Activating household waste separation behaviour in high-rise Rotterdam

Capitalising on the moment of moving for stimulating behavioural change

Iris Groot Koerkamp

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Abstract

Currently, the City of Rotterdam is far from achieving their ambitious 2020 goal of a 40% household waste separation rate (Gemeente Rotterdam, 2017). In 2017, their separation rate was only 28,4% (CBS Statline, 2018). Household waste separation is important to enable the recycling of resources, which has environmental and cost benefits. A transition towards a circular waste management system in Rotterdam needs to take place. For high-rise buildings, the challenge is the biggest: high-rise buildings produce an average of 150 kg more residual waste per year compared to low-rise buildings (Design Innovation Group, 2015). The City of Rotterdam's plans to build more high-rise buildings in the coming years makes it urgent to look for a solution.

Separation at the source currently is more effective than mechanical post-consumer separation. Waste fractions contaminate each other when disposed of together, which impedes full material recovery. However, the success of separation at the source depends entirely on the waste separation behaviour of high-rise residents. Therefore the main research question is: *How to facilitate for high-rise residents the desired behaviour of waste separation at household level, in high-rise buildings?*

From human behaviour theory, behaviour can be explained as a combination of one's motivation, ability, and opportunity. When one's motivation is low, a low ability needs to be sufficient to trigger action. Behavioural change is a process consisting of several stages and can be stimulated by intervention techniques. A change of environment can support a behaviour change. The complexity of waste separation behaviour becomes apparent, as many influencing factors

for waste separation are found from literature. These factors are supported and complemented by interviews and generative research with high-rise residents in Rotterdam.

Understanding high-rise residents' mindset towards household waste separation, reveals four different groups of people: the Enthusiasts, the Potentials, the Skeptics and the Conservatives. The Potentials are closest to following the Enthusiasts in practising waste separation. However, they currently lack a (physical and mental) system for doing so. When considering starting this behaviour, the required effort for creating a system outweighs their medium level of motivation.

To tackle this challenge my design vision is:

"I want to design a product to support the City of Rotterdam with activating the "Potential" to improve their household waste separation in a low effort manner within the first month after moving to high-rise in Rotterdam."

Following the analysis phase, the creation phase took place in which a diverse range of ideas is generated. As main stakeholders in this project, the City of Rotterdam and the high-rise residents evaluated the ideas. Based on their needs for a feasible, innovative, clarifying, activating and supporting solution *Schone start* is selected.

Schone start supports high-rise residents with the creation of a waste separation

habit in the first month after moving, by providing the means to set-up a system for waste separation. The mail delivery package contains a Waste guide, Waste map, small waste bin, medium waste bag, large waste box, stickers and suggestions for use. All essential information to start waste separation is actively provided and in accordance with the circular ambitions of the City of Rotterdam.

Schone start is evaluated with six recently moved high-rise residents in Rotterdam, in a small scale pilot. A prototype of *Schone start* is sent to their home address without further instructions. 1,5 to 2 weeks after receiving *Schone start*, the product is evaluated with the high-rise residents through an interview.

Generally *Schone start* is positively evaluated by the test participants regarding helpfulness with household waste separation. The Waste guide and Waste map were highly appreciated. The waste facilities (waste box, bag, and bin) were partially used, but can be optimised to improve usability. The ease of disposal of the separated waste stays a critical boundary condition: when the containers for separated waste are further than residual waste containers and motivation is limited, residents are not likely to start waste separation.

To implement *Schone start*, its design should be optimised for appearance and size to maximise the percentage of citizens making use of the product. A second step is to organise a large scale pilot (100-200 households) to test *Schone start* among a larger and more diverse group of Rotterdam citizens. It is recommended to evaluate the long-term quantitative effect (the household waste separation rate) and qualitative

effect (awareness of the household waste separation practice) of *Schone start* over six months. In this way, more insights can be gained regarding the potential impact of *Schone start* for different target groups and contexts.

To conclude, *Schone start* supports high-rise residents with the set-up of a waste separation system right after moving into their new residencies by proactively informing them about household waste separation in Rotterdam and providing them with basic facilities to do so. It increases high-rise residents' ability and opportunity while claiming their attention. With *Schone start* the City of Rotterdam is able to activate the "Potential" to improve their household waste separation in a low effort manner.

"To make starting waste separation as easy as possible is a purpose that this package serves well"

- Concludes a high-rise resident in Rotterdam (residing at floor 5 of 23)

Preface

With the completion of this graduation report, my time as a student at TU Delft is coming to an end. I am proud to present to you my graduation project *'Activating household waste separation behaviour in high-rise Rotterdam'*. I could not have achieved this result just by myself. Therefore I would like to thank the following people:

Ruud, from our first meeting I enjoyed talking with you. Your positive energy encouraged me throughout the project. With our explorative minds, we together discovered the complex topic of waste separation and the value of a designer for tackling such a problem.

Jotte, what a help you have been in both living up to my ambitions and tempering them where needed. Your infinite knowledge and critical remarks improved my process throughout and the final result of this project.

Sigrid, **Daan** and **Dries**, this project would not have succeeded without your involvement. Thank you all for dedicating your time to this project, sharing your experience with and perspective on the topic, and thinking along with the proposed solution.

Tjerk, thank you for the possibility to meet up with different stakeholders, to have group discussions with the students and a place to facilitate my workshops with high-rise residents. Fellow **Inclusive City Hub students**, the talks and discussions we had about waste separation, our studies and our graduation approach helped me to define my project better. Meeting you all was a positive addition to my graduation project.

High-rise residents who participated in the interviews, the workshops and the prototype evaluation, your willingness to share your current behaviour, practices, and thoughts with me was indispensable for bringing this project to a good end. Thank you all for your time and energy.

My parents, your ever-present interest in things I am working on is a huge support (even when I do not want to talk about it). After seven years, coming to Diepenveen still feels like coming home. A relaxing weekend at your place helps me to recharge for the next week of reaching for my ambitions. **Maureen**, you have always been my example of hard work and dedication. I can only hope to be as brilliant in what I do as you are in what you do.

Thijmen, for celebrating the successes with me and for putting into perspective my challenges. Your constructive criticism, your compliments about my work and your new ideas helped me to get the best out of myself. Thank you for us being a team.

Friends and **fellow graduating students**, the moments of getting coffee, talking about anything but graduation, having lunch together, sitting in the sun and just spending time together are as much appreciated as the help with and discussions about my graduation project. I hope those moments will last for a long time after graduating.

Dear readers, enjoy the read!

Glossary

City of Rotterdam
In Dutch: *Gemeente Rotterdam.* Indicating the municipality of the city of Rotterdam, the Netherlands, including all people working for the municipality.

Department of Urban Planning
In Dutch: *Stadsontwikkeling.* Department of the City of Rotterdam in charge of planning and designing the future city.

Department of Urban Management
In Dutch: *Stadsbeheer.* Department of the City of Rotterdam in charge of public outdoor spaces in the city. Their job is to ensure the city is experienced as pleasurable, safe and clean. Waste management and recycling is part of their responsibilities.

Environmental parks
In Dutch: *Milieuparken.* Rotterdam citizens can hand in their waste, bulky waste and reusable goods for free at one of the seven Environmental parks in Rotterdam.

Fraction
Indicating a specific separated waste stream, solely containing waste with the same (material) properties. For example glass or paper.

GFE
In Dutch: *Groente-, Fruit- en Etensresten.* Translated as: Vegetable, Fruit and Food waste. Indicating the bio-waste fraction, including food waste and excluding waste from the garden. Often used as replacement for GFT, in contexts where residencies lack a garden.

GFT
In Dutch: *Groente-, Fruit- en Tuinafval.* Translated as: Vegetable, Fruit and Garden waste. Indicating the bio-waste fraction, including waste from the garden.

High-rise
A tall building, consisting of multiple storeys stacked upon each other. For this project high-rise buildings will be defined as *"a set of stacked floors, with a minimum of five storeys in height, housing multiple households, without a private front door at street level"*

KCA
In Dutch: *Klein Chemisch Afval.* Translated as: Small chemical waste. Indicating chemical waste, such as batteries, paint, oil and energy efficient lamps.

Mini container
Private waste container (on two wheels), dedicated to a single household. Often distributed by and property of the local municipality. In Dutch better known by the brand name *'Kliko'*.

Piekfijn
Second-hand shops in Rotterdam. Citizens can visit the *Piekfijn* shops to buy or hand in used goods that are still in good shape.

PMD
In Dutch: *Plastic verpakkingen, Metalen verpakkingen (blik) en Drankenkartons.* Translated as: Plastic packaging, Metal packaging (cans) and Beverages cartons. Mixed plastic recyle fraction.

Post-consumer separation
Household waste separation as carried out by a waste processing company. Separation operation taking place after citizens' waste is collected and transported to the processing company.

Separation at the source
In-home household waste separation as carried out by citizens. Separation operation closest to the source of the waste generation.

Waste charges
In Dutch: *Afvalstoffenheffing.* Taxes citizens pay to the City of Rotterdam as compensation for the collection and processing of their waste.

Content

Introduction

The circular economy is becoming a widely-known term. In a circular economy, waste is minimised and resources are reused in order to decrease the depletion of natural resources (Rijksoverheid, n.d.). Household waste accounts for 14% of the total amount of waste produced in the Netherlands. Nationally, only 49% of this waste is recycled, in contrast with a recycling rate of 92% in the construction industry (Design Innovation Group, 2016). In Rotterdam, the household waste recycling rate is even worse. Only 28,4% of this waste is separated at the source to be recycled (CBS Statline, 2018). This number needs to increase in order to reach the City of Rotterdam's 2020 goal of 40% household waste separation (Gemeente Rotterdam, 2017) and the European Union's ambitious goal of 65% waste recycling by 2035 (European Parliament, 2018).

In theory, separation at the source is a more effective manner of separating household waste than post-consumer separation. With separation at the source, citizens separately dispose of their waste in dedicated containers. With post-consumer separation, waste is disposed of in a mix and mechanically separated in a later stage. Technologies to do so are in development, but post-consumer separation currently proves to be difficult because of the different waste fractions contaminating each other (Weenk, 2017). However, in practice, separation at the source relies heavily on the household waste separation behaviour of the citizens.

Nationally, high-rise areas form a big challenge for optimising household waste separation rates, as residents of high-rise buildings produce on average 150 kg more residual waste per year than their fellow citizens living in low-rise buildings (Design Innovation Group, 2015). In Rotterdam, 75% of the 638.181 inhabitants live in buildings without a private front door at street level (Gemeente Rotterdam, 2018). This number will only grow in the coming years, as the City of Rotterdam plans to build 50.000 new residencies by 2040. Most of these will be built as high-rise buildings within the urban area of the city (Liukku, 2017).

This project focuses on the waste separation behaviour of high-rise residents in Rotterdam. The main research question to be answered in this project is:

How to facilitate for high-rise residents the desired behaviour of waste separation at household level, in high-rise buildings?

The project aims to find out which factors influence the waste separation behaviour of high-rise residents in Rotterdam. With these factors in mind, a solution for the City of Rotterdam will be designed that supports them in realising a behaviour change of their citizens towards household waste separation.

This graduation report consists of five parts. Part one introduces the graduation project by discussing the collaboration partners, the assignment, the context of the project and the initial target group (Chapter 1). Part two comprises the analysis phase. Firstly, the performed research into waste management in Rotterdam, high-rise living, (waste separation) behaviour and existing interventions is presented (Chapter 2). Part two closes with the design brief stating the problem definition and design vision for this project (Chapter 3). Part three explains the creation phase of the project. Diverging into all possible solution directions (Chapter 4)

and consequently converging to the final concept (Chapter 5). Part four presents the final product. *Schone start* is introduced together with its user scenario (Chapter 6). The product elements are explained (Chapter 7) and the product is evaluated (Chapter 8). Part 5 concludes this project. Conclusions are presented (Chapter 9) and a reflection on the project completes this graduation report (Chapter 10).
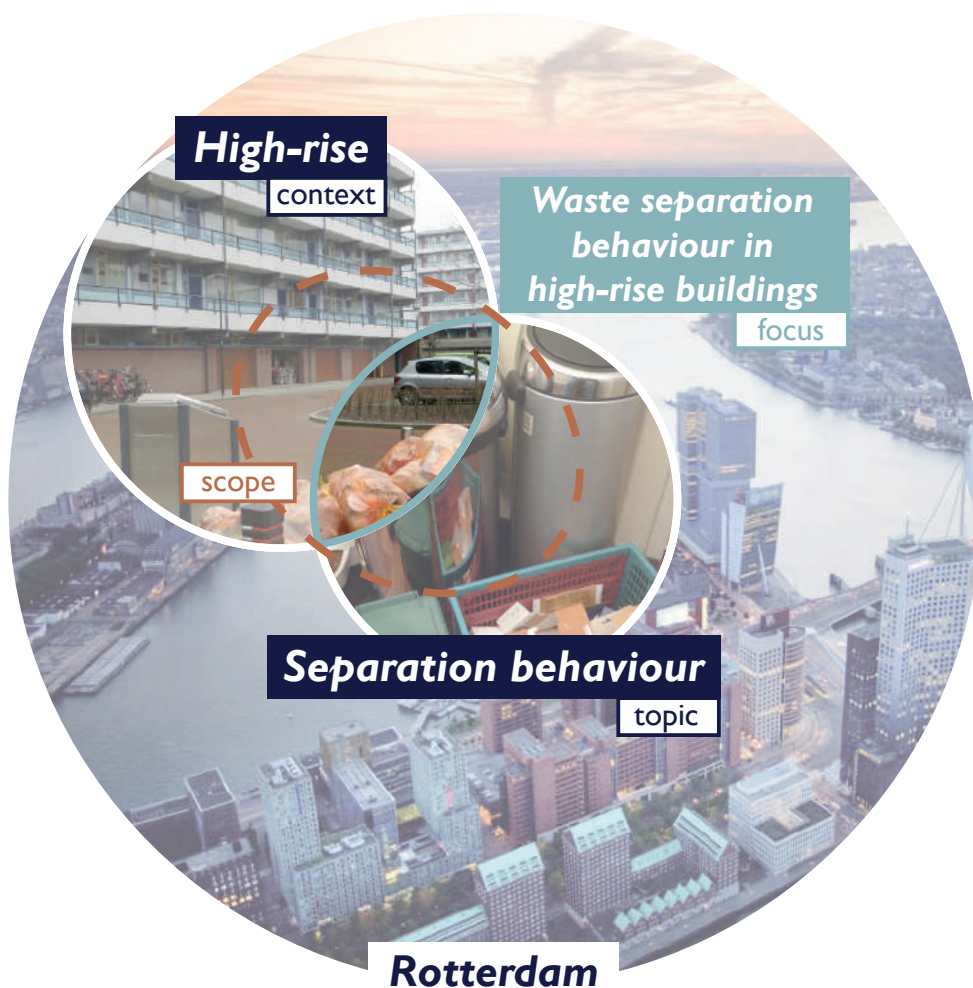
FIGURE 1 *Waste separation in high-rise Rotterdam (Image sources: Rotterdam Tourist Information, City of Rotterdam, 100-100-100.nu)*
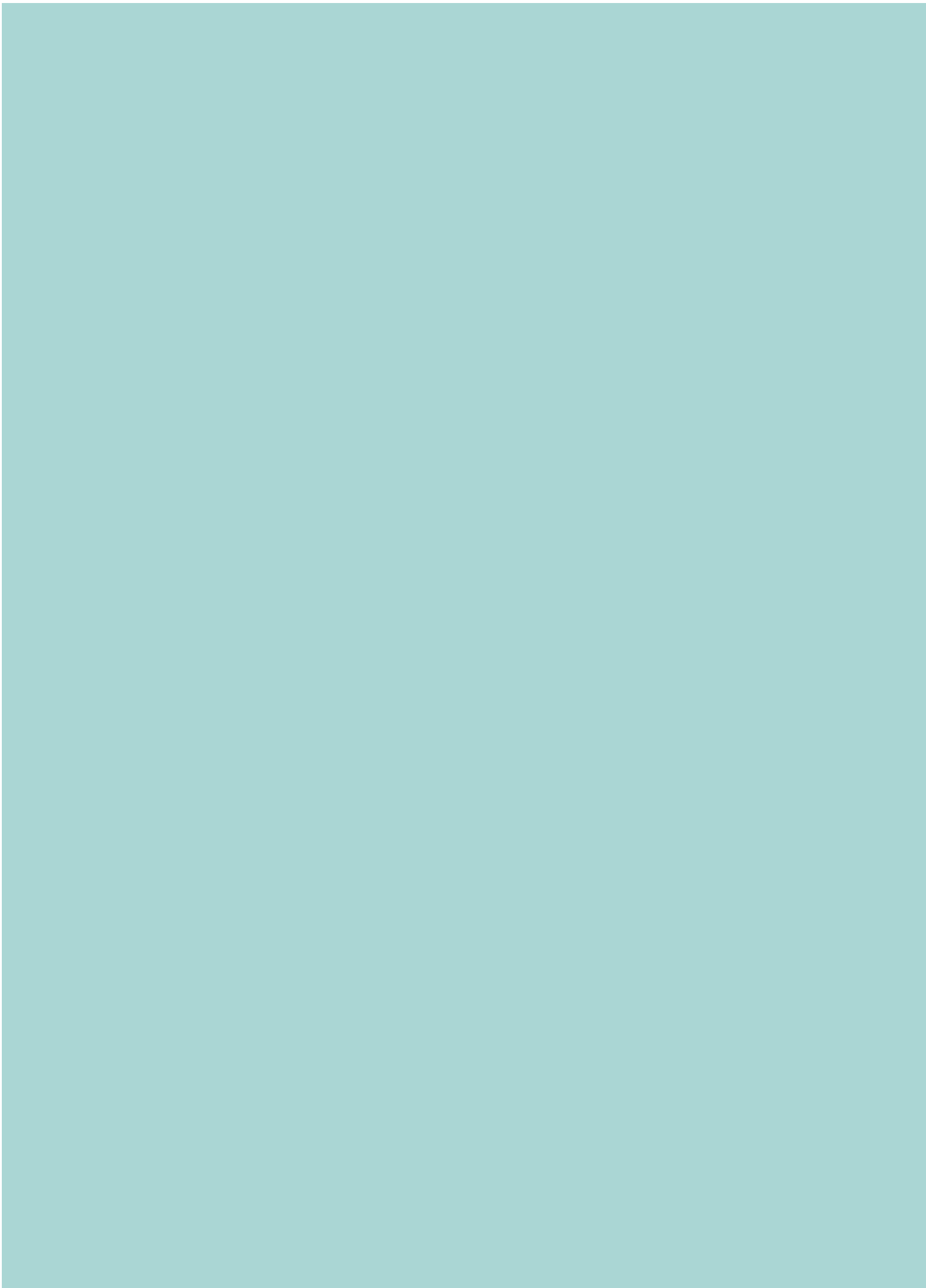
PART 1

Graduation project

Chapter 1. Project

This chapter describes the foundation of the graduation project. TU Delft, the Inclusive City Hub and the City of Rotterdam are collaborating in this project (1.1). This assignment focuses on waste separation in high-rise areas in Rotterdam (1.2). High-rise buildings form the context, as the waste separation rate there is low (1.3). The initial target group consists of the future generation, who needs to adopt the waste separation behaviour in order to ensure a sustainable future (1.4).

1.1 Collaboration partners

This graduation project is a collaboration between three parties: the TU Delft, faculty of Industrial Design Engineering; the Inclusive City Hub and the City of Rotterdam. The Inclusive City Hub serves as platform for executing the project, the City of Rotterdam is involved as case-owner and the graduating student represents the TU Delft as case-solver.

1.1.1 Inclusive City Hub

The Inclusive City Hub is one of the hubs of the Leiden-Delft-Erasmus Centre for Sustainability (Centre for Sustainability, n.d.). It serves as a platform for master students from Leiden, Rotterdam and Delft to graduate individually within an interdisciplinary team, by facilitating meet-ups, workshops and a network of stakeholders. The Hub focuses on complex challenges in the Metropole Region of Rotterdam-Den Haag (MRDH). Specific cases on topics as inclusive societies, climate adaptation and circular economy are tackled by a multidisciplinary group of students. The challenge is to solve these complex problems by innovating at street, neighbourhood or city level in an inclusive way, with all stakeholders involved (Inclusive City, n.d.a).

1.1.2 City of Rotterdam

In this project the City of Rotterdam serves as case-owner, and can provide insights, data and feedback upon request. Together with the Inclusive City Hub, the department of Urban Planning of the municipality formulated the case *'Circular Rotterdam: innovative solutions for waste collection and recycling in high-rise districts'*. Themes of the case include the densification of the city, Rotterdams circular ambition and household waste management (Inclusive City, n.d.b), see 1.2 Project assignment.

1.1.3 TU Delft

The graduating student represents the TU Delft in this collaboration, and is responsible for the planning, project management and execution of the project. This graduation project is defined by the graduating student, within the case *'Circular Rotterdam'* (see 1.2 Project assignment). With this project the student is graduating from the Master Integrated Product Design, faculty of Industrial Design Engineering, of the TU Delft.

FIGURE 2 *The collaboration partners in this graduation project: the Inclusive City Hub, the City of Rotterdam and TU Delft*

1.2 Project assignment

This graduation assignment is formulated by the student within the case 'Circular Rotterdam' of the Inclusive City Hub in collaboration with the City of Rotterdam. The graduation assignment focuses on the waste separation behaviour of high-rise residents, at household level. The aim is design a solution to stimulate their waste separation behaviour.

1.2.1 Circular Rotterdam case

The case *'Circular Rotterdam: innovative solutions for waste collection and recycling in high-rise districts'* focuses on the household waste management challenge in the densifying city centre of Rotterdam: more high-rise buildings will be constructed (see 1.3 Context), and so more waste per square meter will be generated by the citizens. In contrast, the City of Rotterdam has a circular ambition. This includes the need to minimize waste generation, and find ways to entirely recycle the waste produced. There are many challenges within this case, relating to different fields: design (of innovative solutions and smart buildings or (public) areas); management (of the waste system and the division of the responsibilities); technical (processing and recycling of the waste), to name a few (Inclusive City, n.d.b).

1.2.2 Graduation assignment

As stated in the introduction of this graduation report, the current waste separation rate in Rotterdam is 28,4% (CBS Statline, 2018). Rotterdam's goal is ambitious: to recycle 40% of the total amount of household waste by 2020 (Gemeente Rotterdam, 2018). This means Rotterdam needs to step up their game in order to reach their circular goals regarding household waste.

Following the City of Rotterdam's case (1.2.1), this project focuses on high-rise areas. Let's zoom in from high-rise buildings (see 1.3 Context) to their residents and their households. As to tackle the residual waste problem, it is essential to look at the waste separation behaviour of individuals at a household level.

This graduation assignment (Appendix A) focuses on generating qualitative insights into the household level of people living in high-rise buildings, and specifically their behaviour regarding household waste separation and management. The broader context of waste separation and management will be used as exploration and inspiration space.

> *The challenge is to find how to stimulate and facilitate waste separation for residents of high-rise buildings, to minimize the residual waste fraction.*

Assumed is that currently, for residents of high-rise buildings, the perceived (personal or communal) benefits of household waste separation do not sufficiently outweigh the required resources (e.g., space, effort, time, money). When understanding the main barriers for waste separation in high-rise buildings, an innovative solution to support residents of high-rise buildings with waste separation at home will be created.

1.3 Context

The context for this graduation project is high-rise buildings in the city of Rotterdam. Household waste management forms a challenge, especially in high-rise buildings. As many new high-rise buildings will be build in Rotterdam in the coming years, it is important to search for a solution for these areas.

1.3.1 High-rise challenge

As can be read in the graduation assignment (see 1.2.1 Circular Rotterdam case) household waste management forms a challenge in Rotterdam. Especially high-rise areas form a big problem, as inhabitants of high-rise buildings produce 150 kg more residual waste per year than their fellow citizens living in low-rise buildings (Design Innovation Group, 2015).

1.3.2 New build high-rise

FIGURE 3-4

New build high-rise projects in Rotterdam: Post Rotterdam, Coolsingel (right) and Pompenburg (Image sources: AD and top010.nl)

This aforementioned problem of household waste in high-rise areas will only grow. Plans are initiated by the City of Rotterdam to build new high-rise buildings within the urban area of the city (Liukku, 2017). One of the areas where new (high-rise) building developments are planned is Pompenburg. Pompenburg is centrally located, close to Rotterdams Central train Station.

1.3.3 Definition of high-rise

In general, a high-rise building is a tall building, consisting of multiple storeys stacked upon each other. Various definitions exist for high-rise buildings, depending per city and country, specified by either height in meters or storeys, the building's context, or its use (Appendix B). For this project high-rise buildings will be defined as:

"a set of stacked floors, with a minimum of five storeys in height, housing multiple households, without private front door at street level"

1.4 Target group

During the start of the project, an initial target group is defined. This target group serves to ensure gaining valuable conclusions from the qualitative research into the waste management behaviour of high-rise residents. The target group is narrowed down based on demographic specifications.

1.4.1 Demographics of Rotterdam

The population of Rotterdam is relatively young, compared to the rest of the Netherlands (Appendix C). Almost 25% of the citizens is between 20 and 35 years old in 2015, which is 6% above the country's average. This share of young people in the city is estimated to remain the same in the future. In absolute numbers, this group of people will even grow (Gemeenteraad Rotterdam, 2016).

1.4.2 Sustainable future

The young generation of Rotterdam's population forms the future of the city. Their (non) sustainable behaviour will influence this future and sets an example for the generations to come. The research of Bachus, Pollet & Van Ootegem (2015) in Flandres found that young couples and individuals form a risk group regarding waste separation, as their attitude towards waste separation is not optimal. They are less prepared to put effort in waste separation. In contrast, couples in the age of 50-65 years old form a group that separates and collects their waste well. Midden (2015) also states older, higher educated residents, with a relatively high income, separate their waste better.

1.4.3 High-rise residents

Families with children and older households have mixed housing needs, such as green metropolitan residential environments at the edge of the city, living along the river or living in mixed (bubbly and calm) neighbourhoods. Young potentials prefer living in and around the city centre (Gemeenteraad Rotterdam, 2016). In the city centre, many new high-rise buildings will be build in the coming years

(see 1.3 Context). High-rise offers housing possibilities for young people, who usually have problems finding residency in the city. Mainly singles and couples without children are interested in living in high-rise buildings. In the age range of 20-34 years old, this group is large, namely around 80% (Buck Consultants International, 2009).

Conclusion

The initial target group in this graduation project is

"people in the working phase of their lives, aged between 20-35, living alone or in small households of maximum three persons in a high-rise building in Rotterdam."

FIGURE 5

Impression of the initial target group (Image source: Hipwee)
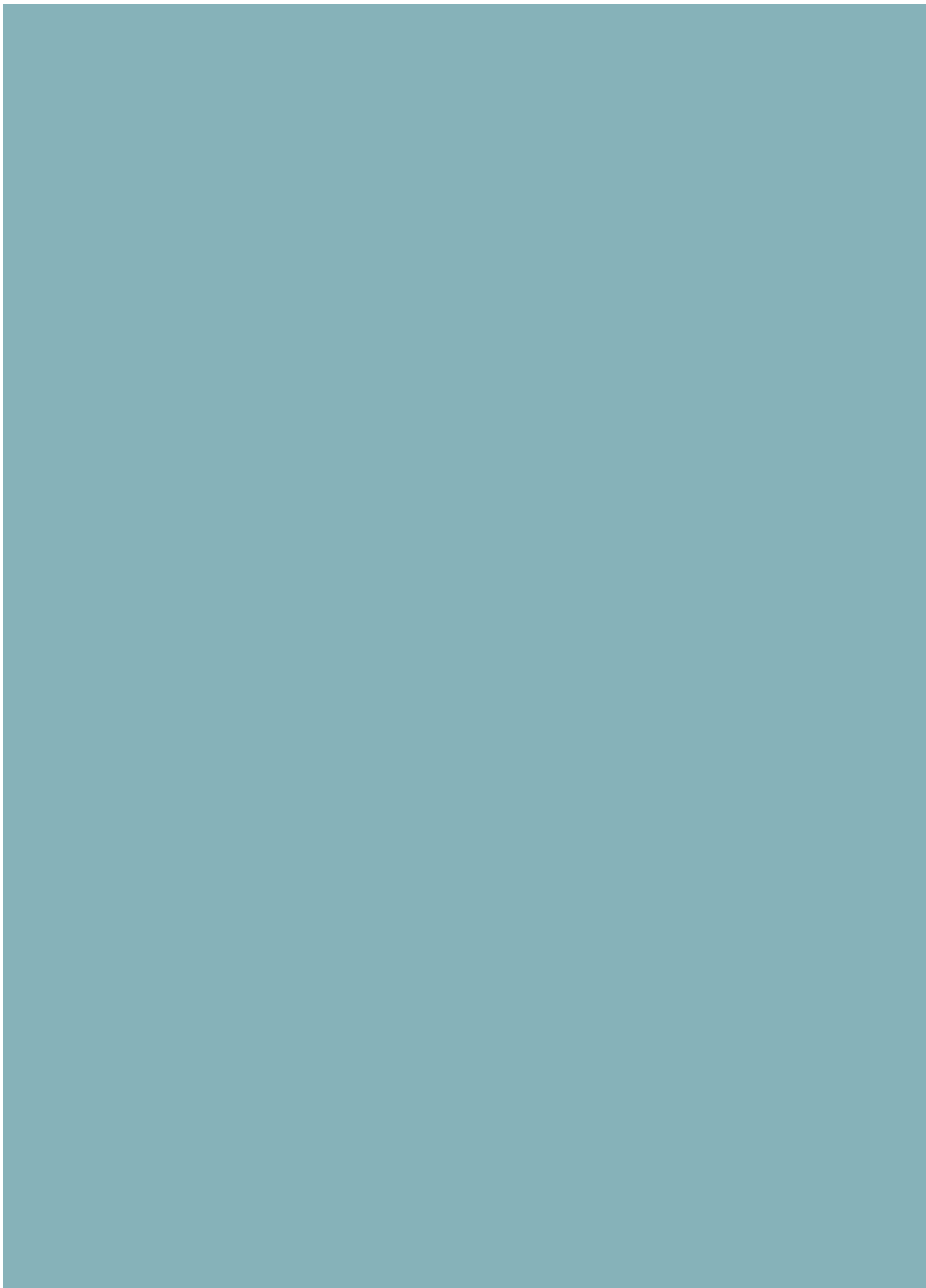
PART 2

Analysis

Chapter 2. Research

This chapter presents the performed research on waste separation behaviour in high-rise buildings in Rotterdam. The current waste management system does not align with the circular ambition of the City of Rotterdam (2.1). High-rise buildings create a particular living culture (2.2). People's waste separation behaviour in high-rise buildings compared to low-rise buildings differs (2.3). Human behaviour can be explained by the building blocks Motivation, Ability, and Opportunity (2.4). Regarding waste separation behaviour, a diverse range of influencing factors is identified from literature, interviews and generative research (2.5). They show that there are differences in residents' mindset towards waste separation (2.6). Several interventions already exist to support waste separation behaviour (2.7).

2.1 Household waste management in Rotterdam

When looking into the current household waste management system in Rotterdam and comparing this to the household waste separation ambition of the City of Rotterdam for the future, a gap can be identified. The City of Rotterdam defines the low rate of separation at the source as a problem. The behaviour of Rotterdam's citizens plays a large part in solving this problem.

2.1.1 Circular household waste ambitions

The City of Rotterdam has a circular ambition: products and resources need to be re-used, so waste is non-existent in the future (Gemeente Rotterdam, n.d.a). Figure 7 illustrates how currently a lot of recyclable waste ends up in the residual waste: 86% of the mass in a Rotterdam garbage bag could potentially be recycled (De AfvalSpiegel, 2018) (Appendix D).

The City of Rotterdam aims to let their citizens separate at the source the following waste fractions (see Figure 6): glass, paper and cardboard, PMD, bio-waste, textile, (deep frying) fat or oil, small chemical waste, bulky (garden) waste, electronic appliances and reusable goods (Appendix E). From the summer of 2019 on, PMD will no longer be collected separately (Appendix F).

The motivation behind the waste separation goals of the City of Rotterdam is twofold:
1. The environmental benefits of material recycling compared to waste incineration;
2. Decreasing the waste processing costs and with that the waste charges (in Dutch: *afvalstoffenheffing*) for citizens (van den Elzen, personal communication, November 16, 2018).

When materials are not recycled, primary resources need to be used to create new materials. These resources are scarce, and their use causes the emission of greenhouse gasses, can harm nature and leads to a loss in biodiversity (Gemeente Rotterdam, n.d.a).

Economic benefits of waste separation into fractions exists when less household waste is incinerated, and incineration costs are saved. Processing bio-waste into compost costs around 1/3 to 1/2 times less than incinerating it as residual waste. Paper and cardboard, and glass even have a positive value, as it can be sold to the processor (Appendix G) (van den Elzen, personal communication, November 16, 2018).

FIGURE 6

Waste fractions for separation at the source in Rotterdam (Image source: City of Rotterdam)

2.1.2 Waste management system

Several stakeholders together make up the complex waste management system in Rotterdam. Through continuous changes, a system transition is in progress with the aim of creating a entirely circular waste management system. The changes can be at a small scale (e.g., changing local waste facilities) or a large scale (e.g., changing policies). Figure 8 serves as a simplified representation of the current system, representing the stakeholders and their mutual relationships.

- **City of Rotterdam:** the City of Rotterdam is the central party in this system. She is the one creating the local waste management policies and delivering waste management services (Department of Urban Management). Besides, she creates the (waste) infrastructure of the future city (Department of Urban Planning). In this representation, (inter)national government is left out of scope.
- **Citizens:** the citizens are the ones executing particular purchase and waste disposal behaviour. They are the first one in the line of household waste processing. Their in-home behaviour (partially) determines whether waste can be recycled or needs to be incinerated.
- **Developers and builders:** the developers and builders are responsible for designing and realizing the build of new high-rise residencies. They determine the context in which the waste separation behaviour takes place.
- **Retailers:** supermarkets, warehouses, kitchen suppliers and (second-hand) shops determine what is offered to citizens to buy. Their products and packaging form the household waste generated by citizens, but may also serve as waste separation solutions (e.g., the range of waste bins or bags available).
- **Waste processors:** the waste

processing companies are the ones taking care of the post-consumer sorting, recycling or incineration of household waste.

For this project, the focus is on the high-rise residencies, the citizens living in these buildings and their waste separation behaviour (see 1.2.2 Graduation assignment). The most important stakeholders are the high-rise residents and the City of Rotterdam.

2.1.3 Current problems in Rotterdam

In Figure 7 it can be seen that a large part of residual waste currently consists of waste that can be recycled. In order to make this recycling possible, the recyclable waste needs to be separated from the residual waste. Separation at the source (household waste separation by citizens at home) is essential in order to make this happen.

According to the Department of Urban Management of the City of Rotterdam, several factors can be indicated for the low household waste separation rates at the

FIGURE 7 *Result in mass percentage of waste sorting of fine residual waste in Rotterdam (spring 2018) (De AfvalSpiegel, 2018, p. 4)*

Real residual waste 14%

Other reusables 13%

KCA and electronic appliances 1%

PMD waste 11%

Textile 4%

Packaging glass 4%

Bio waste 40%

Paper and cardboard 13%
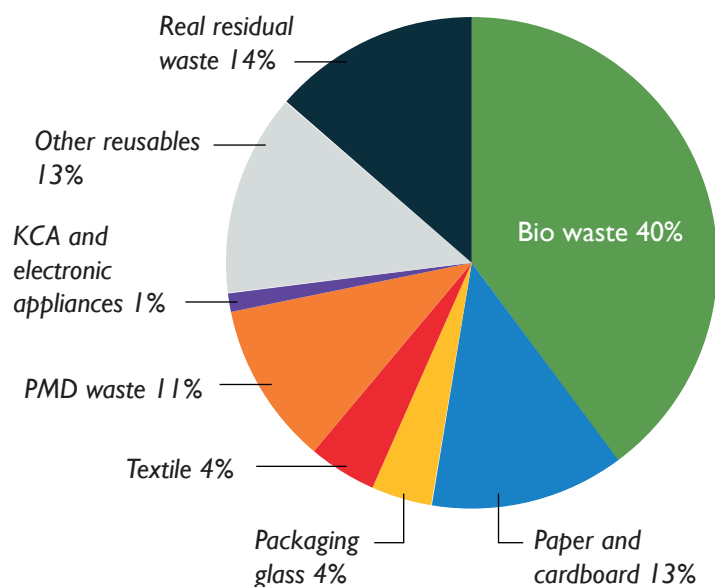
FIGURE 8
Simplified visualisation of the waste management system in Rotterdam

RETAILERS

WAREHOUSE

KITCHEN SUPPLIER

SECOND-HAND SHOP

SUPERMARKET

CITIZENS

CITIZENS

NEIGHBOURING CITIZENS

MUNICIPALITY

WASTE PROCESSORS

BIO PROCESSOR

INCINERATOR

PLASTIC RECYCLER

BUILDER

DEVELOPER

BUILDERS & DEVELOPERS

Stakeholder relations:

1. Social interaction
2. Supply and demand of (waste) products
3. Offering and using municipal services
4. Creating context for in-home separation
5. Planning city development in collaboration
6. Long-term waste processing contracts
7. Collaboration to enable the re-use of products

source, in high-rise buildings (van den Elzen, personal communication, November 16, 2018). These factors influence the separation at the source behaviour of high-rise residents (see 2.5 Influencing factors for waste separation behaviour):

- Space for waste separation at the source is limited, due to small kitchens and a lack of space for waste storage
- The distance between residencies and containers for waste disposal are more significant than in low-rise areas (where mini containers per household are provided)
- Residents in urban areas pay less attention to social norms compared to residents in low-rise areas, due to lower social cohesion and higher anonymity
- A lack of intrinsic motivation or cognitive capacity for waste separation, due to more critical issues to take care of (especially in disadvantaged neighbourhoods). Waste separation has no priority
- A lack of knowledge of the waste separation system of the municipality, caused by language barriers. In Rotterdam 18% of the citizens are low-literate
- Facilities are often focussed on residual waste, and paper and cardboard collection, especially in indoor waste rooms. Containers for glass, PMD or textile can only be found at specific locations in the street

2.1.4 Main requirements for solutions

A solution is needed to solve the problem of a low separation at the source rate. This solution should meet different desires and demands, from the perspective of multiple departments involved. Improving current household waste separation behaviour of residents is key. Preferably, the solution is adaptive to changes in the waste management system.

For the department of Urban Management, the solution should (1) facilitate the source separation of household waste (not for PMD), (2) be easy-to-use for Rotterdam citizens and (3) be economically feasible, whereby the amount of people-hours in operation and the initial investment are important indicators (van den Elzen, personal communication, December 7, 2018). For the department of Urban Development, the solution should (1) be scalable from building level to city level, (2) claim as little valuable public space around the building or at ground floor level as possible, (3) should not need too much underground space and (4) can be piloted at smaller scale (D.B. Zimmermann, personal communication, December 7, 2018).

Conclusion:
The current rate of household waste separation at the source is only 28,4% in Rotterdam, while the aim is to reach a percentage of 40 by 2020. Household waste separation is essential to enable the recycling of materials, which has environmental and costs benefits. The waste management system's primary stakeholders are the high-rise residents and the City of Rotterdam. The waste management system is in transition, towards the City of Rotterdam's circular goals. Improving the in-home waste separation behaviour of high-rise residents (separation at the source) is crucial to become entirely circular. A solution to improve residents' behaviour should be easy-to-use and (economically) feasible.

2.2 High-rise living

In order to gain a better understanding of the context in which the waste separation behaviour takes place, the high-rise living culture is explored. Literature research delivers characteristics that serve as hypotheses for defining the high-rise living culture. Through seven interviews with high-rise households in Rotterdam, the high-rise living culture in Rotterdam is defined.

2.2.1 High-rise living characteristics from literature

Many resources can be found discussing the social aspect of living in high-rise buildings. High-rise residents may experience anonymity and/or loneliness (Churchman & Ginsberg, 1984; Van Dorst, 2005). This anonymity can lead to a lack of social control, as little social interaction discourages residents from addressing any unfavorable behaviour of neighbours (Van Dorst, 2005). Giffort (2007) addresses the impersonal social relations in high-rise buildings. Residents limited presence in public spaces may be a cause of these low social connections (Bloomingrock, n.d.).

Anonymity and a lack of social control may result in above average pollution levels in high-rise buildings (The Guardian, 2002; Van Dorst, 2005). Besides pollution, noise from neighbours may cause nuisance in a high-rise, as neighbouring residencies enclose the buildings.

In contrast to anonymity, control over the level of privacy in a high-rise can be experienced as limited (Churchman & Ginsberg, 1984; Van Dorst, 2005). Freedom to distinguish personal space from public space (Van Dorst, 2005) or to leave the house (caused by the distance between the private front door and street level) (Bloomingrock, n.d.) may be experienced as limited as well.

High-rise apartments are (often) relatively small and lack outside space (The Guardian, 2002). Partly because of this, high-rise buildings are often classified as unsuitable for families with children (Van Dorst, 2005; The Guardian, 2002; Gifford, 2007; Buck Consultants International, 2009).

On the positive side, high-rise buildings are often enjoyed by the central location to places of interest, such as work, public transportation or restaurants (Gifford, 2007; Burgess & Jenks, 2002; Quora, 2015).

2.2.2 High-rise living characteristics from interview data

To understand the waste separation behaviour of high-rise residents in Rotterdam interviews with seven high-rise residents in Rotterdam are conducted (Appendix H). In these interviews, the high-rise life has been discussed as well.

All interviewed residents evaluated the social interaction in the building as low. Residents indicated they recognize faces of their neighbours, but can hardly recall any names. The elevator often forms the central place for small conversations. In one building (where many students are living as well) a

FIGURE 9-10 *High-rise in Rotterdam. Two of the residencies of the interviewees*

Whatsapp group with all residents provided some interaction between neighbours. The group is, for example, used to ask a neighbour to dispose of a garbage bag that is forgotten in the hallway.

Six of the interviewees made remarks regarding nuisance caused by neighbours. Two of them mentioned the absence of noise from neighbours as something that made living in their building pleasurable. The other four indicated a certain amount of noise disturbance from neighbours, be it occasionally or regularly. In one of the interviews the neighbour, who always complains about noise, is mentioned as more problematic than the noise disturbance itself.

The level of privacy is mentioned in four interviews, but mainly to indicate that no privacy problems are experienced. Two residents enjoy their building, because of the unobstructed view outside, which provides privacy as well. However, one of them is not sure whether neighbours do look into their living room. One resident mentioned not to have any privacy issues, upon asking about what is disliked about high-rise living. The fourth resident mentioned a lack of privacy as one of the non-appealing aspects of high-rise living. The distance between street-level and the private front-door is mentioned in one interview and positively evaluated. It provides the resident with a sense-of-security.

Five of the interviewees evaluated the size of the residency during the interview, and three have made remarks regarding the amount of outside space. Four out of five evaluated their residency as (relatively) small, with a lack of storage or limited freedom to walk around as a result. In the fifth interview, the living room is called big, and the available space big enough. Regarding the outside space, all three interviewees are pleased to have outside space in the form of a balcony. However, one of them would prefer having

a garden. For one of the interviewees, the size of the residency makes it unsuitable for family expansion. For another, family growth could form a reason for moving out of this building.

The central location to facilities or public transportation is positively mentioned in all seven interviews. It is among the main reasons mentioned for liking or even choosing the building. Another positively evaluated aspect of the high-rise life is the outside view. Six of the interviewees mention the view as a reason for liking their building.

Conclusion

From seven interviews with high-rise residents in Rotterdam, the high-rise living culture in Rotterdam can be described by the following characteristics:

- *Little social interaction*
- *Expected nuisance (noise) from neighbours*
- *Relatively small residencies, where balconies form valuable outside spaces*
- *A free and pleasant view outside is valued (preventing privacy problems from neighbours looking in)*
- *Centrally located to public transportation and facilities*

This high-rise living culture shapes the contexts in which household waste separation takes place.

2.3 Waste separation practices

In order to gain a rich understanding of the current in-home household waste management practices of people, a photo study is carried out. This study does not focus on high-rise only, in order to find similarities and differences in practices per building type. The photos show how separating glass and paper have become standard practice, while only a few separate plastic and bio-waste.

2.3.1 Photo study

A photo study obtained qualitative insights into people's waste management behaviour. Fifty-three people responded to the request *"take photos of your bin and your collection place(s) of paper, glass, bio-waste, plastic, cans, etc."* A total of 230 photos has been sent in. Besides the country of residence and housing type, no further demographics of the respondents are collected. However, from a personal connection with the respondents, it is known that students, young starters, families, couples with grown-up children as well as singles with grown-up children were among them.

The received photos were transferred to cards with an indication of housing type, household size and the amount and type of separated waste fractions on it (Appendix I). Qualitative insights have been extracted from this collection of cards.

2.3.2 In-home waste management practices

1. **It is up to oneself how to organize one's in-home waste management**
   - The standard is to have a waste bin for residual waste, and found solutions for separated waste fractions (e.g., crates, boxes, bags). Only in a limited amount of cases, people use a combined waste system (i.e., combined bin or drawer).
   - Glass sometimes does not have a physical collection form, only a fixed collection space (e.g., in a cabinet or on the kitchen counter).
   - Often glass and paper collection is placed together, but apart from the residual waste bin.
   - Residual waste is mostly collected in a bin with a lid which gets full, while glass and paper are piling up more easily. Glass and paper are collected until disposal can no longer be postponed, even when the amount already exceeded the satisfactory limits before. For example, one respondent mentioned *"maybe it is getting time to take it away"* upon sending a photo of the collected paper and cardboard (see Figure 11).
   - In some cases, paper is thrown away in the paper bag or box in which the paper is separately collected in-home. This means the collection system is lost until a new paper bag or box enters the house.

2. **Separating paper and glass from residual waste is quite the standard. Only four and two of the respondents do not separate glass and paper, respectively.**

3. **People who separate more different waste fractions, often have a more consistent or fixed physical system, but not necessarily more professional (meaning collection places can still be composed of paper boxes or shopping bags).**
   - Respondents who separate more different fractions, send photos of separate mini containers more often.
   - When there is more waste separation at home, the residual waste bin is in some cases smaller.

4. **It depends per respondent whether only photos of disposable goods are sent, or that items collected for**
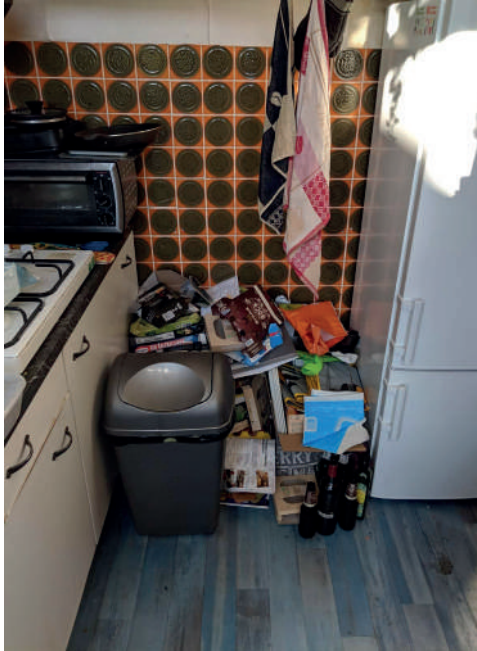
FIGURE 11-15
A selection of the 230 photos received. Top left, paper is piling up. Top middle, glass does not have a physical collection form only a space. Top right, use of a shopping bag for paper collection. Bottom two, use of two bins next to each other.

recycling (e.g., textile or returnable PET bottles and beer crates) are included as well.

5. Among the respondents, the ones who separated more different waste fraction, often lived in detached, semi-detached of terraced houses. In contrast, the ones who separated paper and glass only, mostly live in flats, upstairs apartments or terraced houses.

Conclusion
The current in-home practices of high-rise residents show the relevance of looking into stimulating household waste separation in high-rise buildings, compared to the practices of low-rise residents. A consistent waste separation system (more than a professional system) appears to be valuable for consistent waste separation behaviour.

2.4 Behavioural theories

In order to understand why people practice household waste management in different ways, general theories of human behaviour have been studied. Motivation, Ability, and Opportunity are found as building blocks leading to particular behaviour. Several intervention techniques exists to stimulate behaviour change, which is a process of several stages to go through.

2.4.1 Behavioural models

From a behavioural science perspective, people's waste separation behaviour can be explained by the model in Figure 17. The model combines the Motivation Ability Opportunity behavioural model of Ölander and Thøgersen (1995) with the Theory of Planned Behaviour of Ajzen (1991). The model shows how people's behaviour regarding waste separation (or other behaviours) is formed by one's Motivation, one's Ability, and one's Opportunity to take on a particular behaviour.

FIGURE 16

Fogg's Behaviour Model illustrates the relation between Motivation and Ability

Motivation, Ability, Opportunity

According to the model, one's intention towards specific behaviour is influenced by one's attitude towards, the subjective norms

regarding and perceived control of the behaviour. Attitude refers to one's evaluation of the behaviour, as being something positive or negative. Subjective norms refer to one's perceived social pressure (Ajzen, 1991). Perceived control is described as *"people's perception of the ease or difficulty of performing the behavior of interest."* (Ajzen, 1991, p.183). Intention leads to a behavioural disposition (Ölander and Thøgersen, 1995), indicating a tendency towards performing the behaviour. The stronger one's intention, the more likely one will perform the behaviour (Ajzen, 1991).

One's intention to perform specific behaviour only leads to the performance of this behaviour in case one's abilities are sufficient (Ölander and Thøgersen, 1995). The two factors habit and task knowledge together form the Ability component of the model. Ölander and Thøgersen (1995) illustrate how *"the force of (old) habit"* (p.364) can unconsciously cause the performance of 'old behaviour'. In the case of waste separation this old habit can cause sorting failures. Similarly, task knowledge is also of importance for the prevention of sorting failures.

Ölander and Thøgersen (1995) indicate how objective preconditions form the Opportunity for (not) performing a specific behaviour. Also, they point out the subjective perception of the overall and situational conditions. For example, someone might be highly motivated to separate waste but lives in a neighbourhood with scarce recycling containers (objective condition). Therefore this person may experience waste separation as not possible (subjective perception).

MOTIVATION

Beliefs
times
Evaluations
of outcome

Attitude

Control beliefs
times
Perceived power

Perceived control

Intention

Subjective norm

Normative beliefs
times
Motivation
to comply

ABILITY
Habits
Task knowledge

BEHAVIOUR

OPPORTUNITY
Overall and situational conditions
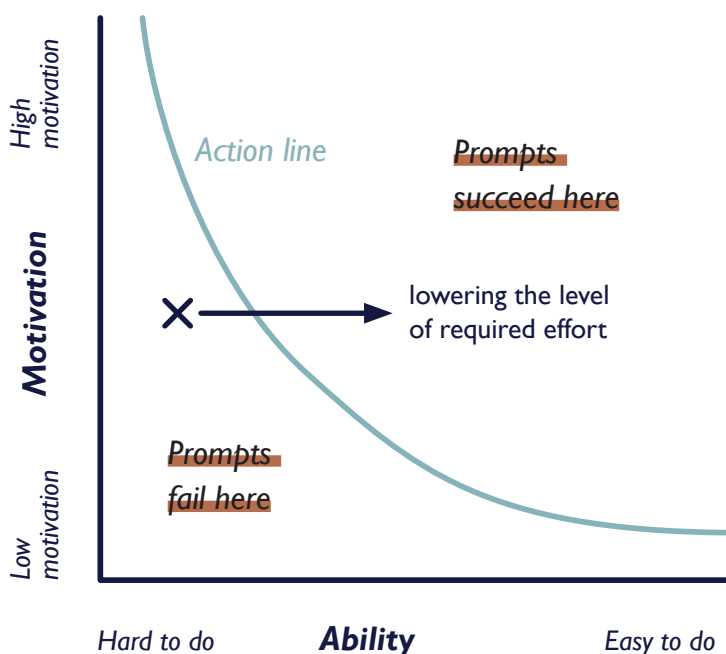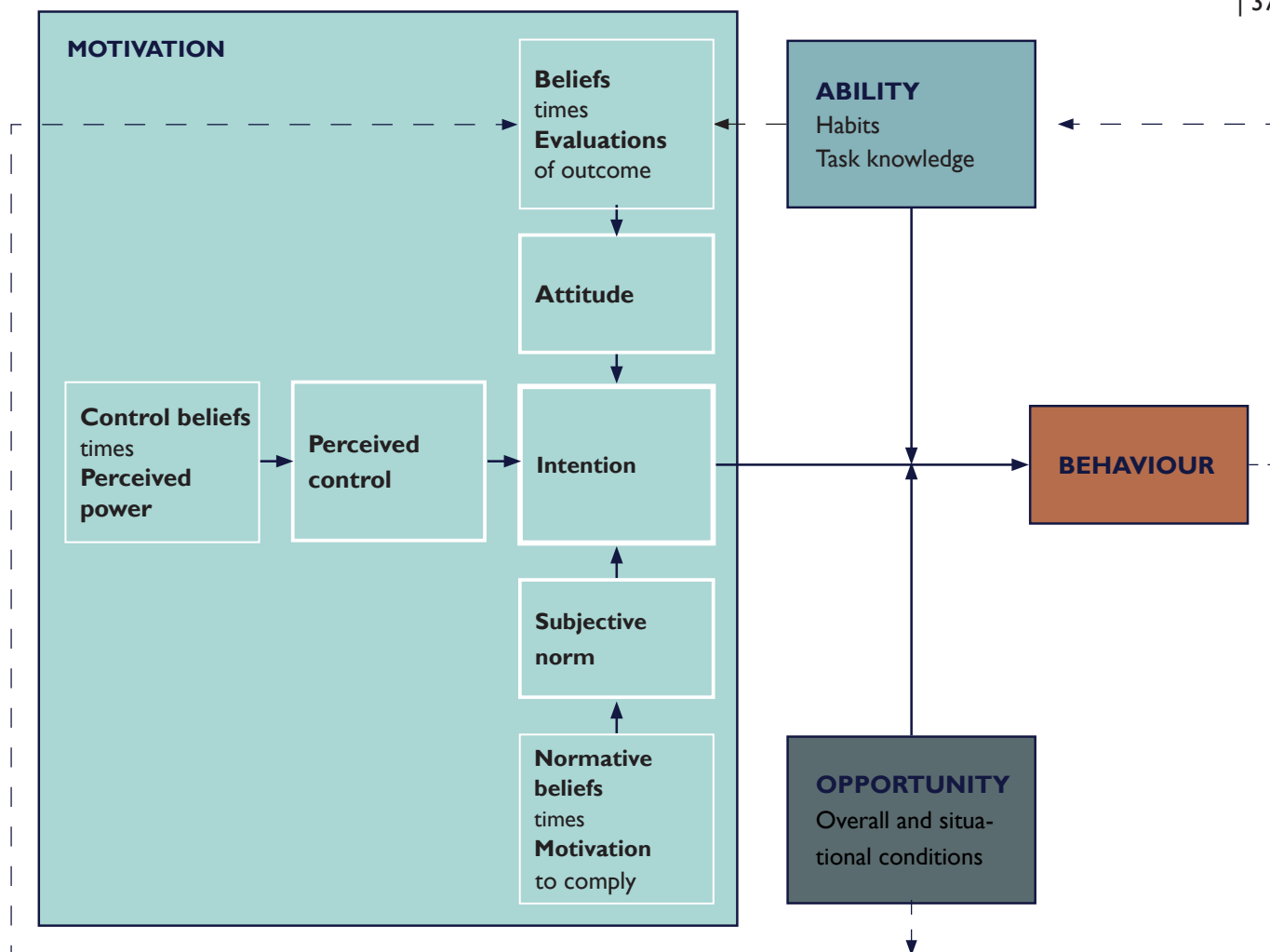
Fogg's Behaviour Model

Fogg's Behaviour Model (Figure 16) describes how action only takes place if the elements of Motivation, Ability and Prompt exist at the same moment. The prompt is a trigger for a particular behaviour. Prompts succeed if one's motivation is high enough to put in the required effort, or if the required effort is so low that even low levels of motivation are enough to trigger action (Fogg, 2009).

2.4.2 Behavioural change

Starting new behaviour or changing existing behaviour takes time. Lally, Van Jaarsveld, Potts & Wardle (2010) found in their research it

takes 66 days on average to change a habit. In order to do so, there are multiple stages to go through. Lewin (1951) simplifies the change process into three stages: unfreeze, change, refreeze. This means that, before any behaviour can be changed, it is important to break through the status quo to prepare for the change to take place. During the change stage, the desired changes are implemented. In order to maintain the behavioural change, support needs to be provided in the refreeze stage, to keep people on the right track. The behavioural change stages are described by Prochaska & DiClemente (1983) as Precontemplation, Contemplation,

Preparation, Action, and Maintenance. In which stage a person is, depends on one's motivation, ability, and opportunity.

In this project, the stages can be illustrated as follows:
- Precontemplation: the high-rise resident does not see a need for household waste separation in the near future.
- Contemplation: the high-rise resident consciously thinks of, and considers, household waste separation as a possibility. One sees the benefits; however, one is also aware of the effort needed to start this new behaviour.
- Preparation: the high-rise resident undertakes steps with the intent to change.
- Action: the high-rise resident starts the new behaviour of household waste separation
- Maintenance: the high-rise resident separates household waste consistently with a low likeliness to relapse into the former behaviour.

In order to trigger behaviour change, interventions can be used. Michie, Van Stralen & West (2011) describe nine intervention techniques aiming for behaviour change. These intervention techniques influence one or multiple of the behavioural elements, which they indicate as Capability, Opportunity and Motivation (comparable to the building blocks of Ability, Opportunity and Motivation). The intervention techniques are Education, Persuasion, Incentivisation, Coercion, Training, Restriction, Environmental restructuring, Modelling and Enablement. Interesting to notice is that most interventions focus on triggering the (mind of the) individual person, not the context. However, the techniques of Environmental restructuring and Enablement provide ways of stimulating behaviour change by changes in the environment. A change in or new environment supports behaviour change by reminding of the new behaviour or by blocking the unconscious execution of old behaviour. The moment of moving, where someone's complete environment changes, is indicated before as valuable moment for changing waste separation behaviour (Design Innovation Group, 2015).

Conclusion

A way of explaining human behaviour from behavioural science perspective is by distinguishing the building blocks Motivation, Ability, and Opportunity. In order to start a specific behaviour, someone needs to go through several stages. One's Motivation, Ability, and Opportunity influence how easily one can go through all stages into the Maintenance stage. Environmental restructuring can offer a starting point for behaviour change, for example when one moves to a new residency.

2.5 Influencing factors for waste separation behaviour

In order to gain insight into how to stimulate waste separation behaviour, it is essential to understand what factors influence people's Motivation, Ability, and Opportunity towards waste separation. These influencing factors are found in literature and confirmed and enriched through interviews and generative research.

2.5.1 Influencing factors from literature

Rich literature is available regarding waste separation behaviour. Selected findings from literature are presented (see Figure 18), clustered following the Motivation, Ability, Opportunity model (see Figure 17).

Motivation

In literature multiple factors are discussed influencing the motivation of people towards waste separation behaviour (see Figure 18). Attitude, perceived control and subjective norms together shape the intention towards the behaviour (see 2.4.1 Behavioural models). Midden (2015) states that positive relations are found for the intention towards waste separation and the actual behaviour. An explicit, thought-through and specific intention is a better predictor for behaviour, compared to less actual intentions.

One's attitude is, among other things, influenced by one's environmental awareness, altruistic reasons, the willingness to accept responsibilities, costs and (negative) perceptions towards the separation task.

Environment and material recycling

For most consumers, the goal of waste separation is to enable the recycling of materials (Thøgersen, 1994). The goal of recycling, and with that a motivation to recycle, is to care for nature and to protect the environment (Thøgersen, 1994; Midden, 2015; Kirakozian, 2016). In Flanders, young people show less environmental awareness compared to people of middle-age or higher age. The same counts for people with low-incomes, compared to mid- or higher-incomes (Bachus, Pollet & Van Ootegem,

2015). Midden (2015) discusses how environmental awareness mainly influences the behaviour, in case the required effort is low. Next to that, waste separation is better predicted by attitudes and norms related to waste separation, and less by environmental awareness in general (Midden, 2015).

Altruistic reasons

As waste separation (often) lacks personal benefits while requiring effort, altruistic reasons and public benefits are important in shaping people's attitude (Thøgersen, 1994; Midden, 2015). Personal benefits gained, such as a better consciousness, are often related to public benefits, as a healthy environment (Thøgersen, 1994). Research shows that people evaluate waste separation as 'satisfying' (Midden, 2015; Kirakozian, 2016).

Accepting responsibilities

Thøgersen (1994) indicates that the willingness to comply with the demands of authorities relates to participation in waste separation. The same counts for the willingness to accept moral obligations (Midden, 2015).

Costs

Midden (2015) states economic factors, such as municipal costs for waste management, can influence people's attitude. Kirakozian (2016) states that user fees may decrease the amount of generated household waste if accompanied by public awareness campaigns. *"Flat-rate pricing systems"* (p. 1483), where costs are independent of the amount of waste produced, are found undesirable (Kirakozian, 2016).
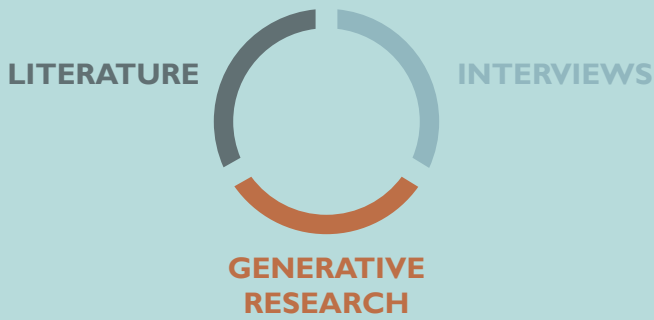
FIGURE 18 *Overview of influencing factors for waste separation behaviour from literature, interviews and generative research*

LITERATURE   INTERVIEWS

GENERATIVE RESEARCH

ABILITY

understandability of the system

accessibility of the info

knowledge of the environment

(un)consciously acting

task division + responsibility

raised like this

disposing on the way out

insight in volume

MOTIVATION

environment

recycling of materials

altruistic reasons

accepting responsibilities

costs

negative perceptions

social norms

trust in others

lack of priority

perceived impact of actions

extra required cognitive effort

positive feeling when disposing

OPPORTUNITY

space at home

presence of waste facilities

location of waste facilities

form of waste facilities

provided services

nuisance

physical limitations

required effort

Negative perceptions

Perceived nuisance and inconvenience can cause negative perceptions towards waste separation, leading to a negative attitude. Perceived nuisance can be a bad smell (Thøgersen, 1994; Midden, 2015), lack of hygiene (Midden, 2015) or vermin and fly problems (Tucker & Speirs, 2003). Perceived inconvenience is caused by overfilled containers (Thøgersen, 1994), bring systems (Thøgersen, 1994), lack of information (Thøgersen, 1994), lack of time (Midden, 2015), waste requirements (Tucker & Speirs, 2003) and clutter (Tucker & Speirs, 2003; Midden, 2015). Negative perceptions can block the initiation of waste separation behaviour. In contrast, the intention towards waste separation can be fuelled by opposite perceptions, such as 'waste separation does not necessarily take up much space'. Next to that, for separators, the strengthening of negative perceptions over time can cause drop-out (Tucker & Speirs, 2003).

Social norms and trust in others

According to the model in Figure 17, subjective norms depend on normative beliefs and the motivation to comply with these beliefs. Social norms and normative feedback, in the form of observation or communication, can play a role by reducing insecurity about the contribution of neighbours to waste separation. As waste separation is a collective performance, this insecurity can negatively affect the (intention towards) waste separation behaviour. Normative feedback has a positive influence on behaviour (Midden, 2015). Kirakozian (2016) finds that social influence can also negatively affect waste separation behaviour, in case the social norm is not to recycle. Social cohesion is related to social norms: when the outflow is high, and the social interaction low, social norms are less clear for new residents of the neighbourhood (Midden, 2015).

Thøgersen (1994) states that the impact of attitudes on behavioural intention is strong, unlike that of social norms. Midden (2015) lists multiple studies that show the importance of social norms for waste separation. However, he also states that the effect is less reliable than that of attitude.

Ability

Habits and task knowledge influence the performance of behaviour (see Figure 17). Task knowledge is influenced by understandability of the system, accessibility of information and the level of general knowledge about the environment. Regarding habits, task division and (un)consciously acting can influence the desired behaviour (see Figure 18).

Understandability of the system

Understanding the system can be split up in understanding the (local) process, and knowledge of the different fractions. Bachus, Pollet & Van Ootegem (2015) indicate that icons or information in multiple languages can serve its purpose in communication and information regarding the system, towards immigrants or non-native speakers. Waste products (e.g., packaging of multi-layered material) that are difficult to classify into the right waste fraction can make the process of waste separation complex (Midden, 2015).

Accessibility of the information

Information about waste separation is essential for the promotion of this behaviour (Kirakozian, 2016). A lack of information can result in undesired or wrong separation behaviour (Thøgersen, 1994). Midden (2015) indicates the function of social proximity for information distribution (for example regarding the provided waste services).

Knowledge about the environment

General knowledge about sustainability issues can play a role in waste separation. However, Midden (2015) states that people have difficulties in seeing the relationship between their behaviour and big environmental issues.

As stated before, general environmental awareness is not a reliable predictor for waste separation behaviour.

(Un)consciously acting

Both Thøgersen (1994) and Midden (2015) indicate how unconsciously acting upon old habits, can obstruct (perfect) waste separation in the initial stage of adopting the new behaviour. Midden (2015) discusses the informative function of the context (e.g., form giving of containers), to activate one's consciousness at the moment of separation.

Task division

A clear task division, with one main responsible person, can positively influence waste separation results (Bachus, Pollet & Van Ootegem, 2015)

Opportunity

Lastly, overall and situational conditions influence waste separation behaviour (see Figure 17). For waste separation, (a lack of) space at home, the presence and location of waste facilities, the form of waste facilities, provided services, nuisance, physical limitations and the level of required effort play a roll (see Figure 18).

Space at home

Small residencies result in a lack of space to store separated waste (Bachus, Pollet & Van Ootegem, 2015), especially for voluminous waste, like plastic or cardboard boxes. High-rise often lacks such storage space. It, therefore, makes waste needs to be disposed of more often (Midden, 2015). Thøgersen (1994) states a higher demand concerning storage, creates a weaker system. Midden (2015) agrees that (a lack of) space can affect the desired waste separation behaviour. Residents of houses separate more, compared to people living in flats, which may be allocated to the amount of storage space available (Midden, 2015; Kirakozian, 2016).

FIGURE 19
(Right page) Place of residency of the seven interviewees and the ten participants of the workshops

Presence and location of waste facilities

Precise information is needed for the stimulation of waste separation, but a suitable infrastructure that facilitates this separation is essential (Kirakozian, 2016). Midden (2015) states that multiple studies showed a negative relationship between distance to waste facilities and waste separation. Larger distances lead to less separation. The lack of equipment negatively influences the start of waste separation behaviour as well. Individual containers positively influence waste separation (Kirakozian, 2016).

Form of waste facilities

Midden (2015) states that the success of a waste separation programme depends on the choice of containers. The size, form, and division of fractions should be adapted to the user group of the facilities. For example, a small residual waste container can stimulate residents to separate more waste (only if this limitation is accepted). Also, a proper waste container provides clear cues for smooth operation, even in situations where users are multitasking.
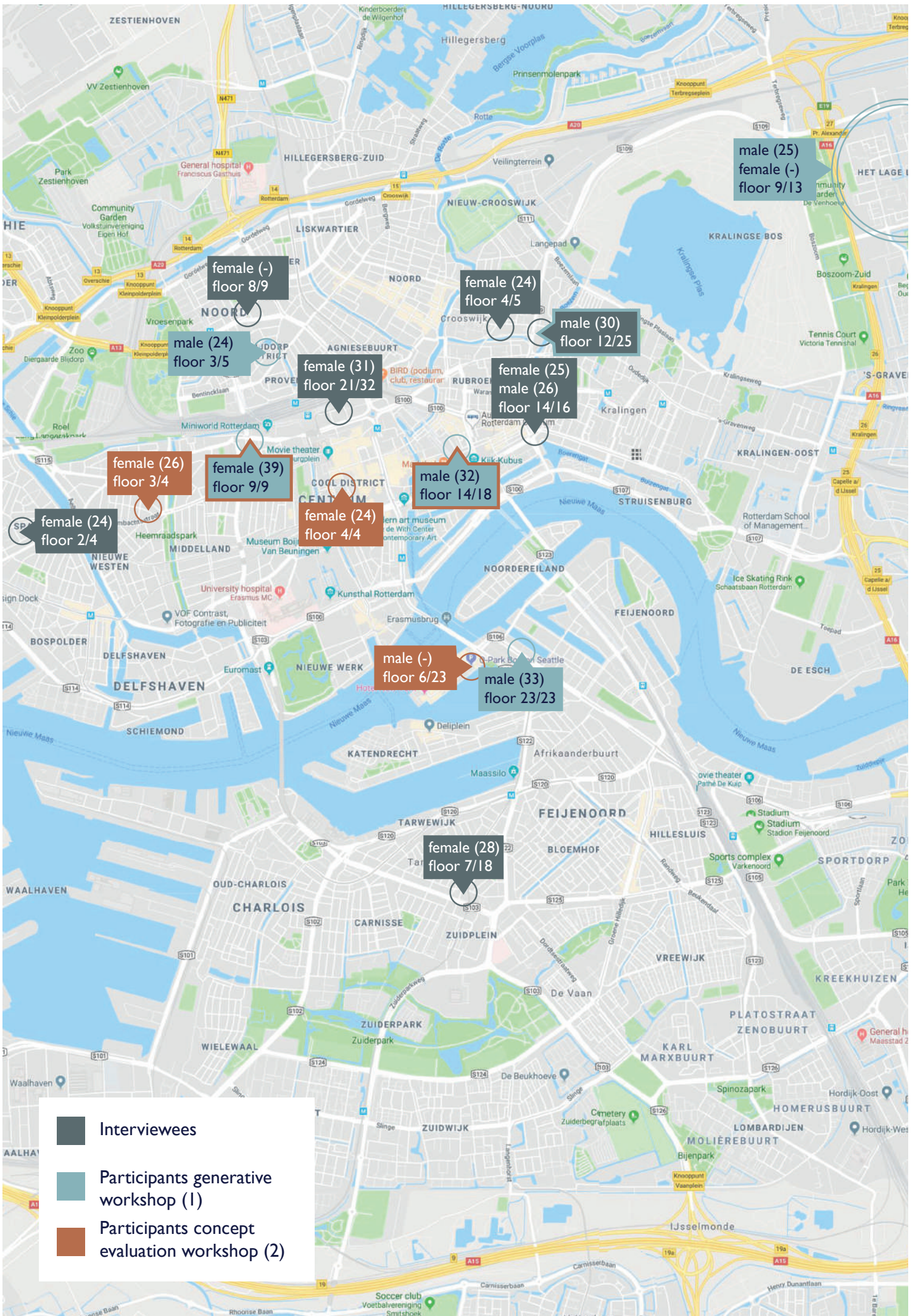
Provided services

The provided service, in the form of a bring or collection system and arranged collection schedules, can influence the performed waste management behaviour. Demanding residents to transport their waste and to comply with timetables, in low service systems, may negatively influence their waste separation behaviour (Thøgersen, 1994). Collection systems lead to more participation than bring systems (Midden, 2015; Kirakozian, 2016). Easier collection schedules (more fractions at the same moment) can increase participation (Midden, 2015).

Nuisance

Nuisance, in the form of smell or visual disturbance, can affect the performance of the desired behaviour. In specific, this counts for the in-home separation of food waste (Midden, 2015).

Map of Rotterdam showing participant locations.

Interviewee labels (on map):

- male (25) / female (-) / floor 9/13
- female (-) / floor 8/9
- male (24) / floor 3/5
- female (24) / floor 4/5
- male (30) / floor 12/25
- female (31) / floor 21/32
- female (25) / male (26) / floor 14/16
- female (26) / floor 3/4
- female (39) / floor 9/9
- male (32) / floor 14/18
- female (24) / floor 2/4
- female (24) / floor 4/4
- male (-) / floor 6/23
- male (33) / floor 23/23
- female (28) / floor 7/18

Legend:

- Interviewees
- Participants generative workshop (1)
- Participants concept evaluation workshop (2)

Physical limitations

Physical limitations can exist at high age or when one's physical condition is not optimal. Not possessing a car is also considered a physical limitation. These limitations can obstruct waste separation at home, or the proper disposal of (separated) waste (Bachus, Pollet & Van Ootegem, 2015).

Required effort

Waste separation should be comfortable, user-friendly and convenient. For example, the user interface of a system should not be too complicated, or required force during usage should not be too high (Midden, 2015). Kirakozian (2016) also discusses the positive effect of limited required effort for waste separation. Tucker & Speirs (2003) indicate that the required time or effort for waste separation is of importance, to prevent drop-out of separators.

2.5.2 Influencing factors from interviews

Seven interviews are conducted with high-rise residents in Rotterdam, in order to understand whether the factors influencing waste separation behaviour found in literature are of influence in high-rise Rotterdam as well. For one interview, both residents were present during the interview. In all other cases, one of the residents is interviewed (see Figure 19).

The interviews were semi-structured interviews (Appendix H). All interviewees were asked to add remaining thoughts around the topics discussed, at the end of the interview. From the interviews, most Motivation, Ability and Opportunity factors found in literature could be confirmed (see Figure 18). The five new factors identified from the interviews, for Motivation and Ability, are discussed below. No additional factors are found for Opportunity.

Motivation

Additional Motivation factors identified in

the interviews are lack of priority, perceived impact of actions and extra required cognitive effort (see Figure 18).

Lack of priority

Some of the interviewed residents mention their willingness to separate their household waste but point out it just not happened yet. Other priorities can be a reason for this.

"It's not that only the creation of a proper waste system has not happened yet. There are still many things that need to happen in the house, so it has no priority now."

Perceived impact of actions

In four interviews it became clear that hesitation exists about whether the recycling of separated fractions indeed happens.

"In cities, I always wonder whether it eventually ends up altogether."

This hesitation of whether to believe in the system or not and what impact an individual can truly make may negatively affect the intention towards waste separation. Figure 17 shows how perceived control influences the behavioural intention.

Extra required cognitive effort

The (perceived) effort to separate household waste, influences residents' attitude towards waste separation. One resident finds several different garbage bags too much of a hassle. Two residents mention how easy it is to just throw everything together in one bag. The amount of effort residents are willing to invest, depends on the strength of their motivation.

Ability

Additional Ability factors identified in the interviews are being raised like this, disposing on the way out and insight in volume (see Figure 18). Among other insights, the importance of the understandability of the system is once more stressed:

"For example, I wouldn't know where the plastic container is located in my neighbourhood. So, therefore I am not going to separate plastic."

Raised like this

For many of the interviewees separating glass from residual waste is a habit; something they have become used to do over a longer period. Two residents mention their waste separation behaviour has to do with how they are raised.

"Not throwing your glass in the residual waste bin, that is just how I am raised".

Disposing on the way out

Five residents mention that in their household it is a habit to dispose of the garbage bag at a moment they are already leaving the building. The bag may be taken out of the bin earlier, and temporarily stored near the door or in the hallway. None of the residents mentioned any task division for disposing of the bag. The first to leave the building while having time to pass by the container takes the bag on the way out.

Insight in volume

One of the interviewees mentions how the individual impact of waste separation becomes clear once one separates more. This increases one's knowledge about the impact of waste separation, and can in addition also influence one's motivation (e.g., the perceived impact of actions).

"When you separate a lot, you can clearly see how much residual waste is left. So, the amount of food you sometimes waste as well."

FIGURE 20 *Seven high-rise residents of Rotterdam came together to take part in the generative workshop*
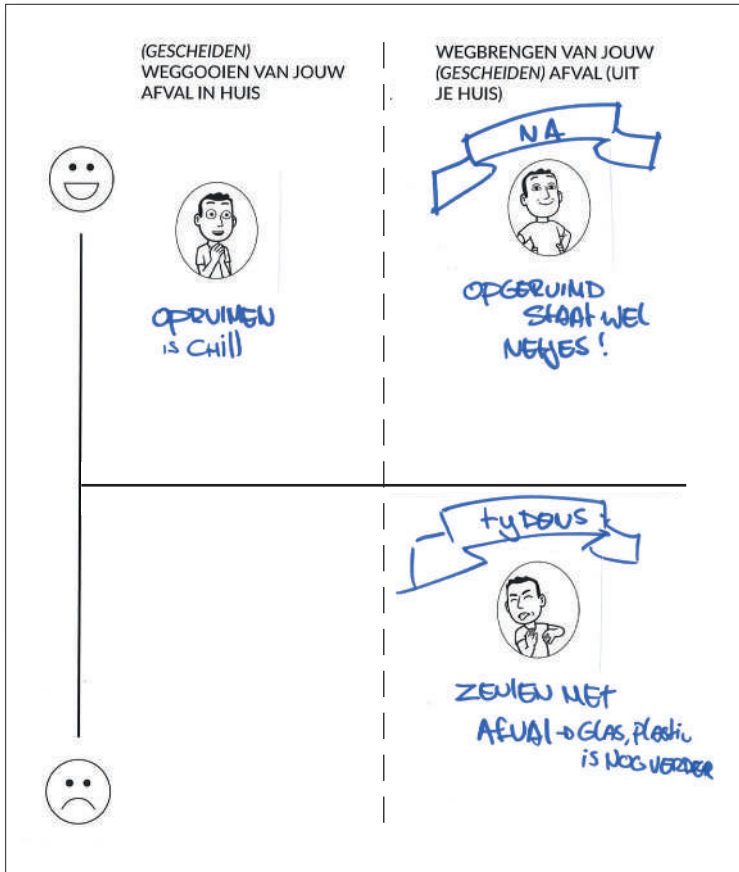
FIGURE 21 *Snip from a worksheet filled by a generative workshop participant. It shows the positive feeling when disposing*

Opportunity

No new Opportunity factors influencing waste separation behaviour are found from interviews. However, the importance of the right facilities is stressed.

"If I just had a container for plastic, one for glass, one for paper, one for bio-waste and one for residual waste in my downstairs waste-room, yes, then we would create the same upstairs."

2.5.3 Influencing factors from generative research

In order to complement the explicitly mentioned influencing factors of high-rise residents in the interviews, with insights regarding their unconscious needs, a generative workshop is executed. During this workshop, seven high-rise residents of Rotterdam were present (see Figure 20), of which one was also among the interviewees.

In the week previous to the workshop, the high-rise residents were asked to fill in a workbook with five small exercises at home, in order to sensitise their mind regarding the topic of household waste management. The workshop itself consisted of four parts (Appendix J).

From the interviews, most Motivation, Ability and Opportunity factors found in literature and complemented with interviews could be confirmed (see Figure 18). One new Motivation factor could be identified. No additional factors are found for Ability and Opportunity.

Motivation

The additional Motivation factor identified through the generative workshop is the positive feeling when disposing of household waste (see Figure 21).

Positive feeling when disposing

Evaluating the residents' current waste system during the workshop uncovers the positive feeling some of the residents experience after waste disposal (in Dutch: "opgeruimd staat netjes").

Conclusion

In Figure 18 the influencing factors for waste separation behaviour found in literature, interviews and a generative workshop are presented, using the Motivation, Ability and Opportunity model as a framework. This overview serves as a starting point, and its completeness or the classification of the factors is open for discussion. What this overview does offer, is insight into the complex nature of waste separation behaviour.

2.6 Personas

From the performed research has been found that the behavioural intention of people regarding household waste separation differs. While some are highly motivated to separate their waste, others doubt the impact of this behaviour. Following their intention towards household waste separation, high-rise residents can be classified into four different groups.

2.6.1 The Enthusiast

The Enthusiast finds it (intrinsically) important to separate household waste, and tries his or her best to execute this task. The strategy to support the Enthusiast with household waste separation is to facilitate the execution of the desired behaviour. For example, by offering the possibility to dispose of bio-waste in separate containers. The Enthusiast is in the Action or Maintenance stage (see Figure 22).

2.6.2 The Potential

The Potential is on the edge of moving from the Contemplation to the Preparation stage, or even to the Action stage. The Potential sees the purpose and (environmental) benefits of waste separation but is aware of the costs (resources, time, effort) for starting this behaviour. The strategy to support the Potential with the desired behaviour is to activate him or her to start trying it.

2.6.3 The Skeptic

The Skeptic is in the Precontemplation phase, and will not start waste separation soon. He or she does not see or is not convinced of the purpose of waste separation, and believes his or her contribution is limited. The strategy to help the Skeptic move from Precontemplation into the Contemplation stage is to inform him or her about the purpose and the (factual) process of circular waste management. Providing insight into the amount of material that can be recovered and the kind of products that can be produced with recycled material will help the Skeptic to lose his or her skepticism. Extrinsic motivation (in the form of financial or personal benefits) may help to activate Skeptics as well.

2.6.4 The Conservative

The Conservative is also in the Precontemplation phase, but for different reasons than the Skeptic. Even though the Conservative might have heard of waste separation, he or she has just never thought about making changes in his or her in-home waste disposal system. The Conservative likes to stick to old habits and is not likely to change this. The strategy to help the Conservative to move to the Contemplation stage is to demonstrate the alternatives for in-home waste separation and to create an attractive advantage for changing the current habit.

2.6.5 Transition strategy

Similar to the adoption of new products and technologies, the adoption of new behaviour is a gradual transition, which knows early adopters as well as laggards (see Figure 22). In this case, the Enthusiast is leading the way, followed by the Potential, that needs an extra push. The Skeptic and the Conservative are furthest from adopting the desired waste separation behaviour and moving into the Action and Maintenance stage. Following the theory of the Innovation Adoption Curve of Rogers, the best strategy is to convince innovators and early adopters first, followed by the early majority. The late majority and laggards will need more time and will follow later.

In line with the transition strategy, the Potential will be the focus persona for this project. The Potentials are close to starting the desired behaviour. With little help from the City of Rotterdam, this group can be activated.

FIGURE 22

Visualisation of Prochaska & DiClemente's five stages of Behavioural Change along the Rogers Innovation Adoption Curve, indicating the estimated positions of the four different personas
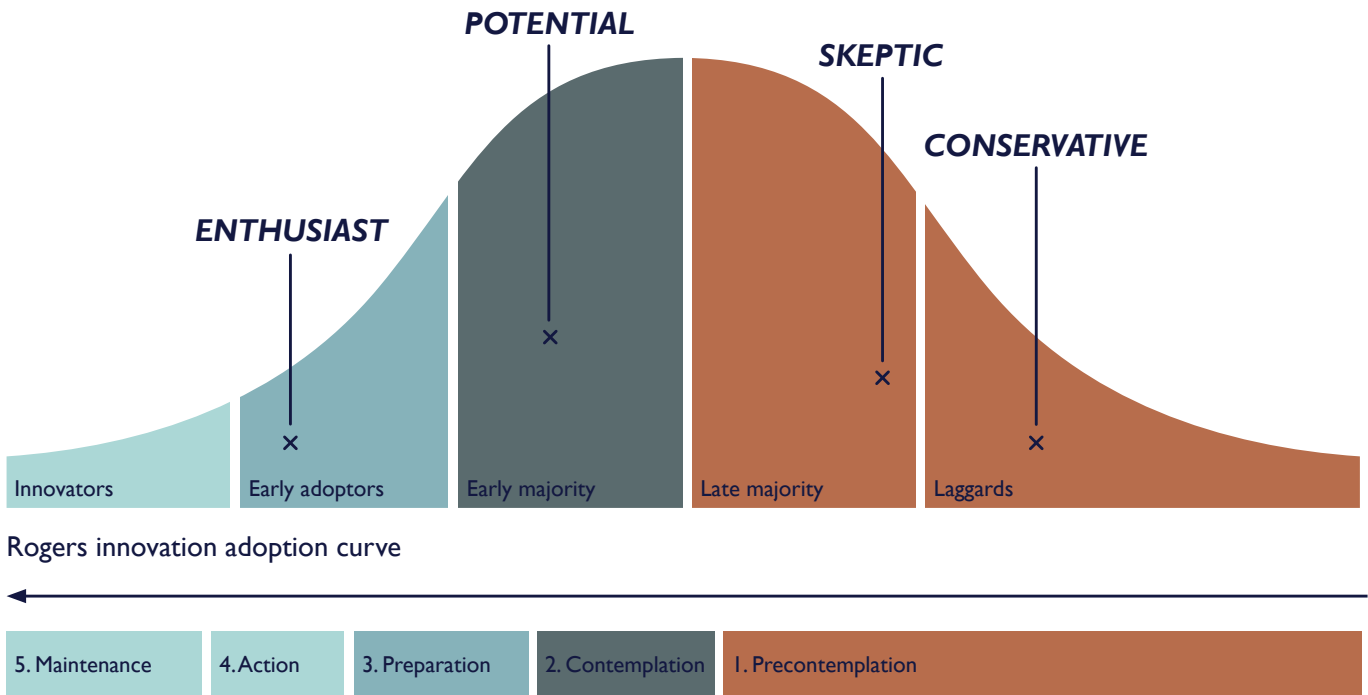
Conclusion

The Enthusiast forms the example citizen, highly involved in household waste separation. In line with the transition strategy, the Potential is the first one that will follow, with relatively small interventions needed. Therefore the Potential will be the target persona to create a solution for. Once the Potential turns into an Enthusiast, the group of citizens displaying the desired waste separation behaviour grows. New Potentials can emerge from the group of Skeptics and Conservatives in the meantime, only if an effort is made to help them move to the Contemplation phase.

Rogers innovation adoption curve

Prochaska & DiClemente's five stages of behavioural change

"I collect my bio-waste in a separate bin. Only, at the end of the week, I have to throw it in the residual waste container, as there are no facilities for bio-waste."

THE ENTHUSIAST

Mirjam (29) Lives together with a friend on the 5th floor

- Separates glass, paper, PMD and even bio-waste from residual waste.

- Very motivated to separate her waste, to care for the environment by enabling recycling.

- Strives to minimise her residual waste, by over-enthusiastically categorising everything in a separated fraction. Hereby the crisp bag wrongly ends up in the PMD.

- Tries to convince the friend she is living with to join her in separating the garbage as well.

"After we moved into our new house, there are just so many things to do and fix. Organising our waste separation is just not on top of the list."

THE POTENTIAL

Tom (30) and Elise (27) Living together in an apartment on the 8th floor

- Separate glass from residual waste, and aim to keep paper separated as well. However, when throwing out a box of paper, the collection system is lost. Paper then ends up with residual waste.

- Know about the possibility of waste separation, and find they should separate more. However, they have not started to do it yet.

- Perceive the change to a new system as a hurdle. Do not allow themselves time to organise their kitchen for better separation.

"I can try all my best to separate it, but why would I? I heard that, in the end, everything is still thrown together and incinerated."

THE SKEPTIC

Willem (28) Lives together with his girl-friend on the 13th floor

- Separates only glass from residual waste, for practical reasons: so it does not break and tears the garbage bag.

- Knows of the possibility of waste separation, but questions the impact of himself as individual. Is skeptic about the reliability of the system: is the waste really recycled and not burned?

- Finds waste separation a hassle and likes to go for the way of the least effort: all waste goes into one bin, resulting in only one bag to dispose off (except for glass).

"I separate my paper and glass from my residual waste, because this is how my parents do it at home as well"

THE CONSERVATIVE

Emma (32) Lives alone in an appartment on the 10th floor

- Separates paper and glass from residual waste, consistently with a long-term habit.

- Heard about waste separation, but never actively thought about it as an option for doing it at home as well.

- Does not see alternatives for how she is currenlty collecting her waste. She lives in a small appartment and feels she does not have space for waste separation.

- Does not know anything about possibilities for making new products out of recycled materials.

2.7 Existing interventions

Several interventions and solutions to household waste separation already exist or are being piloted in Rotterdam, the Netherlands, or other parts of the world. They aim to increase the Motivation, Ability or Opportunity of residents. The existing solutions all have their advantages and disadvantages for introduction by the City of Rotterdam.

FIGURE 23

Wasted app: collecting point with waste separation (Image source: Smart Magazine)

2.7.1 Motivation

Several interventions aim to increase residents motivation to start waste separation (Appedix K). Diftar is an example of such intervention. Several municipalities in the Netherlands already implemented Diftar. It means that disposing of residual waste is charged per bag (when purchasing the bag or with a card system upon disposal), while separated waste can be disposed of for a lower rate or for free (VANG huishoudelijk afval, n.d.a). The City of Rotterdam does not use the Diftar system, as it is susceptible to abuse. Residents can make use of non-charged bags or containers to dispose of their residual waste for free with the danger of polluting separated waste fractions. Besides financial encouragement, motivation can also be boosted by rewarding systems. An example is the Wasted app (Wasted, n.d.) (see Figure 23).
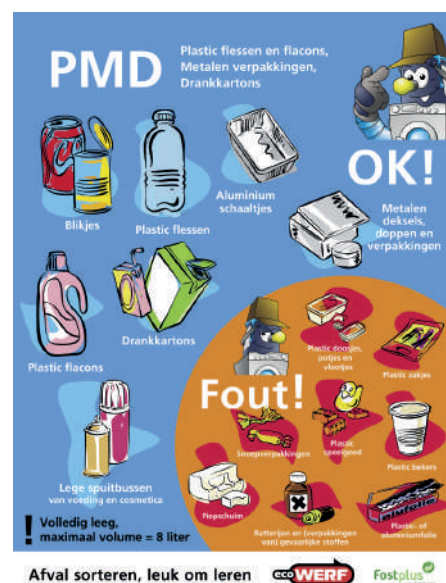
2.7.2 Ability

Providing information is essential for stimulating residents to separate their waste. Many examples of information campaigns of municipalities can be listed. Campaigns are often focused on one goal. For example, educating residents when a new fraction is introduced (e.g., with the introduction of the PMD fraction), providing waste separation guidelines (e.g., worn out clothes can be disposed of in the textile container) or general awareness. Posters are one way to communicate this information (see Figure 24). However, information providence alone is not enough to incite action.

2.7.3 Opportunity

Several facilities or products exist that increase the opportunity for residents to separate their waste (Appendix K). In cities this the location of waste facilities is of influence. When containers for different

FIGURE 24

(Right) A poster to instruct about the separation of PMD: plastic, metal and beverage cartons (Image source: Wikiwijs, Kennisnet)

fractions are clustered, the required effort for waste disposal for citizens decreases (see Figure 25). Different kinds of municipal services are introduced, such as the Optibag system in Norway (Holmerz, 2015) (see Figure 26). Besides municipal facilities, there are several products for in-home use available, such as combined waste bins or drawers. For municipalities, it often is too expensive to provide such products for their citizens. Citizens themselves are not always aware that these products exist or are not motivated to spend money on such products.

Conclusion

Several interventions to stimulate the household waste separation behaviour of citizens exists. In order to come up with a valuable solution for the City of Rotterdam, it is crucial to ensure the solution is within the power of the municipality. It should prevent abuse of the system, to prevent downgrading the quality of separated fractions. The solution should be scalable and cost-efficient. For residents, the solution should be convenient and clear.

FIGURE 25
(Top) Clustered waste containers in one location decrease the level or required effort for citizens (Image source: HCTECH.CO)

FIGURE 26
The Optibag system makes use of coloured bags, that can be disposed of in one container (Image source: Ecofriendly.ru)

Chapter 3. Design brief

This chapter summarizes the goal of this design project. The defined problem is high-rise residents' lack of a waste separation system in combination with a high level of required effort to create such a system (3.1). A valuable solution supports the City of Rotterdam with activating high-rise residents' waste separation behaviour by lowering the effort to start (3.2).

3.1 Problem definition

In the research phase, it has been found out that within the target group high-rise residents generally know what household waste separation is. They name to care for the environment or to enable the recycling of resources as the purpose of waste separation. However, not all residents are sufficiently motivated by environmental reasons. Besides, an in-home separation system is often missing.

3.1.1 Lack of a system

Many factors influence the household waste separation behaviour of high-rise residents (Figure 18). In many cases the combination of factors currently impedes separation behaviour. This is not only due to unfavourable contextual factors or the municipal system in place. It also has to do with the current practices of residents at household level and what they are used to. Currently, many high-rise residents do not have a system for themselves to separate their household waste into different fractions.

Not in a physical form:
- (Most) high-rise residents do not use a fixed in-home system for household waste separation, such as a multicompartment separation bin, or reusable boxes or crates.
- In-home are no physical cues, reminders or information present for high-rise residents at the moment of household waste separation.

Not mentally:
- High-rise residents are not used to separating (all) their waste. It is not (yet) a habit to them. For some, separating paper and/or glass is, as they are used to this behaviour since a longer period.
- People (often) dispose of their waste unconsciously, which makes it hard to change existing behaviour.

3.1.2 Motivation vs. effort

Considering to start household waste separation is only the first step of habit change (Prochaska & DiClemente, 1983).

When considering household waste separation a tradeoff is made between motivation and required resources (effort, time, money) for starting or executing the behaviour (Fogg, 2009). As no personal benefits for waste separation are present, the motivation for waste separation generally is medium-low. Only for Enthusiasts, the environmental benefit delivers enough motivation. For others, the effort needed to create a new system forms a barrier.

Conclusion
Before getting into the Action and Maintenance stage of adopting waste separation as a new behaviour, the hurdle of the lack of a (physical and mental) system needs to be overcome. However, the high effort needed to arrange this new system for household waste separation does not correspond with the medium-low levels of motivation.

3.2 Design vision

From the insights gathered during the design research, a design vision has been created. This design vision serves to guide the project in a valuable direction. The vision will be used to select ideas with the potential to have a positive contribution to the design problem.

3.3.1 Design vision
My design vision is as follows:

> *"I want to design a product to support the City of Rotterdam with activating the "Potential" to improve their household waste separation in a low effort manner within the first month after moving to high-rise in Rotterdam."*

3.3.2 Explanation of the vision
In general, the project is about household waste separation in high-rise buildings in Rotterdam. Consequently, the desired behaviour is source separation of household waste. As the City of Rotterdam is the case-owner, it is crucial to create a solution that lies within the field of influence of the municipality. For example, to design a multifunctional waste separation bin, to be sold to consumers, will be a solution direction outside of the daily business of the City of Rotterdam. Therefore, such a solution direction will not be considered valuable within this project.

As a designer, I have the ambition to create a product concept for the City of Rotterdam. This product should illustrate a new form or channel to contribute to the circular waste management transition, next to more common municipal approaches as (marketing) campaigns, informative web pages or letters, and waste collection services.

The personas (see 2.6 Personas) describes different groups of citizens with a different mindset regarding household waste separation. For this project, the "Potential" will be targeted. This group is closest to following the "Enthusiast" in waste separation and therefore is an attractive group to get along in the transition towards circular waste management.

The "Potential" is generally aware of waste separation and often even considering it. However, they are not yet acting upon it. Therefore, it is essential that the solution is activating and helps citizens to move from considering the waste separation behaviour to actually performing this behaviour. Therefore, in line with Fogg's Behaviour Model (see 2.4 Behavioural (change) theories), the desired behaviour should be as effortless as possible to overcome the medium levels of motivation for household waste separation.

The moment of moving forms the ideal situation for behavioural change (Design Innovation Group, 2015). The new environment will help citizens to overcome the barrier of (unconscious) habitual in-home waste disposal. A habit change will be more easily created. In Rotterdam, in the coming years, many new high-rise residencies will be built. These offer a chance for large scale implementation of the solution.

PART 3

Creation

Chapter 4. Ideation

This chapter presents the ideation phase of the design project. First, an idea exploration has taken place. The many ideas are clustered and evaluated with the City of Rotterdam and high-rise residents in order to come to a valuable concept choice (4.1). Several different solutions spaces within the waste management system are explored during the idea exploration (4.2).

4.1 Ideation approach

60 |

The idea generation phase started with an exploration into all possible solution directions. A selection of promising ideas has been made in collaboration with the City of Rotterdam and from a concept evaluation with high-rise residents. This resulted in one final concept.

4.1.1 Idea generation

The approach of the creation phase is visualised in Figure 28. This phase starts with exploring as many possible solutions to the problem as possible. Interviews with high-rise residents, several conversations with representatives of the City of Rotterdam, existing solutions (see 2.7 Existing interventions) and high-rise residents' ideal scenarios from the generative workshop (Appendix J) provided inspiration. Besides that, a creative session with fellow design students was set-up, in order to generate as many new ideas as possible, in a relatively small amount of time (Appendix L).

4.1.2 Idea selection

The ideas generated during the idea exploration were clustered into fourteen idea clusters (Appendix M-N). These idea clusters are mapped in the visualisation of Rotterdam's household waste management system and indicate the different possible

solution spaces.

A broad range of fifteen ideas, representing the different solution spaces, was selected. This selection of ideas has been discussed with the City of Rotterdam. During this meeting, two representatives of the Urban Management department sorted the fifteen ideas on scales of Innovativeness, Feasibility, and Desirability (Appendix O).

Based on this meeting, three promising concept ideas are selected (Appendix P). High-rise residents evaluate these three concept ideas during a workshop (see Figure 27 and Appendix Q). After this workshop, a final concept evaluation has resulted in the final concept selection (Appendix R-S). This concept is discussed with representatives of the Urban Planning and the Urban Management department. Requirements for further development of this concept solution are gained (Appendix T).

FIGURE 27

Second workshop with high-rise residents. The residens evaluate the three concept ideas.
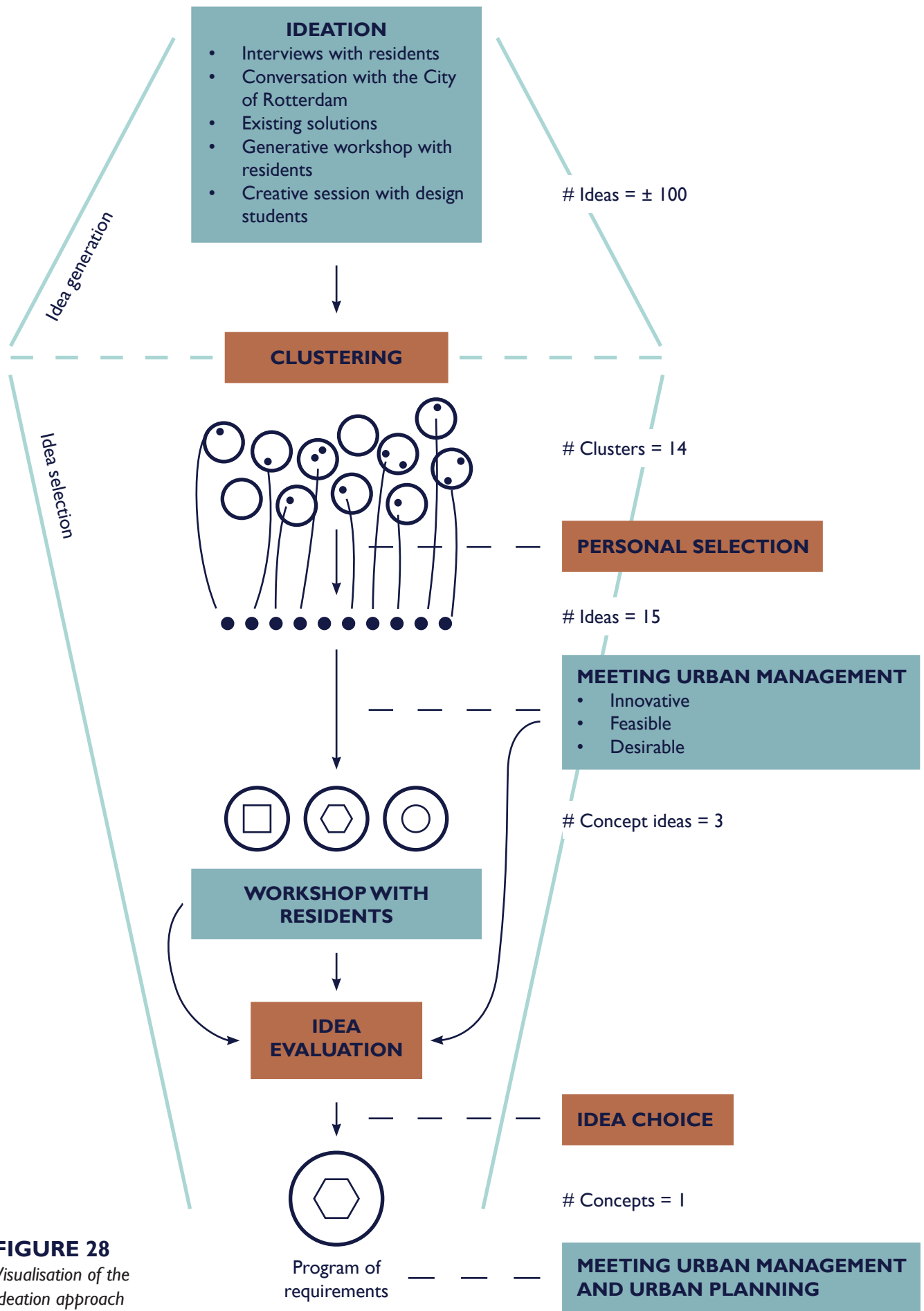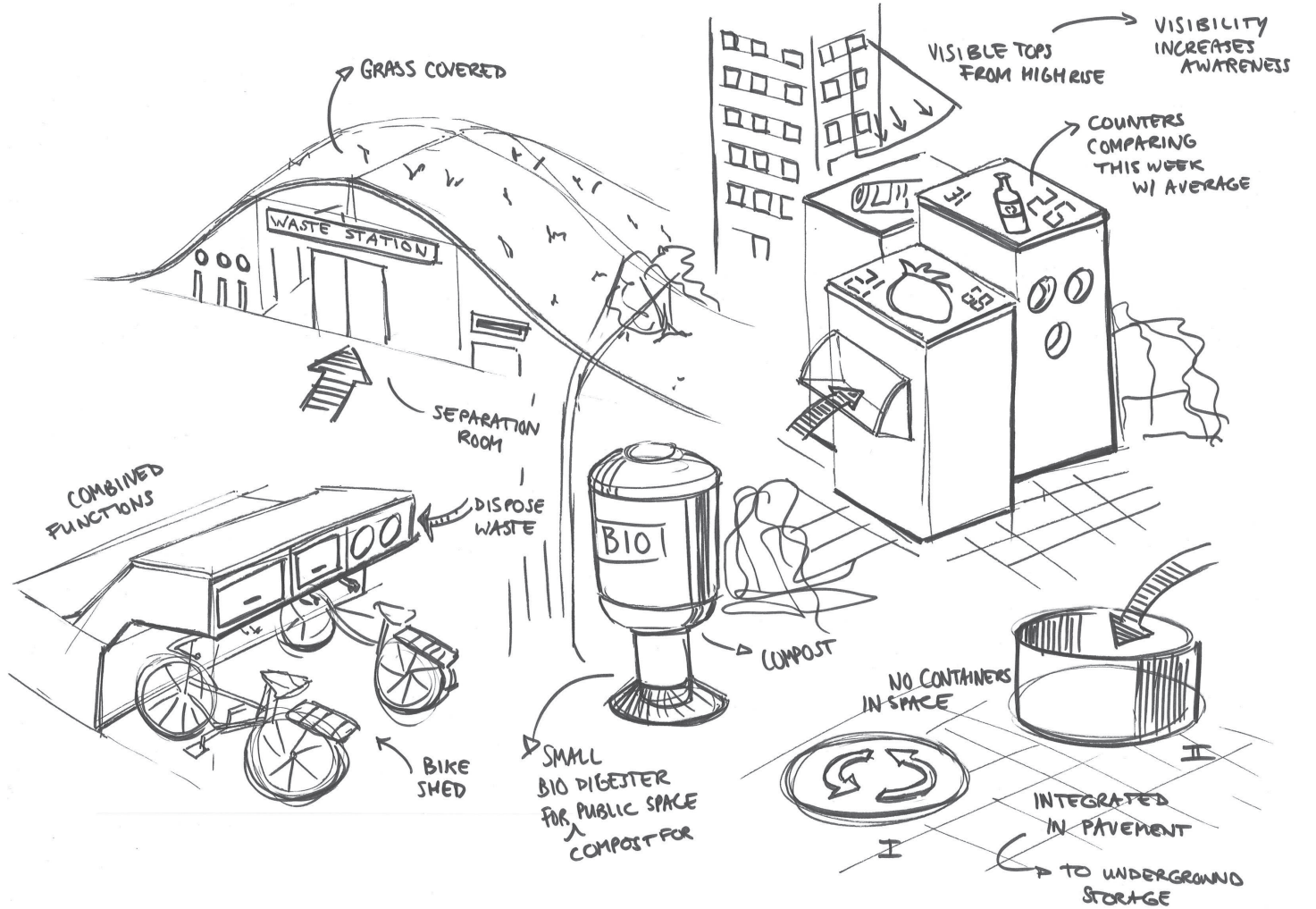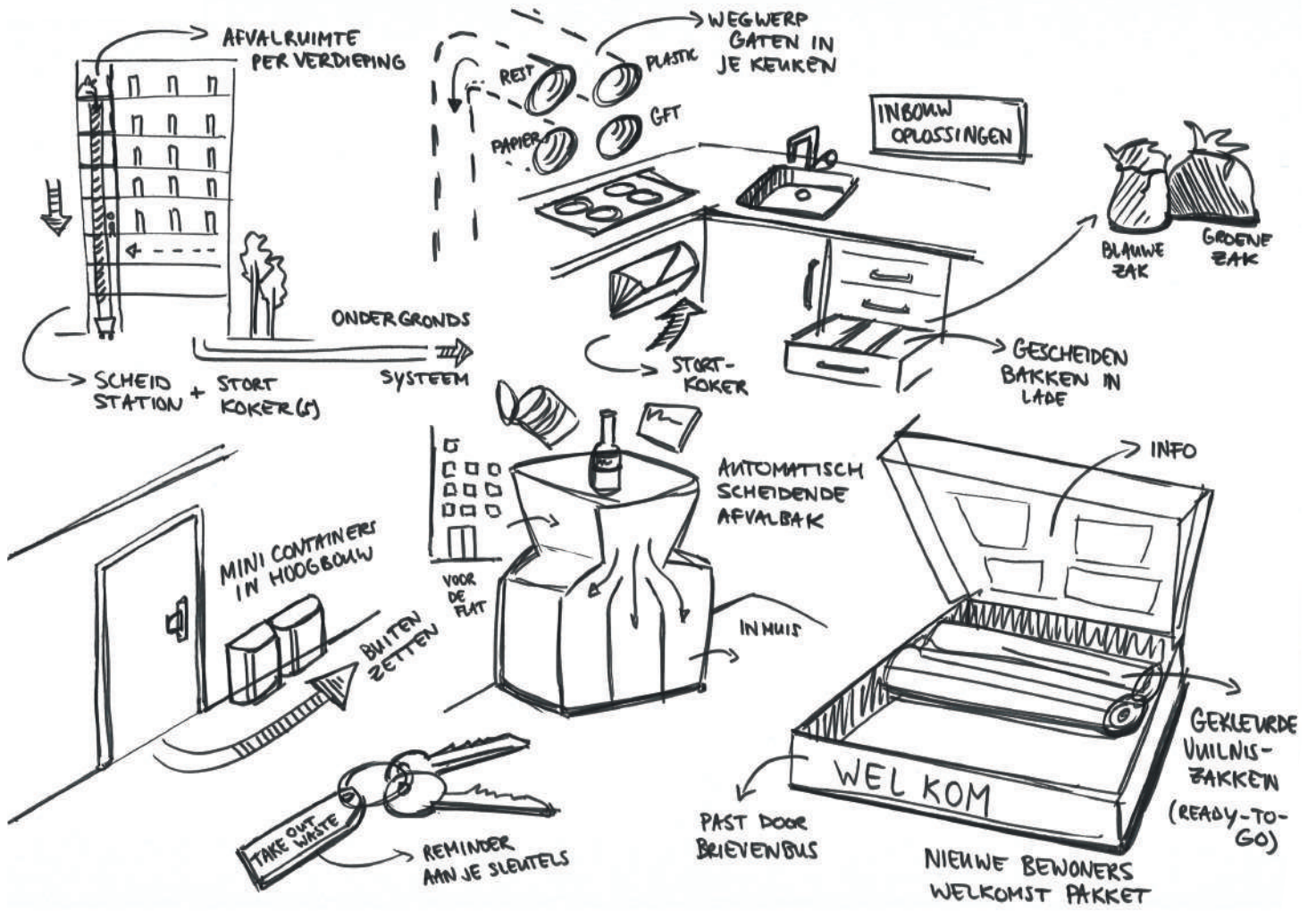
IDEATION

- Interviews with residents
- Conversation with the City of Rotterdam
- Existing solutions
- Generative workshop with residents
- Creative session with design students

Ideas = ± 100

Idea generation

CLUSTERING

Clusters = 14

Idea selection

PERSONAL SELECTION

Ideas = 15

MEETING URBAN MANAGEMENT

- Innovative
- Feasible
- Desirable

Concept ideas = 3

WORKSHOP WITH RESIDENTS

IDEA EVALUATION

IDEA CHOICE

Program of requirements

Concepts = 1

MEETING URBAN MANAGEMENT AND URBAN PLANNING

FIGURE 28

Visualisation of the ideation approach

AFVALRUIMTE PER VERDIEPING

SCHEID STATION + STORT KOKER(S)

ONDERGRONDS SYSTEEM

REST

PLASTIC

PAPIER

GFT

WEGWERP GATEN IN JE KEUKEN

INBOUW OPLOSSINGEN

STORT-KOKER

BLAUWE ZAK

GROENE ZAK

GESCHEIDEN BAKKEN IN LADE

MINI CONTAINERS IN HOOGBOUW

BUITEN ZETTEN

VOOR DE FLAT

AUTOMATISCH SCHEIDENDE AFVALBAK

IN HUIS

INFO

TAKE OUT WASTE

REMINDER AAN JE SLEUTELS

WEL KOM

PAST DOOR BRIEVENBUS

NIEUWE BEWONERS WELKOMST PAKKET

GEKLEURDE VUILNIS-ZAKKEN (READY-TO-GO)

GRASS COVERED

WASTE STATION

SEPARATION ROOM

VISIBLE TOPS FROM HIGHRISE

VISIBILITY INCREASES AWARENESS

COUNTERS COMPARING THIS WEEK W/ AVERAGE

COMBINED FUNCTIONS

DISPOSE WASTE

BIO

COMPOST

BIKE SHED

SMALL BIO DIGESTER FOR PUBLIC SPACE COMPOST FOR

NO CONTAINERS IN SPACE

INTEGRATED IN PAVEMENT

TO UNDERGROUND STORAGE

TAKE OUT WASTE

OUTSIDE

WALL

IN KITCHEN

THROW AWAY WASTE

FOLDABLE PAPER BIN

TO TAKE OUT ON YOUR WAY OUT

REMINDER AT FRONT DOOR + INDICATOR WHAT TO TAKE OUT

SEPARATE YOUR PAPER

TAKE ME HOME

SUPERMARKETS ADVERTISING TO TAKE CARDBOARD BOX HOME TO SEPARATE PAPER

ALL IN 1
IN DIFFERENT COLOURED BAGS

REMINDERS FOR WASTE TAKE OUT PER ACTIVITY

TAKE OUT BIO-WASTE WHEN DOING GROCERIES

TAKE OUT GLASS WHEN GOING TO SPORTS

TAKE OUT PAPER WHEN GOING TO WORK

EARN FROM RECYCLING

PAY FOR WASTE

USE OF PASS + WEIGH SYSTEM FOR ALL CONTAINER

CURRENT ACCOUNT

HOW TO SAVE MONEY

TIPS

FOR WASTE SEPARATION

9

GEDEEL-DE BAK MET BUREN

LUIKJE OM ELKAAR AAN TE SPREKEN OP FOUT GEDRAG

BUREN

JIJ

INFORMELE MEETING MET NIEUWE BUREN

SELECTEER AFVAL

HOOFD BUURT-BEWONER + AFVAL COACH

FOLDER VAN GEMEENTE

LEEGT AUTOMATISCH VIA GOEDE KANT

IN JUISTE BAK

VUILNIS LIFT NAAST PERSONEN-LIFT

BAK MET WEEG-SENSOR

BELONINGEN SPAREN

SPAREN PER GESCHEIDEN KG AFVAL

PASJES SYSTEEM

SELF DRIVING OPHAAL WAGEN IN HET GEBOUW

WASTE APP

STATISTICS

HOE GOED DOET JOUW GEBOUW HET?

"SCORE BORD" GESCHEIDEN AFVAL

ZICHTBAAR VOOR BUREN

€ kg min

REST

PRULLEN BAK OP DE GANG

SOCIALE CONTROLE

4.2 Solution spaces

Fourteen different solutions spaces are found within the waste management system in Rotterdam. In for this project relevant solutions directions, the Social welcoming concept, the Welcome box concept and the Insightful containers concept are created.

FIGURE 29
(Pages 62-63) Compilation of ideas. For all idea sheets, see Appendix M.

4.2.1 Solution directions
An impression of the ideas generated in the idea exploration is visible in Figure 29. More ideas can be found in Appendix M

The fourteen defined idea clusters (see Figure 30), all connect to the one or multiple of the elements of the Motivation Ability Opportunity model (see Figure 17 and Appendix N). This means the ideas in the clusters aim to increase either the motivation, ability or opportunity of high-rise residents or a combination of these factors. Not all idea clusters fall within the framed scope of this project. This project aims to provide a solution in power of the City of Rotterdam to support their citizens with in-home waste separation.

4.2.2 Concept ideas
The three most promising concept ideas selected from the meeting with the Department of Urban Management of the City of Rotterdam (Appendix O) are the Social welcoming concept (A), the Welcome box concept (B), and the Insightful containers concept (C) (Appendix P). The Social welcoming concept is informative, and motivating through personal commitment. The Welcome box is informing, and increasing the opportunity by facilitating. Insightful containers are motivating and informing through tracking.

Conclusion
Three concept ideas are selected in collaboration with the City of Rotterdam. The other solution spaces can provide inspiration for later projects. Evaluating the solutions with high-rise residents is essential.

FIGURE 30 *(Right page) Visualisation of the solutions spaces in the waste management system of Rotterdam. The A, B and C indicate the three concept ideas.*

PEOPLE

Good examples

Reminder

Reward

Social

A

Legal agreements

MUNICIPALITY

A B

Inform

Easier sorting

Tracking C

HIGH-RISE RESIDENT

Easier disposal

In-home facilities

B

HIGH-RISE BUILDING

Positive experience

Guidance to facilities

Outside facilities

C

Transparency of black box

WASTE FACILITIES

PROCESSING FACILITIES
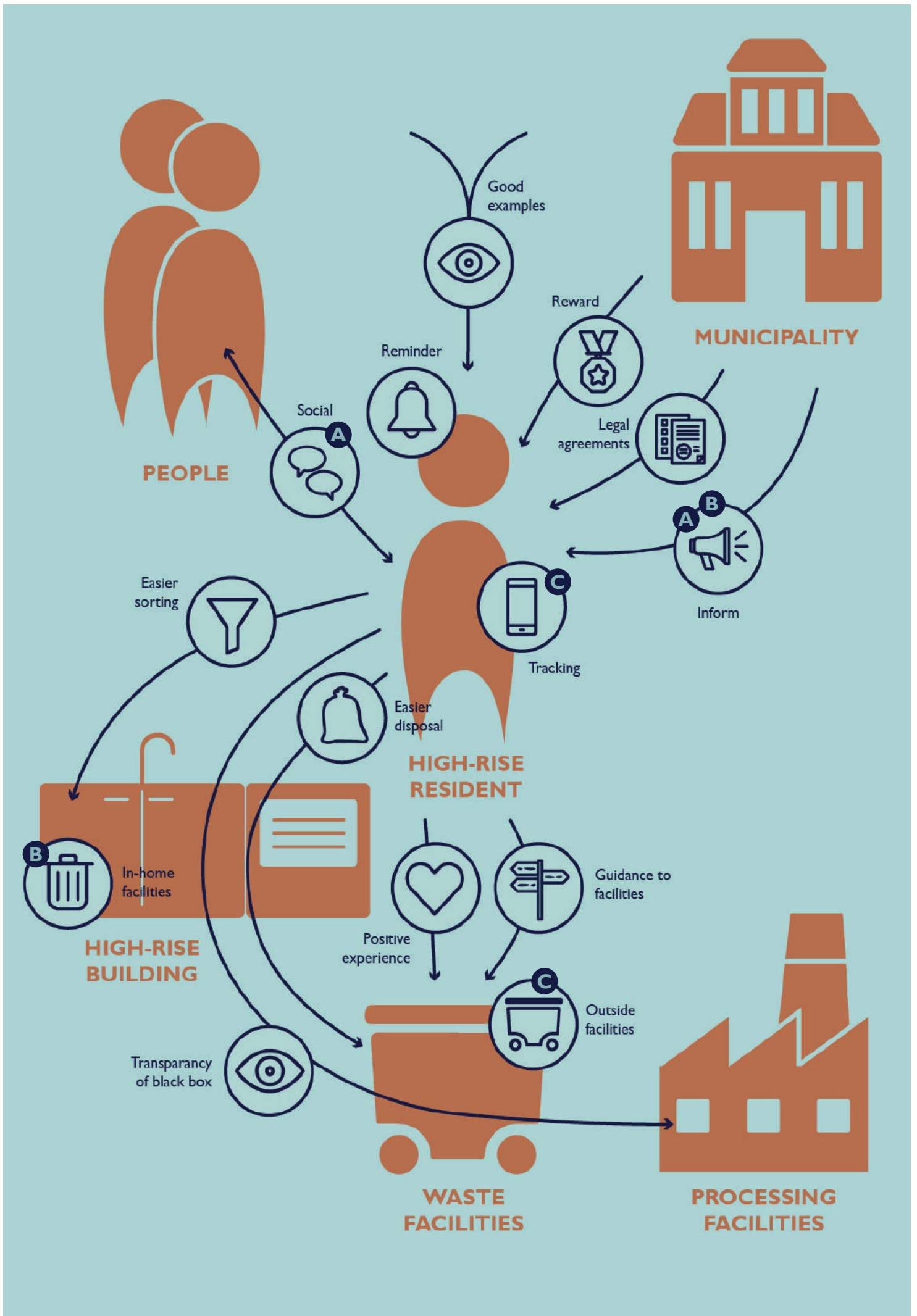
Chapter 5. Final concept

This chapter presents the final concept selected. The Welcome box activates high-rise residents to start waste separation at the moment of moving to a high-rise building in Rotterdam (5.1).

5.1 Welcome box

The Welcome box has been selected as the final concept. The concept is positively evaluated by both the City of Rotterdam and the high-rise residents. The concept lowers the required effort to start waste separation at the moment of moving to a high-rise building in Rotterdam.

5.1.1 The concept

The Welcome box is a package recently moved high-rise residents receive from the City of Rotterdam, within the first month after moving. This Welcome box contains information about the household waste separation policy in the city of Rotterdam. For example, information about the waste types that need to be separated and the locations of municipal waste containers. Besides information, the box contains facilities to start waste separation right away, such as garbage bags or means to create a waste separation system at home.

5.1.2 Tackling the barriers

The Welcome box responds to several motivation, ability and opportunity factors identified during the research phase of this project (see 2.5 Influencing factors for waste separation behaviour).

Regarding the motivation of high-rise residents, it influences the factors *'negative perceptions'*, *'no priority'* and *'extra cognitive effort required'*. The box aims to reduce the negative perception that starting waste separation at home requires a lot of time and effort. Priority is given to this activity, by actively confronting residents with the topic. The perceived extra cognitive effort required is reduced by providing information about what waste types to separate and how. The goal is to show to people that trying waste separation is really easy.

Regarding the ability of high-rise residents, the box serves the most critical factors: *'understandability of the system'* and *'accessibility of the information'*. The Welcome box instructs high-rise residents about their waste separation task, while actively providing them with the information they need in order to execute this task.

Regarding the opportunity of high-rise residents for waste separation behaviour, the box tackles the factor of *'presence of waste facilities'* and *'required effort'*. The box provides in basic in-home waste separation facilities that residents can use right away.

5.1.3 Fit with the design brief

Figure 31 shows how the Welcome box scores along the main requirements of the City of Rotterdam and of high-rise residents. In Appendix R and S the score of the Welcome box is compared to the scores of the other two evaluated concept ideas. In a second workshop with high-rise residents, the Welcome box is evaluated as most desirable concept (Appendix Q).

In line with the design vision (see 3.2 Design vision) the Welcome box is a product to support the City of Rotterdam in their circular ambition. The product is highly feasible and desirable for the municipality (Appendix O). As a medium-high level of motivation is present with the Potential (see 2.6 Personas), the box aims at activating waste separation behaviour among this target group by increasing their ability (see Figure 16) through offering facilities and information. Low effort from high-rise residents is required, as they receive all means at home within the first month after moving. This timing ensures a new waste separation habit can be established before non-separating behaviour has become habitual in their new residency.
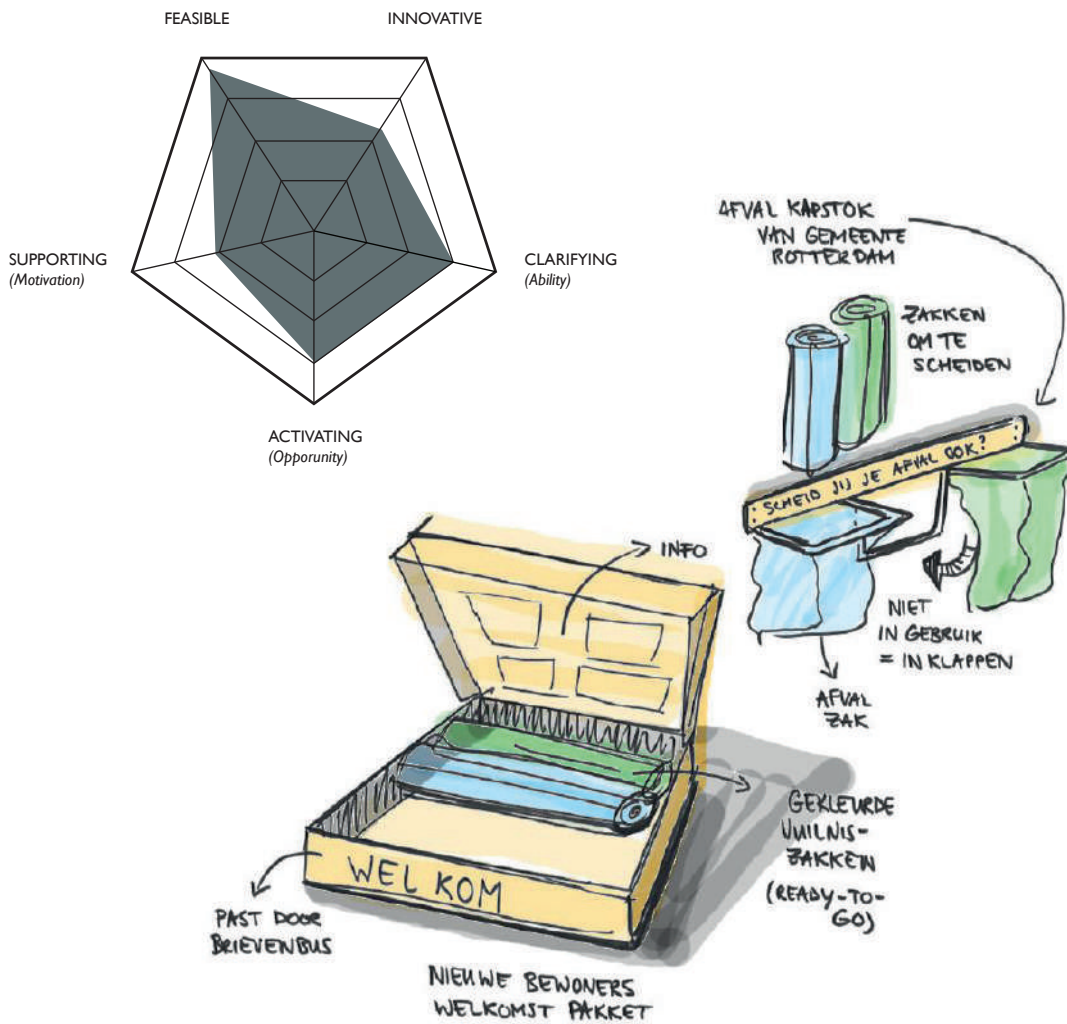
FIGURE 31
Visualisation of the Welcome box concept including its evaluation

5.1.4 Requirements for further development

The program of requirements for further development of the Welcome box can be found in Appendix T. These requirements are jointly set-up with representatives of the Urban Planning and Urban Management departments of the City of Rotterdam.

Main requirements are:
1. The product should inform the user about the household waste collection system in place in the area where the user is living
2. The product should facilitate for the user to start separation of glass, paper and cardboard, bio-waste (if possible), textile, KCA, PMD, residual waste
3. The information provided by the product is the minimally required information needed to act according to the ambitions of the City of Rotterdam, without having to access other information channels

4. The product should fit through a standard letterbox (max. 380x265x32mm)

Conclusion
The final concept is the Welcome box. This box facilitates and informs high-residents to start household waste separation, upon moving into their new residency. The concept is evaluated as desirable by both the City of Rotterdam and high-rise residents. The concept needs to be further developed and evaluated through a small scale pilot.
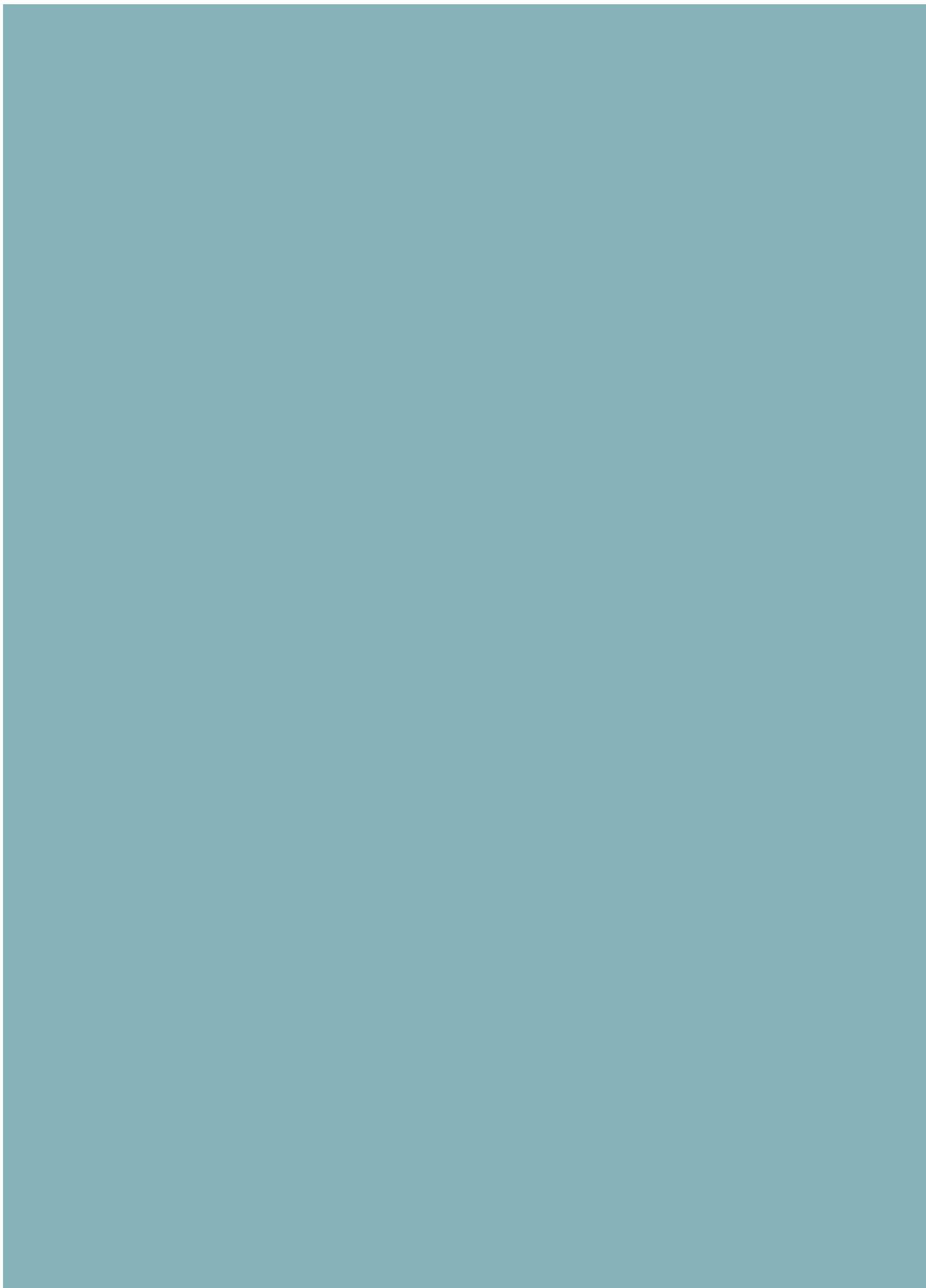
PART 4

Product

Chapter 6. *Schone start*

*This chapter introduces **Schone start**. The City of Rotterdam sends out **Schone start** to high-rise residents right after they moved into their new home. In this way, they actively include their citizens in their circular household waste management ambition (6.1). The user receives the product as a present for direct use. One month after receiving the package a reminder is sent (6.2).*

6.1 *Schone start*

Schone start *is a new concept of the City of Rotterdam, that will be sent to recently moved high-rise residents. It activates their waste separation behaviour in a low effort manner, providing all necessities to take on this behaviour directly.*

With *Schone start* the City of Rotterdam supports high-rise residents in the first month after moving to start household waste separation. The City of Rotterdam has the circular ambition to recycle all of the recyclable household waste by 2030 (Gemeente Rotterdam, 2017). With *Schone start* they actively transfer this ambition to their citizens. Providing this product for free shows citizens the ambition of the City of Rotterdam is real.

Schone start actively lowers the barrier for citizens to change their household waste habits towards (optimising their) household waste separation. The moment of moving provides the ideal moment for habit

change: the citizen finds oneself in a new environment, where new habits need to be created. *Schone start* offers the means for waste separation for the first one or two months after moving, as changing a habit takes 66 days on average (Lally, Van Jaarsveld, Potts, & Wardle, 2010). The product has a temporary lifespan. However, its intended effect on the household waste separation rate is lasting and forms the *raison d'être* of the product.

Schone start consists of a delivery package, containing three waste collection facilities, stickers and the necessary information to start household waste separation (see Figure 33). Based on the municipal personal records database (in Dutch: *gemeentelijke basis administratie*) of the City of Rotterdam, generating and sending out the boxes can be automated. *Schone start* can be sent by mail, as it fits through a standard mailbox (Figure 32).

The perforated lines around the Waste map and Waste guide allow that the Waste map and Waste guide can be pushed out of the delivery package to save for later consultation.

FIGURE 32

Schone start *as received by high-rise residents via mail (Photo by: Lieke van Raan)*

FIGURE 34-35

(Next pages) The Waste guide and Waste map as included in Schone start

FIGURE 33
Schone start
*displayed and
explained (Photo by:
Lieke van Raan)*

Stickers | Icon stickers of the different waste fractions. They offer the possibility to dedicate a particular box, bag, bin or place at home to a certain waste fraction.

Waste guide | Indicating the household waste fractions that can be separated in one's neigbourhood, including separation guidelines (page 76).

Waste map | Indicating the closest waste disposal points relative to citizens' houses. The map is personalised according to one's registered address (page 77).

Large waste box | Foldable cardboard waste box, 16L (A4 size). Suitable to collect paper, glass or small appliances (KCA).

Medium waste bag | Textile waste bag, 9,0L. Suitable to collect textile, glass or KCA.

Small waste bin | Foldable plastic waste bin, 2,4L. Suitable to collect biowaste or batteries and small lamps (KCA).

Suggestions | Indicating proposed usage of the waste collection facilities in *Schone start*.

Alsjeblieft. Speciaal voor jou als (nieuwe) bewoner in Rotterdam!

In Rotterdam scheiden wij ons afval. Dat vinden wij heel normaal. Daarom krijg je van ons dit pakket. Dit pakket helpt jou om ook je afval te scheiden. De Afvalwijzer vertelt je waar je afval bij hoort. De Afvalplattegrond laat zien waar de containers staan in jouw buurt. Scheid je afval en zie het terug als iets nieuws!

Dat doe je goed! Dankjewel.

Afvalwijzer Rotterdam

In Rotterdam scheiden wij ons afval. Van gescheiden afval kunnen weer nieuwe producten gemaakt worden. Doe jij hieraan mee? Deze Afvalwijzer vertelt je welk afval je waarbij weggooit!

TIP Druk de Afvalwijzer uit deze doos en hang het in je keukenkastje!

Glas
- ☒ servies
- ☒ spiegel
- ☒ wijnglas
- ☒ ovenschaal
- ☒ raam
- ☑ glazen potje
- ☑ glazen fles
- ☑ met metalen deksel
- ☑ met restjes

Plastic, Metaal, Drankenkartons
- ☒ aluminium-laagje
- ☒ piepschuim
- ☒ speelgoed
- ☑ plastic fles
- ☑ blikje
- ☑ drankpak
- ☑ met restjes

Papier en karton
- ☒ vies papier
- ☒ vet papier
- ☒ drinkpak
- ☒ plastic folie om tijdschrift
- ☑ kranten
- ☑ dozen
- ☑ nietjes
- ☑ venster-envelop

Groente, fruit en tuinaval
In jouw wijk wordt GFT (nog) niet apart ingezameld. Info: www.rotterdam.nl/gft/

Textiel
- ☒ natte kleding
- ☒ verf- of olievlekken
- ☒ speelgoed
- ☑ (versleten) kleding
- ☑ schoenen
- ☑ riemen
- ☑ knuffels

Klein chemisch afval
- ☒ elektrisch apparaat
- ☒ gloeilamp
- ☒ luiers
- ☒ asbest
- ☑ batterijen
- ☑ spaarlamp
- ☑ medicijnen
- ☑ verf en lak
- ☑ benzine

Grof vuil
- ☒ bruikbare spullen
- ☒ bouwafval
- ☒ puin
- ☒ asbest
- ☑ kapotte meubels
- ☑ matras
- ☑ grote apparaten

Rest afval
- ☒ glas
- ☒ papier
- ☒ textiel
- ☒ apparaten
- ☒ asbest
- ☑ luiers
- ☑ kapot servies
- ☑ pak of zak aluminium-laagje

Vet en olie
- ☒ benzine
- ☑ frituurvet

Grof tuinafval
- ☒ zand en aarde
- ☑ takken en stronken

Oude apparaten
- ☒ koelkast of droger
- ☑ alles met snoer of batterij

**?**

Weet je niet waar je afval thuis hoort? Geen probleem!

De Afvalscheidingswijzer van Milieu Centraal helpt je hierbij.

www.afvalscheidingswijzer.nl

Afvalplattegrond Rotterdam

TIP Druk de Afvalplattegrond uit deze doos en hang het in je keukenkastje!

Deze Afvalplattegrond laat zien waar jij je gescheiden afval kan weggooien of wegbrengen. De containers zijn op loopafstand van jouw huis. Da's dichtbij!

Up-to-date locaties van ondergrondse containers in Rotterdam?

Zoek via de Afvalkalender op jouw postcode.

www.afvalkalender.container-beheer.nl

TIP

Breng nog bruikbare spullen naar Piekfijn.

Piekfijn winkel
Tweedehands spullen
Lege batterijen
Mariniersweg 255

TIP

Dit milieupark is voor jou het dichtstbij:

**Milieupark
Prins Alexander**
Afval, vet en olie, grof vuil, grof tuinafval
Nikkelstraat 131
(ingang Hoofdweg)

🚶 **2 min**
180 m

🚶 **1 min**
75 m

Praxis
Energiezuinige lampen
Elektrische apparaten
Mariniersweg 106

Hoogstraat

Mariniersweg

🚶 **3 min**
230 m

Jouw huis

Groenendaal

🚶 **3 min**
210 m

Gooi PMD of papier weg onderweg naar de supermarkt.

TIP

TIP

Laat bruikbare spullen of grof vuil gratis ophalen! Maak een afspraak via:
📞 14 010 @ https://concern.ir.rotterdam.nl/grofvuil-www/

Burgemeester van Walsumweg

6.2 User scenario

Shone start *is aimed at recently moved high-rise residents in Rotterdam. They receive the product for free after registration with the municipality. The user scenario is illustrated below. Hannah recently moved to a high-rise building in Rotterdam.*
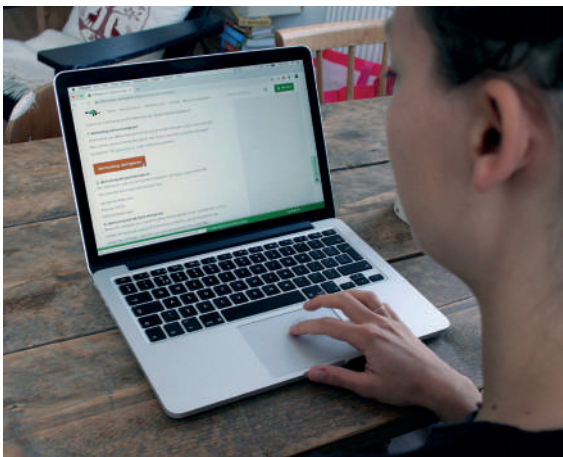
1. Hannah moves to a high-rise building in Rotterdam. She registers her new address online with the City of Rotterdam.

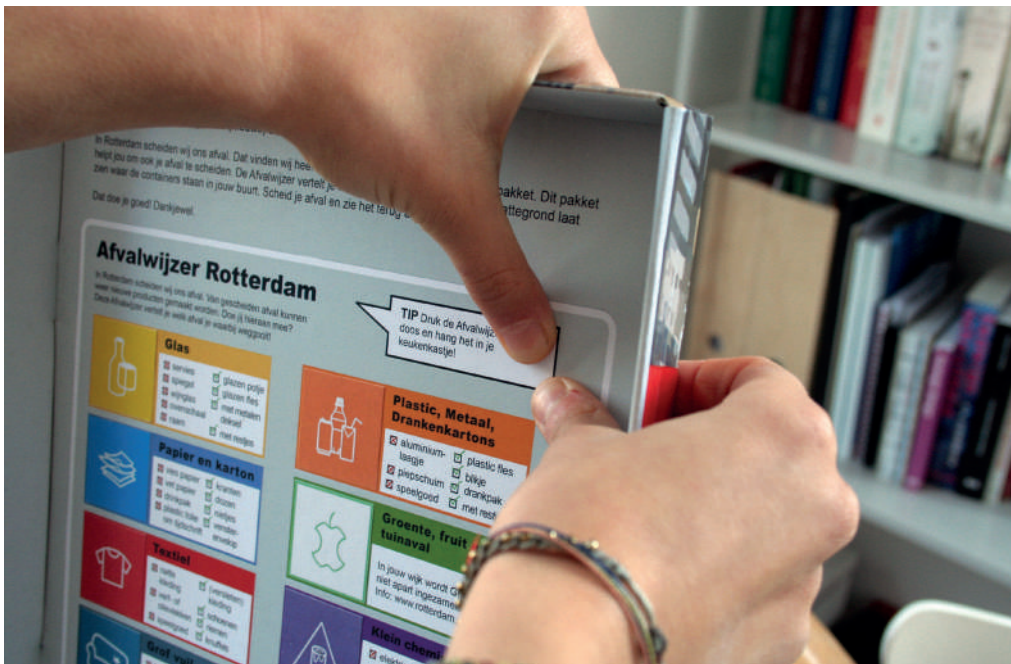2. Within a week after registration, Hannah receives *Schone start* at home by mail.
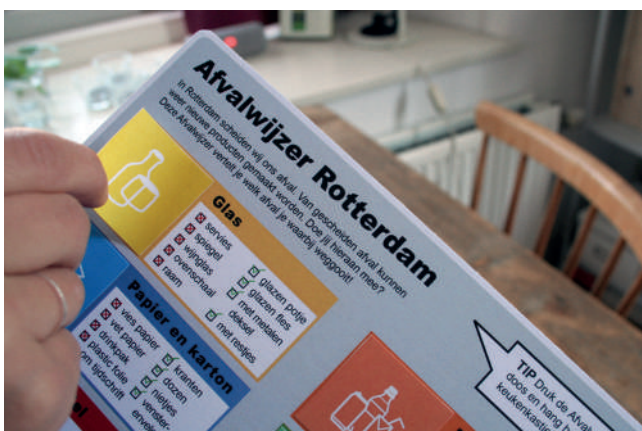

"It's nice to receive a present!"

3. Hannah reacts surprised and curious. She is happy to open the box and explore its content.

4. She finds out the box contains facilities for household waste separation. She goes through the instructions to set up her own in-home waste separation system.

5. Firstly, Hannah presses out of the box the Waste map and Waste guide.

6. Using the provided suggestions, Hannah chooses to use the large waste box for glass, the medium waste bag for textile, and the small waste bin for empty batteries and broken lamps. She sticks the corresponding stickers at the right waste collection product.

8. *Schone start* is complementary to the box she already uses to separate paper and cardboard. Her waste separation system is now ready to use.

7. Hannah decides to hang the Waste guide and Waste map on the inside of the cupboard door in her kitchen.

"I am not sure where to throw away this lamp"

9. During the week, Hannah tries to throw away the waste with the right garbage. When she hesitates, she uses the QR code on the Waste guide to look it up.

10. At the end of the week, Hannah consults the Waste map to find out where to dispose of her waste. She finds out *Piekfijn* second-hand shop is really close to her house. She will go there this weekend to bring away the old chair she no longer wants to have.

Conclusion

New high-rise residents of Rotterdam automatically receive a free Schone start *after registering at the City of Rotterdam. The product facilitates to start waste separation. However, proper follow-up is needed in order to ensure the maintenance of the behaviour.*

11. A month after receiving *Schone start*, Hannah finds a card from the City of Rotterdam in her mailbox. She is invited to order a free refill of her household waste separation box. After scanning the QR code, she decides on an extra large waste box to use for paper. The card also communicates the separation results achieved in Rotterdam so far.

Chapter 7. Product elements

*This chapter explains **Schone start**'s detailing. The content of **Schone start** is optimised for starting in-home waste separation. The product consists of a delivery package, including waste separation facilities (7.1). **Schone start**'s communication is developed to stimulate action. It provides all the essential information, which is communicated directly and effectively (7.2).*

7.1 Product content

The content of Schone start is tailored to the needs of high-rise residents in Rotterdam. A combination of simple and easy to use waste facilities, and the necessary information takes away the required effort to start waste separation. The waste facilities aid direct separated waste collection. All provided content fits through a standard mailbox.

7.1.1 Delivery package

The delivery package (see Figure 36) is folded out of corrugated cardboard, and form fittings make glue unnecessary (Appendix U). The maximum dimensions of 320x265x30mm are within the maximum allowed size of mailbox packages of Post NL (Post NL, n.d.).

FIGURE 36
Delivery package of Schone start *(Photo by: Lieke van Raan)*

The top and bottom parts of the delivery package are perforated. The receiver of the package can push out the Waste map and Waste guide from the package.

7.1.1 Waste facilities

After an exploration (Appendix V-W) and first evaluation (Appendix X-Y) the optimal content of *Schone start* is composed. A large waste box, medium waste bag, and small waste bin are provided. All products are foldable and fit in the delivery package.

Small waste bin
The small waste bin (see Figure 38) has a volume of 2,4L and is die cut out of 0,8mm thick Polypropylene (PP) (Appendix Z). PP is a strong and ductile, making it possible to bend and fold it multiple times without tearing (Kunststofshop, n.d.). Form fittings ensure the product can be folded in shape, without the use of glue (Appendix AA). This material can be used from -10 to 110 degrees Celsius and is suitable for contact with food (Kunststofshop, n.d.). The volume of 2,4L makes the small bin suitable for storage of bio waste. PP is water resistant so that the waste bin can be placed on the kitchen counter.

Medium waste bag
The medium waste bag (see Figure 37) has a volume of 9,0L and is sewed out of textile (Appendix Z). At the top, the bag has a string to close off the bag. The textile material makes it possible to wash the bag if needed. The bag has a hook to hang it and handles to take it.

Large waste box
The large waste box (see Figure 39) has a volume of 16L and is made out of 2,5mm thick corrugated cardboard. Cardboard is cheap and easy to die cut in the right shape (Appendix Z). It is foldable into a box without the use of glue (Appendix BB). The

snap lock bottom provides stiffness, making the box suitable for separating paper or glass. The box has cut out handles for easy transportation.

7.1.3 Costs

The estimated costs of *Schone start* are a total of €5,00-6,00 per box. The price contains the production and printing of the parts (Appendix CC).

Conclusion

The content of the product is optimised based on first user evaluation insights. The package contains three foldable waste collection facilities, made out of Polypropylene, textile and corrugated cardboard. It all comes folded together in a mailbox delivery package.

FIGURE 37 *The medium waste bag (Photo by: Lieke van Raan)*

FIGURE 38 *(left) The small waste bin (Photo by: Lieke van Raan)*

FIGURE 39 *(bottom right) The large waste box (Photo by: Lieke van Raan)*

7.1 Product communication

*The communication of **Schone start** is optimised to stimulate action. The outside of the box is designed as of a present, in line with the principle of reciprocity. The language used is compact and clear. The information is self-explanatory, though references to extra information are provided. The use of icons and colours is in line with the household waste standards in Rotterdam.*

7.2.1 *Schone start* as a present

Reciprocity is one of Dr. Robert Cialdini's six principles of persuasion. The principle says people feel obliged to give back after receiving a gift or service first (Influence at Work, 2018). This principle is already used in (communication) campaigns about household waste separation. For example, in Hoogeveen citizens received the *BESTgoed-tas* to give away old books, toys, and appliances (SHIFT Gedragsverandering, 2016). The same principle is used for *Schone start*: the delivery package looks like a present (see Figure 36), and the citizen receives waste facilities for free. In return, they are asked to separate their household waste.
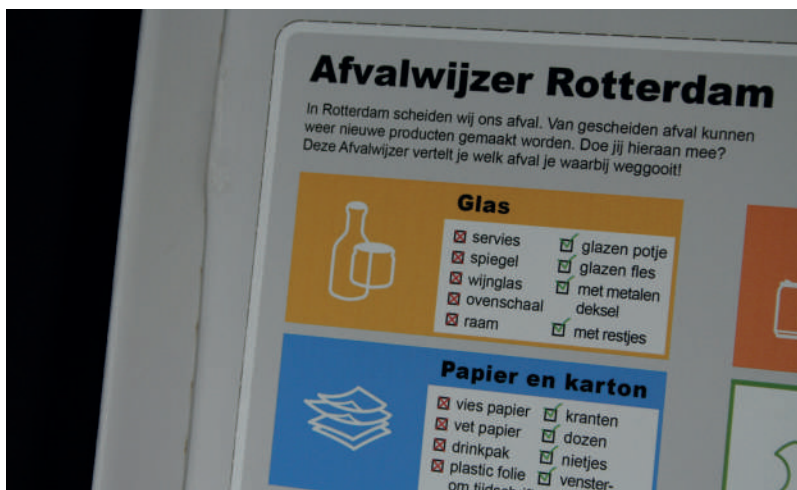
7.2.2 Waste guide and Waste map

The waste guide shows all fractions to be separated with short instructions to what does and does not belong to this fraction. The *don'ts* are mentioned in the left column, as the western reading direction is from left to right. In this way, people read what does

not belong to the fraction first. This order prevents wrong separation behaviour (D&B, 2017). The instructions are short to not overload people with information. Besides, a QR code to *Afvalscheidingswijzer* of *Milieu Centraal* (Translated: *Waste separation guide* of *Environment Central*) is added (Milieu Centraal, n.d.). In this way, no effort is needed for people to access the right information at the moment they need it.

Next to the Waste guide, the box contains a Waste map. This Waste map shows the direct neighbourhood of the high-rise resident. The map is automatically generated based on the address of the receiver. It contains the closest locations of municipal waste containers, supplemented with the locations of KCA disposal points, *Piekfijn* shops and the Environmental park. Without this map, the residents would need over five different webpages to find out this information (Appendix DD). Walking route, time, and distance are indicated to take away all effort for recently moved residents to find out this information themselves. Providence of the complete and necessary information is essential for stimulation of the desired behaviour (D&B, 2017).

7.2.3 Suggestions for use

In order to not only inform people about what to do but to also support them with how to separate waste, suggestions for the use of the waste disposal products are included (Appendix EE). The first product evaluation (Appendix Y) learned that residents do not want to be told how to arrange their waste separation system. However, they needed suggestions for use cases.

FIGURE 40

The order of the separation guidelines (don'ts on the left) prevents separation mistakes

7.2.4 Colours and icons

The colours and icons used in *Schone start* correspond to the standard waste icons and colours used by the City of Rotterdam. For example, the same colours and icons are used on municipal waste containers (see Figure 41). Consistent use of colours and icons helps to create associations with residents, which is desirable (D&B, 2017). Stickers with standard colours and icons make that residents can create in-home consistency with outside facilities. Besides, the stickers serve as reminders for the desired behaviour.

7.2.5 Communication style

The communication style of the City of Rotterdam is direct, compact and understandable. The sentences are formulated actively (Gemeente Rotterdam, n.d.b). This style fits well with the most effective information providence regarding waste separation (D&B, 2017). The language level is B1, which can be understood by 80% of the population (Paktaal, 2019). The used language is Dutch. However, it is recommended to create at least an English version of the package, in order to ensure as many citizens as possible understand the information provided. More than 50% of the population in Rotterdam has a migration background. This means that they or at least one of their parents has been born abroad (Rotterdam in Cijfers, 2019). Packages in additional languages (e.g., French, Arabic) can be created in case where there appears to be a need for it.

7.2.6 Waste facts

The main aim of *Schone start* is to stimulate waste separation behaviour for residents with medium-high motivation, by lowering the required effort to start. Therefore the content, information, and communication focuses on this goal. However, to support the motivation present (or for skeptic citizens to increase their motivation by informing them about the impact one can make with

waste separation) one simple waste fact per fraction is printed on the inside edges of the delivery package (see Figure 42).

FIGURE 41
(Top) Use of waste separation colours and icons on containers in Rotterdam (Image source: Echt Hoogvliet)

FIGURE 42 *A waste fact per waste fraction is printed on the edge of the delivery package*

Chapter 8. Product evaluation

*This chapter evaluates **Schone start**. A pilot test with six high-rise residents receiving a personalised prototype is carried out, from which recommendations for further product development are provided (8.1). **Schone start** can be implemented by developing, testing and upscaling it, so that it can result in the behavioural change desired in the waste management transition in Rotterdam (8.2).*

8.1 Pilot test

A first pilot with the product is carried out by sending six prototypes to six moved high-rise residents in Rotterdam. Overall, the results were positive. The combination of information and facilities supports waste separation. However, the location of the containers is an important influencing factor.

8.1.1 Test set-up

To evaluate *Schone start* six prototypes (see Figure 43) are sent out to six recently moved high-rise residents in Rotterdam. Approximately 1,5-2 weeks after receiving the package, *Schone start* is evaluated with the residents through an interview, to understand how they have used and experienced *Schone start* and how it can be improved. A limitation of this product evaluation is that the residents realise they are participating in a pilot test. However, the participants were not informed about what package they would receive, and no instructions for usage were given apart from the information included in the package. See Appendix FF for the full test set-up.

FIGURE 43

Prototypes with personalised Waste maps used during the pilot test with six high-rise residents in Rotterdam

8.1.2 Pilot test results

Generally, *Schone start* is positively evaluated by the test participants regarding helpfulness with household waste separation (Appendix GG). The remark has to be made that the participants mostly agreed on household waste separation as being important

(Appendix GG). One of the six participants had not opened *Schone start* between receiving it and the evaluation date (19 days later), because of being too occupied with other activities. Therefore no evaluation data of the product usage is known for this person.

Almost all participants highly appreciated the Waste map and Waste guide. They enjoyed pressing both parts out of the package to save it. Positive remarks were made regarding having all information together, complete and personalised (e.g., including locations for disposal of KCA); being informed instead of having to search for the information yourself; knowing what is expected from waste separation in Rotterdam, what waste belongs to which fraction and where to dispose of it.

"Then you do not have to go to Rotterdam.nl yourself and search around till you finally find the right webpage. You just receive such simple overview, which is very nice to have."

Three of the participants set or hung the Waste map and Waste guide in sight (see Figure 44-45). It was requested to have double-sided tape included to enable directly hanging them.

"A friend asked: "Where did you get this map? It would be really great if everyone would have this!""

The waste facilities in the package were (partially) used by four of the participants (Appendix HH). Reasons for not using it were mainly the too small size of the facilities, not liking the looks of them or already having an alternative collection system in place. The facilities supported participants to separate or collect a certain fraction better (e.g., creating a dedicated place for empty batteries) or resulted in activating them to start separating a particular fraction:

"The large waste box was ideal for separating paper, which I started doing upon receiving the package. Before that, I just threw away paper with the residual waste. In retrospect, I think I could have arranged a cardboard box myself earlier, but you just do not do that…"

The facilities were used differently by the participants, in addition to their waste separation system already in place. So was the large waste box used for paper, bottles or a plastic bottle with frying oil (Appendix HH).

Disposing of the separated waste stays a barrier for waste separation after receiving *Schone start*. Two of the participants indicate this as a reason for not starting to separate their household waste more. Both participants have an indoor waste room in their building, where only paper, residual waste and, for one of them, glass can be disposed of.

Schone start fits through the mailbox in four out of six cases (Appendix II). Two participants mentioned it was like receiving a present. Receiving the package as soon as possible after moving into a new house is mentioned as the ideal reception moment. However, receiving *Schone start* was still
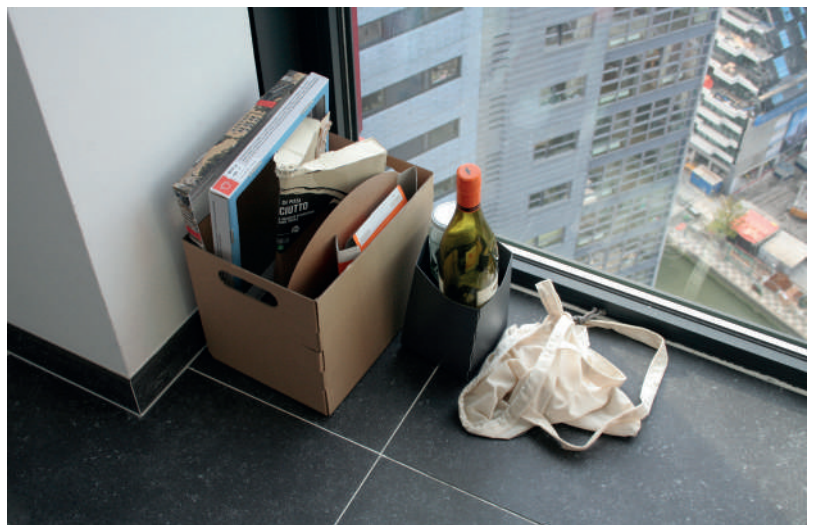
appreciated after having lived somewhere for a couple of months.

8.1.3 Product development recommendations

Based on this pilot, it is recommended to optimise the provided facilities (waste box, bag, and bin) regarding user-friendliness and desirability (size, material, design) in order to maximise the percentage of citizens using them. A challenge is to increase the size of the provided facilities (so they facilitate the disposal of larger waste items and so waste can be collected longer), while slightly

FIGURE 44-45
(Top) The Waste map and Waste guide at the homes of two test participants

FIGURE 46
(Bottom) The provided waste collection facilities are evaluated as too small

decreasing the size of the delivery package (Appendix II). Providing more explicit suggestions of use (e.g., by including photos of the waste facilities in use in context) can be beneficial. It is essential to test the improvements with high-rise residents to evaluate the intended effect.

Next to that, the risk of people not opening the package needs to be decreased by optimising the delivery package of *Schone start* (e.g., by indicating there is a free present inside). For the worst case scenario of citizens not using *Schone start* at all, the negative impact of the product ending up as waste needs to be decreased. For example, by thinking about material reduction, a recollection system and production of *Schone start* out of recycled materials. Through this *Schone start* itself can demonstrate what can be done with separated household waste. The Waste map and Waste guide need a final iteration, ensuring complete information providence and being understood correctly.

Conclusion
- *Receiving* Schone start *and exploring its content triggers the recipient to think about the topic of household waste separation consciously: the package claims attention*
- *Pro-actively informing citizens helps to improve their understanding of what needs to be separated, how to do this and where to dispose of it*
- *Offering facilities combined with information lowers the barrier to start waste separation and activates this behaviour with residents who do not experience significant practical limitations (such as the absence of or large distances to containers) or a lack of motivation (to separate waste for environmental purposes only)*
- *The provided facilities need to be optimised to maximise the number of citizens using them*

8.2 Product implementation

The implementation of **Schone start** *by the City of Rotterdam is a process consisting of multiple phases. First, the product has to be made ready for a large scale pilot. When the pilot succeeds, the implementation can be scaled up. Throughout the waste management transition towards a fully circular system, the product can be adapted when needed.*

8.2.1 Product development
The first step in the product implementation process is to make the product large scale pilot test ready. Based on the first small scale pilot test with six participants, the product content and dimensions can be finalised (see 8.1.3). Besides, it is advisable to automate the generation of the Waste map included in *Schone start* based on postcode, by developing software to plot the locations for disposal of KCA, bulky waste, appliances, and reusable goods in the municipal map with container locations (Appendix DD). The scale and level of personalisation of the Waste map need to be determined while balancing production cost efficiency (generalising it) and user-friendliness (tailoring it).

8.2.2 Large scale pilot
Before implementing *Schone start* throughout the whole city of Rotterdam, it is advisable to organise a large scale pilot (100-200 households) to evaluate the long-term effect of the product. This pilot needs to be carried out in line with the intended scenario of *Schone start*. This means the product will be distributed within the first month after the citizens' registration with the City of Rotterdam. The households are not informed about receiving *Schone start* neither do they know they are participating in a pilot test, as to prevent this from affecting the results. Objective and realistic metrics need to be defined at the start of the pilot for measuring the effect. It is recommended to look into both the quantitative effect on the amount of separated household waste (intended effect) and the qualitative effect on citizens mindset towards household waste separation (valuable side-effect). It is advisable that the pilot takes at least six months.

8.2.3 Upscaling
When the minimal desired effect on citizens' household waste separation behaviour is achieved during the pilot test, the distribution of the product can be scaled up so new high-rise residents in Rotterdam automatically receive *Schone start* upon registration with the municipality.

8.2.4 System transition
Schone start can be used throughout the transition towards a circular waste management system as the product is adaptive to changes. For example, when bio-waste containers are installed in a particular neighbourhood, information about the bio-waste fraction is included on the Waste guide. Additionally, a roll of biodegradable bags can be added to complement the current package. *Schone start* can even be sent to neighbourhoods in Rotterdam with weak waste separation rates to activate the waste separation behaviour of current residents.

8.2.5 Behaviour change
Schone start is a tool to activate household waste separation in Rotterdam. Achieving this goal asks for measures even if this means sending a package that (partially) results in generating more waste. Not all parts of the product will be as useful for all citizens. However, the range of facilities and information is necessary to provide flexibility for end-users to adopt *Schone start* in their current waste management system. Reaching the intended behavioural effect compensates for these limitations. To ensure *Schone start* activates all recently moved residents it is recommended to adapt the language of the package to the nationality of the user.

FIGURE 47

Product implementation steps
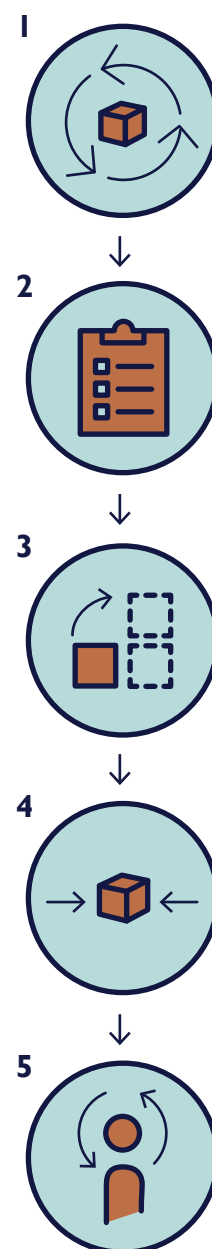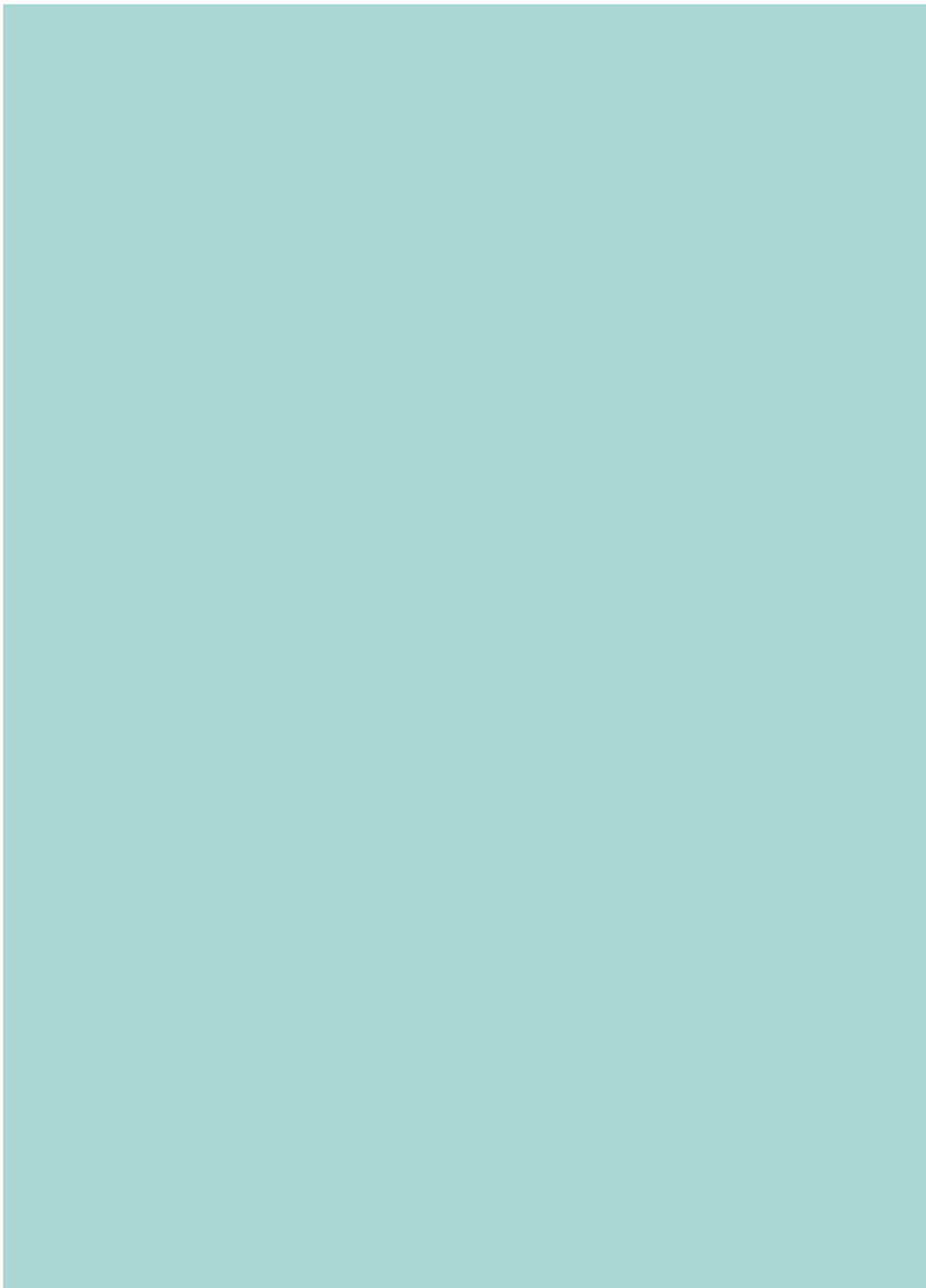
PART 5

Conclusion

Chapter 9. Conclusions & Recommendations

This chapter concludes the project based on the design brief presented in Chapter 3 and provides overall recommendations. An evaluation of the final result with the problem definition is made, where the product's effect on the influencing factors for waste separation behaviour is discussed (9.1). Schone start fits within the formulated design vision (9.2). Recommendations for the continuation and improvement of this project are provided, together with recommendations for supporting the waste separation behaviour in Rotterdam in general (9.3).
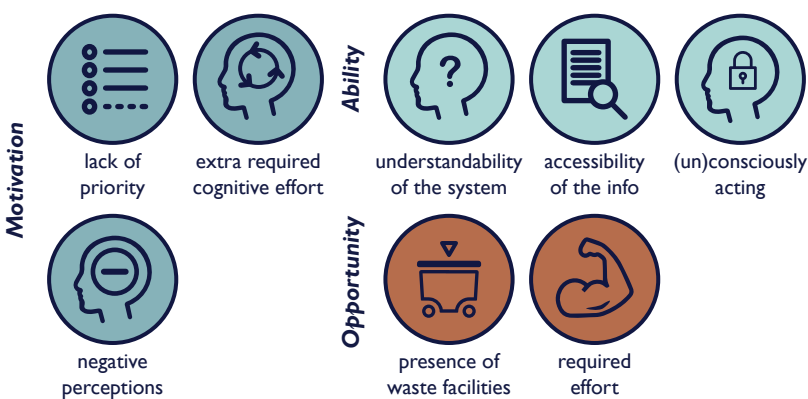
9.1 Evaluation with the problem definition

Based on the performed research a problem definition has been presented (see 3.1). The effort to arrange an in-home waste separation system does not match with the low-medium level of motivation of high-rise residents for waste separation. Schone start helps to create an in-home waste separation system in a low-effort manner.

9.1.1 Influencing factors

The overview of influencing factors for waste separation behaviour in Figure 18 (page 40) shows the complexity of this behaviour. *Schone start* mainly influences the factors displayed in Figure 48. The information provided aims to enhance the users understanding of waste separation in Rotterdam and makes the information effortlessly accessible. Receiving the package triggers consciously considering waste separation and strives to prioritise waste separation for citizens. Pro-actively informing about and providing facilities for waste separation lowers the amount of (cognitive) effort, time and money needed to start or improve this behaviour. The waste box, bag, and bin ensure the presence of in-home waste facilities.

FIGURE 48 *The influencing factors for waste separation that are affected by Schone start*

Motivation
- lack of priority
- extra required cognitive effort
- negative perceptions

Ability
- understandability of the system
- accessibility of the info
- (un)consciously acting

Opportunity
- presence of waste facilities
- required effort

Currently *Schone start* does not yet optimally support high-rise residents in creating waste separation and disposal routines. The Waste guide and Waste map serve as physical reminders. However, users need to actively change their disposal routines themselves, which can create a barrier to start in-home waste separation. Regarding the motivational factors, *Schone start* mainly influences citizens' perception of waste separation as something that is a hassle to arrange. However, to activate not only Potentials (see 9.3.4) extrinsic motivators (such as rewards or free presents) and insight in the (collective) impact of waste separation might be needed. The opportunity for waste separation can be drastically improved by optimising the presence and location of waste containers in Rotterdam (see 9.3.3).

9.1.2 Tackling the problem

Schone start helps to set-up the waste separation system that is currently lacking for many high-rise residents. The offered facilities provide the start of a physical system. The information and physical presence of the product help to start a mental system too. However, a long-term pilot test needs to show whether this is enough help for citizens to create a lasting waste separation routine. *Schone start* lowers the required effort needed to create a waste separation system, matching the low-medium levels of motivation of high-rise residents.

Conclusion

Schone start *is a positive step towards solving the defined problem. Implementation of the product by the City of Rotterdam is expected to have positive results. However, this does not mean that the problem is solved entirely. The City of Rotterdam should still stay active in the facilitation of the transition towards a circular waste management system for their citizens.*

9.2 Evaluation with the design vision

The analysis phase has been concluded by presenting the design vision for this project (see 3.2). Schone start is a good match with the created vision. It can serve as a tool for the City of Rotterdam to activate the desired behaviour of waste separation in their citizens.

9.2.1 Design vision

The design vision I created for this project is:

"I want to design a product to support the City of Rotterdam with activating the "Potential" to improve their household waste separation in a low effort manner within the first month after moving to high-rise in Rotterdam."

9.2.2 Evaluation

As aimed at, *Schone start* is a product usable and useful for the City of Rotterdam. Implementing the product in their municipal services lies within their influence. *Schone start* supports the City of Rotterdam to transfer their circular waste management ambition to their citizens.

The first product evaluation shows positive effects on activation of waste separation behaviour by the combination of pro-actively informing high-rise residents about waste separation and providing the first means for starting the desired behaviour. The combination lowers the amount of required effort. Thus, *Schone start* serves as catalyst for activating waste separation behaviour. According to a test participant:

> *"To make starting waste separation as easy as possible is a purpose that this package serves well"*

Small improvements in quantity or quality of the separated waste after receiving *Schone start* were made (see 8.1 Pilot test).

The participants of the first pilot test were not selected based on being a Potential. From the evaluation interviews and observation of the current waste separation practices, the participants can be categorised as Enthusiasts and Potentials and some Conservative characteristics can be found as well. As recommended in 9.3.5 evaluating *Schone start* for the different personas can help to understand the impact of the product better.

Because of the moment of distribution, *Schone start* supports high-rise residents in the first month after moving to a high-rise building in Rotterdam. The sooner after moving the product is received, the better it supports in setting up a (new) system. However, as one of the test participants mentioned:

> *"I believe that if you send out this package to the whole city of Rotterdam, it will still help people that already live here for 3, 10 or 15 years."*

9.3 Recommendations

Recommendations can be provided for further continuation of the Schone start project, regarding the important boundary conditions for success and the targeted population, for understanding the potential impact of Schone start and for improving the performed research.

9.3.1 Logistics and financial model

Next to further product development and testing, the logistics of production, storage, and automated distribution needs to be arranged in order to realise the product implementation plan (see 8.2 Product implementation). This includes dividing responsibilities of project tasks within the City of Rotterdam. The financial model for testing and large scale implementing the product (e.g., production costs, distribution costs, return on investment) needs to be set-up and approved within the City of Rotterdam.

9.3.2 Development of usage scenario

The product implementation does not stop after the distribution of *Schone start* to recently moved households. In order to ensure long-term effects, the follow-up scenario needs to be detailed. How often do people receive follow-up notes or reminders? How to ensure people keep using the product, or more important, keep separating their waste over time? This scenario needs to be further developed and tested.

9.3.3 Ease of disposal

From the initial research and the small scale pilot test (see 8.1 Pilot test) it has been found that the disposal scenario for household waste is a crucial influencer in household waste separation behaviour. This project mainly focused on in-home waste separation behaviour. However, barriers to easy waste disposal can block in-home waste separation. Therefore, it is essential for the City of Rotterdam to make the disposal of separated household waste more convenient for high-rise residents. It is key to make the disposal of separated waste as easy as (or easier than) disposal of residual waste. Locations of separated containers need to be clustered and as closely as possible (in contrast with the current situation in Figure 49). Indoor waste rooms need to have containers for all common waste fractions or should not be there at all. Next to that, projects to help citizens to build waste disposal in their daily routine, to lower the amount of required and perceived effort for disposal, need to be created. If possible, these solutions can be integrated into *Schone start*.

9.3.4 Target group

This project focused on activating the Potential: the group of high-rise residents already in favour of household waste separation, but not actively performing this behaviour yet. This is an important group to activate; however, 2.6 Personas shows there are also Skeptics and Conservatives. In order to activate these groups, different strategies need to be used. Motivating and informing this group is of particular importance, where the focus should not (only) be on the environmental impact, but mainly on personal benefits. A limitation of this project is the focus on the initial target group of

FIGURE 49

The closest disposal points for paper, glass, textile and PMD are scattered over four different locations (snap from one of the prototypes)

young urban people. Besides that, only Dutch people are included in the research and evaluation phase. A recommendation is to test the effect of this product with a broader and more representative sample for Rotterdam, including the elderly, families and immigrants.

9.3.5 Potential impact

More research can be performed, with different context and demographic factors as variables, to understand the exact impact of the proposed solution. For example, the effect of *Schone start* for different high-rise housing types (e.g., four storey terraced houses, a high-rise neighbourhood or a forty storey high stand-alone residential tower) or different waste facilities (e.g., indoor waste rooms or underground waste containers) can be researched. This can result in knowledge as a basis to tailor *Schone start* to specific city areas to increase its impact. Evaluating the impact of *Schone start* for the defined personas (see 2.6 Personas) can be helpful to understand for whom the product is most effective. The timing of the package can be researched as well, in order to find out if the moment of moving is indeed the ideal timing and if effects are still obtained by sending *Schone start* at other moments. Next to that, *Schone start* could be piloted in other cities than Rotterdam.

9.3.6 Research improvements

The research in this project can be improved in several ways. The overview of influencing factors for waste separation behaviour can be evaluated and elaborated with data from more interviews and generative research with a more representative sample of Rotterdam's citizens. The behavioural and mindset effect of *Schone start* can be evaluated over the long term for multiple demographic target groups and/or geographic areas. More research into existing (waste separation) behavioural interventions or campaigns can generate insights for product and effect optimisation.

Chapter 10. Reflection

In this chapter, I present my reflection upon this graduation project (10.1). Reflecting helps me to understand who I am as a designer, what I learned during this project and what I like about the design process. The most important insights are shared in this chapter.

10.1 Personal reflection

In this reflection, I look back at the start of my graduation project, my role as designer for complex challenges, the use of qualitative research to design for behavioural change, stakeholder engagement and my personal learnings from completing this project individually.

Before starting my graduation project in November 2018, I spend about six to eight weeks discovering what I would like to do as the final project of my time at TU Delft. Reflecting upon my past projects, within and besides my studies, I found out that for me the topic of the project is of less importance than the way of working during the project. I mainly enjoy using my design research and design thinking capabilities and methods to work from the *fuzzy front end* to a concept solution. *"Well great insight,"* I thought, *"But how is this ever going to help me to find or formulate a project?"* Continuing my search, I concluded that what inspires me the most as a designer are *complex societal problems*. With *complex* I mean problems where the solution direction is not yet known. Moreover, the exact problem (often a combination of multiple smaller problems) is not even known yet. Usually, multiple stakeholders make up the scene, and conflicting interests might be present. The cases were solving the problem can lead to value for people, society or the environment (the *societal* part) are the ones where I would preferably want to invest my effort and time in.

Via the Inclusive City Hub, I found out about the *Circular Rotterdam* case of the City of Rotterdam. At first, I doubted about the project, as *'household waste'* did not really appeal to me. But then I realised that if no one likes to *get their hands dirty,* we will never end up with a fully circular and sustainable world. After committing to the problem and diving into the topic, I found out that a lot had been done within the topic already: existing research; several products to reduce or reuse waste; and a broad range of (municipal) projects, campaigns, and interventions. This resulted in the thought:

"How can I ever deliver a valuable contribution to this challenge, within six months, just by myself?"

This caused a slight sense of demotivation. Reflecting upon it now, I can only say that as long as the problem is not yet solved all contributions are valuable to move into the right direction or to learn from.

Next to that, I learned to understand better what the strength of a designer is. Eager to learn and interested in current solution directions, I went to the symposium *Hoogbouw en Afval* in Amsterdam at the start of my graduation project. At the end of the evening, I left slightly disappointed. All talks had focused on (potential) causes for a low separation rate in high-rise buildings. Where were the solutions? Throughout my Industrial Design Bachelor and Master at TU Delft, I learned methods to explore, structure and define a problem and to take these insights to deliver a valuable solution for all stakeholders. This explorative and solution-oriented mind is what makes me as a designer, design researcher and design thinker a valuable and unique contribution in a multidisciplinary project team.

Throughout my studies, I learned a broad range of methods that I applied within this graduation project. My design research phase consisted of a photo (observation) study, interviews, and generative research, among other things. This combination resulted in a richness of data and insights that could not be obtained from quantitative research. This confirmed my preference for qualitative

research in the early phases of a project. The combination of several qualitative research methods complemented each other. For example, from the interviews, it was sometimes hard to understand the users' behaviour. Was the answer of a resident really the reason that he/she did not separate their household waste? Or was it just an excuse as he/she might neither have known the exact reasons for his/her own behaviour? Doing generative research confirmed and completed the interview insights. It was informative to experiment with various workshop setups: from residents' workbooks, where several aspects of their current practices were openly addressed, to letting them comment on existing products and services. It taught me again that as a designer I should not be hesitant to show ideas early on (when they are not yet finished). Feedback can prevent me from putting my effort into 'wrong' ideas or can help to optimise existing ideas. For the same reasons, concept testing or validation is essential, especially when dealing with human behaviour.

This brings me to the complexity of designing for human behaviour. As can be seen in Figure 18 on page 40 of this report, a broad range of factors influences one single human activity. Moreover, human behaviour is not a fixed and balanced process. If one or two of the factors change, the whole situation changes and the observed behaviour may differ from what was to be expected based on the previous behaviour. This makes designing for human behaviour challenging ánd interesting to me as a designer.

This project consisted of multiple stakeholders: the Inclusive City Hub, the City of Rotterdam and Rotterdam's high-rise residents. A valuable insight for my working future is the double importance of stakeholder engagement. Firstly, obtaining insights from the stakeholder perspective is essential to deliver a valuable solution. And secondly, what we should not forget as

designers, is the importance of stakeholder engagement and management for letting your solution succeed. When graduated, this project is no longer my focus. However, the problem is not yet solved. Therefore I am really happy I will have the chance to present my project internally at the City of Rotterdam in June 2019.

Lastly, I want to say something about my personal learnings from doing this project individually. During the start of the project, I struggled to find a balance between my ambitious goals and the realistic amount of work one person can deliver in one day. When starting to set minimum and ambitious goals per week, intending to end up in the middle, I realised how this prevents stress, but might also temper my motivation or the drive for excellence. Towards the end of the project, I managed to balance my ambition and workload better. Therefore, I can now proudly say that

I did deliver a valuable contribution to the challenge, within six months, all by myself.

FIGURE 49 *Me as creative facilitator in the generative workshop with high-rise residents*

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