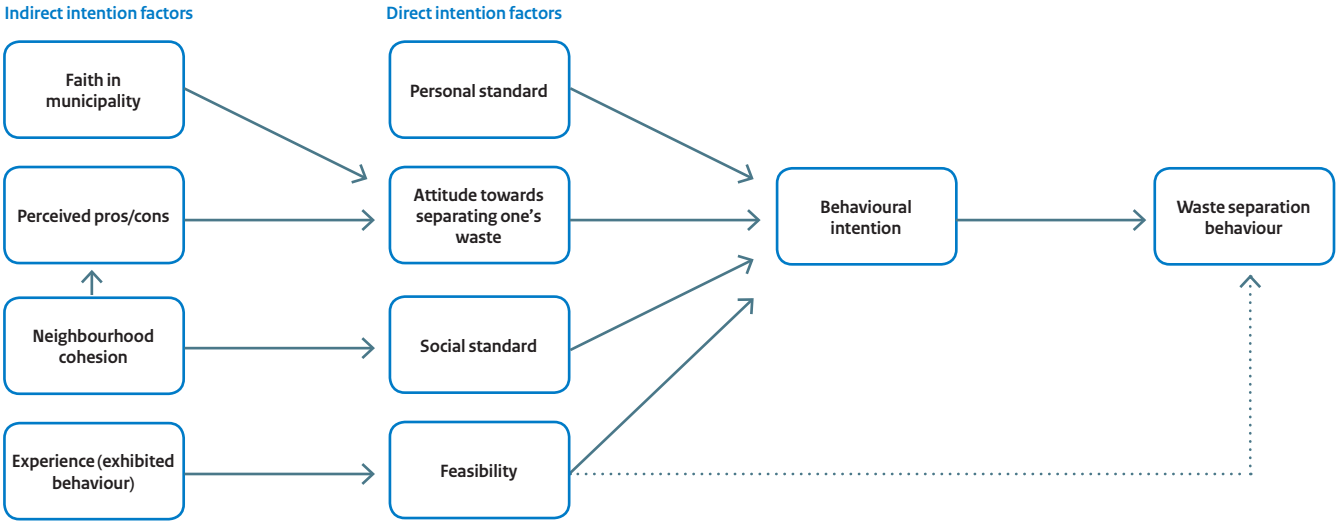


Figure 3.3: Conceptual framework for waste separation behaviour (analysis model for the survey questions).

Intervention techniques	Behavioural factors measured with survey
Opportunity	
Facilitating storage at home	Perceived feasibility
Changing distance to waste collection point	Perceived feasibility
Motivation	
Setting personal goals & activating	Intention
Performance feedback	Attitude, Intention
Influencing attitude (the use of waste separation)	Attitude
Strengthening social standard & activating	Social standard
Social modelling	Social standard, Perceived feasibility
Acknowledging & reducing resistance	Attitude
Pre-emptive gift	Attitude
Promising reward	Attitude

Figure 3.4: The link between the ten intervention techniques that were tested and the measurements from the survey.

3.3 Data processing

3.3.1 Collected data

In order to properly set up and evaluate the pilots, it was necessary to gather and register data from the households. Municipalities supplied data on the residences (e.g. surface area; WOZ (Real Estate Valuation Act) value; floor; type of residence; availability of: balcony, elevator, storage area, garden) and the residents (the gender and year of birth per person per address). Furthermore, the municipalities reported any mutations on a quarterly basis during the pilot programme (relocations, births, deaths). The data on the residences and their residents were delivered by the municipalities in an encrypted format. In other words, although it is possible to link together data pertaining to a single address, it is not possible to determine what that address is.

To gain insight into people's waste disposal behaviour, the data from the keycards were used. Households needed these keycards to make use of the communal waste containers. The frequency with which households used their keycards was tracked. Legally speaking, participation was not mandatory because residents could have opted to dispose of their waste elsewhere (without using their keycard). The data pertaining to the use of the keycards were encrypted in a similar manner as the data concerning the residences and their residents.

Furthermore, surveys were conducted in every municipality at two, sometimes three, moments during the pilot programme. This concerned the baseline measurement (shortly before the start of the interventions), an optional interim measurement (after the initial interventions were completed) and the final measurement (shortly after the final interventions were completed). These data were gathered with permission from the residents in question. The survey data were encrypted in a similar manner as the data concerning the residences, their residents and keycard usage.

Lastly, the quality of the collected organic waste was assessed. To determine whether the organic waste deposited in the communal containers was not too contaminated to be processed as such, the contents of the containers were inspected by the waste processor. In practice, this was done by first combining the contents of a number of containers. In some municipalities, this also concerned containers used by residents who were not taking part in the pilot programme.

3.3.2 How were the data stored and processed?

All data were pseudonymised, which means the data were encrypted so as to make it impossible to trace them back to specific individuals. Furthermore, the registrations were reported to the Dutch Data Protection Authority. All participating cities also drew up a data processing agreement. This agreement was used to record what data were provided and for what purpose and by whom the data were processed. It was also recorded how the data are protected and when they will be destroyed.

All municipalities delivered their data to the municipality of Rotterdam's Research and Business Intelligence (OBI) department. Municipal staff then verified the data's completeness and (where possible) correctness and linked them together.

Before the researchers of the Think Tank could analyse the data, OBI Rotterdam anonymised the data (which goes one step further than pseudonymisation). This encrypted file will be made available to other researchers via DANZ following the completion of the publications.

3.4 Safeguarding privacy

Personal data were processed for the purpose of this project. Due attention was paid to the privacy safeguards and the relevant laws and regulations. With the implementation of the new General Data Protection Regulation on 25 May 2016 (and its entering into force on 25 May 2018), the requirements for the processing of personal data were sharpened. The following will therefore cover the lawfulness and legal grounds for the data processing.

Lawfulness: In order to properly analyse the effects of interventions on behaviour, it is essential to measure people's individual behaviour in combination with the corresponding motivational and ability factors. During the pilot programmes, various types of data were collected: characteristics of households, behaviour of households and motivation of households. To meet the requirement of data minimisation, the Think Tank critically assessed what data needed to be collected.
For all forms of data, it was described what the steps of the collection process were, what organisation can access the data and what the data's storage period is. The participating households were informed prior to the start of the pilot programmes. Households had the option to object to the collection and processing of their data.

Legal grounds: The legal grounds for the collection of data is “a task governed by public law.” A task is governed by public law if it is based on grounds created specifically for public administration under or pursuant to the law.

Municipalities that wish to conduct pilot programmes of their own in a similar manner are advised to take the following steps:

Ten tips for municipalities[21]

1. Determine whether the municipality has recorded the purposes of conducting the study.
2. Assess whether the internal privacy conditions and any other legal obligations have been met.
3. Report the data processing to the data protection officer or the Data Protection Authority.
4. Prior to submitting an internal request for the aforementioned data from the Key Register of Persons (BRP), a request must be submitted to the municipal executive.
5. Check whether data processing agreements were signed with the processors who process data for the purpose of the study.
6. Participants in a behaviour project who conduct a pilot commit to this guideline with an administrative commitment.
7. Structure the data collection, data processing and key management in accordance with a privacy guideline.
8. Make sure to meet the information requirement that states participants must be properly informed.
9. Specify how the right to object to data processing is handled and how the data of participants who exercise this right are deleted and adopt the municipality's existing approach to data subjects' other rights, such as their right of access and right to rectification.
10. If this has not been done yet, structure the keycard management in accordance with applicable privacy legislation.

[21] See also Steps for the use of personal data for waste management policy: https://www.vang-hha.nl/@209284/stappenplan-gebruik/.

4 Findings per municipality

The research structure was explained in chapter 3. This chapter covers the results of each of the six pilot programmes. For each municipality, the structure of the pilot and its results are briefly explained. The more in-depth work documents per pilot, which contain additional information, will be made available separately.

4.1 Almere

4.1.1 Structure

Location

The pilot was conducted in the Boulevardflats in Almere from January 2017 until April 2018. It is an apartment complex in the Stedenwijk Midden (see figure 4.1.1). The residences have an average WOZ value of € 132,000. The ground floor consists of parking spaces, storage areas and entrances. None of the residents have a garden.

The area consists of 450 apartments. The apartment complexes have three to five residential floors and the residences have an average living area of 79 m2. Fifty-six percent of the apartments are home to single-person households, while the remaining apartments are inhabited by two to four people. In total, 703 people live in the area.

Basic package

Prior to and during the pilot, waste was collected in underground containers. At the start of the pilot, the number of containers for residual waste was reduced (from 14 to 4) and five containers for organic waste were placed. This means residents had no way of separating their organic waste prior to the pilot. The available containers for plastic, metal and beverage cartons (PMD), glass and paper were not modified for the pilot. Prior to the start of the pilot, the containers were given a specific colour to indicate the waste stream they were designed for (see figure 4.1.2). The underground containers for residual waste, organic waste and PMD feature an access-control system, which allows residents to open the containers with a keycard.

At the start of the pilot, residents received a letter with information about the project and about how to access the containers, as well as general information about waste separation (including the benefits of waste separation).

Figure 4.1.1: The boulevard flats in Almere seen from the street.

Figure 4.1.2: Underground containers in Almere have distinct colours per waste stream.

Figure 4.1.3: Intervention 1 in Almere - "facilitating storage at home."

Figure 4.1.4: Intervention 2 in Almere - "strengthening social standards & activating."

Via that same letter, they were invited to attend a neighbourhood gathering during which the information was verbally clarified. The official start of the pilot took place when a keycard with which to access the underground containers was given by the alderman to a representative of the homeowners' association of the boulevard flats.

Together, these measures form the basic package. All residents in the pilot region received the basic package. The households that only received the basic package (and no additional behavioural interventions) formed the control group.

Behavioural interventions

Two behavioural interventions were tested in Almere. The first intervention was *"facilitating storage at home:" offering a waste separation bin for use in the kitchen*. The expectation is that waste separation can be stimulated by making it easier to store the various separated waste streams in the home. The bin that was offered is a deluxe model with a volume of 60 litres that can be used to store four different separated waste streams, e.g. organic waste, residual waste, PMD, paper and glass (see figure 4.1.3)[21].

The second behavioural intervention that was tested is *"strengthening social standards & activating:" informing households about the waste separation behaviour of other households in the pilot region*. The expectation is that people can be motivated to separate their waste (even) better by giving them factual information about the behaviour of others. People can be influenced by the behaviour exhibited by (many) other people. The rule of thumb that we use (consciously or subconsciously) is "if many others are doing it, it must be okay." Of course, it is important to make sure that the normative message accurately describes the behaviour of other residents. The factual behaviour was communicated via posters that were put up in the apartment buildings (see figure 4.1.4).

Research structure

The basic package and the two behavioural interventions were gradually tested (successively) among a total population (N) of 450 households. The interventions were each tested among circa half of the households in the pilot region. This means there were four groups: (1) a control group that only received the basic package and no additional behavioural interventions, (2) a group that was offered a bin, but did not receive information about the behaviour of others, (3) a group that was offered a bin as well as information about the behaviour of others and (4) an group that was not offered a bin, but only information about the behaviour of others.

4.1.2 Results

Base period

To analyse the effects of the basic package, the behaviour of households after the introduction of organic waste containers is examined. The effect measurements began after the introduction of the basic package. Figure 4.1.5 illustrates how soon after the introduction of the basic package households first made use of the organic waste containers.

During the base period, i.e. the period after the introduction of the basic package (and before the start of the interventions), 64% of the households used the organic waste containers at least once. During the base period, 28% of the households could be classified as frequent waste separators23[22]. Of all households that used the waste collection facilities at least once, 44% continues to separate their organic waste. The average number of days that a household disposes of its organic waste is 0.55 days per week (or once every 1.8 weeks). A similar pattern was found for PMD[23].

[21] The Joseph Intelligent Waste Totem was used for this pilot.

[22] A "frequent waste separator" is a household that uses the organic waste container at least once every 1.5 weeks. An "infrequent waste separator" is a household that does not or hardly ever make use of the organic waste container (less than once every 1.5 weeks).

[23] More information about the results over time and those for PMD can be found in the detailed report per municipality.

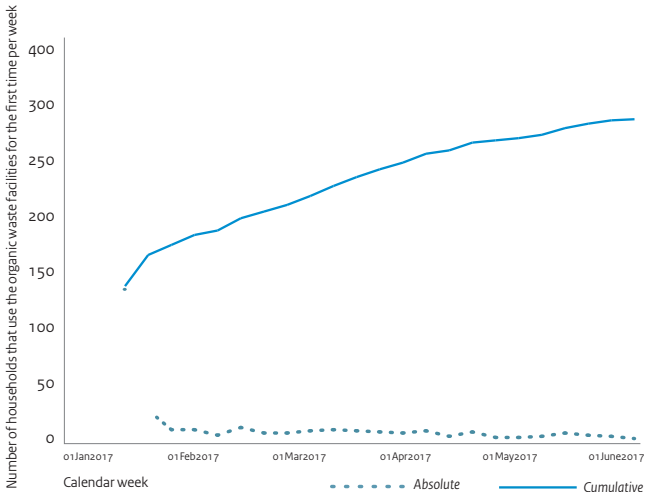


Figure 4.1.5: The number of households that make use of the organic waste container in Almere for the first time.

Looking at the household characteristics, it is notable that single-person households separate their organic waste 10% less frequently than families ($p<0.02$). Households that contain one or more senior citizens separate their organic waste 27% more frequently than households without a senior member ($p<0.01$). Other characteristics such as living area and WOZ value do not impact the frequency with which households make use of the organic waste containers.

The surveys show that the entire group believes waste separation to be "highly desirable," while the attitude of frequent waste separators during the base period is slightly more positive.
Residents display varying levels of intention to separate their waste. For organic waste, people's intentions are clearly weaker than for PMD. The primary obstacle with regard to separating waste is storage in the kitchen and the home.

Intervention 1 – *"facilitating storage at home"*

To determine whether the expectations are correct, the intervention group and the control group (which only received the basic package) were compared. We looked at the frequency with which households separate their organic waste. Figure 4.1.6 shows the average number of user days for households that received an intervention (a deluxe waste sorting bin) versus those that did not[24]. This is an average value of all households; some never use the container, while others do so one or multiple days per week.

During the intervention period, the households in the intervention group (which were offered the waste separation bin) disposed of their organic waste significantly more often than those in the control group. On average, households with a waste separation bin dispose of organic waste 0.14 user days more often per household per week (or once more every 7.1 weeks, an increase of 24%). The data do show that the difference between both groups gradually diminishes over time. With regard to the use of the PMD containers, no significant difference was found: the waste separation bin does not result in households disposing of their PMD waste more frequently.

Of the households that were offered the intervention, slightly less than half (44%) decided to accept it[25]. We see that these households dispose of their organic waste on average 0.33 days more often per week ($p = 0.01$). Although there is a positive impact on the separation of PMD waste, this does not differ significantly from 0. We see that not only infrequent waste separators were interested in receiving the bin, but that households that were already actively separating their waste during the preliminary measurement also accepted the bin.

We also examined whether households continue to separate their waste properly during the intervention period or not. Figure 4.1.7 illustrates the change in the behaviour of households in the intervention group and those in the control group. The number of frequent waste separators who continue to separate their waste is slightly higher in the intervention group, but it does not differ significantly from the control group. However, significantly more households in the intervention group that did not separate their waste yet during the base period became frequent waste separators after the intervention (an increase of six percentage points ($p=0.09$)).

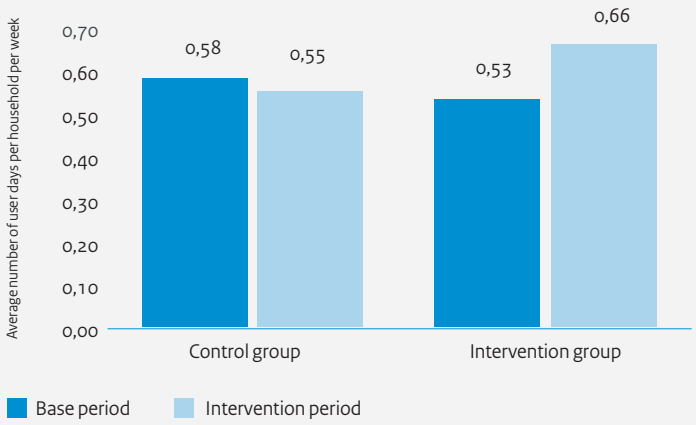
The surveys show that the households that accepted a bin are satisfied with its appearance and ease of use. Furthermore, households that received and began using a waste separation bin have a more positive attitude towards the separation of organic waste (compared to the situation prior to the intervention).

Intervention 2 – *"Strengthening social standards & activating"*

Unfortunately, the control group for the second intervention, "strengthening social standards & activating," also came into contact with the intervention. The social standard was communicated via posters on standards, which were easy to move around. These signs were frequently moved from the corridors of the apartment buildings to more central areas. The results of the surveys support this finding. There is no observable difference in the degree of exposure to the social standard message between the intervention group and the control group. Both groups possess an equal level of knowledge of the message, i.e. the listed percentage of frequent waste separators in the neighbourhood. This intervention was not implemented effectively, which makes it difficult to draw accurate conclusions regarding the effects of social standards on people's behaviour. Nevertheless, the results of this intervention are described below for the sake of completeness.

[24] Intention-to-Treat (ITT), see section 3.1.3. for more information.

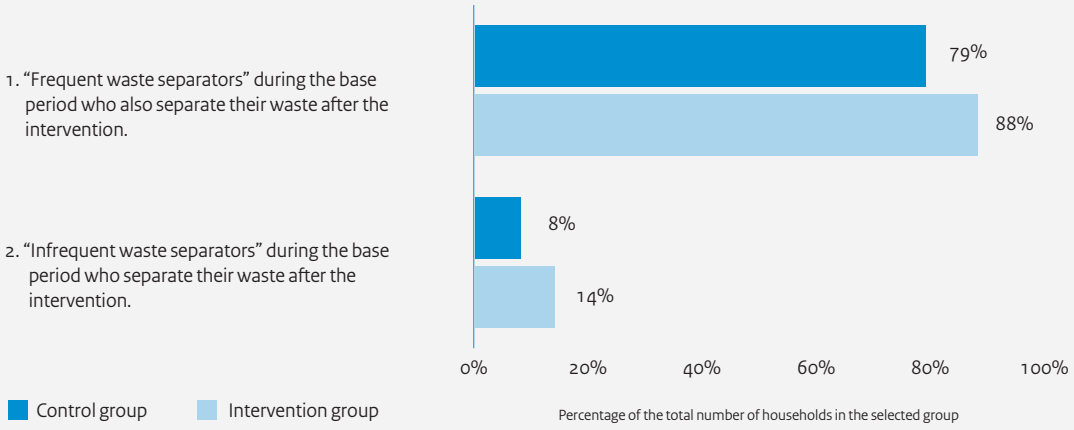
[25] Treatment-on-the-Treated (ToT), see section 3.1.3. for more information.



Effect size	P-value
0,14	0,00

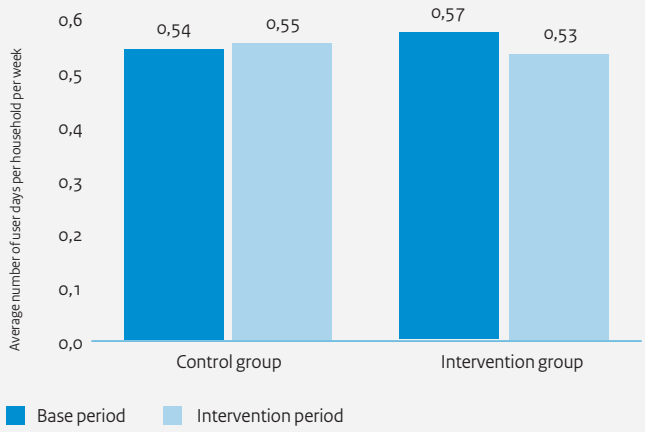
Figure 4.1.6: Use of organic waste facilities for intervention 1, "facilitating storage at home," in Almere[1].

[1] Effect size is an indicator for the effect that the intervention has. Simply put, it is calculated by (intervention-control) during the base period + (intervention-control) during the intervention period. The P-value is a statistical indicator of the reliability of the result. The smaller this value is, the more unique and consistent the result is. The standard value is p<0.05.



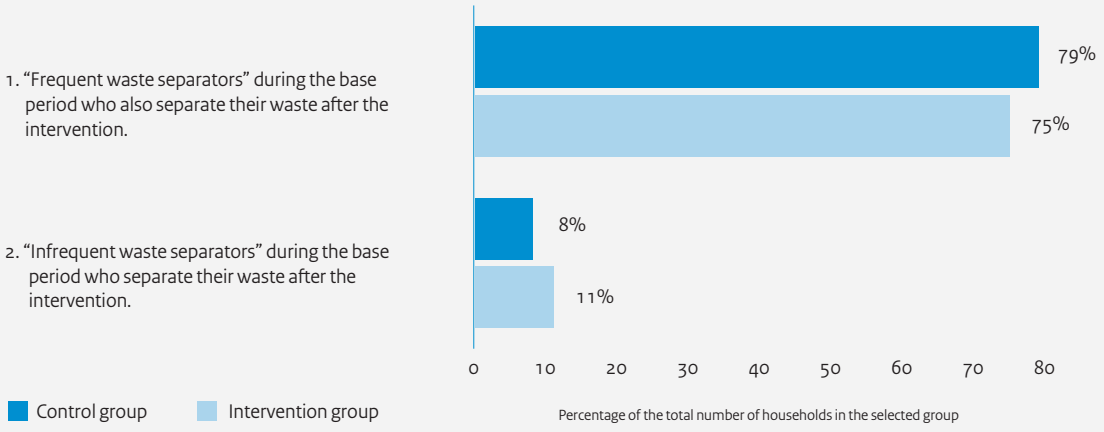
Separator group	P-value
1. Frequent	0,23
2. Infrequent	0,09

Figure 4.1.7: Changes in households' behaviour for intervention 1, "facilitating storage at home," in Almere.



Effect size	P-value
-0,04	0,27

Figure 4.1.8: Use of organic waste facilities for intervention 2, "strengthening social standards & activating," in Almere.



Separator group	p-value
1. Frequent	0,63
2. Infrequent	0,45

Figure 4.1.9: Changes in households' behaviour for intervention 2, "strengthening social standards & activating," in Almere.

Figure 4.1.8 shows the average number of user days for households that were offered the intervention "strengthening social standards & activating" versus those that were not offered this intervention.

No significant difference was found between the intervention group that received information about the waste separation behaviour of other households and the control group. This outcome was the same for both organic waste and PMD.

We also examined whether households continue to separate their waste properly during the intervention period or not. Figure 4.1.9 illustrates the change in the behaviour of households in the intervention group and those in the control group. The number of frequent waste separators who began and stopped separating their waste is comparable between both groups (there is no significant difference).

Conclusions

- During the base period, 64% of the households used the organic waste containers at least once and 28% of the households were classified as frequent waste separators. Of all households that used the waste collection facilities at least once, 44% continues to separate their organic waste.
- Households with a waste separation bin deposit organic waste an average of 0.15 user days per household per week more often (i.e. once more every 7.1 weeks, an increase of 27%). It should be noted that the difference between both groups gradually diminishes over time. The waste separation bin did not result in a significant increase in the use of the PMD containers.
- Unfortunately, the control group for the second intervention, "strengthening social standards & activating," also came into contact with the intervention. Both groups possess an equal level of knowledge of the message, i.e. the listed percentage of frequent waste separators in the neighbourhood. It is therefore not possible to draw accurate conclusions regarding the effect of this intervention.

4.2 Amsterdam

Figure 4.2.1: Aerial photograph of the residential complexes on Amsterdam's Java-eiland.

Figure 4.2.2: A newly added organic waste container on the Java-eiland.

4.2.1 Structure

Location

The pilot was conducted on the Java-eiland in Amsterdam from November 2016 until January 2018. It involved residential complexes with five to seven residential floors (see figure 4.2.1). In between the structures, there are courtyard gardens that are primarily used by the residents of the residential complexes.

The area consists of 1570 apartments. 38% of the apartments are occupied by single-person households and 13% of the residents are over the age of 65. In total, 3,184 people live in the area.

Base package

Prior to and during the pilot, waste was collected in underground containers. At the start of the pilot, eleven additional aboveground containers for organic waste were placed in the area. These are 240-litre mini-containers with a housing (see figure 4.2.2). This means residents had no way of separating their organic waste prior to the pilot. The available containers for plastic, metal and beverage cartons (PMD), glass and paper were not modified for the pilot. The containers for residual waste and organic waste feature an access-control system, which allows residents to open the containers with a keycard.

At the start of the pilot, residents received a letter with information about the project and general information about waste separation (including the benefits of waste separation). They also received a keycard with which to open the organic waste containers, a flyer containing information about (the use of) the organic waste containers and a seven-litre organic waste bin for use on their kitchen counter, along with a roll of compostable organic waste bags (see figure 4.2.3). These waste bins were actively distributed door to door. Residents were also given the option to pick a waste bin themselves from a local coffee house. They could also pick up extra bags for their bins there.

Together, these measures form the basic package. All residents in the pilot region received the basic package. The households that only received the basic package (and no additional behavioural interventions) formed the control group.

Figure 4.2.3: A seven-litre organic waste bin and compostable bags.

Figure 4.2.4: Intervention 1 in Amsterdam – "influencing attitude."

Figure 4.2.5: Intervention 2 in Amsterdam – "pre-emptive gift."

Figure 4.2.6: Intervention 3 in Amsterdam – "promising rewards."

Behavioural interventions

Four behavioural interventions were tested in Amsterdam. The first intervention is *"influencing attitudes": emphasising the use of waste separation*. The expectation is that stimulating a positive attitude towards waste separation - by emphasising the use of waste separation - will motivate households to change their behaviour. The behavioural interventions consisted of two letters. The first letter contained information about what happens to separated food waste and what useful products are made from it, e.g. biogas and compost (see figure 4.2.4). The second letter emphasised the usefulness of waste separation once more and contained a concrete example of what can be made with separated organic waste: a small bar of soap made from recycled citrus fruit skins.

The second and third interventions were centred around offering some form of *"reward."* One variant consisted of a *"pre-emptive gift."* Residents received a bamboo cutting board. It came with a letter from the municipality with a complimentary remark for frequent waste separators and an encouraging message for infrequent waste separators. The intention was to generate feelings of reciprocity with the gift (see figure 4.2.5).

The other variant consisted of *"promising a reward."* Residents were promised a (one-time) reward if they would actively start to separate their organic waste (even better). The exact nature of the reward was not revealed. Residents ultimately received a small bar of soap made from coffee grounds (see figure 4.2.6).

Lastly, the extent to which *"changing the distance to the waste collection point (physical)"* influences residents' waste separation behaviour was examined. The expectation is that reducing the physical distance to the waste collection point will make it easier to exhibit the desired behaviour, thereby stimulating residents to do so. During the implementation of the attitude intervention, the physical distance between some residences and the nearest organic or residual waste container was changed by adding several new organic waste containers and turning an existing residual waste container into a plastic container. This resulted in a smaller distance to the nearest organic waste container for 16% of the residents and a greater distance to the nearest residual waste container for 4% of the residents. This measure made it possible to assess the effect of the physical distance to a container on people's waste separation behaviour.

Research structure

The basic package and the three behavioural interventions were gradually tested (successively) among a total population (N) of 1,090 households. This means there were four groups: (1) a control group that only received the basic package and no additional behavioural intervention, (2) a group that was offered intervention 1 *"influencing attitude,"* (3) a group that was offered intervention 2 *"pre-emptive gift,"* and (4) a group that was offered intervention 3 *"promising reward."*

The effect of the distance to the container was tested by comparing the differences between the following three groups: households for which the organic waste container was ten metres closer than the residual waste container; households for which the residual waste container was ten metres closer than the organic waste container; households for which both containers were equally far away.

4.2.2 Results

Base period

To analyse the effects of the basic package, the behaviour of households after the introduction of organic waste containers is examined. The effect measurements began after the introduction of the basic package. Figure 4.2.7 illustrates how soon after the introduction of the basic package households first made use of the organic waste containers.

During the base period, i.e. the period after the introduction of the basic package (and before the start of the interventions), 53% of the households used the organic waste containers at least once. During the base period, 28% of the households could be classified as frequent waste separators[21]. Of all households that used the waste collection facilities at least once, 53% continues to separate their organic waste. The average number of days that a household disposes of its organic waste is 0.43 days per week (or once every 2.3 weeks).

With regard to the household characteristics, it is notable that the elderly are more likely to separate their waste and that single-person households dispose of their separated waste 16% less often. Other characteristics, such as the apartment's living area and WOZ value, do not impact the frequency with which households make use of the organic waste containers.

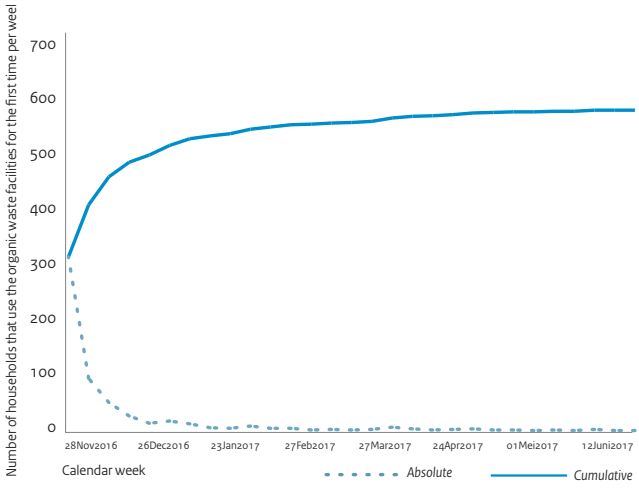


Figure 4.2.7: The number of households that make use of the organic waste container in Amsterdam for the first time.

[21] A "frequent waste separator" is a household that uses the organic waste container at least once every 1.5 weeks. An "infrequent waste separator" is a household that does not or hardly ever make use of the organic waste container (less than once every 1.5 weeks).

The surveys show that the entire group believes waste separation to be "highly desirable." Residents display varying levels of intention to separate their waste. The primary obstacle with regard to separating waste is storage in the kitchen and the home. In general, infrequent waste separators perceive more feasibility issues.

Intervention 1 – *"Influencing attitude (the use of waste separation)"*

To determine whether the expectations are correct, the intervention group and the control group (which only received the basic package) were compared. We looked at the frequency with which households separate their organic waste. Figure 4.2.8 shows the average number of user days for households that received an intervention ("influencing attitude") versus those that did not[22]. This is an average value of all households; some never use the container, while others do so one or multiple days per week.

During the intervention period, the households in the intervention group (to whom the use of waste separation was emphasised) disposed of their organic waste significantly more often than those in the control group. Households that underwent the *"influencing attitude"* intervention deposit organic waste an average of 0.08 user days per household per week more often (i.e. once more every 12.5 weeks, an increase of 23%). Over time, the households to whom the bin was offered continue to make more frequent use of the organic waste facilities than the control group: the effect size does not demonstrably diminish during the measurement period of more than three months.

What households actually accepted the intervention (opened and read the letter) was not measured[23].

We also examined whether households continue to separate their waste properly during the intervention period or not. Figure 4.2.9 illustrates the change in the behaviour of households in the intervention group and those in the control group. The number of frequent waste separators who continue to separate their waste is slightly higher in the intervention group, but it does not differ significantly from the control group. The number of infrequent waste separators who separate their waste after the intervention is not significantly different.

Based on the survey results, it cannot be determined whether the results are actually due to a conscious change in people's attitude. There were no differences in self-reported attitude between the households for whom the use of waste separation was emphasised and the control group.

Intervention 2 – *"Pre-emptive gift"*

Figure 4.2.10 shows the average number of user days for households that received an intervention (*"pre-emptive gift"*) versus those that did not[24].

During the intervention period, the households in the intervention group (which were offered the gift) disposed of their organic waste significantly more often than those in the control group. Households that underwent the "pre-emptive gift" intervention deposit organic waste an average of 0.05 user days per household per week more often (i.e. once more every 20 weeks, an increase of 15%). The data do show that the difference between both groups diminishes over time. After two months, the effect has dropped just below the limit of significance and there is no difference at all after three months.

What households actually accepted the intervention (accepted the gift) was not measured[25].

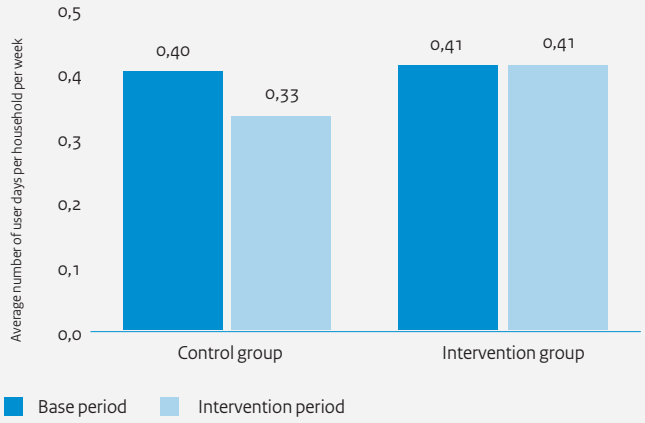
We also examined whether households continue to separate their waste properly during the intervention period or not. Figure 4.2.11 illustrates the change in the behaviour of households in the intervention group and those in the control group. The number of frequent waste separators who continue to separate their waste is slightly higher in the intervention group, but it does not differ significantly from the control group. The number of infrequent waste separators who separate their waste after the intervention is not significantly different. The survey results show that the *"pre-emptive gift"* intervention makes households report a more positive attitude towards the separation of organic waste by the end of the pilot. The increase in positive attitude was highest among the group of households that did not separate their waste during the base period.

Intervention 3 – *"Promising reward"*

Figure 4.2.12 shows the average number of user days for households that received an intervention ("promising reward") versus those that did not[26].

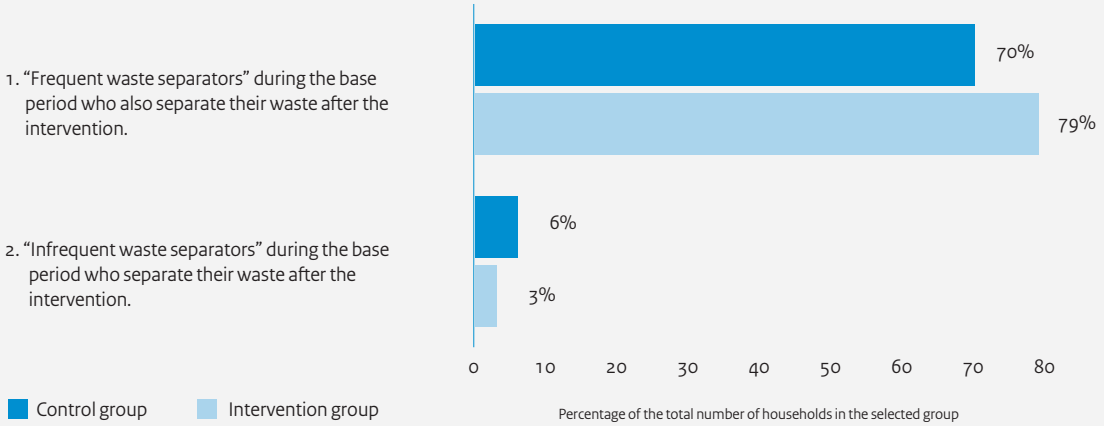
During the intervention period, the households in the intervention group (which were promised the reward) disposed of their organic waste significantly more often than those in the control group. Households that underwent the "promising reward" intervention deposit organic waste an average of 0.05 user days per household per week more often (i.e. once more every 20 weeks, an increase of 16%). The data do show that the difference between both groups diminishes over time. After three months, there is no longer a significant difference between both groups.

[22] Intention-to-Treat (ITT), see section 3.1.3. for more information.
[23] Treatment-on-the-Treated (ToT), see section 3.1.3. for more information.
[24] Intention-to-Treat (ITT), see section 3.1.3. for more information.
[25] Intention-to-Treat (ITT), see section 3.1.3. for more information.
[26] Intention-to-Treat (ITT), zie voor toelichting 3.1.3.



Effect size	P-value
0,08	0,05

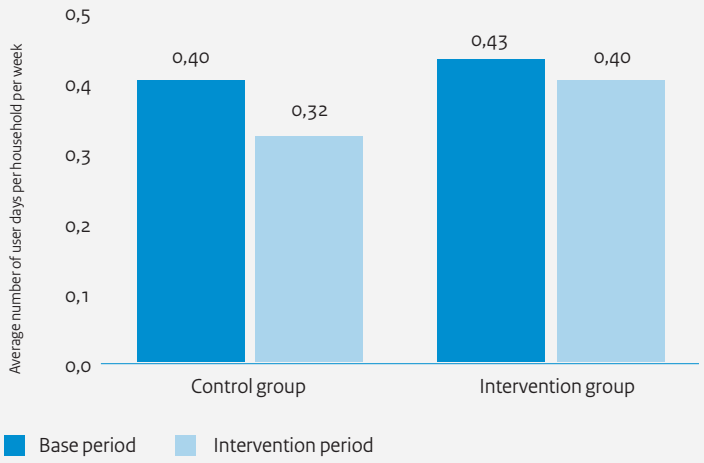
Figure 4.2.8: The use of organic waste facilities for intervention 1 "influencing attitude" in Amsterdam.



Separator group	P-value
1. Frequent	0,20
2. Infrequent	0,19

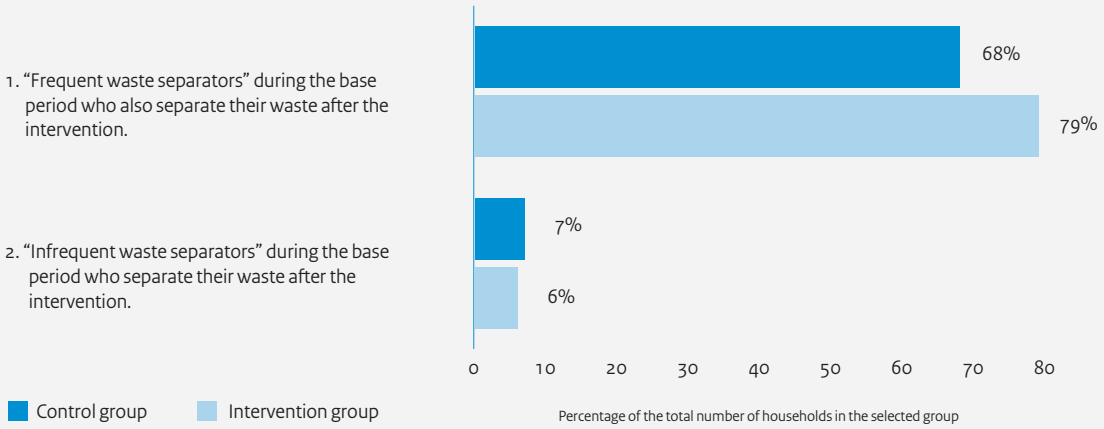
Figure 4.2.9: Changes in the behaviour of households for intervention[1] "influencing attitude" in Amsterdam[1].

[1] Effect size is an indicator for the effect that the intervention has. Simply put, it is calculated by (intervention-control) during the base period + (intervention-control) during the intervention period. The P-value is a statistical indicator of the reliability of the result. The smaller this value is, the more unique and consistent the result is. The standard value is p<0.05.



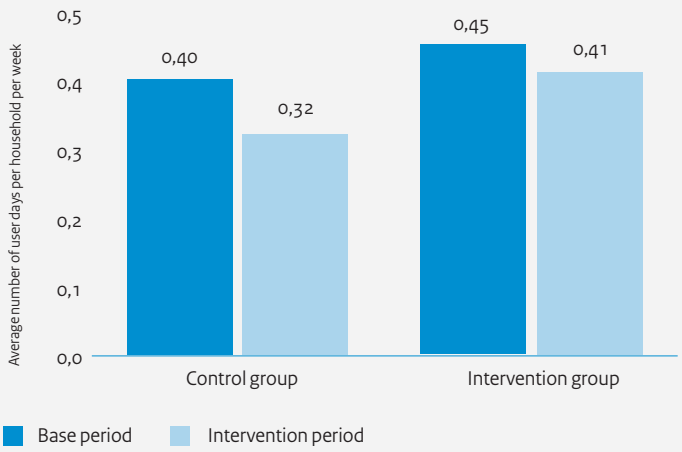
Effect size	P-value
0,05	0,08

Figure 4.2.10: The use of organic waste facilities for intervention 2 "pre-emptive gift" in Amsterdam.



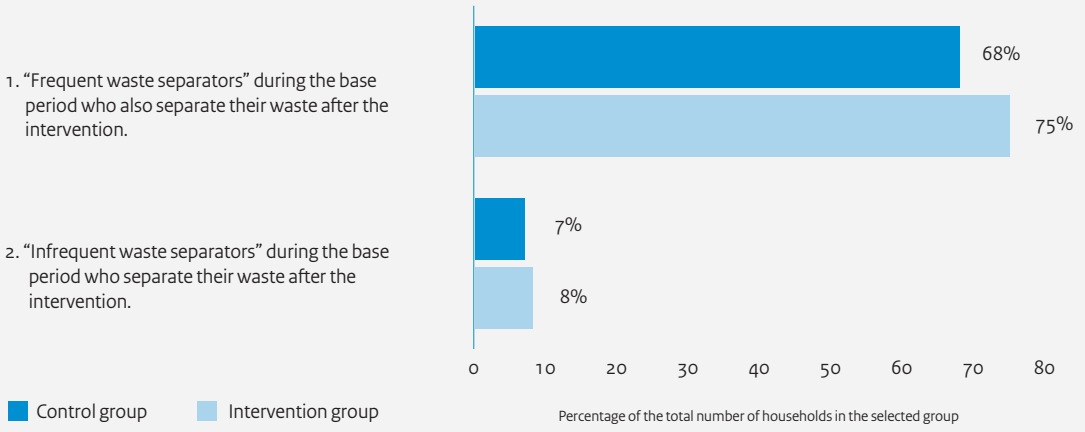
Separator group	P-value
1. Frequent	0,14
2. Infrequent	0,56

Figure 4.2.11: Changes in the behaviour of households for intervention 2 "pre-emptive gift" in Amsterdam.



Effect size	P-value
0,05	0,06

Figure 4.2.12: The use of organic waste facilities for intervention 3 "promising reward" in Amsterdam.



Separator group	P-value
1. Frequent	0,30
2. Infrequent	0,79

Figure 4.2.13: Changes in the behaviour of households for intervention 3 "promising reward" in Amsterdam.

What households actually accepted the intervention (accepted the reward) was not measured[27].

We also examined whether households continue to separate their waste properly during the intervention period or not. Figure 4.2.13 illustrates the change in the behaviour of households in the intervention group and those in the control group. The number of frequent waste separators who continue to separate their waste is slightly higher in the intervention group, but it does not differ significantly from the control group. The number of infrequent waste separators who separate their waste after the intervention is not significantly different.

The survey results show that the "pre-emptive gift" intervention makes households report a more positive attitude towards the separation of organic waste by the end of the pilot. The increase in positive attitude was highest among the group of households that did not separate their waste during the base period.

Intervention 4 – *"Changing the distance to the waste collection point (physical)"*

The distance to the waste collection point is a factor in the behaviour of households: the greater the distance to the nearest residual waste container and the smaller the distance to the nearest organic waste container, the more likely it is that households will actually use the organic waste containers. Reducing the distance to the nearest organic waste container by ten metres will increase the chance that households separate their waste by 1.5 percentage point. Increasing the distance to the nearest residual waste container by ten metres produces a virtually identical result. The conclusions regarding the effects of physical distance must be treated with some caution, since the groups could be not assigned randomly. The findings with regard to the effects of physical distance are supported by the survey results. The shorter distances to the organic waste containers were subjectively felt: the group of residents for whom the organic waste container was closer to their residence perceived it to be significantly closer during the intervention period.

Conclusies

- During the base period, 53% of the households used the organic waste containers at least once and 28% of the households were classified as frequent waste separators. Of all households that used the waste collection facilities at least once, 53% continues to separate their organic waste.
- Households that underwent the *"influencing attitude"* intervention deposit organic waste an average of 0.08 user days per household per week more often (i.e. once more every 12.5 weeks, an increase of 23%). Over time, the households to whom the bin was offered continue to make more frequent use of the organic waste facilities than the control group.
- Households that underwent the *"pre-emptive gift"* intervention deposit organic waste an average of 0.05 user days per household per week more often (i.e. once more every 20 weeks, an increase of 15%). The data do show that the difference between both groups diminishes over time. After two months, the effect has dropped just below the limit of significance and there is no difference at all after three months.
- Households that underwent the *"promising reward"* intervention deposit organic waste an average of 0.05 user days per household per week more often (i.e. once more every 20 weeks, an increase of 16%). The data do show that the difference between both groups diminishes over time. After three months, there is no longer a significant difference between both groups.

4.3 The Hague

4.3.1 Structure

Location

The pilot was conducted in two areas of The Hague's Escamp district between February 2018 and October 2018 (see figure 4.3.1). The first area is the Drentheplantsoen, which consists of four apartment buildings with fourteen residential floors each. The second area is the Steenhouwersgaarde, which consists of five apartment buildings with six residential floors each. The residences in both areas have an average WOZ value of €117,000. Seven residences have a garden.

Together, the areas consist of 537 apartments. The apartments have an average living area of 72 m2. Seventy-two percent of the apartments are occupied by single-person households and the majority (65%) of the residents are over the age of 65. In total, 705 people live in the area.

Figure 4.3.1: The Drentheplantsoen and the Steenhouwersgaarde in The Hague.

Basic package

Prior to and during the pilot, waste was collected in underground containers. At the start of the pilot, four existing residual waste containers were turned into organic waste containers, while another four were repurposed for the collection of plastic, metal and beverage cartons (PMD). This means residents had no way of separating their organic waste prior to the pilot. The area does not have any containers for the collection of paper or glass. This was not changed for the pilot. Prior to the start of the pilot, eye-catching and informative stickers were attached to the containers (see figure 4.3.2). The underground containers for

[27] Treatment-on-the-Treated (ToT), see section 3.1.3. for more information.

Figure 4.3.2: Underground containers in The Hague feature eye-catching informative stickers.

Figure 4.3.3: The Hague - "facilitating storage at home" - variant 1 "waste sorting bin" and kitchen counter bin.

residual waste, organic waste and PMD feature an access-control system, which allows residents to open the containers with a keycard.

At the start of the pilot, residents received a letter with information about the project and about how to access the containers, as well as general information about waste separation (including the benefits of waste separation). Residents also received two free rolls of bags to collect organic waste and PMD. New bags could be picked up from the building's caretaker.

Together, these measures form the basic package. All residents in the pilot region received the basic package. The households

Behavioural interventions

Two variants of a single behavioural intervention were tested in The Hague. This was *"facilitating storage at home": offering two different sets of waste bins for use in the kitchen.* The expectation is that waste separation can be stimulated by making it easier to store the various separated waste streams in the home. The first variant consists of a combination of a 41-litre bin that can be used to store three separated waste streams, the "waste sorting bin," and a two-litre organic waste bin for use on kitchen counters (see figure 4.3.3)[21].

The second variant consists of a combination of a 16-litre bin for storing residual waste and a five-litre organic waste bin for use on kitchen counters (see figure 4.3.4)[22]. The underlying idea is that people will use their existing large waste bin for PMD and the new, smaller bin for other residual waste. The new bin can be mounted inside a kitchen cabinet. Both combinations were delivered to people's homes by environmental coaches.

Research structure

The basic package and the two variants of the behavioural interventions were tested simultaneously among a total population (N) of 537 households. The two variants were each tested among circa one third of the households in the pilot region. This means there were three groups: (1) a control group that only received the basic package and no additional behavioural intervention, (2) a group that was offered the first variant of the waste bins and (3) a group that received the second variant of the waste bins.

4.3.2 Results

Base period

To analyse the effects of the basic package, the behaviour of households after the introduction of organic waste containers is examined. The effect measurements began after the introduction of the basic package. Figure 4.3.5 illustrates how soon after the introduction of the basic package households first made use of the organic waste containers.

During the base period, i.e. the period after the introduction of the basic package (and before the start of the interventions), 52% of the households used the organic waste containers at least once. During the base period, 21% of the households could be classified as frequent waste separators[23]. Van alle huishoudens die ten minste één keer gebruik hebben gemaakt van de inzamelfaciliteiten, blijft dus 40% hun gfe-afval scheiden. Of all households that used the waste collection facilities at least once, 40% continues to separate their organic waste. The average number of days that a household disposes of its organic waste is 0.36 days per week (or once every 2.5 weeks). A similar pattern was found for PMD[24].

[21] This variant made use of the RothoTrio and the Calypso.
[22] This variant made use of the Brabantia and the Garland gft.
[23] A "frequent waste separator" is a household that uses the organic waste container at least once every 1.5 weeks. An "infrequent waste separator" is a household that does not or hardly ever make use of the organic waste container (less than once every 1.5 weeks).
[24] More information about the results over time and those for PMD can be found in the detailed report per municipality.

Figure 4.3.4: The Hague - "facilitating storage at home" - variant 2 "built-in bin" and five-litre kitchen counter bin.

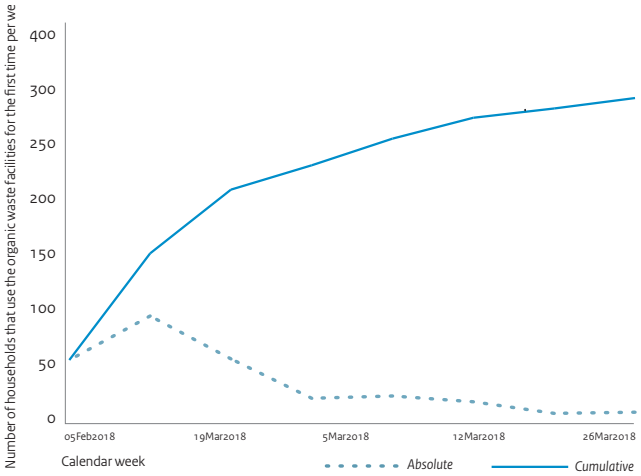


Figure 4.3.5: The number of households that make use of the organic waste container in The Hague for the first time.

Looking at the household characteristics, it is notable that single-person households separate their organic waste 7% less frequently than families. Households that contain one or more senior citizens separate their organic waste 11% more frequently than households without a senior member. Other characteristics, such as living area, WOZ value or what floor of a building an apartment is located on, do not impact the frequency with which households make use of the organic waste containers.

The surveys show that the attitude towards waste separation for infrequent waste separators and frequent waste separators alike was "desirable" to "highly desirable." Residents display varying levels of intention to separate their waste. For organic waste, people's intentions are clearly weaker than for PMD. The primary obstacle with regard to separating waste is storage in the kitchen and the home. Furthermore, correctly determining what material to dispose of in which waste stream proves difficult for some and information about people's own performances is not readily available. Infrequent waste separators are more likely to believe that it is difficult to find the right container at the waste collection point.

Intervention 1 – *"Facilitating storage at home" – variant 1 "waste separation bin"*

To determine whether the expectations are correct, the intervention group and the control group (which only received the basic package) were compared. We looked at the frequency with which households separate their organic waste. Figure 4.3.6 shows the average number of user days for households that received an intervention (a waste separation bin) versus those that did not. This is an average value of all households; some never use the container, while others do so one or multiple days per week.

During the intervention period, the households in the intervention group (which were offered the waste separation bin) disposed of their organic waste significantly more often than those in the control group. Households that received the waste separation bin deposit organic waste an average of 0.11 user days per household per week more often (i.e. once more every 9.1 weeks, an increase of 31%). The data show that, in the long run, the intervention group also makes more use of the organic waste facilities than the group of households to whom the system was not offered, although the effect diminishes somewhat over time and is no longer significant. PMD is also deposited significantly more often, compared to organic waste, although the effect for PMD appears to diminish more rapidly over time.

Of the households that were offered the intervention, circa two thirds (65%) decided to accept it38[25]. We see that these households dispose of their organic waste on average 0.15 days more often per week ($p = 0.04$), while PMD is disposed of 0.12 days more often per week ($p = 0.03$). The decision to accept the offered bin is not dependent on any observable personal or apartment characteristics.

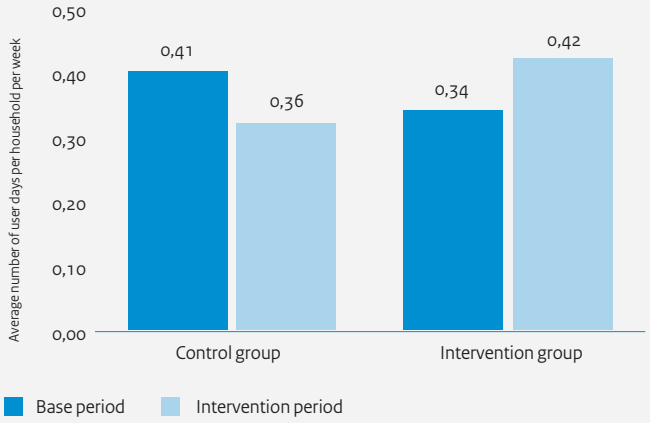
We also examined whether households continue to separate their waste properly during the intervention period or not. Figure 4.3.7 illustrates the change in the behaviour of households in the intervention group and those in the control group. The number of frequent waste separators who continue to separate their waste is slightly higher in the intervention group, but it does not differ significantly from the control group. However, significantly more households in the intervention group became frequent waste separators (an increase of eleven percentage points ($p=0.00$)).

The feedback from the surveys is discussed all at once in the section on variant 2.

Intervention 1 – *"Facilitating storage at home" – variant 2 "built-in bin"*

Figure 4.3.8 shows the average number of user days for households that were offered the intervention (the built-in bin) versus those that were not.

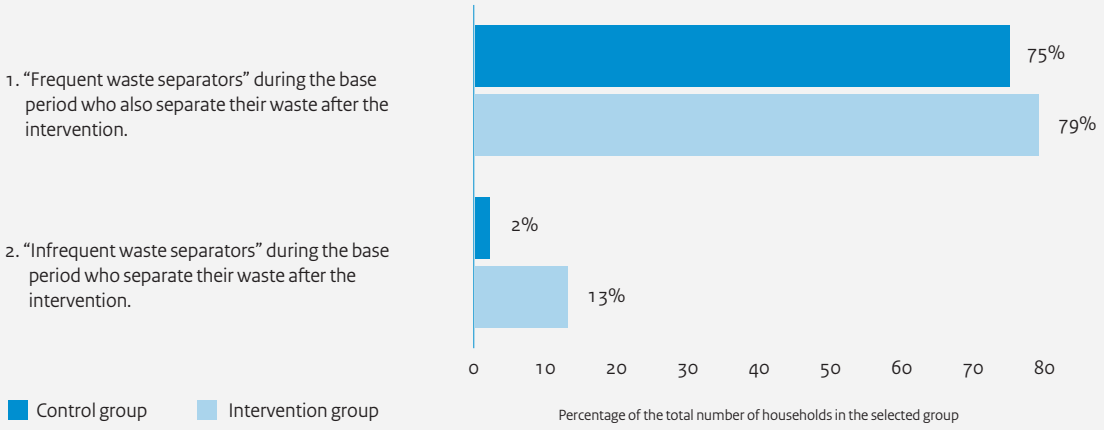
[25] Treatment-on-the-Treated (ToT), see section 3.1.3. for more information.



Effect size	P-value
0,11	0,04

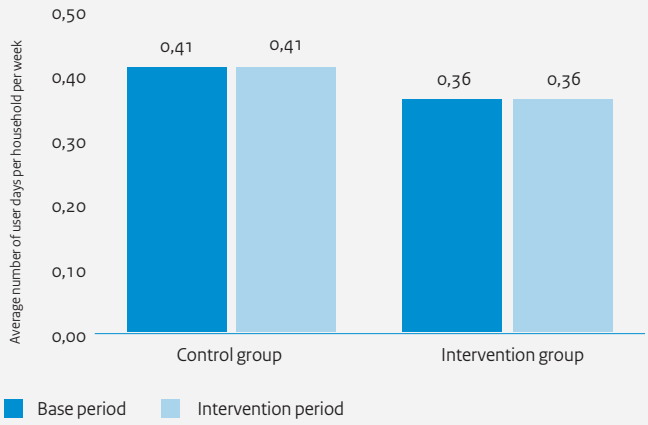
Figure 4.3.6: Use of organic waste facilities for intervention 1, "facilitating storage at home" variant 1 "waste separation bin," in The Hague[1].

[1] Effect size is an indicator for the effect that the intervention has. Simply put, it is calculated by (intervention-control) during the base period + (intervention-control) during the intervention period. The P-value is a statistical indicator of the reliability of the result. The smaller this value is, the more unique and consistent the result is. The standard value is p<0.05.



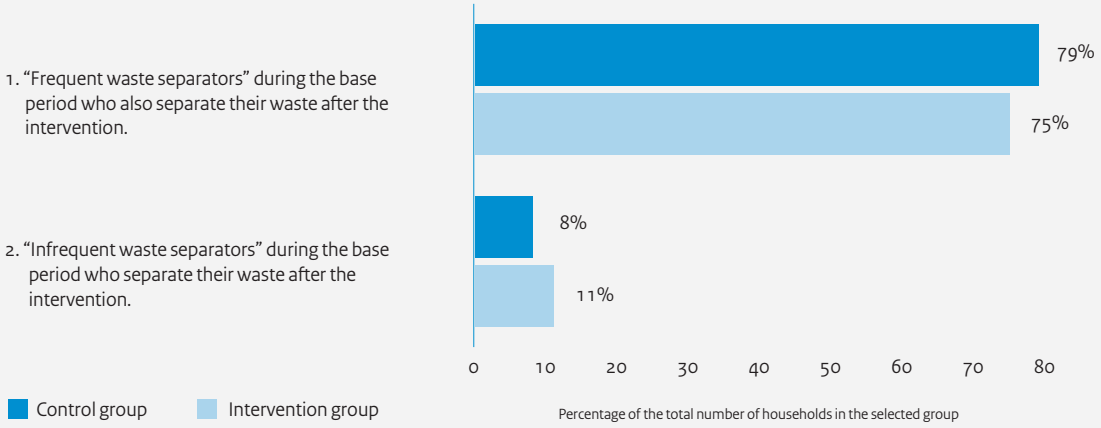
Separator group	P-value
1. Frequent	0,73
2. Infrequent	0,00

Figure 4.3.7: Changes in households' behaviour for intervention 1, "facilitating storage at home" variant 1 "waste separation bin," in The Hague.



Effect size	P-value
0,01	0,88

Figure 4.3.8: Use of organic waste facilities for intervention 1, "facilitating storage at home" variant 2 "built-in bin," in The Hague.



Separator group	P-value
1. Frequent	0,63
2. Infrequent	0,45

Figure 4.3.9: Changes in households' behaviour for intervention 1, "facilitating storage at home" variant 2 "built-in bin," in The Hague.

During the intervention period, the households in the intervention group (which were offered the waste separation bin) disposed of their organic waste equally as often as those in the control group. There is no significant difference between both groups. Similarly, no significant difference was found for PMD.

Of the households that were offered the intervention, circa two thirds (64%) decided to accept it[26]. On average, there are no significant differences with regard to effect - not for organic waste, nor for PMD. The decision to accept the offered bin is not dependent on any observable personal or apartment characteristics.

We also examined whether households continue to separate their waste properly during the intervention period or not. Figure 4.3.9 illustrates the change in the behaviour of households in the intervention group and those in the control group. No significant differences were found between the control and intervention groups.

The survey results show that the waste separation bin and the built-in bin were not accepted by circa one third of the households in the intervention group. Whether or not the bins were accepted has to do with social factors such as the perceived social standard regarding waste separation, prior experiences with waste separation and the gender of the receiving resident (men are less likely to accept the intervention than women). The main reason to refuse the bin was a lack of space in the home. Regarding the accepted large bins and the small organic waste bin, barely half of the households indicate they use it all or most of the time. Users of the bin are only moderately satisfied with its size, user-friendliness and how well its design fits in their home. Overall, 72% of the households are satisfied with the bins, while 28% are dissatisfied. By better coordinating the design and choice of the bins with the needs of residents, the bins' acceptance and usage could be improved. The relative advantage of the waste separation bin may come as a surprise, given that it is not rated any more positively than the built-in bin. When we compare the bin combinations in terms of their design and composition, it becomes clear that the waste separation bin has a stronger impact on waste separation behaviour, because users are confronted with three separate compartments when they open the bin and are basically forced to make a separation decision right then and there.
Furthermore, users have two options with which to separate their organic waste, namely the large bin and the smaller bin on their kitchen counter.

Conclusions

- During the base period, 52% of the households used the organic waste containers at least once and 21% of the households were classified as frequent waste separators. Of all households that used the waste collection facilities at least once, 40% continues to separate their organic waste.
- Households that received a waste separation bin and a smaller organic waste bin for their kitchen counter deposit organic waste an average of 0.11 user days per household per week more often (i.e. once more every 9.1 weeks, an increase of 31%). The data show that, in the long run, the intervention group also makes more use of the organic waste facilities than the group of households to whom the system was not offered.
- However, the combination of a built-in bin with a smaller organic waste bin for use on the kitchen counter did not work. This intervention produces no significant effect whatsoever: not for organic waste, nor for PMD.

4.4 Rotterdam

4.4.1 Structure

Location

The pilot was conducted in the Prinsenland district in Rotterdam from December 2018 until August 2019. The pilot region contains five apartment buildings with eleven to thirteen residential floors each (see figure 4.4.1). The residences have an average WOZ value of € 102,000. The ground floor consists of storage areas and entrances. None of the residents have a garden.

Figure 4.4.1: One of the five apartment buildings (Berninistraat) in Rotterdam.

Figure 4.4.2: Aboveground organic waste containers next to existing underground containers in Rotterdam.

[26] Treatment-on-the-Treated (ToT), see section 3.1.3. for more information.

The area consists of 789 apartments. The apartments have an average living area of 70 m2. Sixty-two percent of the apartments are occupied by single-person households and one third (30%) of the residents are over the age of 65. In total, 1,249 people live in the area.

Basic package

Prior to and during the pilot, waste was collected in underground containers. At the start of the pilot, one underground residual waste container (out of three) for every apartment building was repurposed for organic waste and given a smaller aperture. This means residents had no way of separating their organic waste prior to the pilot. The available containers for plastic, metal and beverage cartons (PMD), glass and paper were not modified for the pilot. The containers for residual waste and organic waste feature an access-control system, which allows residents to open the containers with a keycard. Since the collected organic waste stream was badly contaminated, organic waste was collected in aboveground containers from December 2018 onwards (see figure 4.4.2).

At the start of the pilot, residents received a letter with information about the project and about how to access the containers, as well as general information about waste separation (including the benefits of waste separation). Furthermore, two additional letters were sent. They contained a second keycard and information about the new aboveground organic waste containers.

All these measures together form the basic package. All residents in the pilot region received the basic package. The households that only received the basic package (and no additional behavioural interventions) formed the control group.

Behavioural interventions

Two behavioural interventions were tested in Rotterdam, both individually and in combination. The first intervention is *"setting personal goals & activating": residents set their own waste separation goals to strive towards*. The expectation is that waste separation is stimulated by having residents motivate themselves. Residents can fill out their waste separation goals on a magnet. Public spokespeople hand out these magnets and provide some information (see figure 4.4.3).

The second behavioural intervention that was tested is *"facilitating storage at home"*: offering an organic waste container for use on kitchen counters. The expectation is that waste separation can be stimulated by making it easier to store the various separated waste streams in the home. Public spokespeople distribute these bins and provide some information. Along with the bin, residents receive a roll of waste bags and a flyer containing information about how to use the bags (see figure 4.4.4).

The third intervention group concerned a combination of *"setting personal goals & activating" and "facilitating storage at home."*

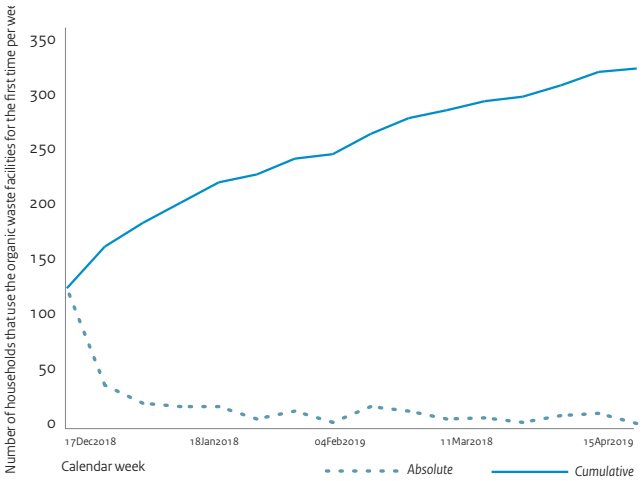


Figure 4.4.5: The number of households that make use of the organic waste container in Rotterdam for the first time.

Research structure

The basic package and the three behavioural interventions were gradually tested (successively) among a total population (N) of 789 households. This means there were four groups: (1) a control group that only received the basic package and no additional behavioural interventions, (2) a group that was offered the *"setting personal goals & activating"* intervention but not *"facilitating storage at home,"* (3) a group that was offered *"facilitating storage at home"* but not *"setting personal goals & activating"* and (4) a group that was offered both interventions.

4.4.2 Results

Base period

To analyse the effects of the basic package, the behaviour of households after the introduction of organic waste containers is examined. The effect measurements began after the introduction of the basic package. Figure 4.4.5 illustrates how soon after the introduction of the basic package households first made use of the organic waste containers.

During the base period, i.e. the period after the introduction of the basic package (and before the start of the interventions), 41% of the households used the organic waste containers at least once. During the base period, 12% of the households could be classified as frequent waste separators[27]. Of all households that used the waste collection facilities at least once, 29% continues to separate their organic waste. The average number of days that a household disposes of its organic waste is 0.22 days per week (or once every 4.5 weeks).

Looking at the household characteristics, it is notable that single-person households separate their organic waste six percentage points less frequently than families ($p<0.04$). On the other hand, households that contain one or more senior citizens separate their organic waste thirteen percentage points more

[27] A "frequent waste separator" is a household that uses the organic waste container at least once every 1.5 weeks. An "infrequent waste separator" is a household that does not or hardly ever make use of the organic waste container (less than once every 1.5 weeks).

Figure 4.4.3: Intervention 1 in Rotterdam – "setting personal goals & activating."

Figure 4.4.4: Intervention 2 in Rotterdam - "facilitating storage at home."

frequently than households without a senior member ($p<0.01$). Other characteristics such as living area and WOZ value do not impact the frequency with which households make use of the organic waste containers.

The surveys show that the attitude towards waste separation for infrequent waste separators was "fairly desirable" to "highly desirable," while frequent waste separators found it to be "highly desirable." Residents display varying levels of intention to separate their waste. For organic waste, people's intentions are clearly stronger than for PMD. The primary obstacle with regard to separating waste is storage in the kitchen and the home.

Intervention 1 – *"Setting personal goals & activating"*

To determine whether the expectations are correct, the intervention group and the control group (which only received the basic package) were compared. We looked at the frequency with which households separate their organic waste. Figure 4.4.6 shows the average number of user days for households that received an intervention (*"setting personal goals & activating"*) versus those that did not[28]. This is an average value of all households; some never use the container, while others do so one or multiple days per week.

During the intervention period, the households in the intervention group (which were offered the *"setting personal goals & activating"* intervention) disposed of their organic waste roughly as often as those in the control group. The minor difference that occurs over time is not significant.

Of the households that were offered the intervention, one third (34%) decided to accept it[29]. There is no significant increase in the frequency with which these households dispose of their organic waste. The results show that especially the households that were already in the habit of separating their waste are willing to set goals; the chance that they will accept the intervention is almost twenty-three percentage points higher ($p = 0.02$).

We also examined whether households continue to separate their waste properly during the intervention period or not. Figure 4.4.7 illustrates the change in the behaviour of households in the intervention group and those in the control group. As before, there are hardly any discernible differences.

The surveys show that the execution of the *"setting personal goals & activating"* intervention was only partly successful. In the intervention group, 41% did not receive a magnet and only 29% of the households in the intervention group indicated that they had set a goal for themselves. These goals were hardly any higher in the intervention group than in the control group.

Intervention 2 – *"facilitating storage at home"*

Figure 4.4.8 shows the average number of user days for households that received an intervention (organic waste bin) versus those that did not[30].

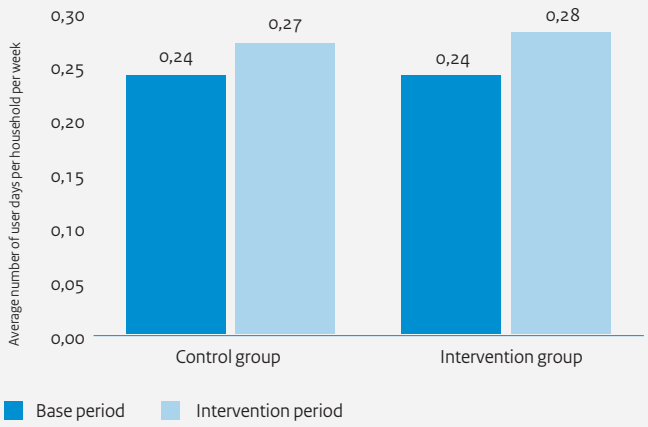
During the intervention period, the households in the intervention group (which were offered the organic waste bin) disposed of their organic waste significantly more often than those in the control group. Households that received the organic waste bin deposit organic waste an average of 0.13 user days per household per week more often (i.e. once more every 7.7 weeks, an increase of 48%). Over time, the households to whom the bin was offered continue to make more frequent use of the organic waste facilities than the control group. This effect is strongest during the first month.

Of the households that were offered the intervention, slightly more than half (53%) decided to accept it[31]. We see that these households dispose of their organic waste on average 0.24 days more often per week ($p = 0.00$). This effect is primarily achieved by the households that accepted the bin, although they were infrequent waste separators at the time. Households that include one or more senior citizens have a greater chance of accepting the bin (26 percentage points; $p = 0{,}005$), single-person households have a smaller change of doing so (20 percentage points, $p = 0{,}038$) and families consisting of three or more people have a greater chance of accepting the bin (43 percentage points, $p = 0.003$).

We also examined whether households continue to separate their waste properly during the intervention period or not. Figure 4.4.9 illustrates the change in the behaviour of households in the intervention group and those in the control group. In the intervention group, the number of households that became frequent waste separators is significantly higher (an increase of ten percentage points ($p = 0.00$)). The number of frequent waste separators who continue to separate their waste is not significantly different.

The survey results show that the intervention of the bin was successfully implemented: it had higher acceptance and usage rates. Most residents are satisfied with the bin and the bag. Given the feedback, it might be advisable to re-evaluate the bag with regard to its strength and density.

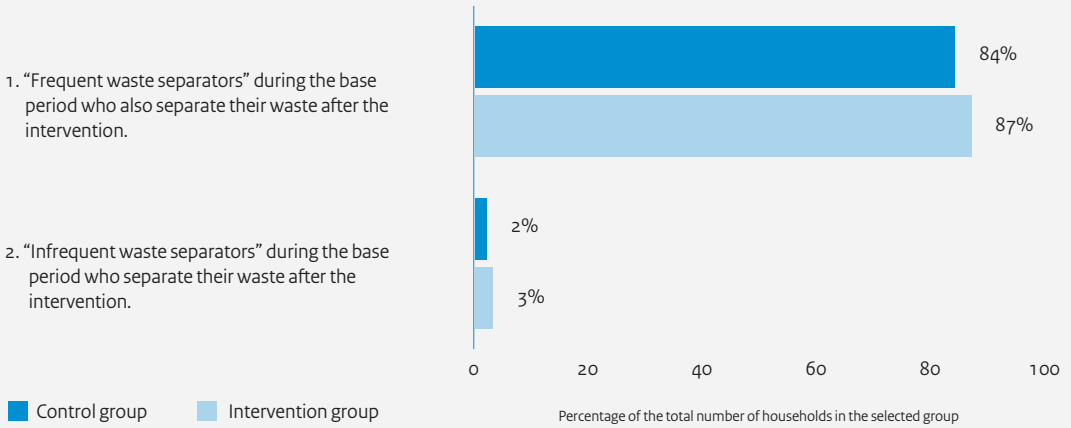
[28] Intention-to-Treat (ITT), see section 3.1.3. for more information.
[29] Treatment-on-the-Treated (ToT), see section 3.1.3. for more information.
[30] Treatment-on-the-Treated (ToT), see section 3.1.3. for more information.
[31] Intention-to-Treat (ITT), see section 3.1.3. for more information.



Effect size	P-value
0,00	0,98

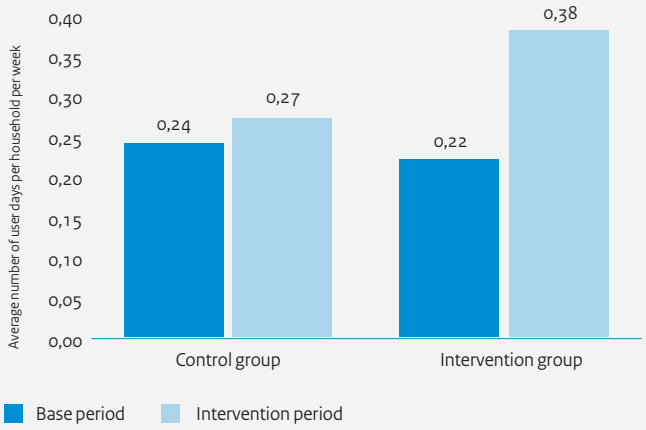
Figure 4.4.6: Use of organic waste facilities for intervention 1, "setting personal goals & activating," in Rotterdam[1].

[1] Effect size is an indicator for the effect that the intervention has. Simply put, it is calculated by (intervention-control) during the base period + (intervention-control) during the intervention period. The P-value is a statistical indicator of the reliability of the result. The smaller this value is, the more unique and consistent the result is. The standard value is p<0.05.



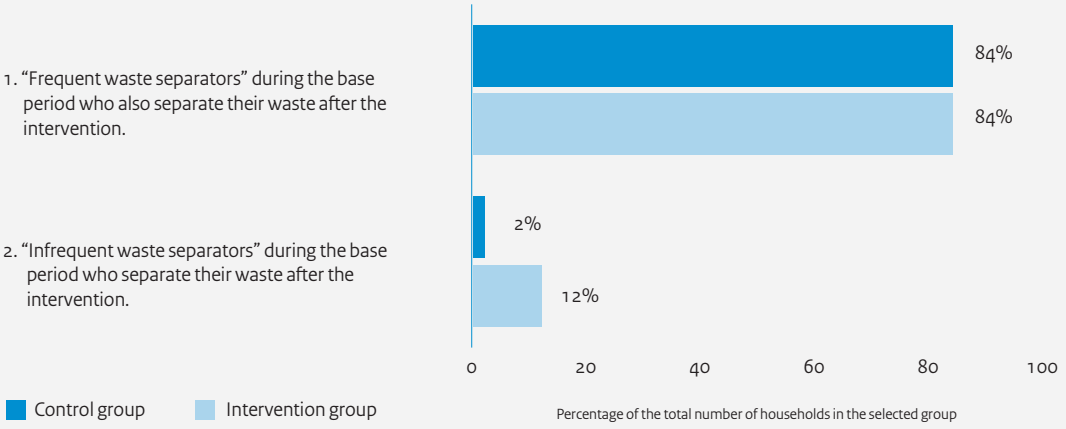
Separator group	P-value
1. Frequent	0,78
2. Infrequent	0,47

Figure 4.4.7: Changes in households' behaviour for intervention 1, "setting personal goals & activating," in Rotterdam.



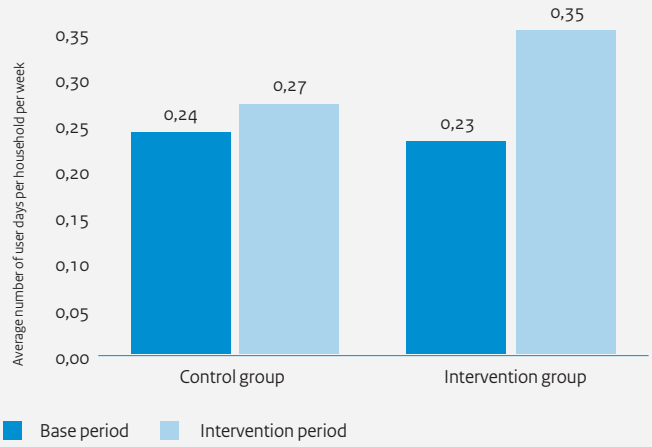
Effect size	P-value
0,13	0,00

Figure 4.4.8: Use of organic waste facilities for intervention 2, "facilitating storage at home," in Rotterdam.



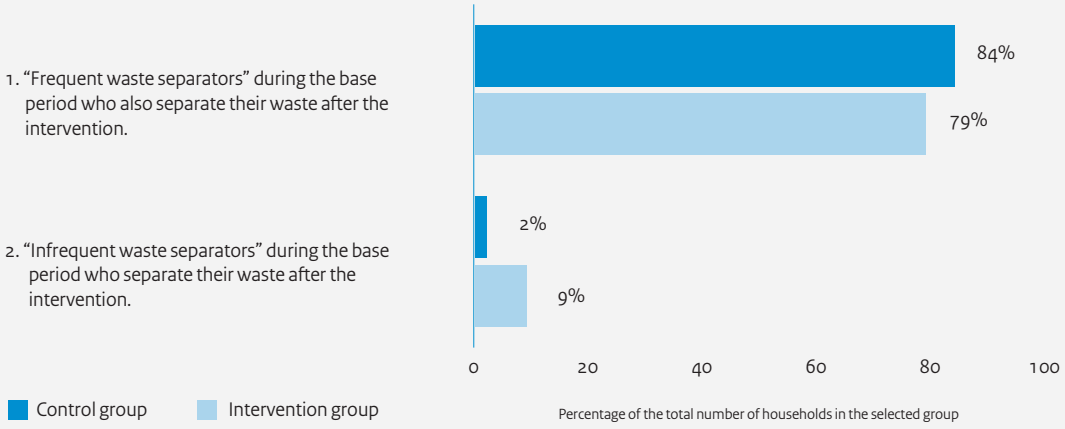
Separator group	P-value
1. Frequent	1,00
2. Infrequent	0,00

Figure 4.4.9: Changes in households' behaviour for intervention 2, "facilitating storage at home," in Rotterdam.



Effect size	P-value
0,08	0,03

Figure 4.4.10: Use of organic waste facilities for intervention 3, "setting personal goals & activating + facilitating storage at home," in Rotterdam.



Separator group	P-value
1. Frequent	0,63
2. Infrequent	0,45

Figure 4.4.11: Changes in households' behaviour for intervention 3, "setting personal goals & activating + facilitating storage at home," in Rotterdam.

Intervention 3 – *"Setting personal goals & activating + facilitating storage at home"*

Figure 4.4.10 shows the average number of user days for households that received an intervention (*"setting personal goals & activating + facilitating storage at home"*) versus those that did not[32].

During the intervention period, the households in the intervention group (which were offered the combined intervention) disposed of their organic waste significantly more often than those in the control group. Households that underwent this intervention deposit organic waste an average of 0.08 user days per household per week more often (an increase of 30%). The data do show that the difference between both groups diminishes over time. After the first month, there is no longer a significant difference between both groups.

Of the households that were offered the intervention, half (50%) accepted and received the bin, while slightly less than half (45%) agreed to set a personal waste separation goal[33]. The results show that some households do not accept one of the interventions. The factors that determine whether a family accepts the intervention or not are roughly the same as for the non-combined interventions of setting goals and using an organic waste bin.

We also examined whether households continue to separate their waste properly during the intervention period or not. Figure 4.4.11 illustrates the change in the behaviour of households in the intervention group and those in the control group.

In the intervention group, the number of households that became frequent waste separators is significantly higher (an increase of seven percentage points (p = 0.00)). The number of frequent waste separators who continue to separate their waste is not significantly different.

The effects of the combined intervention are not as strong as those of the organic waste bin alone. To summarise, *"setting personal goals & activating"* did not work as a stand-alone intervention; *"setting personal goals & activating"* in combination with *"facilitating storage at home"* has a smaller effect than the intervention *"facilitating storage at home"* by itself, without also setting goals.

The survey results show that there is no significant interaction between accepting the bin and setting personal goals. In other words, setting goals does not lead to increased usage of the organic waste bin and vice versa.

Conclusions

- During the base period, 41% of the households used the organic waste containers at least once and 12% of the households were classified as frequent waste separators. Of all households that used the waste collection facilities at least once, 29% continues to separate their organic waste.
- Households that received the organic waste bin deposit organic waste an average of 0.13 user days per household per week more often (i.e. once more every 7.7 weeks, an increase of 48%). Over time, the households to whom the bin was offered continue to make more frequent use of the organic waste facilities than the control group.
- The effects of the combined intervention *"setting personal goals & activating"* and using the organic waste bin are not as strong as those of the organic waste bin alone. *"Setting personal goals & activating"* did not work as a stand-alone intervention; *"setting personal goals & activating"* in combination with *"facilitating storage at home"* has a smaller effect than the intervention *"facilitating storage at home"* by itself, without also setting goals.

4.5 Schiedam

4.5.1 Structure

Location

The pilot was conducted in the Schiedam-West district from June 2018 until June 2019. This area contains low-rise buildings, apartment complexes with a maximum of four residential layers and a number of flats (see figure 4.5.1). The residences have an average WOZ value of €141,000.
Most of the residences do not have a garden. The gardens that are there are not accessible from the back.

The area consists of circa 6,800 residences, 4,137 of which were selected for participation in the pilot. Thirty percent of the residences are single-family dwellings and the average living area is 99 m2. Thirty-six percent of the residences are home to one-person households. In total, 9,241 people live in the area.

Basic package

During the pilot, waste was collected in underground containers. At the start of the pilot, 43 organic waste containers were placed in the area. This means residents had no way of separating their organic waste prior to the pilot. The available containers for plastic, metal and beverage cartons (PMD), glass and paper were not modified for the pilot. Prior to the start of the pilot, the

[32] Treatment-on-the-Treated (ToT), see section 3.1.3. for more information.
[33] Treatment-on-the-Treated (ToT), see section 3.1.3. for more information.

Figure 4.5.1: Examples of the various types of residences in Schiedam-West.

Figure 4.5.2: Aboveground organic waste containers feature an eye-catching appearance.

*	There is a lot of room for improvement. Your neighbourhood can do better! Are you doing your part?
**	There is still some room for improvement. Are you doing your part?
***	Your neighbourhood is doing well. Go earn that fourth star! Are you doing your part?
****	Your neighbourhood is doing well and has almost reached the goal. Go earn that fifth star!
*****	Your neighbourhood is doing very well. Keep it up!

Figure 4.5.3: Intervention 1 in Schiedam - "setting group goals & feedback": statements in the first letter.

containers were given an eye-catching appearance with informative stickers (see figure 4.5.2). The underground containers for residual waste and organic waste feature an access-control system, which allows residents to open the containers with a keycard.

At the start of the pilot, residents received a letter with information about the project and about how to access the containers, as well as general information about waste separation (including the benefits of waste separation). Furthermore, waste management coaches went door to door to explain the changes that were made. Residents could also opt for an organic waste bin for use on their kitchen counter[21]. Almost all households accepted this bin. The bin came with a sticker to explain what waste materials it is (not) intended for. Residents also received an information kit containing a flyer and a card with tips on how to separate organic waste.

Together, these measures form the basic package. All residents in the pilot region received the basic package. The households that only received the basic package (and no additional behavioural interventions) formed the control group.

Behavioural interventions

Three behavioural interventions were tested in Schiedam. The first intervention is *"setting group goals & feedback": setting a collective goal, measuring progress and giving households feedback*. The expectation is that waste separation is stimulated by challenging households to contribute to a collective goal. Households also receive information about how well the neighbourhood separates its

[21] 1.5-litre closed OMRIN/Calypso bin or the open ten-litre Ventimax

Figure 4.5.4: Intervention 2 in Schiedam – "social modelling."

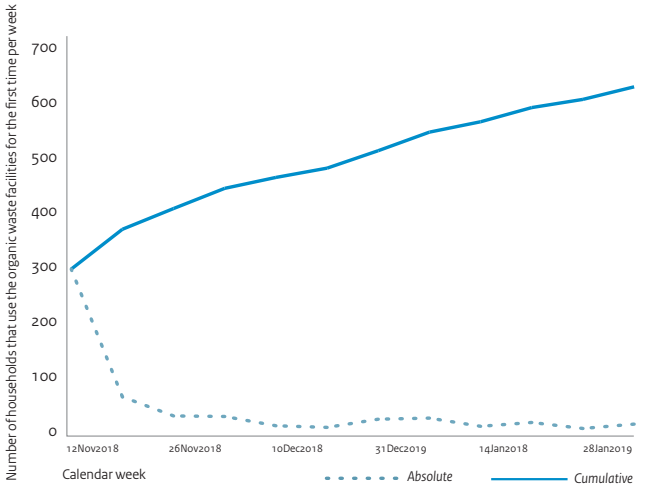


Figure 4.5.5: The number of households that make use of the organic waste container in Schiedam for the first time.

organic waste, i.e. social feedback. For each container, a reasonably attainable goal weight was calculated. Next, four letters were sent to residents at a four-week interval. Each letter contained information about the group's performance and how it relates to the final goal. Based on the performance (and subsequent changes to it), the letters also included an encouraging statement. Figure 4.5.3 shows the various statements included in the first letter.

The second behavioural intervention that was tested is *"social modelling": providing information about similar people in the area so residents can learn from a (example) model*. The expectation is that people are motivated to separate their waste (even) better if they are given a good example. Residents were therefore sent a series of pictures (A4) that show the good example, along with a brief accompanying letter.

The third intervention is a combination of *"setting group goals & feedback"* and *"social modelling."*

Research structure

The basic package and the three behavioural interventions were gradually tested (successively) among a total population (N) of 4,137 households. This means there were four groups: (1) a control group that only received the basic package and no additional behavioural interventions, (2) a group that did receive the *"setting group goals & feedback"* intervention but not the *"social modelling"* intervention, (3) a group that did receive the *"social modelling"* intervention but not the *"setting group goals & feedback"* intervention and (4) a group that was offered both interventions.

4.5.2 Results

Base period

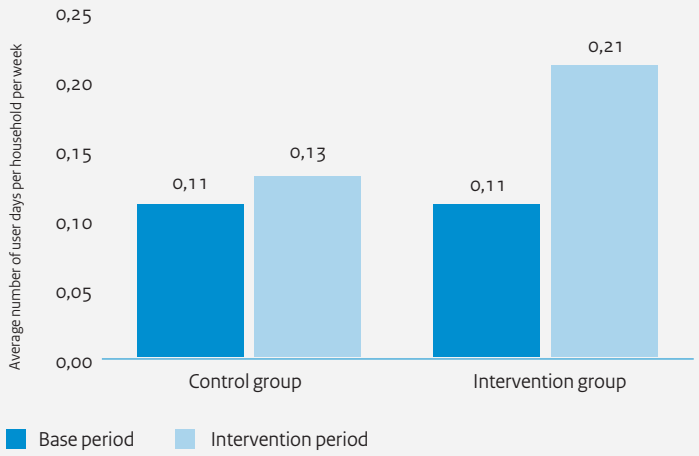
To analyse the effects of the basic package, the behaviour of households after the introduction of organic waste containers is examined. The effect measurements began after the introduction of the basic package. Figure 4.5.5 illustrates how soon after the introduction of the basic package households first made use of the organic waste containers.

During the base period, i.e. the period after the introduction of the basic package (and before the start of the interventions), 16% of the households used the organic waste containers at least once. During the base period, 7% of the households could be classified as frequent waste separators[22]. Of all households that used the waste collection facilities at least once, 44% continues to separate their organic waste. The average number of days that a household disposes of its organic waste is 0.12 days per week (or once every 8.3 weeks).

Looking at the household characteristics, it is notable that single-person households separate their organic waste 5% less frequently than families. Households that contain one or more senior citizens separate their organic waste 6% more frequently than households without a senior member.

Households living in an owner-occupied residence separate their organic waste 2.5% more frequently than households living in a rental property. Households living in a larger residence are more likely to separate their organic waste (all values $p<0.01$). Other characteristics, such as WOZ value and residence type, do not have a (demonstrated significant) impact on the frequency with which households make use of the organic waste containers.

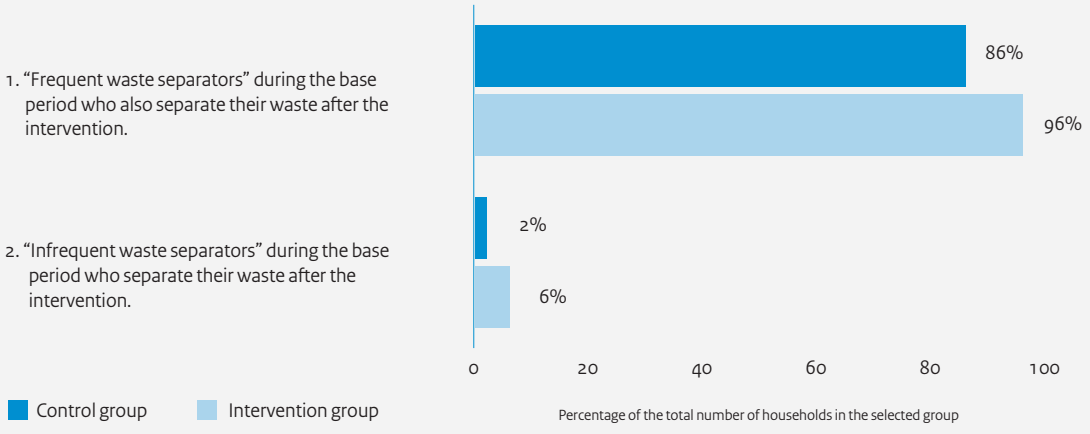
[22] A "frequent waste separator" is a household that uses the organic waste container at least once every 1.5 weeks. An "infrequent waste separator" is a household that does not or hardly ever make use of the organic waste container (less than once every 1.5 weeks).



Effect size	P-value
0,08	0,00

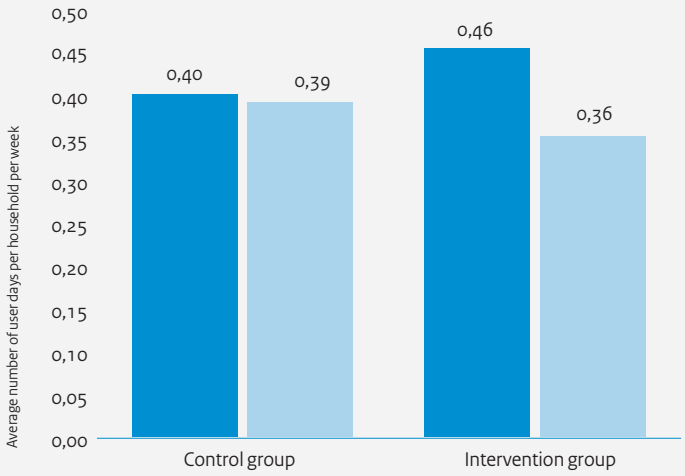
Figure 4.5.6: Use of organic waste facilities for intervention 1, "setting group goals & feedback," in Schiedam[1].

[1] Effect size is an indicator for the effect that the intervention has. Simply put, it is calculated by (intervention-control) during the base period + (intervention-control) during the intervention period. The P-value is a statistical indicator of the reliability of the result. The smaller this value is, the more unique and consistent the result is. The standard value is p<0.05.



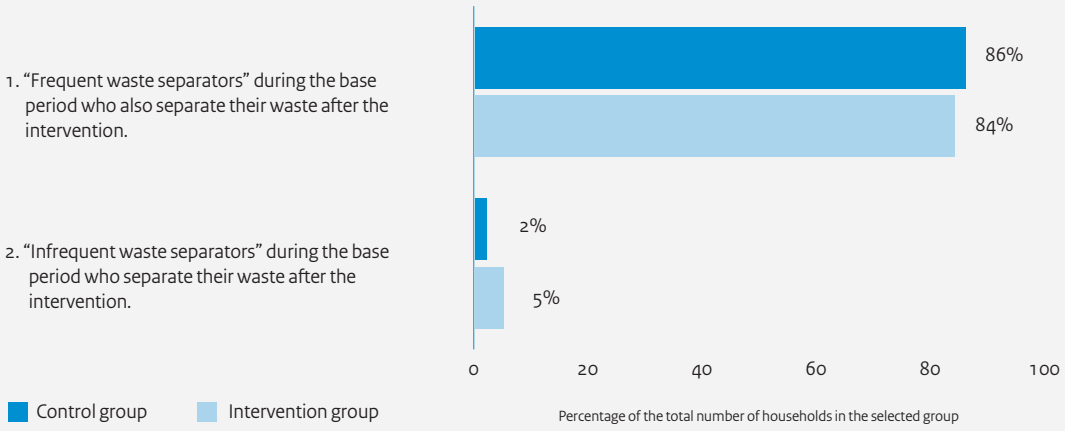
Separator group	P-value
1. Frequent	0,02
2. Infrequent	0,00

Figure 4.5.7: Changes in households' behaviour for intervention 1, "setting group goals & feedback," in Schiedam.



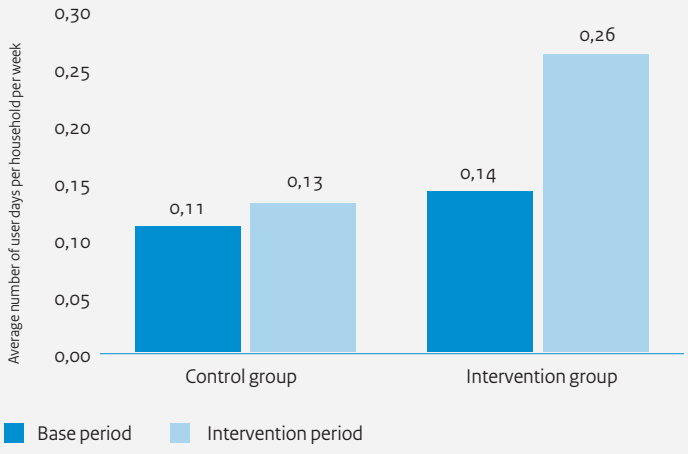
Effect size	P-value
0,03	0,05

Figure 4.5.8: The use of organic waste facilities for intervention 2 "social modelling" in Schiedam.



Separator group	P-value
1. Frequent	0,74
2. Infrequent	0,00

Figure 4.5.9: Changes in households' behaviour for intervention 2, "social modelling," in Schiedam.



Effect size	P-value
0,11	0,00

Figure 4.5.10: Use of organic waste facilities for intervention 3, "setting group goals & feedback + social modelling," in Schiedam.

The surveys show that the entire group believes waste separation to be "desirable" to "highly desirable," while the attitude of frequent waste separators during the base period is slightly more positive. Residents display varying levels of intention to separate their waste. For organic waste, people's intentions are clearly weaker than for PMD. The primary obstacle with regard to separating waste is storage in the kitchen and the home.

Intervention 1 – *"Setting group goals & feedback"*

To determine whether the expectations are correct, the intervention group and the control group (which only received the basic package) were compared. We looked at the frequency with which households separate their organic waste. Figure 4.5.6 shows the average number of user days for households that received an intervention (*"setting group goals & feedback"*) versus those that did not[23]. This is an average value of all households; some never use the container, while others do so one or multiple days per week.

During the intervention period, the households in the intervention group (which were offered the "setting group goals & feedback" intervention) disposed of their organic waste significantly more often than those in the control group. Households that received the intervention deposit organic waste an average of 0.08 user days per household per week more often (i.e. once more every 12.5 weeks, an increase of 65%). The data do show that the difference between both groups diminishes slowly and slightly over time, although the effect remains significant.

What households actually accepted the intervention (opened and read the letter) was not measured[24].

We also examined whether households continue to separate their waste properly during the intervention period or not. Figure 4.5.7 illustrates the change in the behaviour of households in the intervention group and those in the control group. In the intervention group, both the number of frequent waste separators who continued to separate their waste and the number of households that became frequent waste separators are significantly higher (a respective increase of ten and four percentage points ($p < 0.02$)).

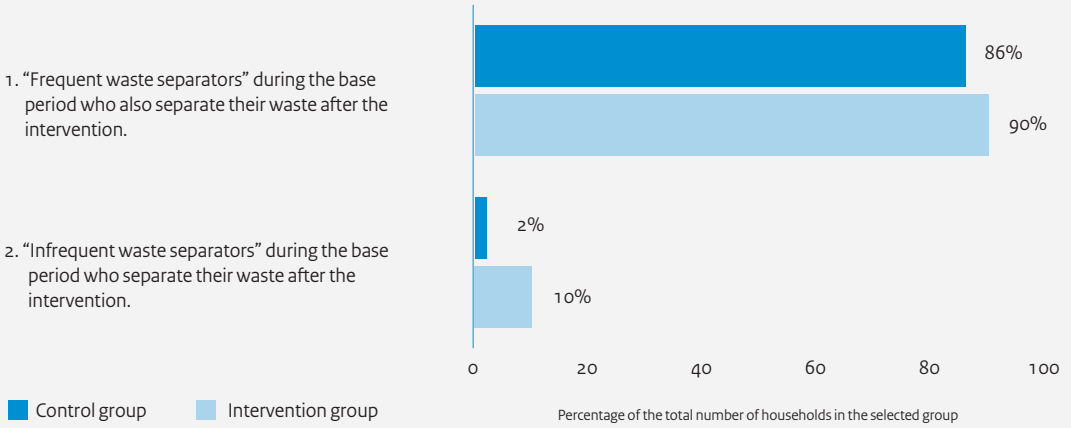
The survey results show that 90% of the respondents found the information comprehensible. More than half deemed the feedback about the container weights to be useful, while the other half appeared to have some difficulty understanding the container information in particular. The information with the performance stars appears to be easier to process.

Intervention 2 – *"Social modelling"*

Figure 4.5.8 shows the average number of user days for households that received an intervention (*"social modelling"*) versus those that did not[25].

During the intervention period, the households in the intervention group (which were offered the "social modelling" intervention) disposed of their organic waste significantly more often than those in the control group. Households that received the intervention deposit organic waste an average of 0.03 user days per household per week more often (i.e. once more every 33.3 weeks, an increase of 27%). The data do show that the difference between both groups gradually diminishes over time and is then no longer significant. What households actually accepted the intervention (opened and read the letter) was not measured[26].

[23] Intention-to-Treat (ITT), see section 3.1.3. for more information.
[24] Treatment-on-the-Treated (ToT), see section 3.1.3. for more information.
[25] Intention-to-Treat (ITT), see section 3.1.3. for more information.
[26] Treatment-on-the-Treated (ToT), see section 3.1.3. for more information.



Separator group	P-value
1. Frequent	0,01
2. Infrequent	0,01

Figure 4.5.11: Changes in households' behaviour for intervention 3, "setting group goals & feedback + social modelling" in Schiedam.

We also examined whether households continue to separate their waste properly during the intervention period or not. Figure 4.5.9 illustrates the change in behaviour exhibited by households in the intervention group and those in the control group. In the intervention group, the number of households that became frequent waste separators is significantly higher (an increase of five percentage points ($p = 0.00$)). The number of frequent waste separators who continue to separate their waste is not significantly different.

The survey results show that the photographs were fairly well read and understood. Opinions about the usefulness of the photographs are divided. Perhaps the more experienced waste separators did not need this form of aid.

Intervention 3 – *"Setting group goals & feedback + social modelling"*

Figure 4.5.10 shows the average number of user days for households that received the *"setting group goals & feedback + social modelling"* intervention versus those that did not[27].

During the intervention period, the households in the intervention group (which were offered the "setting group goals & feedback + social modelling" intervention) disposed of their organic waste significantly more often than those in the control group. Households that underwent this intervention deposit organic waste an average of 0.11 user days per household per week more often (an increase of 84%). When we look at the combined effect, we see that the simultaneous execution of the interventions does not result in a significant increase of the frequency with which the organic waste facilities are used, compared to the frequency of use by households in the *"setting group goals & feedback"* intervention group.

What households actually accepted the intervention (opened and read the letter) was not measured[28].

We also examined whether households continue to separate their waste properly during the intervention period or not. Figure 4.5.11 illustrates the change in the behaviour of households in the intervention group and those in the control group. In the intervention group, both the number of frequent waste separators who continued to separate their waste and the number of households that became frequent waste separators are significantly higher (a respective increase of four and eight percentage points ($p < 0.01$)).

Except for a direct effect of "social modelling" on people's intentions, the surveys show no direct effects of the interventions on residents' intentions or behaviour. The waste disposal data provide more insight. However, there are indirect behavioural effects, namely on behaviour-influencing factors such as attitudes, on people's faith in the municipality, on the feeling of being well informed and on the perceived feasibility of waste separation behaviour.

[27] Intention-to-Treat (ITT), see section 3.1.3. for more information.
[28] Treatment-on-the-Treated (ToT), see section 3.1.3. for more information.

Conclusions

- During the base period, 16% of the households used the organic waste containers at least once and 7% of the households were classified as frequent waste separators. Of all households that used the waste collection facilities at least once, 44% continues to separate their organic waste.
- Households that underwent the *"setting group goals & feedback"* intervention deposit organic waste an average of 0.08 user days per household per week more often (i.e. once more every 12.5 weeks, an increase of 65%). This effect does diminish somewhat over time.
- Households that underwent the *"social modelling"* intervention deposit organic waste an average of 0.03 user days per household per week more often (i.e. once more every 33.3 weeks, an increase of 27%). This effect diminishes over time and is then no longer significant.
- When we look at the combined effect, we see that the simultaneous execution of the interventions does not result in a significant increase of the frequency with which the organic waste facilities are used, compared to the frequency of use by households in the *"setting group goals & feedback"* intervention group.

4.6 Utrecht

4.6.1 Structure

Location

The pilot was conducted among the high-rise buildings on the north-western side of the Beneluxlaan from May 2018 until August 2019. The pilot region consists of apartment buildings with four to ten residential floors on the edge of Kanaleneiland-Noord and Transwijk (see figure 4.6.1). The residences have an average WOZ value of €150,000. Compared to the rest of Utrecht, the apartments are relatively cheap. Some of the apartments (7%) have a garden. More than one third of the apartments (68%) have a balcony.

The area consists of 601 apartments. The apartments have an average living area of 82 m2. Most are owner-occupied apartments. Forty-two percent of the apartments are occupied by single-person households and one in eight residents (12%) is over the age of 65. In total, 1,116 people live in the area.

Basic package

Prior to and during the pilot, residual waste was collected in underground containers. At the start of the pilot, 14 containers in the area were repurposed for the disposal of organic waste. This means residents had no way of separating their organic waste prior to the pilot. The available containers for plastic, metal and beverage cartons (PMD), glass and paper were not modified for the pilot. The organic waste containers were easy to recognise by the green colour and by an affixed sign with the letters "GFT" (see figure 4.6.2). The organic waste containers feature an access-control system, which allows residents to open the containers with a keycard. In some cases, the organic waste containers are located next to the residual waste containers; elsewhere, there are no other containers nearby. The distance that residents have to cover to dispose of their organic waste differs.

At the start of the pilot, residents received two letters that contained information about the project. Via a subsequent letter, the residents received keycards for the organic waste containers and were invited to attend a neighbourhood gathering during which the information was verbally clarified.

Also included in the basic package was an organic waste bin for use on the kitchen counter, along with blank compostable bags and a

Figure 4.6.1: One of the apartment buildings in Utrecht.

Figure 4.6.2: Aboveground organic waste containers positioned next to containers for other waste streams in Utrecht.

Figure 4.6.3: The organic waste bins and bags for use on kitchen counters that were handed out.

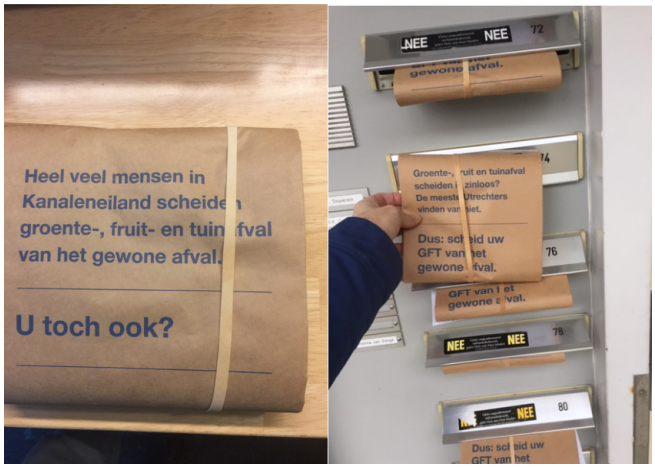


Figure 4.6.4: An example of the compostable bags that were used in Utrecht.

letter detailing how to use the bin (see figure 4.6.3). The bins were distributed door to door one month after residents received their keycards. If residents were not home at the time, the bins were left by their front door. This was the case for half of the participating households. The idea is that the bags make it easier to transport organic waste to the apartment building's organic waste disposal facilities, while also keeping the bin itself clean. The bags were handed out to the households in the pilot region for free.

Together, these measures form the basic package. All residents in the pilot region received the basic package. The households that only received the basic package (and no additional behavioural interventions) formed the control group.

Behavioural interventions

Four behavioural interventions were tested in Utrecht during two consecutive phases. All interventions involved messages printed on compostable bags (see figure 4.6.4). The control group received new blank bags at the same time as the intervention groups. These bags were identical to the ones that were given to all households in the pilot region during the base period.

The first behavioural intervention that was tested is *"strengthening social standards & activating"*: informing households about the waste separation behaviour of other households in the pilot region. The expectation is that people can be motivated to separate their waste (even) better by giving them factual information about the behaviour of others. People can be influenced by the behaviour exhibited by (many) other people. The rule of thumb that we use (consciously or subconsciously) is "if many others are doing it, it must be okay." Of course, it is important to make sure that the normative message accurately describes the behaviour of other residents. A descriptive social standard describes what normal behaviour is, while an injunctive social standard describes what the behaviour should be. The social standards were communicated via two messages that were printed on compostable bags: a message about the descriptive social standard and one about the injunctive social standard.

The second behavioural intervention that was tested is *"acknowledging and reducing resistance."* Once again, this was done with the help of two different messages: one that emphasised the importance of waste separation for the *environment* and one that stressed the

Intervention	Intervention period	Text printed on the compostable bag
Descriptive social standard	1	Many people in Kanaleneiland separate their organic waste. Do you?
Injunctive social standard	1	Is separating organic waste pointless? Most people in Utrecht don't think so. Separate your organic waste from your residual waste.
Reducing resistance, environmental benefits	2	We know separating organic waste is a hassle. But we use your organic waste to make valuable biogas and compost. Will you help?
Reducing resistance, financial benefits	2	We understand that separating organic waste is a hassle, but we can all earn money from it! Will you help?
Blank	Both	None

Table 4.6.5: Description of the different messages.

financial benefits. The underlying thought is that acknowledging the fact that separating waste is not easy while explaining why it is important will motivate people to separate their waste. It is possible to add some variation by emphasising the environmental benefits or the *financial benefits*, because not everyone will value these different benefits equally. Figure 4.6.5 shows an overview of the messages that were used.

Research structure

The basic package and the two behavioural interventions were gradually tested (successively) among a total population (N) of 557 households. The interventions were each tested among circa one third of the households in the pilot region. During the first intervention period, there are three groups: (1) strengthening descriptive social standards & activating, (2) strengthening injunctive social standards & activating, (3) blank bags (control group). During the second intervention period, each group was once again divided into three: (1) *"acknowledging and reducing resistance (environmental benefits)"*, (2) *"acknowledging and reducing resistance (financial benefits)"* and (3) *blank bags (control group)*. This means there were nine different groups in total.

4.6.2 Results

Base period

To analyse the effects of the basic package, the behaviour of households after the introduction of organic waste containers is examined. The effect measurements began after the introduction of the basic package. Figure 4.6.6 illustrates how soon after the introduction of the basic package households first made use of the organic waste containers.

During the base period, i.e. the period after the introduction of the basic package (and before the start of the interventions), 57% of the households used the organic waste containers at least once. During the base period, 25% of the households can be classified as frequent waste separators[21]. Of the households that used the waste collection facilities at least once, 44% continues to separate their organic waste. The average number of days that a household disposes of its organic waste is 0.40 days per week (i.e. once every 2.5 weeks). The organic waste facilities were not used frequently when they were first introduced (0.07 days per week); only after the keycards and the blank bags had been handed out did residents' interest grow.

With regard to the impact of household characteristics on waste separation behaviour, the data show that none of the household characteristics, e.g. age, number of persons per household, living area or WOZ value, influence the decision to separate organic waste.

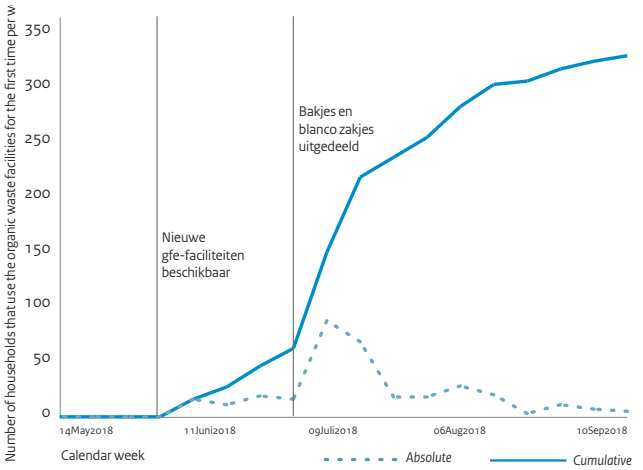


Figure 4.6.6: The number of households that make use of the organic waste container in Utrecht for the first time.

The surveys show that people's attitude towards waste separation is "desirable" to "highly desirable." Residents display varying levels of intention to separate their waste. The primary obstacle with regard to separating waste is storage in the kitchen and the home. The bins and the bags were accepted by most residents and a majority actually used them. People's opinion of the big and bags was generally positive. However, the usage figures are not optimal: 40% of the residents did not use the bin and many residents commented on the usability of the bin and the bags.

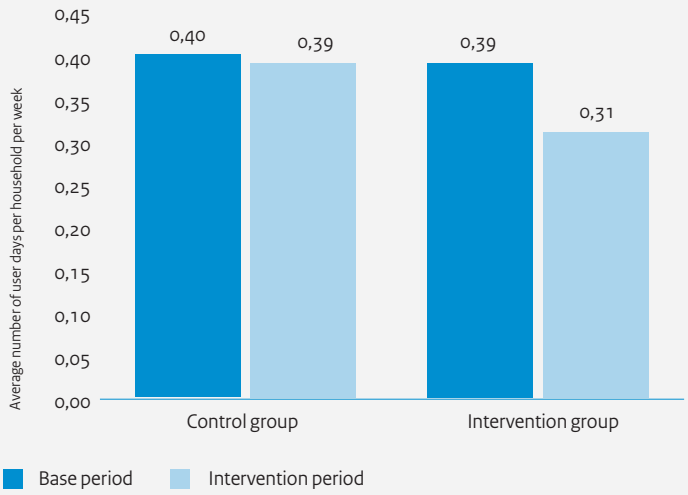
Intervention 1 – *"Strengthening social standards & activating"*

To determine whether the expectations are correct, the intervention group and the control group (which only received the basic package) were compared. We looked at the frequency with which households separate their organic waste. Figure 4.6.7 shows the average number of user days for households that received the intervention (communication about *"strengthening descriptive social standards & activating"*), versus those that did not[22]. Figure 4.6.8 shows the average number of user days for households that received the intervention (communication about *"strengthening injunctive social standards & activating"*), versus those that did not. This is an average value of all households; some never use the container, while others do so one or multiple days per week.

Neither intervention resulted in any improvements to people's waste separation behaviour. On the contrary: compared to the control group, households in the intervention group use the organic waste facilities less frequently after receiving the descriptive social standard. The same goes for the injunctive social standard. There is no discernible statistically significant pattern in the development of the effect size of the descriptive social standard information over time. We do see that the annoyance regarding the injunctive social standard information grows stronger over time.

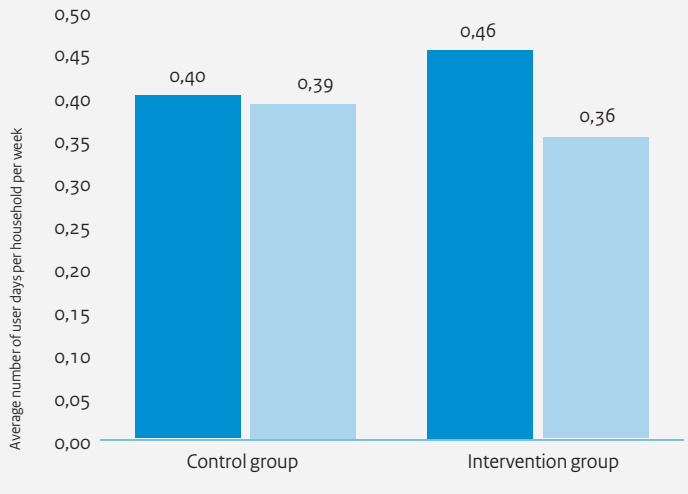
[21] A "frequent waste separator" is a household that uses the organic waste container at least once every 1.5 weeks. An "infrequent waste separator" is a household that does not or hardly ever make use of the organic waste container (less than once every 1.5 weeks).

[22] Intention-to-Treat (ITT), see section 3.1.3. for more information.



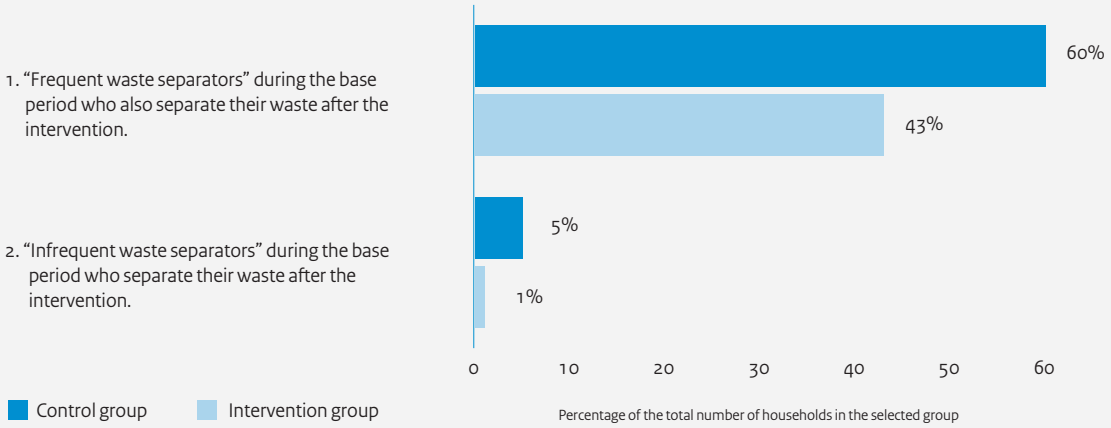
Effect size	P-value
-0,07	0,08

Figure 4.6.7: Use of organic waste facilities for intervention 1, "strengthening social standards & activating - descriptive," in Utrecht.



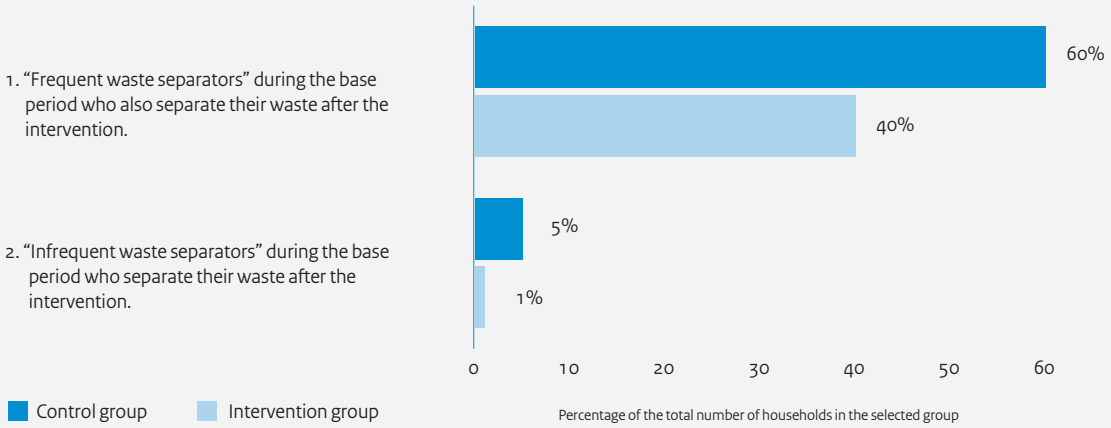
Effect size	P-value
-0,07	0,09

Figure 4.6.8: Use of organic waste facilities for intervention 1, "strengthening social standards & activating - injunctive," in Utrecht.



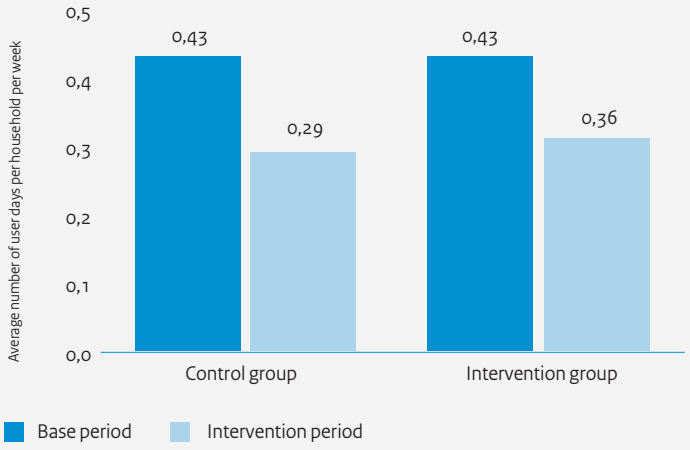
Separator group	P-value
1. Frequent	0,11
2. Infrequent	0,09

Figure 4.6.9: Changes in households' behaviour for intervention 1, "strengthening social standards & activating - descriptive," in Utrecht.



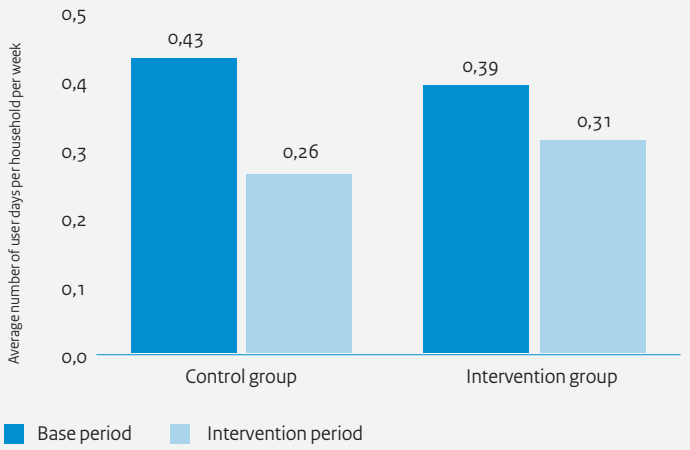
Separator group	P-value
1. Frequent	0,06
2. Infrequent	0,04

Figure 4.6.10: Changes in households' behaviour for intervention 1, "strengthening social standards & activating - injunctive," in Utrecht.



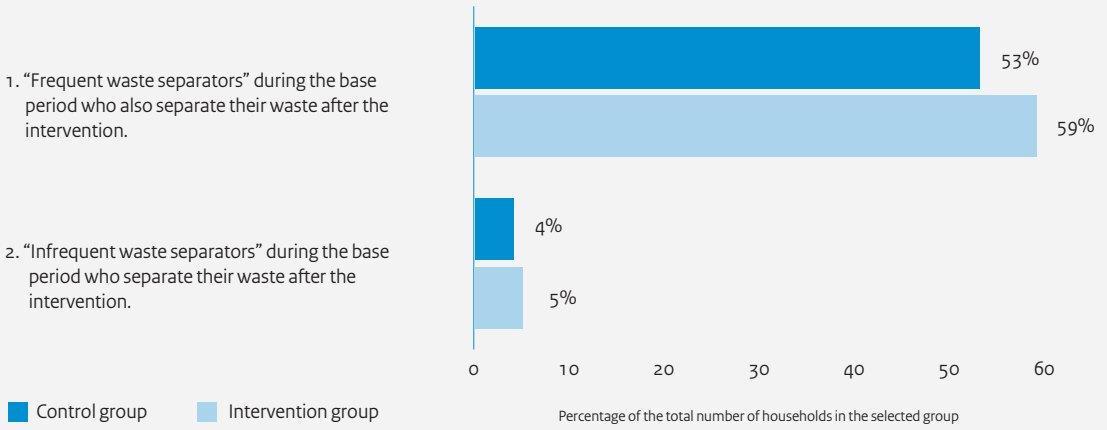
Effect size	P-value
0,03	0,30

Figure 4.6.11: Use of organic waste facilities for intervention 2, "acknowledging and reducing resistance - environment," in Utrecht.



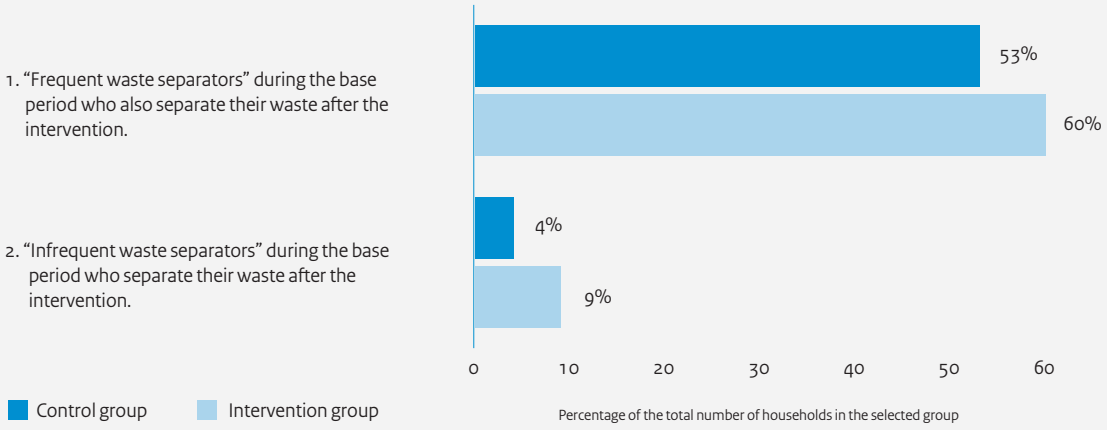
Effect size	P-value
0,06	0,08

Figure 4.6.12: Use of organic waste facilities for intervention 2, "acknowledging and reducing resistance - financial," in Utrecht.



Separator group	P-value
1. Frequent	0,84
2. Infrequent	0,69

Figure 4.6.13: Changes in households' behaviour for intervention 2, "acknowledging and reducing resistance - environment," in Utrecht.



Separator group	P-value
1. Frequent	0,47
2. Infrequent	0,06

Figure 4.6.14: Changes in households' behaviour for intervention 2, "acknowledging and reducing resistance - financial," in Utrecht.

What households actually accepted the intervention (read the message) was not measured.

We also examined whether households continue to separate their waste properly during the intervention period or not. Figure 4.6.9 illustrates the change in the behaviour of households in the intervention group (descriptive standard) and those in the control group. No significant differences were found between the control and intervention groups.

Figure 4.6.10 illustrates the change in the behaviour of households in the intervention group (injunctive standard) and those in the control group. We find that the injunctive social standard information does not affect the odds of a household that was already a frequent waste separator during the base period continuing to regularly separate its organic waste. The injunctive social standard information appears to reduce the odds of an infrequent waste separator becoming a frequent waste separator.

The survey results show that both normative messages received too little attention from residents, likely due to a lack of exposure to the message.

Intervention 2 – *"Acknowledging and reducing resistance"'*

Figures 4.6.11 and 4.6.12 show the average number of user days for the households that received the *"acknowledging and reducing resistance"* intervention, versus those that did not[23].

No significant difference was found in the frequency of waste separation between the intervention group (*"acknowledging and reducing resistance"* with an emphasis on the environment and with an emphasis on the financial aspects) and the control group.

What households actually accepted the intervention (read the message) was not measured.

We also examined whether households continue to separate their waste properly during the intervention period or not. Figures 4.6.13 and 4.6.14 illustrate the change in the behaviour of households in the intervention group and those in the control group. *"Acknowledging and reducing resistance"* (with an emphasis on both the environmental and the financial benefits) has no influence on the odds of households continuing to separate their waste, nor on the odds of them becoming frequent waste separators.

The survey results show that the messages designed to reduce people's resistance to waste separation were insufficiently recalled. The attention paid to these messages by the residents who actually used the bags was slightly higher, yet still too low. There were insufficient differences between conditions to identify any clear differences.

Conclusions

- During the base period, 57% of the households used the organic waste containers at least once and 25% of the households were classified as frequent waste separators. Of all households that used the waste collection facilities at least once, 44% continues to separate their organic waste.
- Neither *"strengthening social standards & activating"* intervention resulted in any improvements to people's waste separation behaviour. On the contrary: compared to the control group, households in the intervention group use the organic waste facilities less frequently after receiving the descriptive social standard. The same goes for the injunctive social standard.
- No significant difference was found in the frequency of waste separation between the intervention group (*"acknowledging and reducing resistance"* with an emphasis on the environment and with an emphasis on the financial aspects) and the control group.

[23] Intention-to-Treat (ITT), see section 3.1.3. for more information.

5 Synthesis of the results

Chapter 4 outlined the findings of the project per pilot. In this chapter, the results of six major pilot projects conducted in various Dutch municipalities are synthesised. In total, more than 8,000 households took part in these pilot programmes. This chapter will cover the effects of the implementation of a basic package and the effectiveness of the various behavioural interventions. Furthermore, we will examine other factors that may influence people's waste separation behaviour and demonstrate the extent to which waste separation behaviour can be clarified with the help of self-reported intentions.

5.1 The basic package

All pilots were conducted in major Dutch municipalities, namely Almere, Amsterdam, The Hague, Rotterdam, Schiedam and Utrecht. The scope of the pilot regions varied between 450 and 4,137 participating households. The apartment complexes had three to fourteen residential layers and the degree of homogeneity of the pilot region differed between the participating municipalities.

In all pilot regions, it was not yet possible to separate organic waste prior to the start of the pilot. Each pilot began with the introduction of a basic package. This basic package was designed to provide the three behavioural components: opportunity, motivation and capacity. If these three components are not sufficiently provided, residents will not separate their waste (see chapter 2). The basic package also serves to create a comparable baseline position in all six pilot regions. The basic package was covered in detail in chapter 3. The contents of the basic package are briefly summarised below:

- Organic waste containers that feature an access system with keycards. The keycards are needed to register how often households deposit their waste.
- Communication via informative letters about the pilot, the why and how of waste separation, where the containers can be found, what modifications were made to existing containers and how to use the keycards. In some cases, a neighbourhood gathering was also organised.
- In Amsterdam, Schiedam and Utrecht, the basic package also included a small organic waste bin. The other three municipalities tested the effectiveness of distributing waste bins as a behavioural intervention (see paragraph 5.2.1).

Effectiveness of the basic package

Waste disposal behaviour

To analyse the effects of the basic package, the (waste disposal) behaviour of households after the introduction of organic waste containers is examined. The effect measurements began after the introduction of the basic package. During the base period, i.e. the period after the introduction of the base period (and prior to the start of the interventions), on average 20% of the households frequently made use of the organic waste containers, while circa half of the households (47%, see figure 5.1) made use of the organic waste containers once. The only exception to these figures was the pilot in Schiedam, where only 7% of the households separated their waste frequently and 16% made use of the organic waste containers only once during the base period. A possible explanation for this discrepancy is the fact that the pilot region in Schiedam was quite large and real high-rise buildings (with more than five residential floors) were only found in some locations.
Residents often had to walk quite a distance to reach the nearest organic waste containers (72 metres, on average). People were likely to encounter a residual waste container on their way to the nearest organic waste container. The number of residual waste containers was fairly high; more than three times as high as the number of organic waste containers. In Utrecht, the residual waste containers outnumbered the organic waste containers by a factor of only 1.5. The walking distances were also smaller in Utrecht. Without including the figures from Schiedam, on average 23% of the households frequently made use of the organic waste containers (three percentage points higher than the average that does include Schiedam).

The average number of days that a household disposes of its organic waste lies between 0.12 and 0.55 days per week (or once every 1.8 to 8.3 weeks). Circa one third of the visits to the organic waste containers during the base period occur during the first week. It is not

Pilot	Frequent waste separators*	One-time waste separators*	Average # of user days per week**
Almere	28%	64%	0,55
Amsterdam	28%	53%	0,43
The Hague	21%	52%	0,36
Rotterdam	12%	41%	0,22
Schiedam	7%	16%	0,12
Utrecht	25%	57%	0,40
Average (with Schiedam)	**20%**	**47%**	**0,35**
Average (without Schiedam)	23%	53%	0,39

*Figures represent the percentage of users of the total (number of households)
**Figures represent the average number of user days per household per week

Figure 5.1 Overview of the percentage of waste separators during the base period per municipality.

true that all households that made use of the waste collection facilities at least once then continue to do so. This means some households used the facilities one or more times during the base period and then stopped using them (before the end of the base period).

The waste disposal behaviour exhibited during the base period in Utrecht suggests that distributing organic waste bins is a good way to generate interests for the organic waste containers. The latter are used significantly more often during the base period after the distribution of the bins, compared to before. The effectiveness of distributing waste bins designed to make waste separation in the home easier was extensively tested as a behavioural intervention; the effects are covered in paragraph 5.2.1.

Household characteristics

We see that different types of households exhibit different behaviour from the outset. For example, single-person households separate their organic waste 5-16% less frequently across all pilots than multi-person households. On the other hand, households that contain one or more senior citizens separate their organic waste 6-27% more frequently than households without a senior member. Schiedam is the only municipality to exhibit minor additional effects: residents of owner-occupied apartments and apartments with a larger living area are more likely to separate their waste. Other characteristics, such as WOZ value, what floor of a building an apartment is located on or the presence of small children, do not impact the frequency with which households make use of the organic waste containers.

Intentions

The surveys show that households that frequently separate their waste generally have a stronger intention to continue doing so in the future, compared to infrequent waste separators. The most commonly reported issue with regard to waste separation is storing the waste in the kitchen and the home. Infrequent waste separators are more likely to perceive obstacles, e.g. feasibility, or find separating waste unpleasant. This group also finds it harder to recognise the different materials (Almere, The Hague) and find the right information (Almere, Schiedam).

It is likely that the intervention effects are partly dependent on the willingness of residents to improve their own waste separation behaviour. Figure 5.2 provides an overview of residents' willingness to separate their waste during the base period. Residents in Amsterdam are most willing to separate their waste, as shown by their positive attitudes, intentions and behaviour. In Almere, residents are active in terms of their waste disposal behaviour and they have a positive attitude, but their intentions and reported waste separation behaviour58 [21] are average. The Hague, Rotterdam and Schiedam score low with regard to the frequency of waste disposal and the reported waste separation behaviour and residents there are less positive in terms of their attitudes and intentions. With regard to residents' initial willingness in terms of behaviour, attitudes and intentions, Utrecht achieves an intermediate score.

[21] Reported waste disposal behaviour is the behaviour reported by residents themselves in a survey. It differs from waste disposal behaviour that is actually measured.

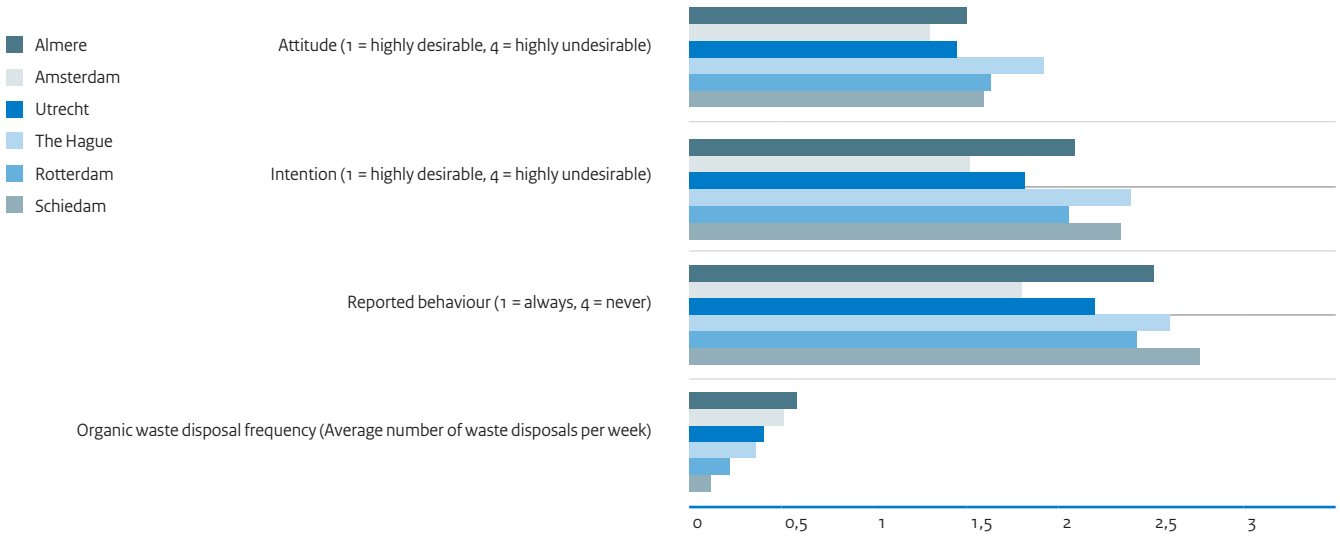


Figure 5.2: Baseline situations, attitude, intention, reported waste disposal behaviour and waste disposal behaviour during six pilots.
Note that the scale of waste disposal frequency data is not comparable to the other scores in absolute terms.

Conclusions

- Each pilot began with the introduction of a basic package. This basic package was designed to provide the three behavioural components: opportunity, motivation and capacity. If these three components are not sufficiently provided, residents will not separate their waste. The basic package consists of organic waste containers that feature an access-control system with keycards, communication about the why and how of waste separation and the pilot programme itself and - in some cases - an organic waste bin. Despite the fact that the basic packages are not identical, they do provide a comparable baseline position in each of the pilot regions.
- During the base period, i.e. the period after the introduction of the basic package (and before the start of the interventions), on average 20% of the households used the organic waste containers frequently. Circa half of the households (47%) have used the organic waste containers once. The average number of days that a household disposes of its organic waste lies between 0.12 and 0.55 days per week (or once every 1.8 to 8.3 weeks).
- Residents in Schiedam used the organic waste containers considerably less frequently, compared to the other pilots. In part, this is due to the (long) walking distance and the relatively high number of residual waste containers, although these factors do not fully account for the difference. No other conclusive explanation was found.
- Different types of households exhibit different behaviour. Single-person households separate their organic waste 5-16% less frequently than multi-person households. On the other hand, households that contain one or more senior citizens separate their organic waste 6-27% more frequently than households without a senior member. Other characteristics, such as WOZ value, what floor of a building an apartment is located on or the presence of small children, do not appear to impact the frequency with which households make use of the organic waste containers.
- Households that frequently separate their waste during the base period generally have a stronger intention to continue doing so in the future, compared to infrequent waste separators. The most commonly reported issue with regard to waste separation is storing the waste in the kitchen and the home. Infrequent waste separators are more likely to perceive obstacles, e.g. feasibility, or find separating waste unpleasant.
- The willingness to separate waste (attitude) differs between the pilot regions during the base period.

5.2 Behavioural interventions

After rolling out the basic package, behavioural interventions were introduced in the pilot regions. In total, ten different instruments were tested. Some instruments were only tested once, while others were tested multiple times (in different forms). The effects of the interventions per municipality, as covered in chapter 4, are shown in figure 5.3.

The think tank assigned the effectiveness scores based on the complete overview that was formed by combining the scores for behaviour, effect size, reported behaviour, attitude and intention. Every intervention was given a score in the form of a number of stars, representing its effectiveness compared to the other tested interventions: a score of zero stars indicates that no effect was found, while a score of three stars indicates that the intervention was highly effective. The behaviour and effect size are the scores as reported in chapter 4. Reported behaviour, attitude and intentions

Intervention	Pilot(s) – Intervention	Behaviour – Significant	Effect size *	% increase**	Reported behaviour	Attitude	Intention	Effectiveness
Facilitating storage at home	ALM, RDM	√	0,14	24,48	√	√	√	3
> Waste separation bin	TH	√	0,11	31	√	X	√	
> Built-in bin	TH	X	x		X	X	X	
Changing distance to waste collection point	AMS, SCH	√	x					2
Setting personal goals & activating	RDM	X	x		X	√	X	0
Setting group goals & feedback	SCH	√	0,08	65	X	√	X	3
Influencing attitude (the use of waste separation)	AMS	√	0,08	23	X	X	X	3
Strengthening social standard & activating	ALM, UTR	○	x		○	○	○	?
Social modelling	SCH	√	0,03	27	X	√	√	2
Acknowledging & reducing resistance	UTR	X	x		X	X	X	1
Pre-emptive gift	AMS	√	0,05	15	√	√	√	2
Promising reward	AMS	√	0,05	16	√	X	X	2

X No evidence of effect

○ Intervention not implemented effectively

√ Significant effect

Effectiveness: star rating

0 = no effect

1 = low effectiveness

2 = moderate effectiveness

3 = high effectiveness

? = inconclusive

* *For facilitating storage at home, the average value was used*

** *Intention-to-Treat. The percentage increase is determined by both the result from the base period and the effect of the intervention. A higher percentage is therefore not necessarily the result of a stronger effect.*

Figure 5.3: Overview of the interventions and their effects across six pilots.

The Hague Waste separation bin: +0.11 user days per household per week	Rotterdam Waste separation bin: +0.13 user days per household per week	Almere Waste separation bin: +0.14 user days per household per week
Waste separation bin  Built-in bin 		
Schiedam	**Amsterdam**	**Utrecht**
		

Figure 5.4: The various waste bins that were handed out to participating households.

were determined based on the survey results. The effect of time was also taken into consideration (see paragraph 5.2.5).

As described in the literature study (see chapter 2), the waste separation behaviour exhibited "behind closed doors" turned out to be an important factor. In three pilots, *"facilitating storage at home"* was utilised in different ways. It scores three stars based on its relative effectiveness (compared to other interventions). Furthermore, *"influencing attitudes (the use of waste separation)"* and *"setting group goals & feedback"* score three stars for effectiveness. Interventions that received a score of two stars - to indicate that they were effective in their own right, yet less so than the interventions that received three stars - are *"changing the distance to the waste collection point," "social modelling," "pre-emptive gift"* and *"promising rewards." "Acknowledging and reducing resistance"* and *"setting personal goals & activating"* achieve a moderate to poor score of one and zero stars, respectively. *"Strengthening social standards & activating"* was not given a score, because this intervention was not executed effectively.

In the following paragraphs (5.2.1 to 5.2.3), we will provide a more detailed overview of the effects of the various behavioural interventions that were tested as part of multiple pilots. For these interventions, a more thorough analysis than the one given in chapter 4 is possible.

These interventions are: 1) *"facilitating storage at home*, (5.2.1), 2) *"changing the distance to the waste collection point"* (5.2.2) and 3) increasing the motivation to separate waste (5.2.3). Insofar as these were studied, paragraph 5.2.4 covers promising combinations of instruments, while paragraph 5.2.5 describes the effects over time.

5.2.1 Facilitating storage at home

In Amsterdam, Schiedam and Utrecht, a small organic waste bin was included in the basic package. For these pilots, it is difficult to accurately assess the effectiveness of the bins, because other changes (as part of the basic package) were implemented at the same time. In Almere, The Hague and Rotterdam, facilitating storage at home with the help of waste bins and bags was tested as a behavioural intervention. It received a score of three stars for effectiveness (see paragraph 5.2). Figure 5.4 summarises the interventions, the various waste bins that were used to implement the interventions and the results. Furthermore, there were differences in the manner in which the bins were distributed (delivered door to door or picked up by residents from a central location) and when this was done. The effects of these differences have not been studied.

Both small organic waste bins for use on kitchen counters and larger, more deluxe models are effective interventions with which to improve people's waste separation behaviour. With regard to the deluxe models, a waste separation bin with compartments for

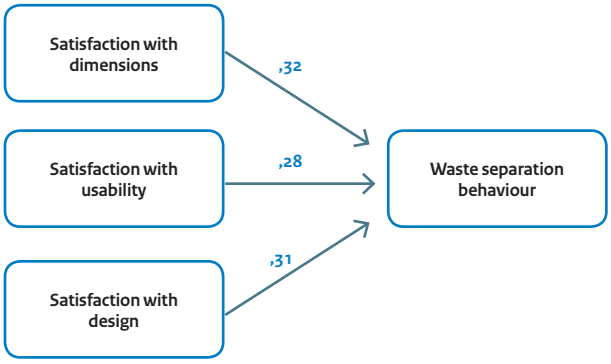


Figure 5.5: Correlations between residents' degree of satisfaction with their bin and their waste separation behaviour.

multiple waste streams appears to be the best choice. This may be due to the fact that users are confronted by three separate compartments when they open the bin, which invites them to make a waste separation decision on the spot. Furthermore, this combination gives users two options to separate their organic waste, while the combination with the built-in bin only allows them to store organic waste in the small bin on their kitchen counter. It should be noted that a waste separation bin is generally more expensive than a small organic waste bin on its own. Lastly, it is important to tailor the design and choice of the bin to the needs of residents, as this can stimulate residents to use their bin more.

In all three pilots, significantly more households in the intervention group (the group that was offered an organic waste bin) that did not separate their waste yet during the base period became frequent waste separators after the intervention (an increase of 6 to 11 percentage points). In all three pilots, the number of frequent waste separators who continue to separate their waste is the same or slightly higher in the intervention group, although this figure does not differ significantly from the control group. In other words, this intervention is particularly suitable to stimulate households that do not (structurally) separate their waste yet to begin doing so.

In the surveys, residents were also asked about their satisfaction with their bin, its dimensions, how well it fits in their kitchen in terms of design and appearance and its usability. We analysed the extent to which these characteristics of the bin design influence people's waste disposal behaviour. The analysis (see figure 5.5) shows that satisfaction with the bin has a significant impact on people's waste disposal behaviour at the waste collection point. This satisfaction is largely made up of the cumulative effects of the bin's dimensions, how well it fits in users' kitchens in terms of design and appearance and its usability. We found a similar effect when looking at the connection between users' satisfaction and their (reported) waste separation behaviour in the kitchen. The three connections we found each have a correlation of 0.3[22].

[22] Correlation is a statistical term for the connection between two variables.

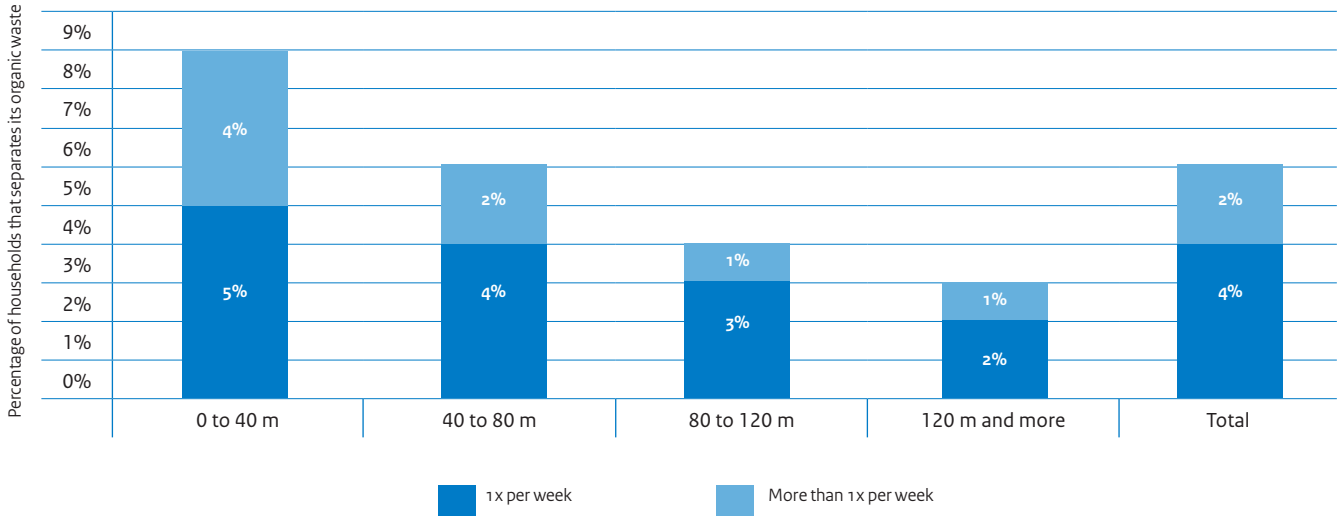


Figure 5.6 Organic waste separation frequency per distance to containers.

In Rotterdam, 89% of the group that received the bin is fairly to highly satisfied with it. 97% also uses the (plastic) bags that were offered. Most respondents had no comments on the bin. Comments (n=45) that were made about the bin and bag were: satisfied (26%), the bag tears easily (24%) and the bag is not sufficiently closed to prevent leaks and keep out flies (16%). In Utrecht, 82% of the users are fairly to highly satisfied with their bin. 74% also uses the (paper) bags that were offered. In total, there were 130 negative comments (n=413) about the bin's design and functionality. Most comments deemed the bin impractical: it is too small, the bin and/or bag leaks moisture, the bag does not close properly, the bin and/or bag break easily. The number of comments on the usability of the bin and bags suggests that there is still room for improvement with regard to its usage. The bin's usage might be further improved by coordinating its design and functionality with residents' wishes.

5.2.2 Changing the distance to the waste collection point

A second intervention that deserves a more in-depth analysis is *"changing the distance to the waste collection point."* In Schiedam, the distance from all organic waste containers to all households (4,137) is known, which makes it possible to examine the connection between people's waste separation behaviour and the distance to the nearest container. Figure 5.6 above shows that there is a correlation between the distance to the nearest organic waste container and organic waste separation.

As this concerns a large number of households whose behaviour was measured for a relatively lengthy period of time, the differences are statistically significant: a smaller distance results in a higher disposal frequency for organic waste, while reducing the distance to the nearest organic waste container by ten metres will increase the chance that households separate their waste by 0.5 percentage point. Another notable result is that an organic waste container will be used less frequently if it is located farther away than the nearest residual waste container.

In Amsterdam, the distance to the nearest waste container also affected households' waste separation behaviour. The greater the distance to the nearest residual waste container and the smaller the distance to the nearest organic waste container, the more likely it is that households will actually use the organic waste containers. Reducing the distance to the nearest organic waste container by ten metres will increase the chance that households separate their waste by 1.5 percentage point. Increasing the distance to the nearest residual waste container by ten metres produces a virtually identical result. The conclusions regarding the effects of physical distance must be treated with some caution, since the groups could not be assigned randomly (the substantiation of this conclusion is therefore not as strong). The findings with regard to the effects of physical distance in Amsterdam are supported by the survey results. The shorter distances to the organic waste containers were subjectively felt: the group of residents for whom the organic waste container was closer to their residence perceived it to be significantly closer during the intervention period.

5.2.3 Motivation-increasing interventions

With the exception of making it easier to separate waste in the home and reducing the distance to the waste collection point, the behavioural interventions were centred around improving people's motivation to separate their waste. Two of these motivation-increasing interventions were used more than once in several pilots: *"strengthening social standards & activating"* (in Utrecht and Almere) and *"setting goals"* (in Rotterdam and Schiedam).

Unfortunately, there were some problems with the implementation of the *"strengthening social standards & activating"* intervention. In Almere,

the intervention was also visible to the control group, which made it impossible to accurately assess its effects. In Utrecht, the *"strengthening social standards & activating"* intervention actually appeared to reduce people's willingness to separate their waste, rather than increase it (see chapter 4). This effect was unexpected and it is probably not the result of a strengthened standard. It turned out that the intervention group was barely able to remember the social standard message any better than the control group. This was even true for the residents who were actually using the bags that had the messages printed on them. It is therefore highly likely that communicating the social standard on waste bags or on the wrapper around a roll of bags is not an effective instrument with which to change people's waste separation behaviour.

In Rotterdam, the *"setting personal goals & activating"* intervention, which used a refrigerator magnet, proved not to be an effective method with which to change people's behaviour. On the other hand, *"setting group goals & feedback"* about their performance proved to be a highly effective intervention, especially in combination with the *"social modelling"* intervention for which residents are shown an example of good waste separation behaviour. It is possible that a collective goal has a stronger motivational effect on people than an individual goal or that the feedback given in the interim makes the intervention more successful. However, if we take a closer look at the "setting an individual goal" intervention in Rotterdam, it becomes clear that the intervention group and the control group set similar goals during the intervention check (i.e. after the intervention).

The most commonly chosen goal was one bag of residual waste per week, which was chosen by 42% of the intervention group, as well as 35% of the control group. The average goal was 1.75 bags for the intervention group and 1.92 for the control group. Allowing residents to set their own goals is less effective because they tend to set less ambitious goals for themselves. These findings advocate a procedure in which the goal is set for rather than by residents, as was done during the pilot in Schiedam. In doing so, it is important to make sure that the set goal is attainable in terms of ambition, while still posing a challenge to residents. Furthermore, adding repeated moments of feedback about people's waste separation performances to the *"setting goals"* intervention made it more effective.

An unexpected benefit, which was not part of the original research design, was more insight into the effects of a survey. See box 5.1.

Box 5.1: The effects of taking part in the research survey

Surveys were taken as part of all pilots, mostly by conducting verbal interviews at home. During these interviews, the residents in question spend circa twenty minutes thinking fairly thoroughly about their own waste separation (behaviour). This could be seen as an intervention in and of itself, as it may affect people's awareness of waste separation. Despite the fact that the study was not set up with this goal in mind, the structure of the pilots made it possible to examine the effects of the surveys on people's waste separation behaviour. It is important to note that conducting the surveys did not affect the research results of the interventions that were designed for this project: the control groups and the intervention groups all received the same surveys.

The analysis was conducted for five out of the six pilots. In all five cities, residents' waste separation behaviour during the five-week period prior to the first survey was compared to their waste separation behaviour during the five-week period after the first survey. In most cities, only the households that were not offered any interventions were used for this assessment. This was done because most interventions were introduced shortly after the first survey was conducted. Methodically speaking, the pilot in Schiedam was most suited for this analysis. Unfortunately, the survey conducted in Amsterdam could not be used for this analysis.

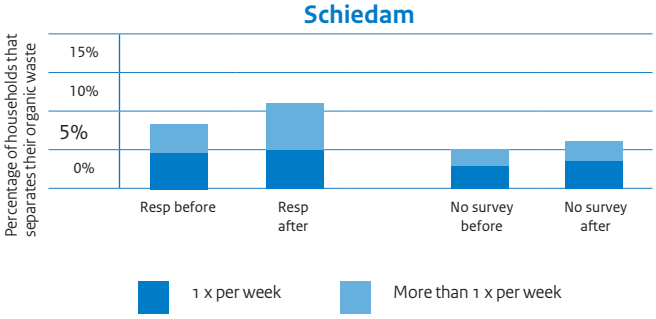


Figure 5.7: The use of organic waste facilities before and after the survey. On the left are the results of the group that received a survey; on the right are the results of the group that did not receive a survey.

In The Hague, Rotterdam, Schiedam and Utrecht, the organic waste separation behaviour of respondents improves by an average of 20%, compared to the group of residents who did not receive a survey. See figure 5.7 for the results from Schiedam. In Almere, the survey has no discernible effect. It is worthwhile to explore this unique form of intervention in more detail in a follow-up study.

5.2.4 Promising combinations

Although multiple interventions were tested during many of the pilots, the effects of the combination of interventions could not be tested in all cases, as doing so requires a minimum number of participating households. This was therefore only possible in Schiedam and Rotterdam.

In Rotterdam, two behavioural interventions were implemented: setting goals with the help of a refrigerator magnet and facilitating the storage of organic waste in the home by handing out organic waste bins and bags for use in the kitchen. However, this proved to be an unsuccessful combination; although the organic waste bins can successfully improve people's waste separation behaviour, the effect diminishes when the use of the bin is combined with setting goals. As described in the previous paragraph, the "setting a goal" intervention was seemingly not implemented successfully and its negative effect, by itself and in combination with the bins, is probably coincidental. The survey results support this; they show a positive effect of setting goals on people's attitude towards waste separation.

In Schiedam, the behavioural interventions *"setting group goals & feedback"* and *"social modelling"* were combined. When we look at the combined effect, we see that the simultaneous execution of the interventions does not result in a significant increase of the frequency with which the organic waste facilities are used, compared to the frequency of use by households in the *"setting group goals & feedback"* intervention group.

In both Rotterdam and Schiedam, combining interventions did not lead to better waste separation behaviour, compared to the results achieved with the individual interventions.

5.2.5 The effect of time

When implementing behavioural interventions, it is also important to consider how long an intervention is effective. Figure 5.8 shows that almost all interventions have a diminished effect or no effect at all after some time passes (two to three months). The interventions that appear to have the most long-lasting effects are *"facilitating storage at home," "setting group goals & feedback"* and *"influencing attitude (the use of waste separation)."* It is notable that all these interventions involve some form of repetition: the bin in the home serves as a constant reminder to people to separate their waste, feedback about waste separation goals was given multiple times and the *"influencing attitude"* intervention consisted of two consecutive letters that each included a small bar of soap to illustrate the use of recycling. To achieve a stable behavioural change, it is therefore advisable to continue stimulating the desired behaviour for an extended period of time.

Intervention	Pilot(s) – Intervention	Behaviour – Significant	After 2-3 months
Facilitating storage at home	ALM, RDM	√	↘
> Waste separation bin	TH	√	↘
> Built-in bin	TH	X	X
Changing distance to waste collection point	AMS, SCH	√	
Setting personal goals & activating	RDM	X	X
Setting group goals & feedback	SCH	√	↘
Influencing attitude (the use of waste separation)	AMS	√	√
Strengthening social standard & activating	ALM, UTR	○	○
Social modelling	SCH	√	X
Acknowledging & reducing resistance	UTR	X	X
Pre-emptive gift	AMS	√	X
Promising reward	AMS	√	X

* *For facilitating storage at home, the average value was used*

X No evidence of effect
○ Intervention not implemented effectively
√ Significant effect
↘ Effect remains, but effect size decreases

Figure 5.8: The effect of the interventions after two to three months.

Conclusions

- The interventions that prove most effective are *"facilitating storage at home," "setting group goals & feedback"* and *"influencing attitudes (the use of waste separation)."*
- In three pilots, *"facilitating storage at home"* was utilised in different ways. It proves to be a highly effective method (compared to other interventions). Both small organic waste bins for use on kitchen counters and larger waste separation bins are effective interventions with which to improve people's waste separation behaviour. The advantages of the smaller bins are their dimensions, usability and lower cost. The advantage of the waste separation bin is the constant invitation to make a waste separation choice on the spot. *"Facilitating storage at home"* is a suitable intervention to convince households that do not (structurally) separate their waste yet to start doing so. Available space and having to store waste in the home form the biggest issues with regard to the intervention's execution. This intervention is more effective when there is coordination between the situation in people's homes and their wishes. Satisfied residents use the bin more. The number of comments about the usability of the bin and bags suggests there is room for improvement in that regard: the bin is too small, the bin and/or bag leaks moisture, the bag does not close properly, the bin and/or bag break easily. The bin's usage might be further improved by coordinating its design and functionality with residents' wishes.
- *"Setting group goals & feedback"* scores three stars and is therefore highly effective. Setting goals proved to be an effective method with which to achieve a collective goal that was set for, not by, residents. The intervention was strengthened with repeated feedback about the group's performance.
- *"Influencing attitude (the use of waste separation)"* scores three stars and is therefore highly effective. This intervention changes residents' attitude by providing clear and correct textual and visual information about waste separation and its usefulness. The intervention was strengthened through repetition: two letters were sent to residents.
- *"Changing the distance to the waste collection point"* earns a decent score of two stars for effectiveness. It should be noted that this intervention was slightly less effective than those rated with three stars. The closer an organic waste container is, the more likely it is for residents to actually use it to separate their organic waste. Another important consideration is the distance to the nearest residual waste container: an organic waste container that is located farther away than a residual waste container is used less frequently.
- The interventions *"social modelling," "pre-emptive gift"* and *"promising rewards"* also earn decent scores of two stars for effectiveness.
- The intervention *"setting personal goals & activating"* proved to have little to no effect. Allowing residents to set their own goals is less effective because they tend to set less ambitious goals for themselves. This advocates the use of a predetermined goal, as was done for the *"setting group goals & feedback"* intervention. The intervention *"acknowledging and reducing resistance"* also proved to have little to no effect. Residents were insufficiently able to recall the messages designed to reduce their resistance.
- *"Strengthening social standards & activating"* was not given a score, because this intervention was not executed effectively. "The devil is in the detail." The lesson learned is to first test interventions in smaller settings ("pre-testing"), before implementing them on a larger scale during a pilot.
- It is very well possible to combine interventions in a complementary manner. During the pilots, these complementary effects were identified, but no strengthening effects were found: no additional better (or worse) waste separation behaviour was found, compared to what each intervention was able to realise on its own. In both Rotterdam and Schiedam, combining interventions did not lead to better waste separation behaviour, compared to the results achieved with the individual interventions.
- An unexpected benefit is that the waste separation behaviour of survey respondents improved by 20% after conducting a (door-to-door) survey, compared to the group of residents for whom no such survey was conducted. It is worthwhile to explore this unique form of intervention in more detail in a follow-up study.
- The effects of the interventions deteriorate over time. The interventions that continue to have a significant effect after two to three months (i.e. *"facilitating storage at home," "setting group goals & feedback"* and *"influencing attitude"*) are all characterised by some form of repetition. To achieve a stable behavioural change, it is therefore advisable to continue stimulating the desired behaviour for an extended period of time or execute interventions periodically.

5.3 Quality versus quantity

As part of all pilot programmes, sorting analyses were conducted on the collected organic and residual waste. These analyses were conducted at the end of every phase of a pilot (base period, intervention period and, possibly, a second intervention period). The analyses were conducted to gain insight into the quality of the collected organic waste and determine whether there were any changes to the composition of the residual waste. Figure 5.9 shows an example of a sorting analysis of collected organic waste. It was not possible to link the sorting analyses to any interventions: the waste containers from which the analysed samples were taken contain waste from both the intervention group and the control group.

The findings are as follows:

- The results of the sorting analyses of the residual waste from the pilot municipalities match the average composition of residual waste from households, as published by Rijkswaterstaat[21].

[21] https://www.afvalcirculair.nl/onderwerpen/monitoring-cijfers/afvalcijfers/afvalcijfers-land/samenstelling/

Figure 5.9 An example of a sorting analysis of collected organic waste. The picture at the top shows the waste before sorting; the picture at the bottom shows the waste after sorting (Almere).

- There is no discernible effect on the composition of the residual waste, not even in the pilots where the majority of the residents were part of the intervention group.
- On average, the collected organic waste contains 12% contamination at the end of the base period (particularly plastic, metal/cans, textile and diapers). It is likely that the novelty of the situation/the need to acclimatise is a factor, although we were not able to measure that with only a single measurement point. Schiedam and Utrecht achieved the best scores with 6% and 2% contamination respectively. With 23%, the residual waste stream in The Hague was the most badly contaminated.
- At the end of the intervention periods, the quality of the collected organic waste had improved to an average contamination percentage of 7%. In Amsterdam and Utrecht, the organic waste was almost entirely clean (with the exception of waste bags). In Almere, three percentage points of the 7% contamination were due to diapers, which can be explained by the municipality's current policy (which allows diapers to be disposed of as organic waste). With 10%, the contamination percentage in The Hague was higher than desirable. See also figure 5.10. In Schiedam and Rotterdam, no analyses of the organic waste were conducted after the end of the intervention period.
- Information, habituation and interventions may have led to the improved quality of the collected organic waste. Another notable outcome is the fact that the collection of organic waste in underground containers that look similar to residual waste containers produces organic waste of relatively poor quality. This was the case in The Hague and Almere. It was also the case in Rotterdam: prior to the start of the baseline measurement (base period), the underground organic waste container was replaced due to the poor quality of the collected organic waste. In its stead came an aboveground mini container in a housing with keycard access, such as the ones used in Schiedam and Amsterdam. Afterwards, there was an immediate and significant increase of the quality of the collected organic waste.
- Outside of the sorting analyses, it was found several times that repurposing an underground residual waste container as an organic waste or PMD container resulted in a badly contaminated waste stream. This suggests that people's habitual behaviour is quite persistent.

Conclusions

- When it comes to processing organic waste, the quality of the collected material is a key factor. At the end of the base period, the organic waste - with an average contamination percentage of 12% for all pilots - was too contaminated to be properly recycled. At the end of the intervention periods, the quality of the collected organic waste had improved in almost all pilots and the waste was now sufficiently clean to be processed. Only in The Hague did the quality of the waste stream remain inexplicably inferior. In the other municipalities, it is likely that information, habituation and interventions led to the improved quality of the collected organic waste. This process of quality improvement begins in the kitchen. It is therefore important that quality-improving facilities are available there as well.
- With an aboveground container (mini containers encased in a housing) and keycard access the high-rise buildings, it is possible to collect organic waste of a good quality. This shows that the design, dimensions and appearance of a container are important, which goes for both aboveground and underground models. Repurposing an existing residual waste container for organic waste or PMD leads to confusion. Underground containers for organic waste also appear to lead to a more contaminated waste stream. Both measures are therefore not recommended.
- To maintain the quality (and quantity) of the collected material, it is advisable to continue stimulating the desired behaviour for an extended period of time. This can be done with the help of communication, for example. It is also important to monitor the quality, for example in collaboration with your organic waste processor who can provide feedback on the quality of the collected material.

[22] https://www.afvalcirculair.nl/onderwerpen/monitoring-cijfers/afvalcijfers/afvalcijfers-land/samenstelling/

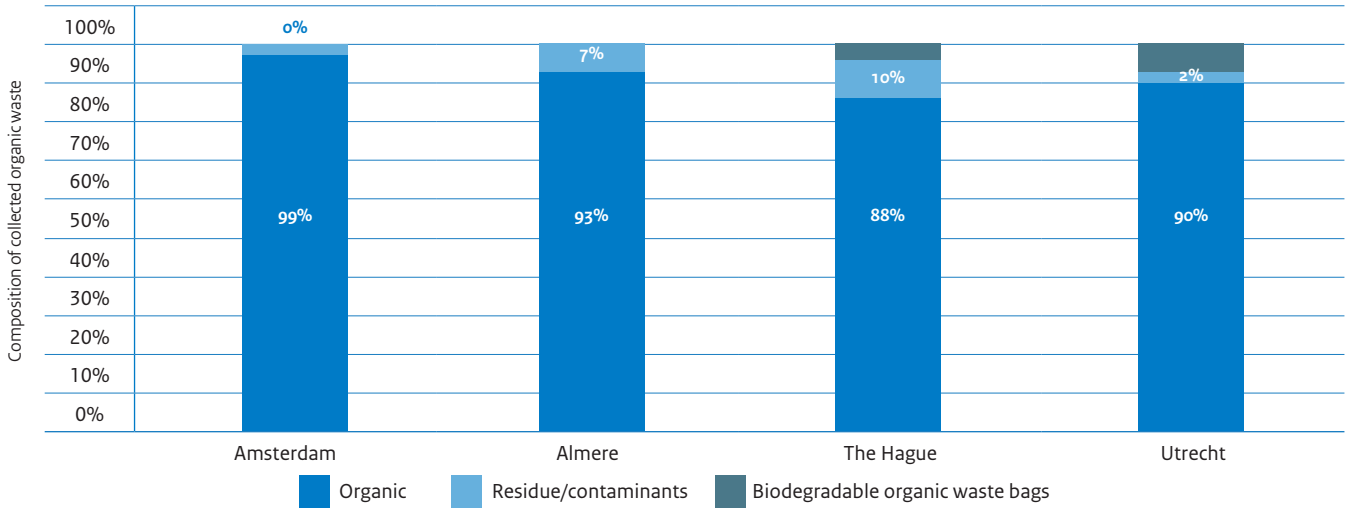


Figure 5.10: The composition of organic waste at the end of the intervention period in four pilots.

Box 5.2, shown below, contains an overview of what experts believe is needed to collect good-quality organic waste from high-rise buildings.

Box 5.2: What can be done to preserve the quality of organic waste?

During the evaluation gathering on 4 December 2019, participants sought to answer this question. The following factors are suspected to affect the quality of organic waste. The expected impact is listed in parentheses*:

- The container must ensure residents have minimal room for error (positive);
- The containers can only be accessed by residents who have a keycard (positive);
- Only bags can fit through the aperture of the container (positive);
- The container is located aboveground, rather than underground (positive);
- The quality of the collected organic waste is visibly inspected (positive);
- The bags for fruits and vegetables that people get in the supermarket are biodegradable and can also be used to collect organic waste (positive);
- Residents frequently receive clear instructions on what (not) to dispose of in the organic waste container (positive);
- The container is frequently inspected for contamination and, if possible, residents are reminded how (not) to use it (positive);
- The container utilises sensors that can detect contamination, which is then communicated to residents (positive);
- Using a highly recognisable bag for organic and/or residual waste (positive);
- An existing residual waste container is repurposed for the disposal of organic waste, instead of placing an entirely new facility (negative);
- Reverse collection: the organic waste container is positioned closer than the residual waste container (negative);
- The municipality uses a PAYT system with incentives for residual waste and/or organic waste (negative);
- The difference between the processing costs of organic waste and residual waste is sometimes too small, which means the business case for municipalities to facilitate extra waste collection options for its residents is hardly interesting from a financial perspective (negative);

** Note that these are the expectations of the participants based on their practical experiences. Not all correlations can be backed up with scientific evidence. Follow-up research could generate more insights into the mistakes made by residents and the expected correlations listed above.*

	Organic waste	Paper & cardboard	PMD	Total*
Maximum waste separation potential (kg/resident/year) Based on the composition of residual waste*	89	59	47	330
Realistic waste separation potential (kg/resident/year) Based on the waste separation results from low-rise buildings	61	34	8	130

Figure 5.11: The waste separation potential per waste stream in high-rise buildings (kg/resident/year) as calculated in the desk study conducted by CE Delft. Figures in kg per resident per year.

Organic waste in the Netherlands	Separated	In residual waste stream	Total
Organic waste in the Netherlands in tons	1492	1000	2492
Organic waste in the Netherlands in kg/resident/year	86	58	144
Organic waste (excluding garden waste) in kg/resident/year (estimate)	17	43	61

Figure 5.12: Amounts of organic waste (with and without garden waste) in the Netherlands

	1. Basic package	2. With intervention	3. Potential
Average number of user days/household/week	0,39	0,66	
Kg/user day	1,3	1,3	
Specific weight (kg/m3)	800	800	
Volume of disposed waste bag (litre)	1,7	1,7	
Kg/household/year	27	46	
Number of residents/household	1,7	1,7	
Organic waste separation potential (kg/resident/year)	**16**	**27**	**61**

Figure 5.13: The waste separation potential per waste stream in high-rise buildings (kg/resident/year) based on the actual results of the pilot [2]

[1] Based on figures from the Dutch Waste Management Association, see: https://www.verenigingafvalbedrijven.nl/public/News/63/download/Werkgroep%20Afvalregistratie_Afvalverwerking%20in%20Nederland%20gegevens%202017_november%202018.pdf

[2] Kg/bag is based on the total amount of disposed material (in kg) divided by the number of bags of waste disposed of in Schiedam. Specific weight figure provided by the Dutch Waste Management Association.

	1. Basic package	2. With intervention	3. Potential
Organic waste separation potential for high-rise buildings (kg/resident/year)	16	27	61
% of residents living in high-rise buildings in 2018	27%	27%	27%
Reduction of residual waste in the Netherlands (kg/resident/year)	**4,4**	**7,3**	**16,7**
Residual waste (2018) (kg/resident/year)	190	190	190
New potential residual waste in the Netherlands (kg/resident/year)	186	183	173
Kg of waste/resident/year (2018)	490	490	490
Increase of separation percentage (of the Netherlands)	**0,9%**	**1,5%**	**3,4%**
Separation percentage of the Netherlands (2018)	62%	62%	62%
New potential separation percentage of the Netherlands	63%	63%	65%

Figure 5.14: The reduction of residual waste and increase of the waste separation percentage for the Netherlands as a whole based on the waste separation potential for organic waste in high-rise buildings.

5.4 Potential savings

This paragraph seeks to answer the following question: *What would the impact be if the results of this study were to be scaled up to include all high-rise buildings in the Netherlands? What if all low-rise buildings were included?* To answer this question, we will draw a comparison to the reality check conducted by CE Delft in 2015, which was introduced back in chapter 2.

Waste separation potential based on desk study

At the time, the reality check showed that *"if residents of high-rise buildings can separate their waste in 2020 to a similar degree as residents of low-rise buildings in 2012, this represents an additional waste separation potential of 620 kt of waste (or 130/kg/citizen/year)."*

This additional potential was calculated based on the "realistic waste separation potential": the amount of waste per waste stream that can be removed from the residual waste stream if the same results are achieved for high-rise buildings as for low-rise buildings[21]. This figure differs from the "maximum waste separation potential": the amount of organic waste still found in the residual waste stream. Figure 5.11 shows an overview of both figures. According to CE Delft, the realistic waste separation potential at the time was 61 kg of organic waste: this was the additional waste that could be separated if people living in high-rise buildings in 2020 were to exhibit the same behaviour as the average person living in a low-rise building in 2012. CE Delft also states that garden waste, paper & cardboard and PMD are important waste streams. Some remarks regarding these data:

- The realistic waste separation potential was calculated in 2015 based on figures from 2012. Since then, various programmes designed to prevent food wastage have been introduced. At this time, there is not yet any incontrovertible evidence to indicate whether these programmes have had a significant effect on food wastage in high-rise buildings. The results of a recent waste composition analysis conducted by CREM do suggest such a decline for the Netherlands as a whole[22].
- The percentages per waste stream were calculated based on a waste sorting test conducted in Utrecht. However, it is unclear to what extent these sorting tests are 100% representative, given that a percentage of garden waste was also measured.

Figure 5.12 shows an overview of the amount of collected separated organic waste and the estimated amount of organic waste in the residual waste stream in 2017 for the Netherlands as a whole.

In the Netherlands, 86 kg of organic waste are collected per citizen per year, while an additional 58 kg are found in the residual waste stream. Based on the input provided by the Dutch Waste Management Association, it is assumed that 20% of the separated organic waste consists of food waste, while 75% of the residual waste stream consists of food waste. At this time, circa 17 kg of organic waste are collected separately per citizen per year, while another 43 kg

[21] To be suitable for recycling, the quality of the waste steam has to be good enough. See also paragraph 5.3.
[22] https://www.milieucentraal.nl/media/5495/voedselverspilling-via-huishoudelijk-afval-2019.pdf

are found in the residual waste stream. These figures match those from the recent waste composition analysis conducted by CREM[23]. Based on these figures, the maximum waste separation potential for the Netherlands as a whole (i.e. not merely for high-rise buildings) is 61 kg per citizen per year, which is lower than the maximum waste separation potential of 89 kg per citizen per year in high-rise buildings, as calculated by CE Delft.

Waste separation potential for organic waste based on actual results

To explore how the results of this study can be translated into a realistic waste separation potential, three scenarios were used:

1. Basic package: calculated based on the average result of the basic packages, with the exclusion of Schiedam[24] (see figure 5.1).
2. With intervention: calculated based on the results of the best intervention (Almere/"facilitating storage at home").
3. Potential: determined based on figures from CE Delft, the Dutch Waste Management Association and CREM. The figure of 61 kg/resident/year was used, as CE Delft calculated that figure as the realistic potential for high-rise buildings and other sources show it to be the maximum potential for the Netherlands as a whole. The effect on other waste streams is not taken into consideration for this calculation.

Figure 5.13 shows the assumptions and results. The main assumption is the amount of organic waste (in kg) that is disposed of each time. This figure was determined based on the total amount of material (in kg) divided by the number of bags of waste that are disposed of. Measurements conducted in Schiedam and Amsterdam show that the bags of waste people dispose of have an average weight of 1.3 kg and a volume of 1.7 litres.

Using only the basic package, the realistic waste separation potential for high-rise buildings in the Netherlands is 16 kg per resident per year. Based on the results of the best intervention, the realistic waste separation potential is 27 kg per resident per year.

[23] https://www.milieucentraal.nl/media/5495/voedselverspilling-via-huishoudelijk-afval-2019.pdf
[24] For clarification, see paragraph 5.1.

Box 5.3: Realistic waste separation potential for organic waste from high-rise buildings in Rotterdam

If the results of this study are extrapolated, what is the expected effect on the waste separation percentage in Rotterdam? op het scheidingspercentage van Rotterdam?

In 2019, the municipality of Rotterdam produced 276 kg of residual waste per citizen per year and achieved a waste separation percentage of 35% for all citizens, see also figure 5.15. If only the basic package is rolled out for organic waste from high-rise buildings, the amount of residual waste will decrease by 12 kg per citizen per year, while the total waste separation percentage goes up by 2.8 percentage points. If the results of the best intervention are achieved on a larger scale, the amount of residual waste will decrease by 27 kg per citizen per year, while the total waste separation percentage goes up by 4.7 percentage points to 40% (i.e. an increase of 14%).

	1. Basic package	2. With intervention	3. Potential
Organic waste separation potential for high-rise buildings (kg/resident/year)	16	27	61
% of residents living in high-rise buildings	75%	75%	75%
Reduction of residual waste in Rotterdam (kg/resident/year)	**12,0**	**20,1**	**45,8**
Residual waste (2019) (kg/resident/year)	276	276	276
New potential residual waste in the Netherlands (kg/resident/year)	264	256	230
Kg of waste/resident/year (2019)	426	426	426
Increase of separation percentage (Rotterdam)	**2,8%**	**4,7%**	**10,7%**
Separation percentage of Rotterdam (2019)	35%	35%	35%
New potential separation percentage of Rotterdam	38%	40%	46%

Figure 5.15: Waste separation potential for organic waste from high-rise buildings in Rotterdam.

	1. Basic package	2. With intervention	3. Potential
Organic waste from high-rise buildings	4,4	7,3	17
Other streams from high-rise buildings	4,9	8,3	19
Organic waste from low-rise buildings	0,0	7,0	32
Total reduction of residual waste (kg/resident/year)	9,3	22,6	67,5

Organic waste from high-rise buildings	0,9%	1,5%	3%
Other streams from high-rise buildings	1,0%	1,7%	4%
Organic waste from low-rise buildings	0,0%	1,4%	7%
Increase in separation percentage (for the Netherlands)	1,9%	4,6%	14%

Figure 5.16: Increase of the waste separation percentage for the Netherlands as a whole if the possibilities for rollout are utilised.

Contribution to targets

The VANG (From Waste To Resource) programme was born out of the national government's Green Growth Strategy, which outlines the government's policy for improving the Netherlands' competitiveness while simultaneously reducing its environmental impact and reliance on fossil resources. Since then, VANG has been made part of the government-wide Circular Economy programme. The VANG-HHA (Household Waste) programme is the subprogramme specifically centred around household waste. Its goals are derived from the Public Framework for Household Waste, which the national government, VNG and NVRD all signed in 2014. It includes the ambition to realise a waste separation percentage of 75% by the year 2020. This ambition was further concretised by defining the target of producing a maximum of 100 kg of residual waste per citizen in that year. By 2025, this figure must be brought down to a maximum of 30 kg of waste[21]

It should be noted that the realisation of both targets also includes a figure of 100 kg for prevention: residual waste should be reduced from 500 to 400 kg per citizen per year. To date, there is no evidence of this decrease yet. Without prevention, a waste separation percentage of 80% would be needed to realise the target of 100 kg of residual waste per citizen per year.

In 2018, the waste separation percentage for collected waste was 62%[22] and 190 kg per citizen per year. The question remains what the results of this study can directly and indirectly contribute to these targets. Figure 5.14 presents an overview of the direct contribution per scenario.

With the basic package alone, the realistic waste separation potential for high-rise buildings in the Netherlands is 16 kg per citizen per year. This lowers the amount of residual waste for the Netherlands as a whole (190 kg per citizen per year) by 4.4 kg. As a result, the waste separation percentage goes up by 0.9 percentage point. Based on the results of the best intervention, the realistic waste separation potential is 27 kg per citizen per year. This lowers the amount of residual waste for the Netherlands as a whole (190 kg per citizen per year) by 7.3 kg. As a result, the waste separation percentage goes up by 1.5 percentage point. It should be noted that it was not the goal of this study to achieve a maximum effect; rather, it was about determining what works and what does not. The expectation is therefore that it will be possible to achieve better results when the measures are actually rolled out on a larger scale and that the amount of collected organic waste is closer to the waste separation potential of 61 kg per citizen per year.

For individual municipalities, the effect on the reduction of residual waste (and therefore the waste separation percentage) may be considerably higher if there are a great number of high-rise buildings in the area. Box 5.3 explains the situation in Rotterdam.

It is also important to note that only organic waste from high-rise buildings was used for this example. There are various ways in which the results from this study can be rolled out in a more comprehensive manner. Most obviously, these are:

a. Other waste streams from high-rise buildings, e.g. paper & cardboard;
b. Collecting organic waste from low-rise buildings.

[21] https://www.nvrd.nl/dossier-actueel/afval-en-grondstoffen/vang/

[22] This figure includes both source and subsequent separation. Statistics Netherlands (CBS) reports a separation percentage of 58% for source separation in 2018 https://www.cbs.nl/nl-nl/nieuws/2019/26/nauwelijks-meer-afval-beter-gescheiden

Potential climate benefits	1. Basic package	2. With intervention	3. Potential
Organic waste separation potential (kg/resident/year)	16	27	61,0
CO2 emission reduction (kg/ton organic waste)	120	120	120
Reduction of climate change per person from separated waste (kg CO2 eq)	1,9	3,2	7,3
Reduction of climate change total (kt CO2)	9	15	34,4
CO2 target government (mt)	48,70	48,70	48,70
Contribution to cabinet target	**0,02%**	**0,03%**	**0,07%**

Figure 5.17: Potential environmental benefits for organic waste from high-rise buildings.

An estimation was made for these options, see figure 5.16. To do so, the following assumptions were made:

- It is assumed that the effect on the other waste streams is the same in all scenarios as the ratio of organic waste versus other waste streams in the reality check.
- These days, the PMD waste stream from high-rise buildings can easily be separated via subsequent separation. This was left out of the calculations so as not to make them needlessly complex. PMD was included in the same manner as other waste streams (see previous bullet point).
- In many areas, residents living in low-rise buildings can already separate their organic waste with the help of a mini container in their garden. The effect was calculated by subtracting the current estimated results (see figure 5.16) from the waste separation potential (a negative effect is not expected).

If the basic package is also rolled out for other waste streams from high-rise buildings, the waste separation percentage goes up by 1.0 percentage point. The basic package's waste separation potential for high-rise buildings is almost equal to the current results in the Netherlands (16 kg versus an average of 17 kg per citizen per year). Rolling out the basic package to low-rise buildings is expected to have hardly any effect, because most of the organic waste from low-rise buildings is already being separated.

If the results of the best intervention can be copied to low-rise buildings or to other waste streams from high-rise buildings, the waste separation percentage goes up by 3.1 percentage points. Combined, that leads to an increase of the national waste separation percentage of 4.6 percentage points, which is circa one third of the difference between the current national waste separation percentage of 62% and the target of 75%. If the full potential of the insights from this study is utilised, it is possible to realise an increase of 14 percentage points for the national waste separation percentage.

Potential climate benefits (CO_2) of separating organic waste

Lastly, we calculated the potential climate benefits of the direct effects. Figure 5.17 shows the assumptions and results. The main assumption is the reduction of the climate impact. To make a proper comparison, it was decided to use the same value that CE Delft used for its own study: 120 kg CO_2 per ton of separated waste[23].

With the basic package alone, the reduction of the climate impact for high-rise buildings in the Netherlands is 1.9 kg of CO_2 per citizen per year. The effect of the results of the best intervention is a reduction of the climate impact of 3.2 kg of CO_2 per citizen per year. In total, this contributes 15 kt of CO_2 reduction to climate change, or a modest 0.03 percentage point to the national CO_2 reduction target[24]

Conclusions

- The focus on separating organic waste from high-rise buildings in the Netherlands mainly has an impact on the country's transition towards a circular economy: the sparing use of natural resources, their reuse and maintaining a healthy soil. The effect of the separated collection of organic waste in the Netherlands on the climate, in terms of CO_2 reduction, is comparatively minor. A comparison was made with the current process for generating energy with incineration.
- In the Netherlands, 86 kg of organic waste are collected separately per citizen per year, while an additional 58 kg are found in the residual waste stream. This includes both food waste and garden waste. Based on the input provided by the Dutch Waste Management Association, it is assumed that 20% of the separated organic waste consists of food waste, while 75% of

[23] There was no review of the correctness of this key figure, how it was calculated, to what extent short-cycle CO_2 was processed correctly and whether the reduced CO_2 emission pertains to the Netherlands (or the international level).

[24] https://www.rijksoverheid.nl/actueel/nieuws/2019/11/01/kabinet-neemt-extra-maatregelen-voor-klimaatdoelen

- the residual waste stream consists of food waste. If we only consider food waste, this means 17 kg of organic waste are collected separately per citizen per year in the Netherlands, while another 43 kg of organic waste ends up in the residual waste stream. The waste separation potential for organic waste in the Netherlands is therefore 61 kg of organic waste per citizen per year.
- If only the basic package is introduced and we assume that one in five households separates their waste, the realistic waste separation potential for high-rise buildings in the Netherlands is 16 kg per citizen per year. This lowers the amount of residual waste for the Netherlands as a whole (190 kg per citizen per year) by 4.4 kg. As a result, the waste separation percentage goes up by 0.9 percentage point.
- Based on the results of the best non-combined intervention, the realistic waste separation potential for high-rise buildings is 27 kg per citizen per year. This lowers the amount of residual waste for the Netherlands as a whole (190 kg per citizen per year) by 7.3 kg. As a result, the waste separation percentage goes up by 1.5 percentage point.
- For individual municipalities, the effect may be considerably higher if there are a great number of high-rise buildings in the area. If Rotterdam only rolls out the basic package for organic waste from high-rise buildings, the amount of residual waste will decrease by 12 kg per citizen per year, while the total waste separation percentage goes up by 2.8 percentage points. If the results of the basic package combined with the best intervention are matched, the amount of residual waste will decrease by 27 kg per citizen per year, while the total waste separation percentage goes up by 4.7 percentage points.
- It was not the goal of this study to achieve maximum effectiveness; it was primarily intended to determine which instruments work and which do not. Furthermore, the impact was calculated solely by looking at the data from the best non-combined intervention. The expectation is therefore that it will be possible to achieve better results by rolling out multiple interventions, so the amount of collected organic waste is closer to the waste separation potential of 61 kg per citizen per year.
- There are various ways in which the results from this study can be rolled out in a more comprehensive manner. The most obvious are (a) other waste streams from high-rise buildings, such as paper & cardboard and (b) collect organic waste from low-rise buildings. Based on the result from the best intervention, the combined effect will be an increase of the national waste separation percentage of 4.6 percentage points, which is circa one third of the difference between the current national waste separation percentage of 62% and the target of 75%. If the full potential of the insights from this study is utilised, it is possible to realise an increase of 14 percentage points for the national waste separation percentage, which puts the national target within reach.

5.5 Survey analysis model

Chapter 2 presented a general framework that - based on existing literature - was used to identify behavioural factors that may impact people's waste disposal behaviour. Many of these factors were tested during the pilots. To do so, we use a behavioural model (see chapter 3, section 3.2.3) in order to gain insight into the correlation between psychological factors such as people's attitude and behavioural intentions and their actual waste separation behaviour. This model was tested with the help of combined data from all surveys and waste disposal behaviour

Behavioural model for separating one's own waste

Demographic and housing characteristics influence behaviour via different paths

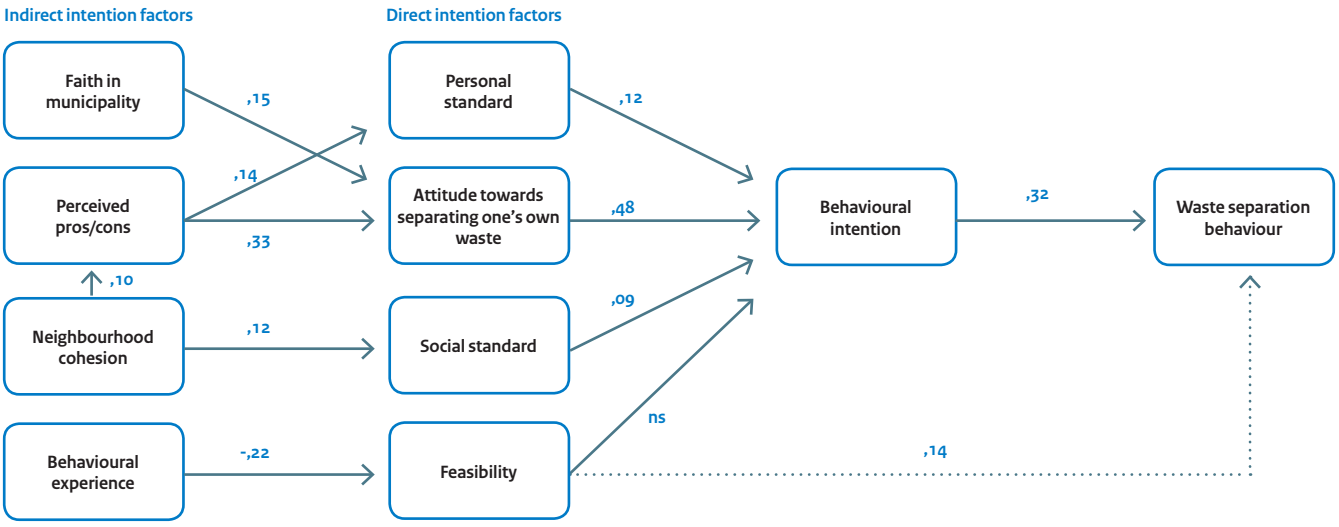


Figure 5.18: Overarching model of psychological factors that affect observed waste disposal behaviour directly and indirectly (values are significant beta coefficients).

measurements from all pilots. The results are shown in figure 5.18. The model shows that, seen across all pilots, the behavioural intention to separate waste is the most direct predictor of people's waste disposal behaviour during the intervention period. The extent to which residents deem waste separation to be feasible is the second-most important direct predictor of their waste separation behaviour.

Factors such as storage and transport to the waste collection point and the use of the containers may play a role in this. Although other psychological factors also influence people's behaviour, the process is governed indirectly via the intention. These factors are important to better understand the behaviour and select interventions. A positive attitude towards separating one's own waste turns out to be the most important factor that directly improves people's intention to separate waste and therefore indirectly affects their behaviour. This attitude can be explained by:

1. The pros and cons perceived by residents. This includes perceived consequences for the environment and nature and largely personal cons, such as it being a difficult, dirty job and the time and attention it takes;
2. Faith in the municipality, such as the expectation that the waste, once collected, is processed correctly instead of being dumped in a landfill.

In all pilots except the one in Rotterdam, feasibility also has a behavioural effect via intentions. If residents e.g. expect difficulties in the execution, their intention to separate waste will be lower. If residents' initial experiences with waste separation are negative as a result of difficulties in the execution, their intention to continue separating their waste in the future decreases. Indirectly, this leads to less waste separation. First impressions are therefore critical. Besides the effects of attitude and feasibility, there are also (smaller) significant effects resulting from the perceived *"strengthening social standards & activating"* and people's personal standards. The current pilots did not examine the effects of influencing people's personal standards. Elsewhere, positive results were achieved through this factor (see chapter 2).

2). *"Strengthening social standards & activating"* was included as an intervention in two municipalities, but it could not be tested due to issues with its practical implementation. Prior research did find positive results for *"strengthening social standards & activating"* (see chapter 2). As the model indicates, the effect of a *"strengthening social standards & activating"* intervention can increase if the cohesion in the neighbourhood is strong. This finding underscores the fact that interventions which target people's social motivation, e.g. *"strengthening social standards & activating,"* are particularly effective in areas with sufficient social cohesion.
When we compare the generic model with the results per pilot, we find that although there are some differences, the overall picture does not change drastically. Intention is always the best predictive factor for behaviour. Attitude is consistently the strongest factor with which to explain people's intention. In most cases, feasibility is the second-most important factor. We also see some effects caused by social standards. The effects of the indirect intention factors are also consistent.
Perceived pros and cons and people's faith in the municipality play a role. Past experiences impact people's opinion of feasibility and their indirect behaviour.

The model described here can be used to design new interventions by focusing on the factors with the strongest behavioural effects. The model (with its measurement instruments) can also be used to gather local data prior to the start of a pilot. These data can be used to further optimise the precision of the predictions. Lastly, the model teaches us that the impact of direct and indirect behavioural factors is complex and can be understood best as a sum of various different factors. There is no simple one-size-fits-all technical solution with a major positive impact. This model analysis therefore also advocates the development of combinations of interventions in practice.

Conclusions

- Since this study allows for the combination of observed separation behaviour and measurements of underlying psychological factors, it becomes possible to clarify what factors have the strongest impact on people's actual behaviour.
- The described behavioural model is robust and can be used to design new interventions by focusing on the factors with the strongest behavioural effects.
- The behavioural intention to separate waste is the most direct predictor of people's waste disposal behaviour during the intervention period.
- A positive attitude towards separating one's own waste, nurtured by a positive balance between perceived pros and cons and faith in the municipality, turns out to be the primary condition for the realisation of strong waste separation intentions.
- If residents' initial experiences with waste separation are negative as a result of difficulties in the execution, their intention to continue separating their waste in the future decreases. First impressions are therefore critical.
- There is no simple one-size-fits-all technical solution with a major positive impact. Instead, the best method is to combine interventions in practice.

6 The menu

The results per pilot are presented in chapter 4, while chapter 5 contains the synthesis of these results. This chapter will map out the effectiveness, budget and practical feasibility of each intervention technique. To visualise this, the results are presented in the form of a menu. Afterwards, we will clarify the menu per technique.

6.1 The basics

Before any techniques designed to influence people's waste separation behaviour can be implemented, some basic requirements must first be met. This means that the facilities, information and environment must be in order. These basics are fundamental for the effectiveness of the interventions.

Example. You want to motivate residents to separate their organic waste, but the organic waste container is always full. Residents will feel resistance when they try to exhibit the desired behaviour. The first thing to do is therefore to make sure the container is usable, before implementing any other interventions designed to reduce people's resistance or boost their motivation.

The basics consist of:
- functional and clean organic waste containers;
- a clean environment that does not violate people's standards;
- clear information about waste streams at home, on the organic waste containers themselves and online.

6.2 Menu

For a municipality, it is interesting to see what intervention techniques are most promising to scale up to other areas. The menu was designed to help make this choice. It presents an overview of the intervention techniques that were tested, along with scores for their respective effectiveness, budget and practical feasibility:

- **Effectiveness** – To assess the effectiveness of the intervention techniques, we determined whether the techniques resulted in significantly more organic waste separation during the pilots. We also took the effect size (the strength of the effect) into consideration.
- **Budget** – Per technique, we made an estimate of the budget based on the implementation of the interventions during the pilots.
- **Practical feasibility** – Per technique, we made an estimate of their practical feasibility, based on the methods and materials used in the pilots.

A clarification of the effectiveness score can be found in paragraph 5.2. The think tank has assigned the scores for budget and practical feasibility based on the experiences from the pilots and a qualitative estimate. It is important to note that the estimates of these two indicators, contrary to the effectiveness score, are not based on quantitative research. In practice, the execution of an intervention - and therefore its budget and practical feasibility - will differ somewhat per municipality.

The menu is intended as a useful document for policy officials looking for concrete guidelines to stimulate waste separation. It makes it easier to choose the right intervention techniques that are designed to stimulate the separation of organic waste from high-rise buildings. The menu can be found in figure 6.1.

Technique	Effectiveness	Budget	Practical feasibility
Facilitating store at home	★★★	★★☆	★★★
Changing the distance to the waste collection point	★★☆	★★☆	★☆☆
Setting personal coals & activating	☆☆☆	★☆☆	★☆☆
Influencing attitudes (the use of waste separation)	★★★	★★★	★★★
Strengthening social standard & activating	☆?☆	★★★	★★☆
Social modelling	★★☆	★★★	★★☆
Setting group goals & feedback	★★★	★★☆	★★☆
Promising reward	★★☆	★☆☆	★☆☆
Acknowledging & reducing resistance	★☆☆	★★★	★★★
Pre-emptive gift	★★☆	★★★	★★★
	* low effectiveness *** high effectiveness	* costly *** inexpensive	* limited feasibility *** high feasibility

Figuur 6.1: De menukaart van interventies en hun effectiviteit, budget en praktische haalbaarheid.

6.3 Clarification per intervention technique

Below, you will find a clarification per intervention technique. We will explain the technique itself and how it impacts various behavioural factors. Next, we will describe how to implement the technique in practice. We will discuss whether it was effective during the pilots. Lastly, we will give an estimate of the technique's budget and practical feasibility.

6.3.1 Facilitating storage at home

Technique	Effectiveness	Budget	Practical feasibility
 Facilitating store at home	★ ★ ★	★ ★ ☆	★ ★ ★
	** low effectiveness *** high effectiveness*	** costly *** inexpensive*	** limited feasibility *** high feasibility*

What? Facilitating the storage of organic waste in the home makes it easier for residents to separate their organic waste. Facilitating storage creates opportunity and therefore capacity for residents to separate their waste. People are creatures of habit who often act on autopilot. If someone is used to throwing their leftover food in the residual waste bin, it will take a lot of cognitive effort and energy to suddenly change this behaviour.

How? To make separating organic waste easier, you set up the environment in a way that inspires the desired behaviour. Offer residents a (small) bin to make separating organic waste a logical and easy option. Think of e.g. biobins in combination with compostable bags or waste sorting bins for use in the kitchen that reduce odours through natural aeration or a filter. This also lowers the threshold for people to take their separated organic waste to the waste container. A good and clearly visible aid in the home has a motivational effect: people are constantly reminded of the need to separate their waste when they see the aid. By adding text and/or symbols, you can strengthen residents' capacity and motivation even more. For example, indicate what types of waste they can throw in their bin (knowledge) or add a "Good job!" symbol to the bin (motivation).

Effectiveness? In the pilots, this intervention had a significant effect on the separation of organic waste. Residents take their organic waste to the organic waste container more frequently when they have a waste sorting bin or small organic waste bin in their kitchen. This intervention also motivates residents who did not separate their waste before to start doing so. It is important to tailor the bin to the available space in the kitchen. Ideally, people are given a choice: have them choose their own bin. Giving people a choice eliminates resistance; after all, they chose the waste bin themselves.

Budget? Facilitating storage at home is a relatively affordable intervention if you distribute small organic waste bins once. The intervention becomes costlier if you opt for more deluxe waste bins, such as a waste sorting bin.

Practical feasibility? Although this is a time-intensive measure, its practical feasibility is high. If a municipality chooses this intervention, the first thing to do is distribute small organic waste bins along with rolls of compostable bags and informative flyers. In addition to being a great way to distribute the bins, a door-to-door promotion also leads to valuable moments of interaction with residents.

Tip! Include waste sorting bins in the development of new apartment complexes. A move is a great moment to change one's behaviour, because new routines have to be formed. The habit of not separating one's waste is also temporarily broken, making this the perfect time to adopt new behaviour. As this situation represents a change in people's lives, they are less resistant to behavioural change.

6.3.2 Changing the distance to the waste collection point

Technique	Effectiveness	Budget	Practical feasibility
 Changing the distance to the waste collection point	★ ★ ☆	★ ★ ☆	★ ☆ ☆
	** low effectiveness *** high effectiveness*	** costly *** inexpensive*	** limited feasibility *** high feasibility*

What? Reducing the physical distance to the waste collection point makes the desired behaviour easier. This gives people more opportunity to separate their waste. People have a natural tendency to preserve their energy. They prefer to spend as little energy as possible on things that are not very important to them (such as separating waste). To stimulate residents to separate their organic waste, it is therefore important to make this behaviour as easy as possible.

How? By reducing the distance to the nearest organic waste container, it takes residents less energy to dispose of their organic waste. If the organic waste container is positioned closer than the residual waste container, this effect will be even stronger, although the organic waste stream will also be more contaminated. The ideal solution is to create a small waste separation and collection point near an apartment complex.

Effectiveness? During the pilot, this intervention had a significant effect on the separation of organic waste. Positioning organic waste containers ten metres closer or placing residual

waste containers ten metres farther away both result in more frequent use of the organic waste container. However, these results must be interpreted with some caution, because the groups could not be assigned randomly.

Note! If your target group exhibits very little or no waste separation behaviour at the moment, it is important to first reduce people's resistance (the reasons why they do not separate their waste) before focusing on improving their motivation.

Budget? The one-time relocation of existing containers or addition of new containers is relatively inexpensive, especially when it concerns aboveground containers. During the pilots, the organic waste collected in aboveground containers was of a higher quality than that collected in underground waste containers. Lastly, the aboveground containers are easier to move around.
Practical feasibility? The practical feasibility of this intervention is lower, given that (underground) containers cannot be (re)positioned simply anywhere. However, adding new containers does create some opportunities. In that case, make sure to position the organic waste container close by and the residual waste container slightly farther away - but not too far away so as to minimise the risk of people simply dropping their residual waste near the organic waste container.

6.3.3 Setting personal goals & activating

Technique	Effectiveness	Budget	Practical feasibility
 Setting personal coals & activating	☆ ☆ ☆	★ ☆ ☆	★ ☆ ☆
	** low effectiveness *** high effectiveness*	** costly *** inexpensive*	** limited feasibility *** high feasibility*

What? Even if residents are willing to separate their waste, they often do not do so as a result of strong habitual behaviour and the need to preserve energy. Setting a clear goal for one's own behaviour makes it easier to strive towards that behaviour. This technique has a primarily motivational effect. For people who are already (partially) motivated, it can result in extra motivation.

How? Let residents create their own realistic goals with regard to the amount of waste they want to separate, for example by having them write down the number of bags by which they want to reduce their weekly amount of residual waste. Optionally, you can use a neighbourhood spokesperson or waste management coach to assist. They can help residents set realistic yet challenging goals for themselves. This results in higher motivation and better separation of the organic waste.

Note! A possible negative consequence of relocation containers is heavier contamination of the organic waste, because disposing of residual waste in the residual waste containers will take more effort. It may be possible to prevent this issue by reducing the size of the aperture of the organic waste containers, so residual waste bags cannot fit through. Nevertheless, the results of the pilot show that contaminants were found even in organic waste containers with a smaller aperture. More tips can be found in the box in paragraph 5.3.

Effectiveness? During the pilot, this intervention did not have a significant effect on the separation of organic waste. It could be interesting to use the intervention on a target group that already separates its waste but can do better in that regard. For a target group that is generally willing to separate its waste but does not do so (yet), for example out of habit, setting goals can be the final push they need to improve their waste separation behaviour.

Budget? Getting residents to set goals for themselves requires moments of personal contact and door-to-door visits. As a result, the intervention is time- and labour-intensive and costly.

Practical feasibility? Planning and executing the moments of personal contact also results in a reduced practical feasibility for this intervention.

6.3.4 Influencing attitudes (the use of waste separation)

Technique	Effectiveness	Budget	Practical feasibility
 Influencing attitudes (the use of waste separation)	★ ★ ★	★ ★ ★	★ ★ ★
	** low effectiveness *** high effectiveness*	** costly *** inexpensive*	** limited feasibility *** high feasibility*

What? An attitude is an evaluative judgement or position with regard to a topic. People believe waste separation to be difficult or easy, important or unimportant and/or useful or useless. Residents have different attitudes towards waste separation, based on (correct or incorrect) information, assumptions, personal experiences or stories told by others. Negative attitudes breed resistance and inhibit the separation of waste. Think of: “everything will just end up in the same place” or “it is just a drop in the ocean.”

How? By stimulating a positive attitude towards waste separation, you can motivate residents to separate their organic waste. Change people's attitude by giving them correct and clear information about waste separation and its use, for example by showing a visual representation of the waste processing journey. In a letter or video,

illustrate how waste is collected, processed and recycled into new materials. Concretely show people that they use these same recycled materials in their everyday lives. Examples include the biogas that powers the buses or compost for plants and horticulture.

Effectiveness? During the pilot, this intervention had a significant effect on the separation of organic waste. Residents deposit their organic waste in the organic waste container somewhat more often, even in the long run. This mainly applies to residents who were already frequent waste separators before the intervention was introduced.

Deepening. This intervention mainly affects residents who already separate their waste. They already possess some knowledge of the importance of waste separation. This group is more receptive of new knowledge. By influencing their attitude, you can stimulate this group to separate their waste even better.

Budget? This technique can be utilised in a cost-effective manner. It can be implemented at a low cost by sending out letters.

Practical feasibility? The technique has excellent practical feasibility. Note that it is important to invest in a proper analysis phase and assess what negative attitudes affect your target group. This allows you to tailor the communication in your letters accordingly.

6.3.5 Strengthening social standards & activating

Technique	Effectiveness	Budget	Practical feasibility
 Strengthening social standard & activating	☆ ☆ ☆	★ ★ ★	★ ★ ☆
	** low effectiveness *** high effectiveness*	** costly *** inexpensive*	** limited feasibility *** high feasibility*

What? People like to conform to the behaviour of others. This is the result of their need to belong to a group. This stimulates people to adhere to social standards. When we see many people around us doing something, we (subconsciously) conclude that this behaviour is good.

How? By showing residents that "most people in the neighbourhood separate their organic waste," you can establish a positive social standard and make residents more likely to separate their waste. The standard is more effective if it is concrete, if people can identify strongly with the group to which it refers and if this group is smaller in size. For example, it is more effective to say "people in this building separate their waste" than "people in this city separate their waste." This technique plays into people's motivation.

Effectiveness? In the pilot, merely strengthening the social standard did not affect people's waste separation behaviour. Neither communicating the *injunctive standard* ("most people believe that you should separate your organic waste") or the *descriptive standard* ("most people separate their organic waste") resulted in improved waste separation behaviour. A positive effect may occur when this technique is combined with others.

Budget? The intervention can be scaled up at a very low cost, for example by distributing letters or posters.

Practical feasibility? When applying this technique in the form of letters and posters, its practical feasibility is relatively high. However, a small study must first be conducted to determine the prevailing social standard in the neighbourhood and customise the message accordingly.

Deepening. When communicating the social standard, it is important that the message meets several requirements:•

- Show that a majority of people do something or believe it to be the right thing to do.
- Communicate a credible message.
- Say something about the desired behaviour, not about attitudes or predictors. In other words, what you want to communicate is that most people separate their waste (behaviour), not that most people believe organic waste is better for the environment (attitude).
- Communicate about a group to which your target group feels connected.
- Avoid the use of contradictions, as our brains find these harder to process.

6.3.6 Social modelling

Technique	Effectiveness	Budget	Practical feasibility
 Social modelling	★ ★ ☆	★ ★ ★	★ ★ ☆
	** low effectiveness *** high effectiveness*	** costly *** inexpensive*	** limited feasibility *** high feasibility*

What? People learn by observing others. With social modelling, you can show people how others behave in a specific situation. This subconsciously motivates people to exhibit the same behaviour in a similar manner.

How? Show your target group that others separate their waste and that they are proud of and appreciated for this. Go over the various steps involved: from cooking to transporting the organic waste to

the organic waste container. Ideally, you should choose people who are similar to residents or related to them in some way, in which residents can recognise themselves and with whom they have a positive association. One way to visualise this information is by using a series of pictures. This technique plays into people's motivation and capacity.

Effectiveness? During the pilot, the use of *social modelling* had a significant effect on the separation of organic waste. This goes for both frequent waste separators and people who did not separate their waste before. The effect became stronger as people received intervention materials multiple times.

Note! It is expected that this intervention will be most effective in neighbourhoods with a strong sense of social cohesion, where residents actually feel connected to the area and can identify with the neighbourhood ambassadors who are used as models.

Budget? As this intervention makes use of flyers or letters, it is very cost effective.

Practical feasibility? The practical feasibility of this intervention is relatively high. If you want to use neighbourhood ambassadors to serve as models for others, this can be a time-consuming process. However, this is not required.

6.3.7 Setting group goals & feedback

What? People are herd animals; they have a tendency to follow the

Technique	Effectiveness	Budget	Practical feasibility
 Setting group goals & feedback	★ ★ ★	★ ★ ☆	★ ★ ☆
	** low effectiveness *** high effectiveness*	** costly *** inexpensive*	** limited feasibility *** high feasibility*

group. It gives them a sense of security and confidence with regard to their own behaviour. If they know their neighbours separate their waste well, they will try to exhibit similar behaviour themselves. Supplying information about the neighbourhood's (good) waste separation behaviour will stimulate residents to do their part.

How? Together with the neighbourhood, set a collective goal to improve the separation of organic waste and give feedback: how well is the neighbourhood separating its waste? This challenges households to contribute to a goal that is important to the entire neighbourhood. By giving feedback in the interim, the intervention provides a form of social feedback. Households can compare the information about the neighbourhood as a whole with their own waste separation performance. This technique plays into people's motivation.

Effectiveness? During the pilot, this intervention had a significant effect on the separation of organic waste. Residents deposit their organic waste in the organic waste container somewhat more often. The effect is stronger for frequent waste separators and is less effective on people who do not separate their waste yet. The improved waste separation behaviour persists in the long run as well.

Giving performance feedback regarding a collective target in combination with *social modelling* turns out to be even more effective; this also gives people a clear action perspective.

Budget? If the facilities to weigh collected waste or register waste disposals are already in place, this technique is relatively cost effective. If that is not the case, implementing these facilities will result in higher costs.

Note! Think carefully about the effects of giving social feedback if the experiment is less successful. If people's waste separation results do not improve immediately, you have to give them negative feedback. This may establish a negative social standard and actually result in worse waste separation behaviour.

Practical feasibility? If the facilities to weigh collected waste or register waste disposals are already in place, this technique is practically feasible. Its feasibility deteriorates if that is not the case, as a result of the logistical challenges involved.

6.3.8 Promising rewards

What? Giving rewards is a form of extrinsic motivation. In other

Technique	Effectiveness	Budget	Practical feasibility
 Promising rewards	★ ★ ☆	★ ☆ ☆	★ ☆ ☆
	** low effectiveness *** high effectiveness*	** costly *** inexpensive*	** limited feasibility *** high feasibility*

words, exterior stimuli - e.g. money, gifts or compliments - are used to trigger people's motivation to change their behaviour. Promising people a reward improves their motivation.

How? There are many ways to use rewards. In the pilot, promised rewards and pre-emptive gifts were both tested (see technique

"Pre-emptive gift"). Promise residents a reward for properly separating their organic waste. They will have a stronger tendency to do their best. Ideally, these rewards are repeated multiple times. That leads to a learning effect, because the positive experience of the reward is linked to the desired behaviour. It is important to communicate beforehand how often residents can expect a reward and make sure the rewards do not stop unexpectedly. The latter may lead to resistance, which has a detrimental effect on residents' waste separation behaviour.

Effectiveness? During the pilot, promising a reward had a significant effect on the separation of organic waste, although this effect decreases over time. This goes for both frequent waste separators and people who did not separate their waste before.

Deepening Promising a reward is effective until people actually receive the reward in question. From that point, the effectiveness decreases fairly rapidly. This short-term effect is often seen during interventions that involve some form of reward. It can be explained by the fact that residents link their behaviour (separating waste) to an extrinsic motivation (the reward), rather than to their own values. As soon as the rewards stop, people start to exhibit less of the good waste separation behaviour.

Budget? This is a less affordable intervention because rewards can be expensive.

Practical feasibility? Its practical feasibility is also somewhat limited, because you have to track each household's waste separation performance to determine whether they have earned a reward. Sending out the rewards by mail improves the technique's feasibility.

6.3.9 Acknowledging and reducing resistance

Technique	Effectiveness	Budget	Practical feasibility
 Acknowledging and reducing resistance	★ ☆ ☆	★ ★ ★	★ ★ ★
	** low effectiveness *** high effectiveness*	** costly *** inexpensive*	** limited feasibility *** high feasibility*

What? People do not like being told what to do: "I get to make my own decisions!" They feel resistance. This is born out of a need for autonomy. By acknowledging resistance yourself, you can reduce the resistance felt by your target group. Voice counterarguments or resistances before your target group has a chance to do so. This keeps them from presenting the counterarguments themselves. If you just said that you understand it is difficult to separate organic waste, it will feel weird for residents to bring up that same argument a second time.

How? Determine what resistance(s) residents feel and acknowledge them. For example, "we understand that separating organic waste can be a hassle" or "organic waste can have an unpleasant smell, we understand that this bothers you." Next, you can present an argument to motivate people, centred around the environmental or financial benefits of waste separation. "Separating organic waste is a hassle. We use that organic waste to make biogas and compost. Will you do your part?" or "... but we all stand to make money from it! Will you help?" This stimulates a change in people's attitude. Acknowledge the resistance via a letter, flyer or poster. In the pilot, we used the organic waste bags that were handed out.

Effectiveness? In the pilot, merely acknowledging the resistance did not affect people's waste separation behaviour. It is important to acknowledge the right resistance. For example, acknowledging the resistance that "separating organic waste is a hassle" can be highly effective for a group that does not separate its waste because they believe it to be a hassle. However, this argument loses its effectiveness when there are other resistances, such as a lack of space in the home or the unpleasant smell.

Note! Simply reducing people's resistance is often not enough to bring about a change in behaviour. It is merely the first step of the path towards behavioural change. The next step is to motivate residents to actually exhibit the desired behaviour. To do so, use techniques that target people's motivation.

Budget? This technique is highly cost effective, because you can make use of letters or posters or because it is used alongside a different intervention.

Practical feasibility? The practical feasibility of this technique is very high. We do recommend conducting an analysis to determine what resistances residents experience. Although it can be a time-consuming process, a proper analysis is critically important.

6.3.10 Pre-emptive gift

Technique	Effectiveness	Budget	Practical feasibility
 Pre-emptive gift	★ ★ ☆	★ ★ ★	★ ★ ★
	** low effectiveness *** high effectiveness*	** costly *** inexpensive*	** limited feasibility *** high feasibility*

What? People have a strong tendency to act in accordance with the "quid pro quo" principle. Receiving a pre-emptive gift generates feelings of reciprocity in the recipient. This means you have a tendency to do something in return when someone gives you something first.

How? Give residents a pre-emptive gift with a complimentary comment for waste separators and a motivational message for those who do not separate their waste. Think of e.g. a (bamboo) cutting board or some other gift that residents associate with the desired behaviour (separating organic waste).

Deepening A pre-emptive gift will generate the strongest feelings of reciprocity when it is personal, relevant and unexpected. Another important condition is that the gift must be unconditional. That is how a pre-emptive gift differs from a delayed reward.

Optionally, you can ask residents beforehand whether they already separate their waste. Based on their response, you can give them a gift with the text "You are doing great, thank you!" or "It's great that you are willing to separate your waste!" Although this will make the intervention more costly, its impact will likely be higher.

Effectiveness? During the pilot, a pre-emptive gift had a significant effect on the separation of organic waste, although this effect decreases over time. This goes for both frequent waste separators and people who did not separate their waste before.

Budget? The intervention is very cost effective, especially when you send the gifts by mail instead of distributing them in person.

Practical feasibility? The technique's practical feasibility is very high if you send the gifts by mail.

6.4 Getting to work with the menu

As a policy official, you can use this menu to make choices regarding the use of behavioural techniques to stimulate the separation of organic waste in high-rise buildings in your municipality. Before selecting what techniques you want to utilise, it is therefore important to choose a thorough approach and base your choice on the results of an in-depth analysis. Based on the experiences we acquired during this project, paragraph 7.3 contains several process-oriented recommendations for municipalities that want to start improving the waste separation in their high-rise buildings.

7 Reflection on the process

This chapter offers a reflection on the substance and process of the project for the benefit of future research projects. The key partners involved in this project were invited to a gathering, during which the results were presented. During this gathering, held on 4 December 2019, these results and the process itself were evaluated.

7.1 Overview of the process

Firstly, an overview of the main events was created in collaboration with the participants. See figure 7.1.

Year	Activity	Product
2014	1. Project initiative 2. Project start (project plan, consortium, assets, project organisation)	• Project plan • Research plan
2015	3. Reality Check 4. Kick-off by Secretary Mansveld 5. Literature study 6. Field research	• Reality Check • Literature study • Field research
2015- 2016	7. Selection of pilot regions 8. Formulating basic package and selecting promising interventions 9. Formulating measurement strategy 10. Formulating research design	• Research plan • 12 promising instruments
2016	11. Development of individual weighing method (unsuccessful)	
2016-2018	12. Preparation of urban pilots (developing interventions, randomisation, etcetera)	• Project plan per pilot
2016-2019	13. Executing pilots (introducing basic package, implementing interventions)	• Log per pilot
2017	14. Ensuring compliance with new privacy legislation	• Privacy Assessment
2019-2020	15. Analysis and reporting	• This report • Appendix with detailed reports per municipality
2017- 2020	16. Events and promotions to share knowledge and results: dissemination.	• Two large intermediate knowledge events • One event for sharing the project results • Various presentations, web page

Figure 7.1: Timeline of the project and its products.

Positive *Negative*

Internal Factors

Strengths

- Participants **share their belief in the use and necessity** of the project. They feel part of an inspirational whole by working together.
- Solid and **balanced organisation** centred around multidisciplinary and constructive collaboration between governments, businesses and the scientific community. The involvement of the latter has a disciplinary and inspirational effect.
- The project was **executed with resilience, optimism and excellent coordination.** Where possible, the same implementation partners were used so as to improve the quality (e.g. when conducting surveys).
- The project was designed in collaboration with professors and practical experts from the field of behavioural science. As a result of the **scientifically substantiated approach (randomised controlled trial) and measurement methods**, the results were validated more effectively and a deeper connection between waste and behaviour was formed. Well-designed pilots not only make it possible to determine what is (not) successful, but also why that is the case.
- The six pilots tested a **good range of interventions**.

Weaknesses

- The execution of the project took **more time** than what was initially planned. This was the result of expected obstacles (such as the need to test the weighing method) and unavoidable obstacles (such as the stricter privacy regulations). This has resulted in more coordination, while the other costs remained within the budget.
- Since **so many parties are involved**, each with their own agenda and autonomy, there were some issues along the way, such as delays, ad-hoc choices of interventions or parties (having a tendency to) dropping out. The think tank sometimes had different insights and a lack of a clear and unified message.
- The **substantive support** from project leaders on the floor with regard to details could have been more intensive at times. Instruments could have been tested more. A number of scientific wishes are not practically feasible.
- Pilot regions must be **large** enough to find clear significant connections.
- The **data set has certain limitations**. Only the frequency of waste disposal was measured, not the amount. A number of errors in the data were only discovered at a later stage. Data must always be checked (four-eyes principle).

External Factors

Opportunities

- Source separation of organic waste in high-rise buildings continues to be an important issue. Forthcoming European legislation that will make the separate collection of organic waste mandatory underscores this fact. Whereas subsequent separation can be used for other waste streams such as PMD, it is not an option for organic waste. It is therefore desirable that **the results of this project are shared through various channels.**
- There are several promising interventions, with regard to both behaviour and physical-technological aspects, that were barely tested or not at all. **Additional tests** will be needed. Examples include resident participation, relocations, grinders, influencing the quality of organic waste.
- The issue and the possible solutions are relevant to municipalities all over the world. **International collaboration** is interesting to allow highly urbanised regions to learn from each other.
- **Give municipalities more knowledge of people's behaviour.** The insights from these pilots may e.g. also be utilised for low-rise buildings.

Threats

- When it comes to organic waste, **the quality of the collected material** is of major importance.
- Conducting **proper measurements** during pilots is costly (in terms of both time and money). If these measurements are not conducted adequately, the results may lead to fewer or even incorrect conclusions.
- There is a risk that municipalities implement **the menu without thinking it through**. It is important to develop a tailor-made solution and keep a constant eye on the project.
- Those parts of the population that do not separate their waste are **harder to reach**, even with this set of interventions.
- Citizens might get **tired of the pilots**. In some districts, municipalities are already running myriad other projects.

Figure 7.2: A SWOT analysis of the project.

The results of the project were shared at various moments while the pilots were ongoing. Partial reports were published, two conventions centred around high-rise buildings were organised and the interim results were presented at various events.

7.2 SWOT analysis

For the second step, the participants conducted a SWOT analysis by identifying the strengths, weaknesses, opportunities and threats of the project. Figure 7.2 outlines the main results of this analysis.

The costs are explained in box 7.1.

Conclusions

- The project represents a unique collaboration because of the solid and balanced organisation centred around multidisciplinary and constructive collaboration between governments, the scientific community, practical experts and businesses. To successfully realise improvements to waste separation, collaboration in the waste management chain and interaction with behavioural experts are critical factors. The downside is that every party has its own agenda and autonomy, which can sometimes lead to issues along the way, such as delays, ad-hoc choices of interventions or parties (having a tendency to) dropping out.
- The project was designed in collaboration with professors and practical experts from the field of behavioural science. As a result of the scientifically substantiated approach (theoretical substantiation, the measurement methods that were used and randomised controlled trial), the results were thoroughly validated and a deeper connection between waste and behaviour was established. Well-designed pilots not only make it possible to determine what is (not) successful, but also why that is the case. These lessons can be put to use during the implementation of future interventions. Once again, it became clear that conducting proper measurements during the pilots is a time-consuming and costly matter. Pilot regions must be large enough in order to find clear significant connections. Data must always be checked (four-eyes principle). If that is not done properly, the results may lead to fewer or even incorrect conclusions.
- For every pilot design, *"the devil is in the detail"* as the saying goes. Even with a properly substantiated approach, pilots never go entirely as expected. The lesson learned is to first test interventions in smaller settings ("pre-testing"), before implementing them on a larger scale during a pilot.
- One of the opportunities is (inter)national collaboration. One of the outcomes of this project is the development, with support from the VANG programme, of the Urban Waste Collection platform for urbanised municipalities in the Netherlands. This platform is already being used by twenty-five municipalities to share knowledge pertaining to joint issues.

7.3 Pilot approach

Based on the experiences acquired during this project, we offer the following process-oriented recommendations for municipalities that want to start improving the waste separation in their high-rise buildings. It is assumed that a specific apartment building or neighbourhood has been selected and that there is room for tailor-made solutions with regard to communication and facilities.

Box 7.1: Clarification of costs

It is impossible to give an exact figure for the costs of the project as a whole. This is because the participating parties each made in-kind contributions themselves. What we can do is estimate the total costs and compare those to the original budget, see figure 7.3.

Budget (figures excl. VAT)	Project plan	Realisation based on estimated costs
External (experts, studies, communication)	€ 417	€ 415
Pilots	€ 890	€ 1,500
Internal hours spent by participants*	In-kind input	€ 835
Total (x1.000)		**€ 2,750**

** An hourly rate of €85 is used for internal hours*

Figure 7.3: Budget versus expenses

The original budget was sufficient to cover the external costs. The realised costs of the pilots are circa €250,000 per pilot. This is higher than the original budget. At the time when the costs per pilot were budgeted, it became clear that the original budget would not be sufficient. At the start of the project, the internal hours that participants spent on it were not made explicit. However, if we do that for the realisation, using an hourly rate of €85, we estimate that this cost all parties €835,000. The estimated total cost of the project is €2.75 million.

Preparation

- Form the project team together with internal and external stakeholders.
- Create an overview of the persons and organisations that have a stake in the project (the stakeholders), such as the homeowners' association, the housing association, the residents' or neighbourhood association, the caretaker, the district police officer, the neighbourhood representative and the municipal contact.
- Inform them about the proposed project: the steps, the schedule, invitation to a neighbourhood gathering, website with information and point of contact (person or helpdesk). By letter, possibly in combination with going door to door.
- Gather information about:
  - > Residents: nationalities, socio-economic status, age range, prominent figures, lifestyle, social connectedness, issues (broad), relationship with/view on the municipality
  - > Residences: owner-occupied/rental, gardens, stairs/elevator, entrance, galleries, layout, communal notice board, storage areas
  - > The existing waste collection: what, where, how, when, how much, quality of the collected separated waste streams. The quantities of the various streams over time are your baseline measurement. At the very least, it is important to gain insight into the amount of residual waste per unit of time, preferably going back one year. If the waste containers use an access system with keycards, it is also possible to acquire information about disposal frequencies. If possible, have a sorting analysis conducted on the residual waste, so you know what to focus on.
- Design the basic package: new containers, locations, collection situation, aids and initial information/communication. Decide what choice you want to offer your residents (collective or per connection). Checklist for the basic package:
  - > Information package, in different languages if necessary, containing information about
    - Why: the motivation for and use of waste separation
    - What and how: waste disposal guide/chart and optional app, to be requested and downloaded
    - Where: locations and pictures of the containers
    - The municipal waste management website where more information can be found
  - > New facilities
    - Clean, undamaged and well cared for
    - Meaningful colour scheme
    - Addition of symbols/pictograms, waste separation information and a way to report any issues.
    - Easily visible and accessible
    - Operational, available and not full
- Design the additional interventions and decide whether and how to present these to residents. Use the information you gathered during the first few steps. Also determine what additional information you need to properly implement these interventions.
- If they have not been involved in the project thus far, have a behavioural expert reflect/advice on the package as a whole.
- Choose and organise the method with which to monitor both the quantities (and possibly the disposal frequency) and the quality of the waste streams and any signals from residents, waste collectors and other stakeholders who have practical insights, e.g. a building's caretaker or panel of residents. Ensure compliance with the GDPR.
- Organise a kick-off with the stakeholders. Points of attention:
  - > Use an experienced individual to supervise the session
  - > Make clear who the project leader/contact person is
  - > Share information about the project's goal, structure and schedule, new facilities
  - > Optionally, you can organise a joint sorting analysis or show a video of how residents' residual waste is being sorted
  - > Inform them about the formal process (participation, etcetera), choices for the residents (per connection or collectively) and how they can indicate their choices
  - > Ask residents to provide any requisite information needed to implement additional interventions
- Conduct a pre-test to fine-tune the interventions. Make use of behavioural knowledge for this.

Project execution

- Implement the basic package
- Conduct the additional intervention(s)
- Oversee proper monitoring procedures
- If needed, evaluate the signals and monitoring data in the interim to make any necessary adjustments to your communication and the facilities

Project completion

- Evaluate the monitoring data, including any information provided by stakeholders
- Make a decision about the follow-up steps (continuation, modification, termination)
- Inform the stakeholders, for example by organising a session or event to mark the conclusion of the project
- Implement the decision and organise its management.

8 Conclusions & recommendations

This chapter presents an overview of the conclusions that were drawn in each chapter. The recommendations that were formulated are also included.

8.1 Objective

The objective of the project is to find **effective instruments that cities can use to improve the source separation of organic waste in urban regions with many high-rise buildings.** In addition to determining what measures do (not) work, the project also considers why these measures do (not) work: it is about acquiring insight **into the factors that determine people's behaviour with regard to waste separation and what factors are important when.** One of the key results of this project is a menu that presents a range of interventions that have been tested in practice and which are designed to bring the realisation of the Netherlands' waste separation target closer. This menu was developed based on experiences covered in existing literature on the subject, field research and various pilot programmes.

8.2 Conclusions based on the results

Basic package

1) In all six pilot regions, organic waste was not collected separately prior to the start of the project. The introduction of a basic package, consisting of organic waste containers with keycard access, communication to residents and possibly a small organic waste container for use in the kitchen, has a visible effect: On average, one in five households makes frequent use of the organic waste containers. About half of the households have used the organic waste containers once. To get more households to separate their organic waste, additional (behavioural) interventions are needed.

1.1 Each pilot began with the introduction of a basic package. This basic package was designed to provide the three behavioural components: opportunity, motivation and capacity. If these three components are not sufficiently provided, residents will not separate their waste. Despite the fact that the basic packages are not identical, they do provide a comparable baseline position in each of the pilot regions.

1.2 Different types of households exhibit different behaviour. Single-person households separate their organic waste less frequently than multi-person households. Households that contain one or more senior citizens separate their organic waste more frequently than households without a senior member. Other characteristics, such as WOZ value, what floor of a building an apartment is located on or the presence of small children, do not appear to impact the frequency with which households make use of the organic waste containers.

1.3 Households that frequently separate their waste during the base period generally have a stronger intention to continue doing so in the future, compared to infrequent waste separators. The most commonly reported issue with regard to waste separation is storing the waste in the kitchen and the home. Infrequent waste separators are more likely to perceive obstacles, e.g. feasibility, or find separating waste unpleasant.

1.4 The willingness to separate waste (attitude) differs between the various pilot regions during the base period.

Behavioural interventions

2) The menu presents an overview of the intervention techniques that were tested, along with scores for their respective effectiveness, budget and practical feasibility. The interventions that prove most effective are "facilitating storage at home," "setting group goals & feedback" and "influencing attitudes (the use of waste separation)." It looks like all three are both practically and financially feasible.

2.1 In three pilots, "facilitating storage at home" was utilised in different ways. It proves to be a highly effective method (compared to other interventions). Both small organic waste bins for use on kitchen counters and larger waste separation bins are effective interventions with which to improve people's waste separation behaviour. The advantages of the smaller bins are their dimensions, usability and lower cost. The advantage of the waste separation bin is the fact that it constantly invites users to make a separation decision on the spot. "Facilitating storage at home" is a suitable intervention to convince households that do

Technique	Effectiveness	Budget	Practical feasibility
Facilitating store at home	★★★	★★☆	★★★
Changing the distance to the waste collection point	★★☆	★★☆	★☆☆
Setting personal coals & activating	☆☆☆	★☆☆	★☆☆
Influencing attitudes (the use of waste separation)	★★★	★★★	★★★
Strengthening social standard & activating	☆?☆	★★★	★★☆
Social modelling	★★☆	★★★	★★☆
Setting group goals & feedback	★★★	★★☆	★★☆
Promising reward	★★☆	★☆☆	★☆☆
Acknowledging & reducing resistance	★☆☆	★★★	★★★
Pre-emptive gift	★★☆	★★★	★★★
	* low effectiveness *** high effectiveness	* costly *** inexpensive	* limited feasibility *** high feasibility

Figuur 8.1: De menukaart van interventies en hun effectiviteit, budget en praktische haalbaarheid.

not (structurally) separate their waste yet to start doing so. Available space and having to store waste in the home form the biggest issues with regard to the intervention's execution. This intervention is more effective when there is coordination between the situation in people's homes and their wishes. Satisfied residents use the bin more. The number of comments about the usability of the bin and bags suggests there is room for improvement in that regard: the bin is too small, the bin and/or bag leaks moisture, the bag does not close properly, the bin and/or bag break easily. The bin's usage might be further improved by coordinating its design and functionality with residents' wishes. The intervention becomes costlier if you opt for more deluxe waste bins, such as a waste sorting bin. Its practical feasibility is high, although it is a time-consuming process.

2.2 "Setting group goals & feedback" scores three stars and is therefore highly effective. Setting goals proved to be an effective method with which to achieve a collective goal that was set for, not by, residents. The intervention was strengthened with repeated feedback about the group's performance. If the facilities to weigh collected waste or register waste disposals are already in place, this technique is relatively cost effective and practically feasible.

2.3 "Influencing attitude (the use of waste separation)" scores three stars and is therefore highly effective. This intervention changes residents' attitude by providing clear and correct textual and visual information about waste separation and its usefulness. The intervention was strengthened through repetition: two letters were sent to residents. This technique can be utilised in a cost-effective manner by sending out letters and offers excellent practical feasibility.

2.4 "Changing the distance to the waste collection point" earns a decent score of two stars for effectiveness. The closer an organic waste container is, the more likely it is that residents will actually use it to separate their organic waste. Another important consideration is the distance to the nearest residual waste container: an organic waste container that is located farther away than a residual waste container is used less frequently. The one-time relocation of existing containers or addition of new containers is relatively inexpensive, especially when it concerns aboveground containers.

2.5 The interventions "social modelling," "pre-emptive gift" and "promising rewards" also earn decent scores of two stars for effectiveness. "Social modelling" and "pre-emptive gift" are both cost-effective and feasible.

2.6 The intervention "setting personal goals & activating" proved to have little to no effect. Allowing residents to set their own goals is less effective because they tend to set less ambitious goals for themselves. This advocates the use of a predetermined goal, as was done for the "setting group goals & feedback" intervention. The intervention "acknowledging and reducing resistance" also proved to have little to no effect. Residents were insufficiently able to recall the messages designed to reduce their resistance.

3) The intervention(s) that are best suited to a specific area depends on local circumstances, such as the attitude of residents. A diagnosis must therefore be conducted before the right intervention(s) can be selected. "The devil is in the detail." It is important to first test interventions in a smaller setting ("pre-testing"), before they are implemented on a larger scale. In this study, one intervention was not conducted effectively ("strengthening social standards & activating"). It should be noted that the menu was developed based on how the interventions were executed during the pilot programmes. A different target group or implementation may lead to different effects.

4) It is possible to combine interventions in a complementary manner. During the pilots, these complementary effects were identified, but no strengthening effects were found: no additional better (or worse) waste separation behaviour was found, compared to what each intervention was able to realise on its own.

5) The effects of the interventions deteriorate over time. The interventions that continue to have a significant effect after two to three months are characterised by some form of repetition. To achieve a stable behavioural change, it is therefore advisable to continue stimulating the desired behaviour for an extended period of time or execute interventions periodically.

Quality

6) When it comes to processing organic waste, the quality of the collected material is a key factor. For other waste streams, a low percentage of organic waste in the residual waste stream is also important: this prevents cross-contamination of recyclables. At the end of the intervention periods, the quality of the collected organic waste had improved to "sufficiently clean" for almost all pilot programmes. Maintaining the requisite level of quality will be a continuous point of attention.

6.1 Only in The Hague did the quality of the waste stream remain inexplicably inferior. In the other municipalities, it is likely that information, habituation and interventions led to the improved quality of the collected organic waste. This process of quality improvement begins in the kitchen. It is therefore important that quality-improving facilities are available there as well.

6.2 With an aboveground container (mini containers encased in a housing) and keycard access for the high-rise buildings, it is possible to collect organic waste of a good quality. This shows that the design, dimensions and appearance of a container are important, which goes for both aboveground and underground models. Repurposing an existing residual waste container for organic waste or PMD leads to confusion. Underground containers for organic waste also appear to lead to a more contaminated waste stream. Both measures are therefore not recommended.

6.3 To maintain the quality (and quantity) of the collected material, it is advisable to continue stimulating the desired behaviour for an extended period of time. This can be done with the help of communication, for example. It is also important to monitor the quality, for example in collaboration with your organic waste processor who can provide feedback on the quality of the collected material.

Impact

7) In the Netherlands, separating the organic waste from high-rise buildings contributes 1.5 percentage point to the national waste separation percentage (based on the results of the most effective non-combined intervention). For a municipality such as Rotterdam, this figure is 4.7 percentage points. The focus on separating organic waste from high-rise buildings in the Netherlands therefore has a demonstrable impact on the country's transition towards a circular economy: the sparing use of natural resources, their reuse and maintaining a healthy soil.

7.1 In the Netherlands, 86 kg of organic waste are collected separately per citizen per year, while an additional 58 kg are found in the residual waste stream. This includes both food waste and garden waste. If we only consider food waste, this means 17 kg of organic waste are collected separately per citizen per year in the Netherlands, while another 43 kg of organic waste ends up in the residual waste stream. The waste separation potential for organic waste in the Netherlands is therefore 61 kg of organic waste per citizen per year.

7.2 If only the basic package is introduced and we assume that one in five households separates their waste, the realistic waste separation potential for high-rise buildings in the Netherlands is 16 kg per citizen per year. As a result, the waste separation percentage goes up by 0.9 percentage point. Based on the results of the best non-combined intervention, the realistic waste separation potential for high-rise buildings is 27 kg per citizen per year. As a result, the waste separation percentage goes up by 1.5 percentage point.

7.3 For individual municipalities, the effect may be considerably higher if there are a great number of high-rise buildings in the area. If Rotterdam only rolls out the basic package for organic waste from high-rise buildings, the amount of residual waste will decrease by 12 kg per citizen per year, while the total waste separation percentage goes up by 2.8 percentage points. If the results of the basic package combined with the best intervention are matched, the amount of residual waste will decrease by 27 kg per citizen per year, while the total waste separation percentage goes up by 4.7 percentage points.

7.4 The effect of the separated collection of organic waste in the Netherlands on the climate, in terms of CO_2 reduction, is comparatively minor. A comparison was made with the current process for generating energy with incineration.

8) It was not the goal of this study to achieve maximum effectiveness; it was primarily intended to determine which instruments work, and which do not. The expectation is therefore that it will be possible to achieve even better results when multiple interventions are actually rolled out on a grander scale. Furthermore, there are various ways in which the results from this study can be rolled out in a more comprehensive manner.

8.1 The most obvious ways in which to roll out the results of this study on a larger scale are (a) to include other waste streams from

high-rise buildings, e.g. paper & cardboard and (b) collect organic waste from low-rise buildings. Based on the result from the best intervention, the combined effect will be an increase of the national waste separation percentage of 4.6 percentage points, which is circa one third of the difference between the current national waste separation percentage of 62% and the target of 75%. If the full potential of the insights from this study is utilised, it is possible to realise an increase of 14 percentage points for the national waste separation percentage, which puts the national target within reach.

Survey analysis model

9) Since this study allows for the combination of observed separation behaviour and measurements of underlying psychological factors, it becomes possible to clarify what factors have the strongest impact on people's actual behaviour. The described behavioural model is robust and can be used to design new interventions by focusing on the factors with the strongest behavioural effects.

9.1 The behavioural intention to separate waste is the most direct predictor of people's waste disposal behaviour during the intervention period.

9.2 A positive attitude towards separating one's own waste, nurtured by a positive balance between perceived pros and cons and faith in the municipality, turns out to be the primary condition for the realisation of strong waste separation intentions.

9.3 If residents' initial experiences with waste separation are negative as a result of difficulties in the execution, their intention to continue separating their waste in the future decreases. First impressions are therefore critical.

9.4 There is no simple one-size-fits-all technical solution with a major positive impact. Instead, the best method is to combine interventions in practice.

Process

10) This project represents a unique collaboration around multidisciplinary and constructive collaboration between governments, the scientific community, practical experts and businesses. To successfully realise improvements to waste separation, collaboration in the waste management chain and interaction with behavioural experts are critical factors. This research utilises a scientific approach based on the approach with the DOE-MEE tool, the theoretical substantiation, a clear phasing into a base period and an intervention period, the random division of participating households into an intervention group and a control group (randomised controlled trial) and the quantitative and qualitative measurement of results. The results have been carefully validated through the application of the best methods available and a deeper connection between waste and behaviour has been established.

10.1 The downside is that every party has its own agenda and autonomy, which can sometimes lead to issues along the way, such as delays, ad-hoc choices of interventions or parties (having a tendency to) dropping out.

10.2 Well-designed pilots not only make it possible to determine what is (not) successful, but also why that is the case. These lessons can be put to use during the implementation of future interventions. Once again, it became clear that conducting proper measurements during the pilots is a time-consuming and costly matter. Pilot regions must be large enough in order to find clear significant connections. Data must always be checked (four-eyes principle). If that is not done properly, the results may lead to fewer or even incorrect conclusions.

10.3 One of the opportunities is (inter)national collaboration. One of the outcomes of this project is the development, with support from the VANG programme, of the Urban Waste Collection platform for urbanised municipalities in the Netherlands. This platform is already being used by twenty-five municipalities to share knowledge pertaining to joint issues.

8.3 Recommendations

1) Get started on organising the source-separated collection of organic waste from high-rise buildings on a larger scale, based on currently available scientific insights and practical experiences. In addition to a number of existing examples, this study has resulted in a clear basic package and a number of validated behavioural interventions. The focus on separating organic waste from high-rise buildings in the Netherlands has a demonstrated impact on the country's transition towards a circular economy: the sparing use of natural resources, their reuse and maintaining a healthy soil. Collecting more organic waste separately is an important factor in the ability of municipalities, the Dutch national government and Europe to achieve its environmental targets.

1.1 Forthcoming European legislation that will make the separate collection of organic waste mandatory underscores this fact. Whereas subsequent separation can be used for other waste streams such as PMD, it is not an option for organic waste. In terms of quantity, the source separation of organic waste from both high- and low-rise buildings can make a significant contribution to the national government's waste separation target. Source-separated organic waste contributes to sustainable energy and a healthier soil.

1.2 Separating organic waste at the source is not only important for the quality of the organic waste itself, but also for that of other waste streams. If less food waste gets mixed in with packaging materials, paper & cardboard and other waste streams, the quality of those streams is expected to improve.

1.3 Municipalities that have or are planning to get to work on their waste collection can make use of the menu. It offers a solid foundation with which to improve the effectiveness of organic waste collection. It should be noted that tailor-made solutions and continuous monitoring are always needed. There are opportunities for municipalities to effectively apply behavioural knowledge, for example by utilising insights from these pilots for low-rise buildings.

1.4 Various cities can be used as examples. Milan has been collecting separated organic waste at the source for years. London is also

testing various interventions to collect more separated waste. Amsterdam and Rotterdam have begun rolling out their organic waste collection efforts in large parts of the city. Lastly, various interesting practical experiences are available in the Netherlands[21].

2) Explore the extent to which the behavioural interventions can be applied to other waste streams from high-rise buildings, such as paper & cardboard, and the collection of organic waste from low-rise buildings. Utilising the full potential of the insights from this study will bring us that much closer to the realisation of the Netherlands' national target.

3) Keep learning from each other. This means close collaboration between municipalities, between municipalities and other chain parties and with experts from other fields, such as behavioural experts. The issue and the possible solutions are relevant to municipalities all over the world.

3.1 In the Netherlands, urban municipalities that want to collaborate on this issue can use the VANG Urban Waste Collection platform, which was born out of the high-rise project.

3.2 This project can serve as inspiration to collaborate with other chain partners and experts from other fields more frequently.

3.3 International collaboration is also interesting, as it allows highly urbanised regions to learn from each other.

4) Where necessary, conduct pilot programmes/practical tests and additional in-depth research. Both are essential in order to take further significant steps.

4.1 There are several promising interventions with which to collect more and cleaner organic waste, with regard to both behaviour and physical-technological aspects, that were barely tested or not at all. Examples of behavioural interventions are improving resident participation, utilising relocations as an opportunity to acquire new habits and using enforcement. Examples of physical-technological interventions are the use of a food grinder in the kitchen and new forms of organic waste containers. More pilots will have to be conducted to learn more about these interventions.

4.2 There are no other known projects anywhere in the world that involve applied scientific research into the relationship between behavioural science and waste separation in high-rise buildings on this scale. That leaves plenty of room for follow-up research. Box 8.1 presents a number of questions that were formulated based on the results of this project.

[69] See e.g. the analysis of other pilots in the Netherlands https://www.vang-hha.nl/nieuws-achtergronden/2018/afvalscheiding/analyse-o/analyse/ en Midden (2017) accessible via https://www.vang-hha.nl/nieuws-achtergronden/2016/hoogbouw/verbetering/@148641/literatuurstudie/.

Box 8.1: Questions for potential follow-up (behavioural) research

a) How can the positive effect of facilitating waste separation in the home be maximised? What facilities, e.g. bins and bags, are most effective in this regard? What is the best way to distribute these facilities?
b) How can waste separation behaviour be improved by realising changes to the distance to residual and separated waste containers? What are the optimal distances and how can these be realised for as many residents as possible?
c) How can surveys be used effectively to get more households to separate their waste?
d) Attitudes stimulate waste separation behaviour if they are positive, if they are strong and stable and if they are active. How can the positive and sustainable effect of influencing attitudes be improved by developing interventions designed to make attitudes more positive, stable and active?
e) The effect of interventions, e.g. rewards and feedback, deteriorates over time. What kind of "intervention maintenance" is needed to turn behavioural changes into habitual behaviour?
f) The menu presents an overview of possible interventions, but it is not possible to offer a standard recipe. Furthermore, the overview itself is incomplete. This raises the question of how municipalities can be supported with setting up, designing, executing and evaluating waste separation projects, based on the specific local situation.
g) What instruments for pre-testing and effect evaluation are important for municipal pilots and how can municipalities be supported in this, using available materials among other things?
h) How can the quality of waste separation at the source in the home and at the waste collection point be optimised? What interventions centred around facilitation and motivation are suitable and available?
i) To what extent can active resident participation play a role in the development and implementation of pilot projects and during what phases? What is the best way to go about this? Think of e.g. resident advisory groups, consultation meetings, focus groups, (online) polls.
j) To what extent can digital tools (e.g. smartphone apps) be developed to support the interventions that are implemented in local pilots? Think of e.g. performance feedback interventions (e.g. at the group level), instructions on correct container usage and waste separation and a complaints and suggestions box.
k) How can the behavioural influencing that occurs within households (e.g. children influencing their parents' behaviour and vice versa) improve the household's waste separation behaviour?
l) How do the waste disposal frequency data relate to the waste disposal weight data? Is there a strong connection between the two or can they provide distinctive insights?
m) What are the specific requirements of high-rise buildings when it comes to realising waste separation and successfully influencing behaviour?

Acknowledgements

On 9 March 2015, state secretary Mansveld officially kicks off the VANG-HHA "Improving waste separation in high-rise buildings" project. Together with the key project partners, we have gathered in Almere in high spirits to confirm that we will get to work on one of the biggest challenges when it comes to waste separation in cities: how to stimulate residents in urban environments to separate their own waste?

Unhindered by any doubts, I initially draw up an optimistic schedule. We expect to present the results in two years' time. However, the enormity of the challenge of bringing together the various perspectives and organisations quickly begins to dawn on me. We are dealing with thirteen parties who are all eager to play a role in the steering group, various internal and external supporting parties from the participating municipalities and scientists from a number of fields.
Some examples of the challenges we face are the development of a reliable measurement system, the need to protect residents' privacy and making sure parties stay involved. I am therefore not at all surprised that the project took longer than what was initially expected.

Now, it brings me great joy to see the results of the project presented in their entirety in this report. These results form a piece of the puzzle of helping municipalities turn their waste into resources. I am thrilled to see that municipalities such as Almere, Amsterdam, The Hague, Rotterdam, Schiedam and Utrecht have already taken the next step and are working on (or preparing for) the rollout of waste separation to high-rise buildings. Furthermore, there are various initiatives in and outside the Netherlands that show it is primarily a matter of taking carefully considered action.

I want to take this opportunity to thank the persons and organisations without whom this project would never have been realised. Thanks:

- To the initiators and supporters of this project and its steering group: The municipalities of Amsterdam, Almere, The Hague, Rotterdam, Schiedam and Utrecht, Irado, HVC, Dutch Waste Management Association. The Ministry of Infrastructure and Water Management, Rijkswaterstaat, VNG and NVRD for your continued support of this project through VANG-HHA[1] and via the Behavioural Insight Team. Gerhard Schoonvelde, Anouk Teuns, Anneke Bruijze, Wouter Rikken, Patricia Lemen, Joost van Maaren, Daan van den Elzen, Stef le Fèvre, Ruben Voerman, Sylvia Meintser, Jos de Bruijn, Bianca van der Vusse, Henk Visser, Paul van Trigt, Michel Hoogerwerf, Ralf Arents, Jeffrey Steenes, Nicole Cup, Huib van Herrewegen, Piet Burgering, Fabienne Mantes, Femke MacKenzie, Jennifer Koster-Bos, Paul Picauly, Mark van Waas, Addie Weenk, Guus van den Berghe, Suzanne Pietersma, Odette van de Riet, Harm van de Wal, Sharon van der Spek, Ianthe Nieuwenhuis, Marc Pruijn, Sander van Leeuwen, Peter Henkens, Max Narinx, Bas Peeters, Maarten Goorhuis and Samuel Stollman, thank you for your guidance in the steering group!
- To the researchers and experts involved in this project: The municipality of Rotterdam, the Netherlands Environmental Assessment Agency, Tilburg University, Eindhoven University of Technology, the Ministry of Infrastructure and Water Management, Rotterdam, D&B and others for providing support in the form of research capacity. Daan van Soest, Mirthe Boomsma, Cees Midden, Addie Weenk, Marn van Rhee, Gert-Jan de Maagd, Odette van de Riet, Suzanne Pietersma, Danielle Broeze, Jessanne Mastop, Kevin de Goede, Jorn Horstman and Reint-Jan Renes. Thank you for your endless support in the think tank! Tim Brethouwer, Jetske Bouma, Jaap Ham, Geert Bergsma, Nanda Naber, Marieke Rietbergen, Evelien van Dorp, Roely Graman, Suzanne Brunsting, Eva van den Broek, Bert Pol, Tom Melis, Mark Verschuur and Nina Crox, thank you for contributing your all-important support and research! Monique Hennekens, Paulien Maarleveld, Nelleke Groen, Evelien Mertens, Bas de Groot, Hans van Impelen and Bob Wassenburg for support with regard to privacy!
- To the project leaders involved in the study's field research: Esther Somers, Riny de Jong, Henk Visser, Carla Poulain, Annette Kok, Sander Rijksen, Manon Nederstigt, Martine van der Linden, Marijn Verwer, Roeland Hop, Carise Bac, Daan van den Elzen, Richard van Coevorden, Joost Moerkerk, Pepijn Koops, Michiel van Esch, Hans Heijkoop, Christine Waasdorp, George Derksen, Elke Phielix, Ferry Warnaar, Casper Voormeulen, Gert-Jan Klaasse Bos, Jeanine van de Grootevheen. Thank you for your assistance with the study's practical application!
- For the guidance received from Rijkswaterstaat and NVRD: Sandra Schudde, Charlotte Hartmann, Joke van der Ham, Gunhild Meijer, Ageeth Boos, Manon de Beer, Anneloes Griffioen, Anne Hänni and Marina Simunovic. Thank you for all your hard work! Guus van den Berghe & Bas Peeters: thank you for your role as mentor of this project and myself!
- To everyone else who contributed to this project in some form or another.

Kind regards,
Gijs Langeveld, Project leader

[1] https://www.vang-hha.nl/programma/

Glossary

Term	Meaning
Waste (sorting) bin	A bin designed to facilitate the collection of waste in the home (i.e. not in a public/shared space).
General framework	The framework with which to explain and predict waste separation behaviour and sustainable behaviour in a broader sense.
Base period	The period from the introduction of the basic package up to the start of the intervention(s).
Conceptual framework	The framework of waste separation behaviour that was used as the basis for the survey questions.
Control group	The group of households that received the basic package, but not any of the interventions.
(collection) Container	A container designed to facilitate the collection of waste in a public/shared space (i.e. not in the home).
Effect size	An indicator for the effect that an intervention has. Simply put, it is calculated by (intervention-control) during the base period + (intervention-control) during the intervention period.
Survey	A series of questions presented to households. The results offer a snapshot representation of the situation.
Reported waste disposal behaviour	The behaviour reported by residents themselves in a survey. It differs from waste disposal behaviour that is actually measured.
Organic waste	Fruit, vegetables and food waste. In some cases, this waste stream may also include garden waste.
Household	A (group of) resident(s) living at a single address.
Implementation moment of an intervention	The moment/period when an intervention is initiated.
Intention-to-Treat (ITT)	The group to whom the intervention is offered.
(behavioural) Intervention	A psychological concept designed to change people's behaviour in some way.
Intervention period	The period during which the interventions are conducted (begins after the implementation moment).
Instrument	A means with which to operationalise an intervention.
Infrequent waste separator	A household that does not or hardly ever make use of the organic waste container (less than once every 1.5 weeks).
Research design/Grand Design	The overall approach to the project.
P-value	A statistical indicator of the reliability of a result. The smaller this value is, the more unique and consistent the result is. The standard value is $p<0.05$.
PMD	Plastic, metals and beverage cartons.
Frequent waste separator	A household that makes use of the waste separation facilities in question at least once every 1.5 weeks (i.e. at least two out of every three weeks).
Waste separation potential	The amount of waste per waste stream that can be removed from the residual waste stream. The realistic waste separation potential refers to the amount of waste that can be removed from the residual waste stream if the same waste separation results are achieved in high-rise buildings as in low-rise buildings. The maximum waste separation potential refers to the amount of organic waste that is still included in the residual waste stream.
Waste disposal behaviour	Households' actual waste disposal behaviour, as measured with a continuous measurement.
Treatment-on-the-Treated (ToT)	The group that accepts the intervention.

Abbreviations of organisation names

DANS-KNAW	The Netherlands institute for permanent access to digital research resources
BIT	IWM's Behavioural Insight Team.
IenW	Ministry of Infrastructure and Water Management
NVRD	Royal Dutch Waste Management Association
OBI (Rotterdam)	Municipality of Rotterdam, Research and Business Intelligence department
RWS	Rijkswaterstaat
VANG-HHA	The “Van Afval Naar Grondstof” (“From Waste To Resource”) programme, subprogramme “Huishoudelijk Afval” (“Household Waste”)
VNG	Association of Dutch Municipalities

Justification

Client	This study was conducted by order of the municipalities of Almere, Amsterdam, The Hague, Rotterdam, Schiedam-Irado and Utrecht, HVC, the Ministry of Infrastructure and Water Management (IWM), NVRD, Rijkswaterstaat and the Dutch Waste Management Association.
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Editing and layout	Joke van der Ham, Gijs Langeveld and Addie Weenk (editors), Charlotte Hartmann-Willemsen and Kris Kras Context, Content and Design
Translation	Vertaalbureau Perfect
Review	Kat Heinrich
Contact	www.vang-hha.nl
Version	July 2020

The “Improving waste separation in high-rise buildings:
More separation of organic waste in cities through behavioural
change” is a product of the Implementation Programme VANG-HHA.

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July 2020

The Implementation Programme VANG-HHA is conducted by IWM, Rijkswaterstaat,
NVRD and VNG.