A CIRCULAR BULKY WASTE COLLECTION SYSTEM FOR THE CITY OF ROTTERDAM.

MASTER THESIS
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PREFACE

Dear reader,

It is hard to believe that one chapter of life is ending, and another is about to begin. My time at the Faculty of Industrial Design Engineering in Delft has come to an end. This thesis represents not only the end of my academic journey but also the beginning of new opportunities.

Back in September 2017, I dreamed of becoming the next Steve Jobs, the designer behind the iPhone 24 or a the creator of a groundbreaking IKEA furniture line using less material but more strength. However, my graduation project is focused on bulky waste management and has taught me something far more important. As product designers we know how to design new things. As strategic designers we know how to bridge the gap from company to consumer. The most important part nowadays is to bridge the gap from consumer to disposal. With this graduation project I was able to expand my knowledge on the life after the usage. It is exciting to figure out how to reuse, recylce or repurpose products that we throw away every single day.

I want to thank my supervisors of the TU Delft, Ellis and Sander, for their guidance and expertise. The bulky waste problem was one I wanted to solve from the perspective of consumer behaviour and an entrepreneurial method. Your critical feedback pushed me to improve my ideas, draw logical conclusions which made my project much stronger. The things I have learned in the past six months are worth so much more than the 30 ECTS I have earned.

I was fortunate to receive coaching not only from TU Delft, but also from the municipality of Rotterdam. My coaches, Daan and Ab, thank you for helping me navigate the complicated world of the municipality. Even if it was something as simple as letting me in after forgetting my pass again, or joining me for one of my pilot days. Your guidance, support and hands-on mentality provided the perfect environment for me to freely create solutions.

Also, I want to thank all the stakeholders that helped me to bring the project to the real-world. Everybody at the Projectbureau and Schone Stad during the research phase. A special thanks to the employees of the Werf Melanchtonweg, whose assistance was crucial during the pilot. Not to forget everybody at the Wijkhub at Teilingerstraat and give-away store, for their advice on neighborhood dynamics and the initiatives of swapping products.

To my friends and family, I can not thank you enough. To all the friends I made in Delft—both inside and outside the faculty—you helped me grow into the person I am today. To my parents, who read the entire draft before the green-light version (that was a hell of a job, believe me) and gave me helpful feedback. Not only during my graduation project, but throughout my entire time at high-school and university. To the rest of my family, your endless support and belief in me have meant everything.

I also want to speak out my gratitude to my friends in and around my hockey team. It might not be common to mention them in a Master thesis, but this past year was a hard one. You were always there for me. Whether it was listening, supporting, or just being there, you made a huge difference.

And last but not least, my boyfriend Berend. Even without reading a single sentence of this thesis, your creative ideas and entrepreneurial mindset inspired me to think differently and kept me going. Thank you, honey.

Now it is time to start diving into this thesis, I hope you find the results as exciting to read as they were to create. And to leave you with a thought that guided my process, I will share this quote from Albert Einstein:

"We cannot solve our problems with the same thinking we used when we created them"

(Albert Einstein, theoretical physicist)

Keep that thought and have fun reading. You know you will.

Emma Groenewold

Rotterdam & Delft
December 2024

EXECUTIVE SUMMARY

This thesis addresses the issue of bulky waste management in Rotterdam. The processing methods are underdeveloped, and inefficiencies in the current collection system result in valuable materials being frequently incinerated. The city strives to achieve its circularity goals: to prevent waste, improve separation, and ensure high-quality processing. This thesis presents a circular service system that integrates citizen behaviour, innovative waste management, and stakeholder engagement to give bulky waste a second life and save valuable products and materials from incineration.

The research used the principles of Effectuation to create opportunity spaces within the scope. With the use of participatory design methods the collaboration with citizens and municipal employees was ensured. This was needed for emphasizing practical engagement and real-world solutions. This thesis is structured by integrating Effectuation with the New Product Development process. This entrepreneurial thinking approach and iterative design explored possibilities for adaptive problem-solving.

The current bulky waste collection system in Rotterdam is inefficient and environmentally harmful. The barriers were identified through three distinct processes: the internal operations of the municipality, the structure of facilities for bulky waste, and the interactions between citizens and these facilities. Despite these barriers, they could be formed into opportunities for innovative solutions. Insights of the research phase confirmed that a redesigned collection system is needed. It revealed that citizens prioritize convenience, have no transport or motivation to dispose bulky waste sustainably. The design challenge outlined the importance of an on-demand transportation service that combines convenience for citizens with recovering as much material as possible.

There were three concepts created according the design challenge and compiled goals. Each concept had to comply with the principles of reduce the residual waste, rethink current waste management, recover as much materials, repurpose the reusable items collected and relieve the citizens and municipality. The created concepts included (1) a material platform for reuse and repurposing, (2) a sponsor system to encourage community donations, and (3) a second-hand transportation platform for rapid turnover of reusable items. These concepts are combined into one pilot to test real-life situations. The purpose of the pilot was based on the validation on four areas: feasibility of the logistics, preference of the citizens, convenience experienced by the collector and financial viability.

The pilot refined that the logistics with a cargo bike-based collection system was operationally feasible. Appointment scheduling, supported by photo uploads, allowed for more accurate volume estimation and route optimization. To improve the collectors convenience, the shifts should be limited to four hours and the bikes need to contain rain covers to ensure dry transportation of products and materials. In the future the use of electric vehicles can attract a wider range of employees suitable for the bulky waste collection.
Financially, the pilot demonstrated that transitioning to cargo bikes is viable. An external revenue stream from items for sale further enhancing this viability. The collection fee of €10 proved to be accepted by the citizens.
The preferences of the citizen highlighted the emotional satisfaction with knowing their products would find a new owner. This positively influenced their perception of the service. The emotional connection to reuse created trust and made the service more appealing. Additionally, citizens donated more items when it could benefit citizens in need. This response highlights the potential for the service to enhance community engagement while aligning with the municipality's goals of reducing waste.

RepurposeRide is the final design. It is a transportation network using cargo bikes to redirect bulky waste within neighborhoods, giving items a second life through reuse at Wijkhubs and giveaway stores. Materials of lower status are delivered to environmental parks for high-quality processing. This system prevents waste from being crushed in compactor trucks, contributing to waste prevention, improved separation, and high-quality processing. RepurposeRide is positioned as a social enterprise dedicated to achieving Rotterdam's circularity goals through community engagement and environmental impact. By using municipal means such as cargo bikes and storage facilities, the service can easily be integrated into current municipal operations.

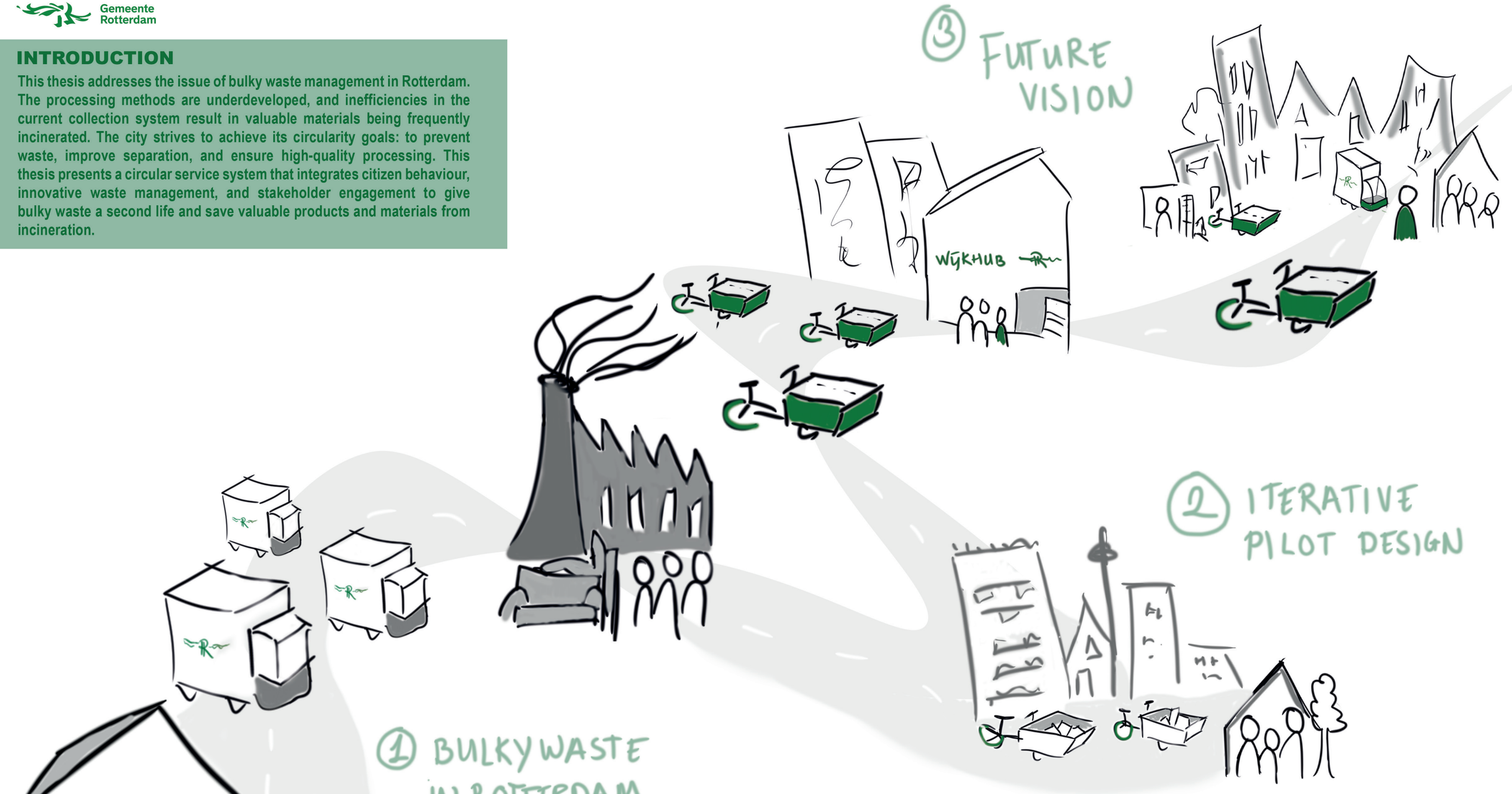
Implementation can be done by following the strategic and tactical roadmaps. The strategic roadmap defines the overall development towards a future vision. The tactical roadmap provides detailed actions according to chosen roadmap elements per horizon. These roadmap elements contain trends in the market, rules and regulations, stakeholder engagement, technology developments, behaviour changes and system integrations. These steps ensure that RepurposeRide aligns with the predefined goals while adapting to the municipal environment.

In conclusion, RepurposeRide demonstrates a citizen-centered, circular bulky waste collection service for Rotterdam's waste management. Circularity, convenience and community engagement are the foundations to support reuse, enhance material recovery and prevent waste. While limitations remain, the project provides a basis for further development. RepurposeRide strives to combine environmental responsibility with social impact, establishing an identity rooted in sustainable entrepreneurship.

Gemeente Rotterdam

INTRODUCTION

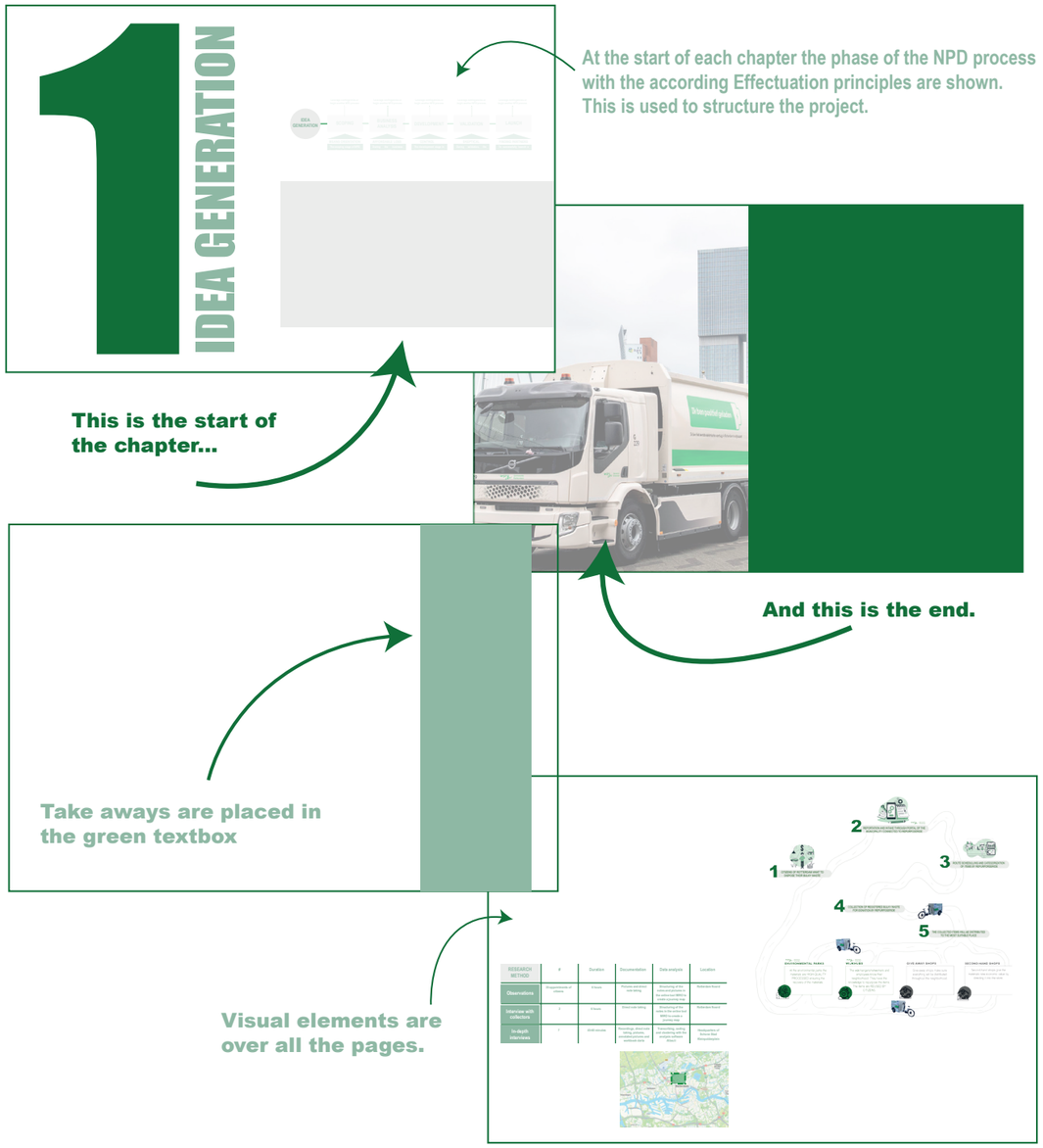
This thesis addresses the issue of bulky waste management in Rotterdam. The processing methods are underdeveloped, and inefficiencies in the current collection system result in valuable materials being frequently incinerated. The city strives to achieve its circularity goals: to prevent waste, improve separation, and ensure high-quality processing. This thesis presents a circular service system that integrates citizen behaviour, innovative waste management, and stakeholder engagement to give bulky waste a second life and save valuable products and materials from incineration.



CONCLUSION

RepurposeRide demonstrates a citizen-centered, circular bulky waste collection service for Rotterdam's waste management. Circularity, convenience and community engagement are the foundations to support reuse, enhance material recovery and prevent waste. While limitations remain, the project provides a basis for further development. RepurposeRide strives to combine environmental responsibility with social impact, establishing an identity rooted in sustainable entrepreneurship.

READING GUIDE



Important statements and questions are shown in this typography?

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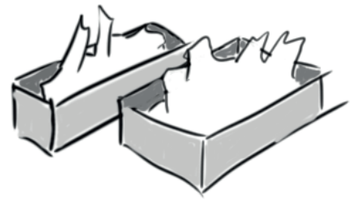
Stakeholders list

Citizens

The citizens of Rotterdam have participated in this research to examine their disposal behaviour.

Schone Stad

Waste management of Rotterdam is executed by the division Schone Stad of the municipality. Under Schone Stad the Projectbureau operates as the innovation department.



Environmental Parks

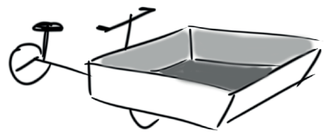
The waste collection areas are in the periphery of the city. In different fractions the waste is source separeted as much as possible.

The collection service

Bulky waste collection in Rotterdam is done with the compactor truck.

Wijkhubs

The Wijkhubs in Rotterdam are the bridge between the citizens and the municipality. There are locations throughout the city.



Cargo bike

The cargo bike is from the municipality of Rotterdam and used for the project ‘Leenvervoer’. In this research it is used as a mean for RepurposeRide.

External partners

Second hand shops, give-away stores and educational institutes that could serve as distribution channels.

De HER

De HER is a circular center that will open its doors in January 2025. This is the new environmental park for Hillegersberg-Schiebroek.

LIST OF DEFINITIONS

Glossary

Waste management

Bulky waste
Household waste that is larger than certain dimensions. You can think of your old sofa, closet or washing machine.

Compactor truck
The truck that is used for the collection service of bulky waste in Rotterdam. This truck has a compact element that crushes the material. It results in more space for waste transport.

Environmental park
Locations throughout the city for bulky waste drop-off. The park is divided into several containers for source-separation of the waste.

Projectbureau
The projectbureau is the innovative department of Schone Stad. A lot of new initiatives are investigated and tested by the advisors of this department. This is the department I am part of during my internship at the municipality of Rotterdam.

Grondstoffennota
The nota of the goals regarding the materials of waste. In this nota the statements of the circularity goals are written.

Design methods

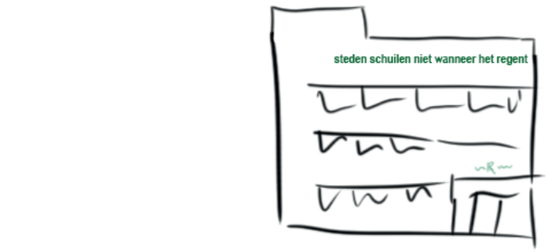
Effectuation
The entrepeneurial method used for this graduation project. This method is developed by Sarasvathy (2001).

NPD
New Product Development. This is a product development method written down in a stage-gate process.

Participatory design
A design method whereby the target group is invited to participate in the design process.

Translations

EN	NL
Bulky waste	Grofvuil
Environmental park	Milieupark
Compactor truck	Pers kraak wagen
Second hand shops	Tweedehands/Kringloop
Cargo bike	Bakfiets



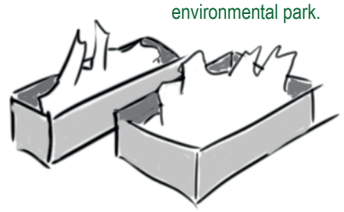
Schone Stad
Responsible for processing the bulky household waste of the citizens of Rotterdam.

Citizens of Rotterdam
Can choose between the collection service or drop-off at the environmental parks.

Illegally placed on the streets
The compacter truck collects the bulky waste placed on the street.

Collection service
The compacter truck collects the bulky waste placed on the street.

Drop-off at environmental parks
Citizens bring their bulky waste to the environmental park.

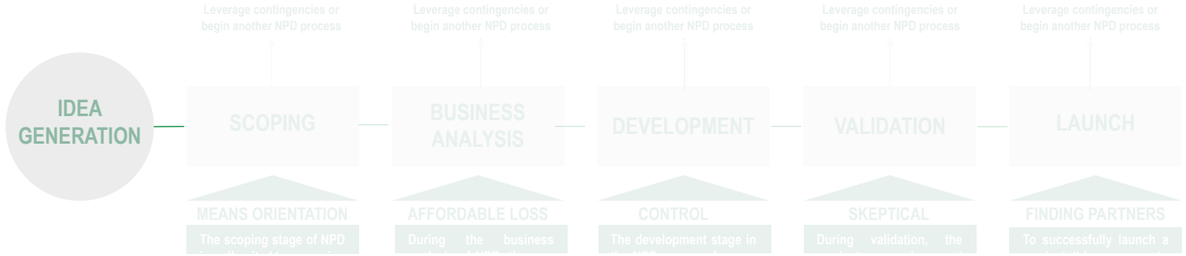


After separation and incineration
All the waste from the collection is transported to the processor. At the processor the waste is after separated and later incinerated.

Reuse and recycle possiblities
At the environmental parks the waste will be source-separated. It is suitable for reuse and recycling.

TABLE OF CONTENTS

1 IDEA GENERATION



PROBLEM DEFINITION

1.1 What is the scope of the project? Why do we need to solve this?

The subject of this project is the management of bulky waste in Rotterdam. Bulky waste reduction is one of the pillars of the city to reduce their residual waste streams. Due to its undefined and underdeveloped waste stream, bulky waste ends up in incinerators, despite its reuse and recycle potential.

Introduction

In this chapter the need for a circular economy is stated. The goals of the Netherlands and the mission of the city of Rotterdam are introduced. Furthermore, the context of the waste management of Rotterdam is explained according to the Grondstoffennota (Gemeente Rotterdam, 2023).

1.2 Which design approach is most appropriate to handle this type of problem?

The principles of effectuation, as it relates to the structure of the New Product Development process, is employed to address this problem. The bulky waste issue cannot be solved through theoretical methods alone, it necessitates a hands-on and entrepreneurial thinking approach.

Approach

The chosen approach is Effectuation by Sarasvathy (2008). To give this project more structure, the research of Duening et al. (2012) is used. In that research, the principles of Effectuation are plotted within the stage gate process of New Product Development.

Methods

For idea generation I used participatory design and qualitative research. In this chapter I explain why this was suitable and how this is validated and used in combination with the chosen approach of Effectuation.

PROBLEM DEFINITION

Introduction

The issue at the core of this graduation project is defined by a macro-level perspective. The next step is how this is addressed in the Netherlands and how it contributes to the problem identified by the city of Rotterdam. Figure 1 provides a schematic representation of this.

World

Our dependence on non-renewable and polluting energy sources significantly drives the climate crisis, making an equitable shift to renewable energy essential for reducing global emissions. However, this transition addresses only part of the problem. According to research from the Ellen MacArthur Foundation (2019), switching to renewable energy can only mitigate 55% of emissions. The remaining 45% originates from the production of everyday items such as cars, clothing, and food. The need to change our consumption behaviour is more necessary than ever. Developments in circular manufacturing and waste management is needed to create a system that can work long-term for the economy, society, and the environment (Ellen McArthur Foundation, 2024). The importance of starting the circular economy in cities is because of their dense concentration of resources, capital, data, talent, and hubs of innovation. This makes them ideal for supporting circular business models like sharing, reuse, and product-as-a-service systems.

The butterfly diagram: visualizing the circular economy

The butterfly diagram on Figure 1 (Ellen McArthur Foundation, 2024), shows a visual representation of the circular economy. It illustrates the continuous flow of materials within two cycles: the technical cycle and the biological cycle. In the technical cycle, products and materials are maintained in circulation through reuse, repair, remanufacture, and recycling processes. Conversely, the biological cycle involves returning biodegradable materials to the earth, thereby regenerating natural ecosystems. The Dutch governments (R-ladder - Strategieën van circulariteit. (n.d.)) use a different model but it used the same principles. This one is called the R-ladder, a framework that illustrates the degrees of circularity strategies which is comparable to the technical cycle of the butterfly diagram.

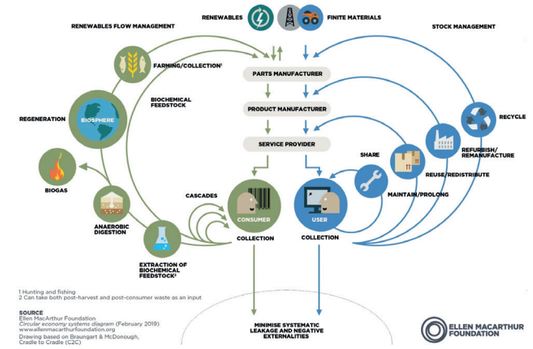
The Netherlands

In 2016, the Netherlands announced its goal to transition to a circular economy with the launch of the national initiative "The Netherlands Circular by 2050." The government hopes to achieve a fully circular economy by 2050 and 50% circularity by 2030 with this program. To do this, efforts are made to reduce the amount of raw materials used, select substitutes, increase the lifespan of products, and guarantee superior processing (Ministry of Infrastructure and Water Management, 2024). A Raw Materials Agreement and Transition Agendas were followed by the start of the first 2019–2023 implementation program. The National Circular Economy Program 2023–2030 (NPCE) is the most recent comprehensive national policy document (Ministry of Infrastructure and Water Management, 2024). New rules and regulations will help develop circular economies.

Waste regulations

Dutch waste legislation is based on the European principle of "the polluter pays." The Environmental Management Act (Wet Milieubeheer) forms the foundation for the rules and guidelines regarding waste management in the Netherlands. This principle means that the costs for waste processing and disposal are charged to those responsible for producing the waste. This encourages producers and consumers to reduce waste and promote recycling.

The 'Wet Milieubeheer' contains provisions on waste prevention, separation, collection, processing, and disposal. Municipalities have responsibilities such as organizing waste collection and processing. They must develop waste policies and implement measures to promote waste prevention, separation, and recycling. Municipalities are also given specific tasks, allowing them to regulate and implement local waste management. As a member of the European Union, the Netherlands also follows European directives and regulations.



WORLD

45% of the emissions orginates from the production of everyday items. The need to change our consumption behaviour is necessary. Developments in circular manufacturing and waste management is crucial to create a system that can work long-term for the economy, society, and the environment (Ellen McArthur Foundation, 2024).

THE NETHERLANDS

The government wants to achieve a fully circular economy by 2050 and 50% circularity by 2030.

ROTTERDAM

A decrease of household waste from 281 [kg] per person in 2021 to 240 [kg] per person by 2026.

PROBLEM

Despite its reuse and recycle potential, bulky waste streams are undefined and under developed. It ends up in the incineratiors.

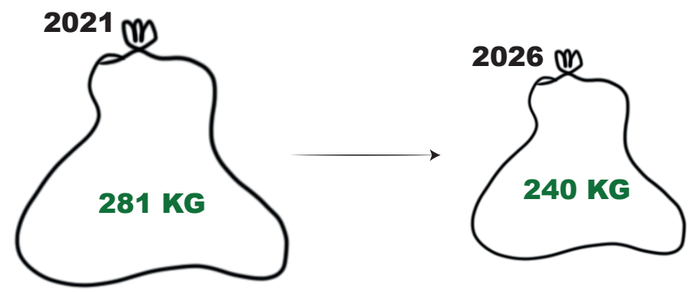


Figure 1: The butterfly diagram (Ellen McArthur Foundation, 2019) and R-ladder principles (R-ladder - Strategieën van circulariteit. (n.d.))incorpotated with the worldview of the problem definition. At last the goal of Rotterdam.

Rotterdam

Rotterdam has circular ambitions and envisions itself as a waste-free city by 2050. Waste-free denotes a system in which all collected waste is directed towards destinations, where it can be effectively utilized or repurposed. The Grondstoffennota (2023) outlines more detailed targets, seeking to decrease household waste from

281 [kg] in 2021 to 240 [kg] per person by 2026.

Rotterdam is aiming to reduce waste generation, promote household waste separation, and maximize the reuse of residual streams (Grondstoffennota, 2023) (Figure 2).

Among these waste streams is bulky waste, often overlooked despite its potential for recycling and reuse. These streams remain undefined and underdeveloped because of the rare initiatives and mentality of the citizens.

Bulky waste is undefined. It is a collective term for everything that does not fit within one of the fine material waste streams and does not fit in the regular residual waste bin. The following definition is used by the municipality:

"***Bulk waste from households, that is larger than certain dimensions and does not fit into a regular container.***"

Rotterdam prioritizes bulky waste management, among with some other pillars, shown in Figure 3 (Grondstoffennota, 2023). To achieve the circularity goals of 2050, radical change in system-infrastructure is needed, otherwise the municipality will be dependent on the technical developments of processing companies in the future.

Grondstoffennota

The municipality of Rotterdam identified pillars (Figure 3) to focus on to achieve their goals. The pillars include fine, bulky and industrial waste in forms of materials. Waste prevention and citizen engagement (communication, behaviour influence education, participation and neighborhoods) in forms of change in environment and mentality. Also, the divisions of waste streams are structured. In the next sections, more information will be provided about the pillars and waste streams that are relevant the bulky waste problem.

Waste management facilities

In Rotterdam, the waste management system is organized and handled internally. Only the processing is done by commercial partners. The citizens are paying annual waste taxes (between €337,10 and €437,30 per household) (Gemeente Rotterdam, 2024). This variation is dependent on the number of residents in your household. This is an all-inclusive price to make use of all waste management facilitations of Rotterdam.

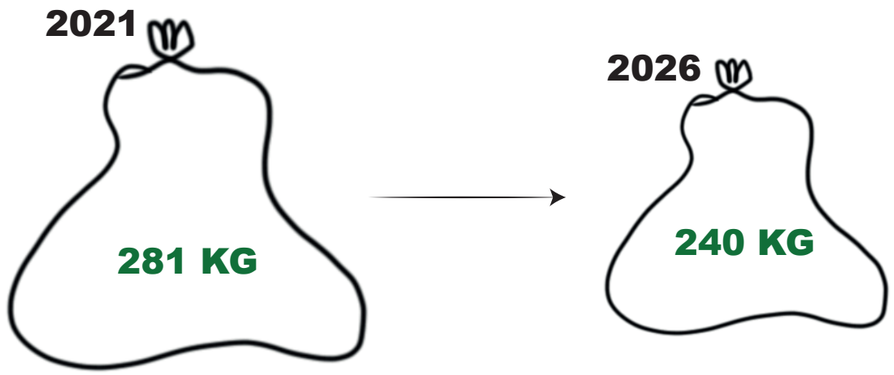


Figure 2: The goals of Rotterdam regarding residual waste (Grondstoffennota, 2023)

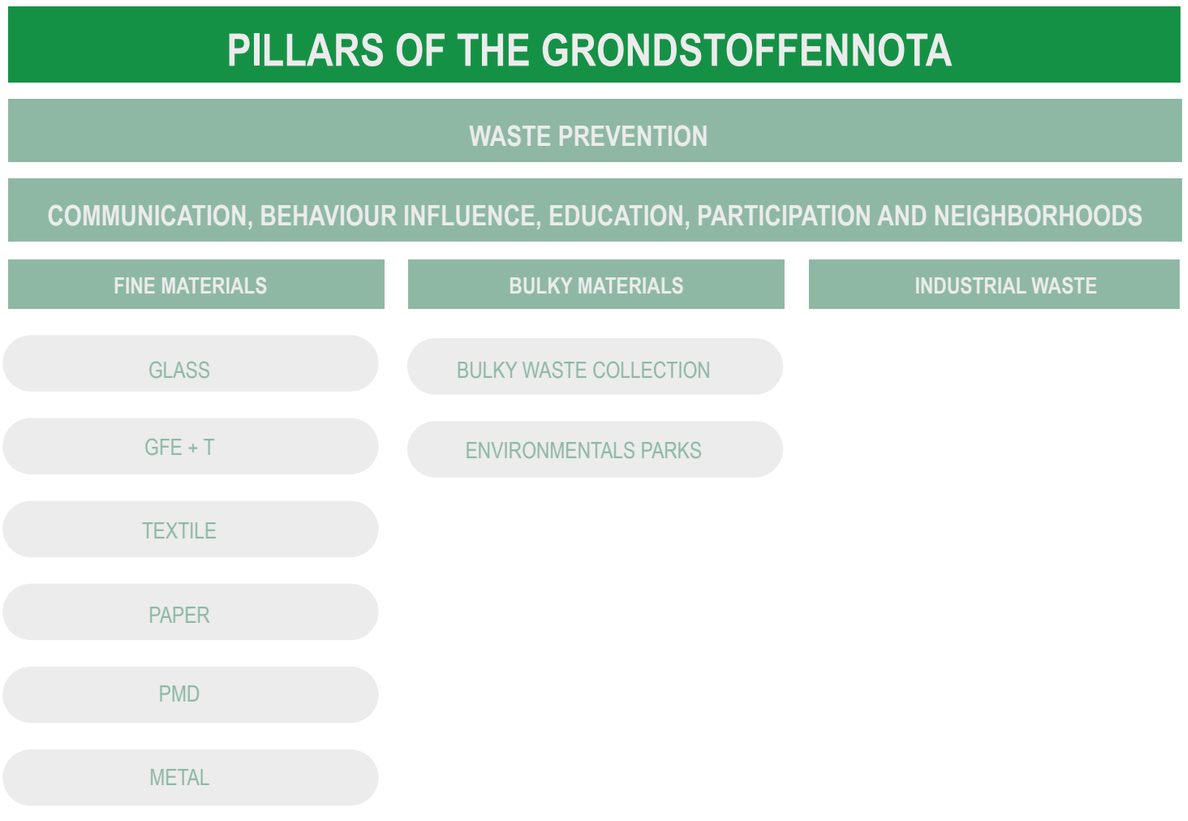
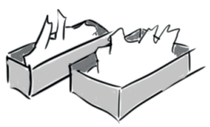
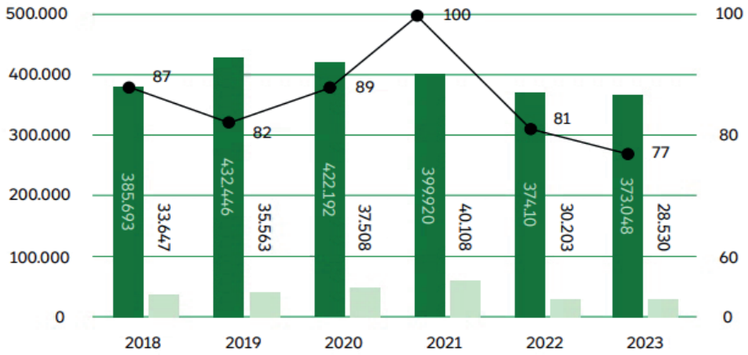
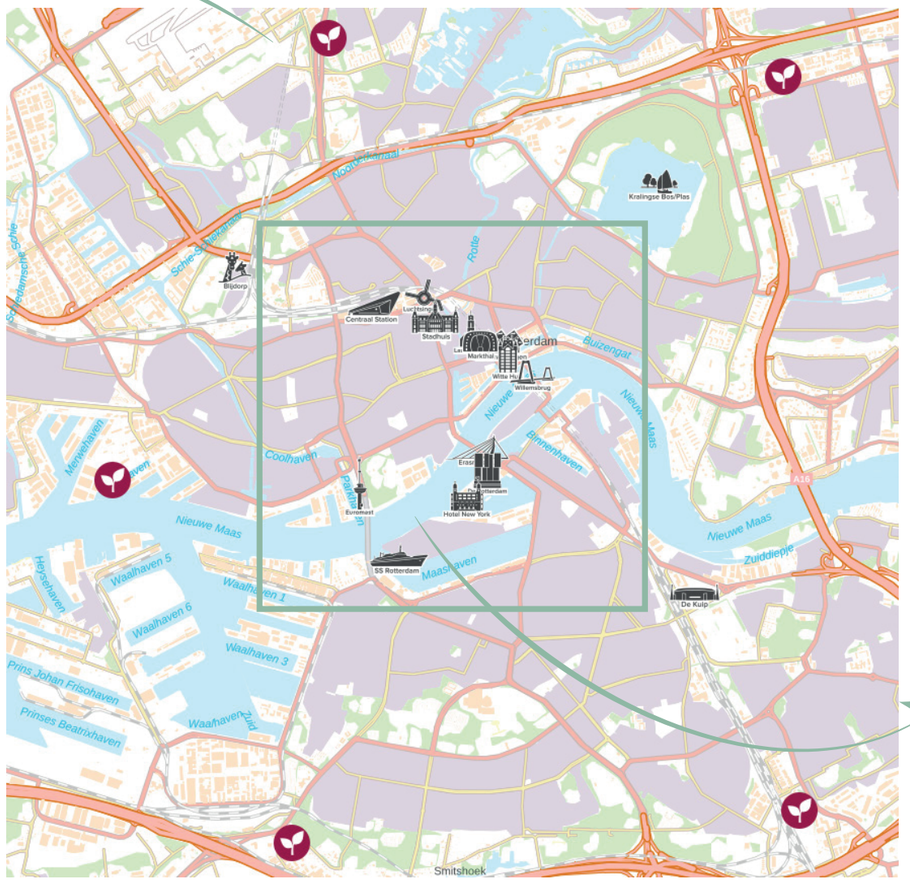


Figure 3: The pillars of the Grondstoffennota of Rotterdam (Grondstoffennota, 2023)



ENVIRONMENTAL PARKS





APPOINTMENTS FOR COLLECTION

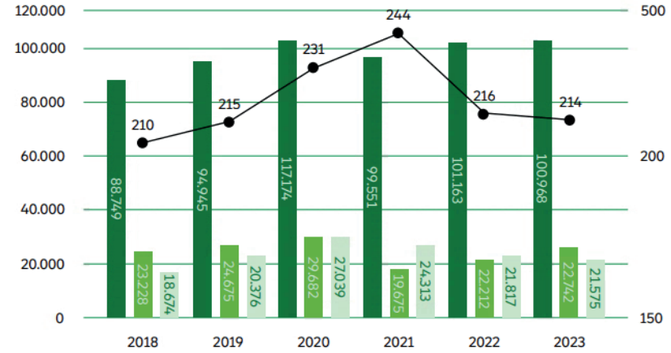


Figure 4: Data of the environmental parks and collection service of Rotterdam (Grondstoffennota, 2023)

There are two types of disposal possibilities for bulky waste in Rotterdam. In Figure 4 the data from 2018 till 2023 can be found for the drop-off and the collection service. The possibilities for the citizen; 1) bring it to one of the environmental parks across the city. 2) make an appointment for collection at home.

1) Drop-offs at environmental parcs

The environmental drop-off parcs of Rotterdam are located at the periphery of the city (Figure 4). This is because of the needed space to collect and store materials. This requires transport, time and motivation for the citizens to bring their disposed goods to the parcs. The municipality is focusing on making drop-offs at the environmental parks the default optios. It is free* for all citizens (Gemeente Rotterdam, 2024).

There are initiatives to improve transportation and awareness to the environmental parks. For example; expansion of the opening hours, shared cargo transport, new environmental parks and pop-up environmental parks.

If your look at the data of the drop-offs at the environmental parks, nearly 400.000 citizens have visited the parks with an average of 77 [kg] of each citizen in 2023. In 2020 and 2021 a increase is shown, this could be due Covid. In this period of time citizens were reorganizing their home situation because of the mandatory homeworking.

2) Collection service

The collection service is provided free* of charge to all citizens of Rotterdam. Appointments can be scheduled via telephone or an online portal of the municipality. A date can be selected at the citizens choice, and instructions will be provided regarding the placement of bulky waste items on the street. The service will be collected by a compactor truck and subsequently processed by the designated processing partner, most of it will end up in the incinerators.

The collection service is considered as not circular and the needed steps for source-separation are already been taken. For example, the mattress collection service will provide an external truck for collection of mattresses. A matress has potential for recycling and takes a lot of volume in the compactor truck.

On average, 100.000 appointments are made yearly with 214 [kg] of material per appointment in 2023. The same explanation, for the increased numbers in 2020 and 2021, is valid for the collection service. The number of appointments was higher due Covid and the trend of reorganizing furniture by the citizens.

While citizens report bulky waste to the municipality, there lacks a viable market or infrastructure for bulky waste in an inner-city environment to redirect this waste for a second life, leading much of it end up in incinerators instead of being reused or recycled.

*Free of charge means, the citizens do not have to pay additional costs for making use of the bulky waste services.

Potential of bulky waste

All the data of the residual waste of Rotterdam in 2023 (confidential Appendix A) is visualized in Figure 5. The focus is on bulky waste in the form of an alluvial chart.

The total residual household waste of Rotterdam contains of 261.542.000 [kg] per year. The amount of bulky waste is 55.766.000 [kg] per year, accounting for 21.3% of the total waste. Of this bulky waste, 61.3% is brought to environmental parks, while 38.7% is collected by municipal services. This number includes everything that is placed on the street illegally. At the environmental parks, 86.7% of the bulky waste is source-separated and a lot of new initiatives of the municipality are focused on the environmental parks. However, none of the collected bulky waste is source-separated. It is crushed during pickup, and up to 50% can be separated afterwards through secondary sorting. The rest ends up in the incinerator. Novel innovations have not been developed to improve recycling and reuse for bulky waste collection. Furthermore, pilot programs for collecitons have not been started. To conclude;

it is desired to have an increase of the usage of the environmental parks and a decrease of the collection service.

Waste prevention and behaviour influence

The municipality of Rotterdam is making efforts to increase waste prevention. The goal is to reach the citizens to encourage them to separate and reduce their waste generation. Education and communication is used by the municipality to reach the desired behaviour. This is an important matter and to understand the extent to which citizens are willing to shift their behaviors to sustainable practices.

This can be analyzed using Fogg's Behavior Model (2007) and the research of Shiv & Fedorikhin (1999). In the model of Fogg, motivation is set against ability of doing. To achieve the desired behaviour, waste separation should be as easy as possible. For example, the containers should not be too far away, and practical tips and tools can assist in the process. It is also founded by the municipality that motivation is higher when citizens are doing it for their own living environment or a local goal. Our decision-making process can be divided into two systems. The first one is the intuition and instinct, used for fast, associative and unconscious decisions. The second one is the rational thinking, this takes effort and logic. It is stated that only 5% of the time this rational thinking is used. Most of the time, our brain uses simplified shortcuts to make an easy and fast decision. Our rationality is limited, due lack of information, cognitive limitations and biases. Therefore, it is crucial to give the citizens enough information and limited cognitive load to make the right decision regarding proper disposal.

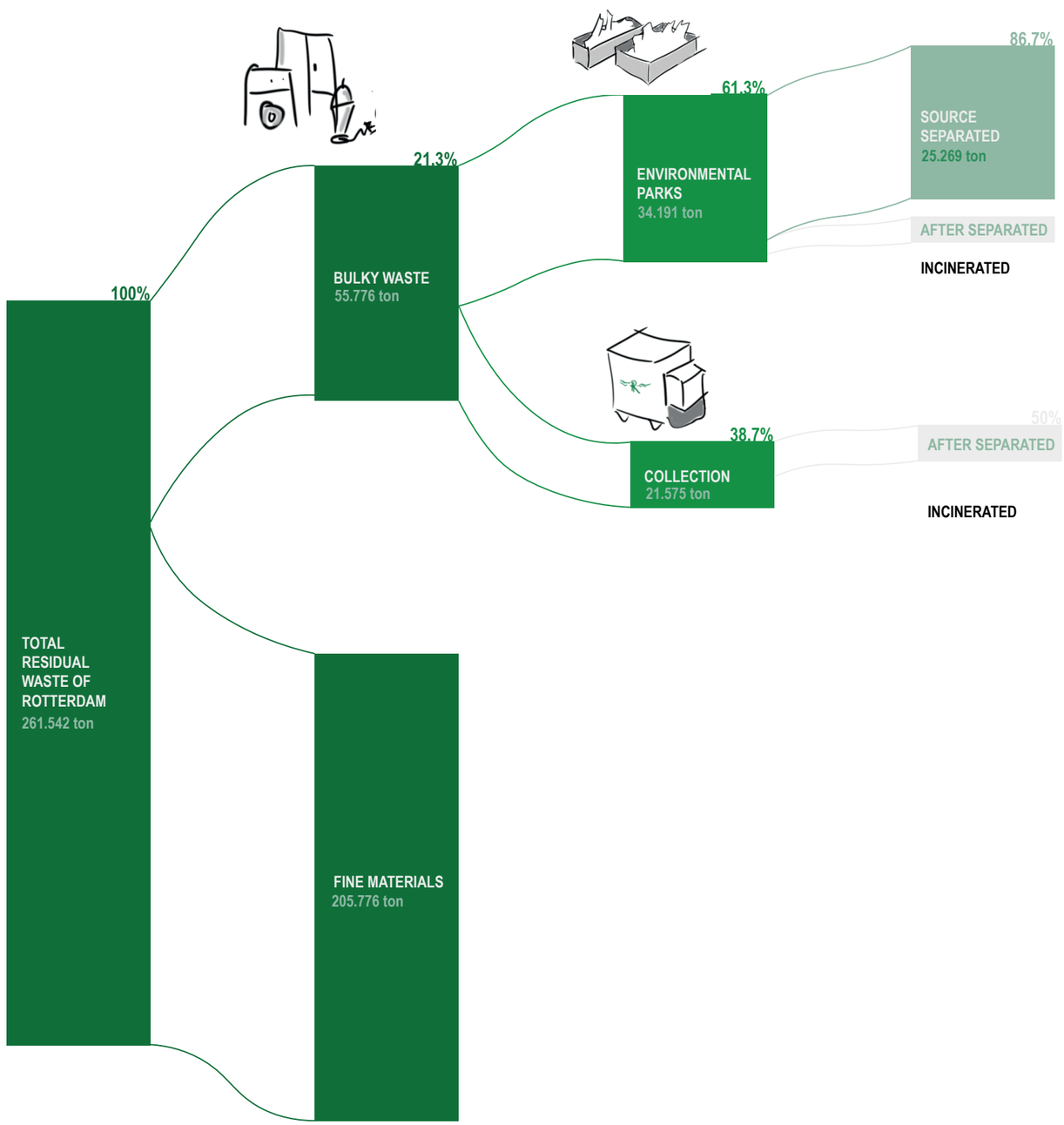


Figure 5: Alluvial chart of the total residual waste of Rotterdam. Data from (Gemeente Rotterdam, 2024) can be found in confidential Appendix A

Problem

The bulky waste problem of Rotterdam will be the main focus of this graduation project. A design brief is formulated for direction to the desired outcome. Additionally, the first R-goals are set up (Figure 6).

Design brief

Aligned with Rotterdam's waste management targets, this project aims to create a service system focusing on bulky waste reduction, separation, and reuse. The main challenge lies in ensuring operational feasibility and viability for the municipality, and desirability for all stakeholders and citizens of Rotterdam. The municipality of Rotterdam processes citizen waste but lacks circular distribution channels. Citizens contribute to the supply side by bringing, reporting and dumping bulky waste, while potential stakeholders for reuse or upcycling could serve as outlets or partners.

To achieve the waste reduction goals (R-goal 1: reduce) (Grondstoffennota, 2023), it is important to increase the source-separation at environmental parks and decrease collection with the compactor truck (R-goal 2: rethink). Connecting supply of bulky waste with the demand of recyclers or buyers, is a dynamic process that requires a forward-thinking approach that anticipates future needs and adapts to changing environments. This involves understanding demand and supply dynamics, identifying effective distribution channels, and exploring new waste management approaches.

Research questions

The project is focused on bulky waste environment that is suitable for reuse in an inner-city environment by mapping the stakeholder environment and designing a strategic (product) service solution using different (new) distribution channels.

"How can a service system for bulky waste, that is suitable for reuse and recycle, be designed and implemented for the municipality of Rotterdam through stakeholder participation?"

This research question will be answered through different sub-questions:

1. Who are the current and potential stakeholders in the system and what are their needs and wishes?

2. How should the municipality of Rotterdam position itself in the complex stakeholder context of bulky waste collection?

3. How can a service system for the reuse of bulky waste be designed and validated?

4. How can the municipality of Rotterdam apply the insights from this project to realize and implement the proposed service system?

5. What value does the system deliver?

Deliverables

The deliverables of the project contain a service system design for bulky waste in the inner-city environment. I will develop an improved bulky waste management system, based on the needs and wishes of all stakeholders. The system will be validated in Rotterdam, and with feedback, the next iteration will be designed.

A strategic roadmap for future implementation

For the future implementation of the service system design, the internal and external capabilities of the municipality of Rotterdam, and its position in the changing context are analyzed. Possible future scenarios are drawn to develop a roadmap to support the transition towards this new form of bulky waste collection. This roadmap will include all steps that are needed to achieve the cooperation with other parties and stakeholders.

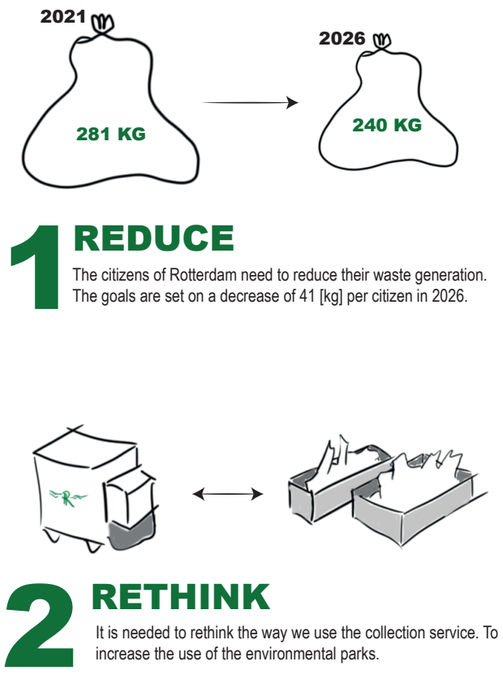


Figure 6: The R-goals after design brief

Approach

As stated in the design brief, this problem requires a forward-thinking approach that anticipates future needs and adapts to changing environments. Therefore, an explorative approach is chosen. A combination of Effectuation by Sarasvathy (2001, 2008) and the research of Duening et al. (2012) is used. In this chapter the framework of this combinatin is explained and how this is applied for this project.

Framework

The goal of this graduation project is to create an innovative service solution in a market that does not exist yet. The exact value of bulky waste is also not defined, yet. Although, it is assumed that it has value for reuse, repair and recycling. The principles of Effectuation could be of good use because this approach drives on opportunistic thinking and that is exactly what the bulky waste problem needs.

Effectuation

The framework for this thesis is rooted in the principles of effectuation, a concept introduced by Sarasvathy (2008). Effectuation theory explores entrepreneurial reasoning, and the methodologies entrepreneurs use to navigate the uncertainties of the future. The core idea contrasts with causal logic, which starts with a predetermined goal and finds the means to achieve it. Causal logic can be compared to a manager who starts with a clear goal and methodically plans the steps to achieve it. This approach is linear and goal-oriented, focusing on optimization and efficiency within known constraints. Effectual logic begins with the means at hand and allows goals to emerge organically through the process of experimentation and adaptation. It resembles a chef who starts with available ingredients and improvises to create new recipes. This approach is iterative and adaptive, leveraging on creativity which shape new inventions.

The key concepts of effectuation

- Knightian uncertainty refers to situations where it is impossible to calculate probabilities for future outcomes. Entrepreneurs navigate through uncertainties without clear predictions or predefined strategies.

- Unlike traditional strategic planning that relies on fixed goals and preferences, effectual thinking embraces goal ambiguity. Goals are not seen as static but evolve over time based on new experiences and insights.

- Isotropy implies that the environment is not something external to be adapted to, but rather something that can be influenced and shaped. Entrepreneurs using effectual logic actively mold their surroundings rather than simply fitting into them.

BIRD IN HAND MEANS ORIENTATION	In practice, entrepreneurs begin with their current means—who they are, what they know, and whom they know. They envision possible outcomes and take small steps, learning and adjusting as they progress. This approach emphasizes action over extensive planning, allowing goals to emerge through interactions and experiences.
FOCUS ON THE DOWNSIDE AFFORDABLE LOSS	Expert entrepreneurs focus on what they are willing to lose rather than potential gains. They seek opportunities with manageable risks and higher flexibility, enabling them to adapt and pivot as needed. This minimizes costly failures and facilitates continuous learning.
CRAZY QUILT FIND PARTNERSHIPS	The "crazy quilt" principle emphasizes building partnerships rather than competing. Entrepreneurs engage in interactions with potential stakeholders to form commitments that reduce uncertainty and collectively shape the market. These early commitments create a foundation for expanding partnerships and defining market entry strategies.
LEMONADE PRINCIPLE LEVERAGE CONTENGENCIES	Entrepreneurs can adapt, turning setbacks into opportunities. They learn not only to manage surprises but to exploit them, seeing every challenge as a potential avenue for innovation. By not tying their ideas to specific markets, they remain flexible and open to new possibilities.
PILOT-IN-THE-PLANE CONTROL	This principal highlights control, co-creation, and shaping the future in uncertain environments. Effective entrepreneurs leverage available means and collaborate with stakeholders to actively influence and innovate their environment.

Figure 7: The five principles of Effectuation (Sarasvathy, 2008)

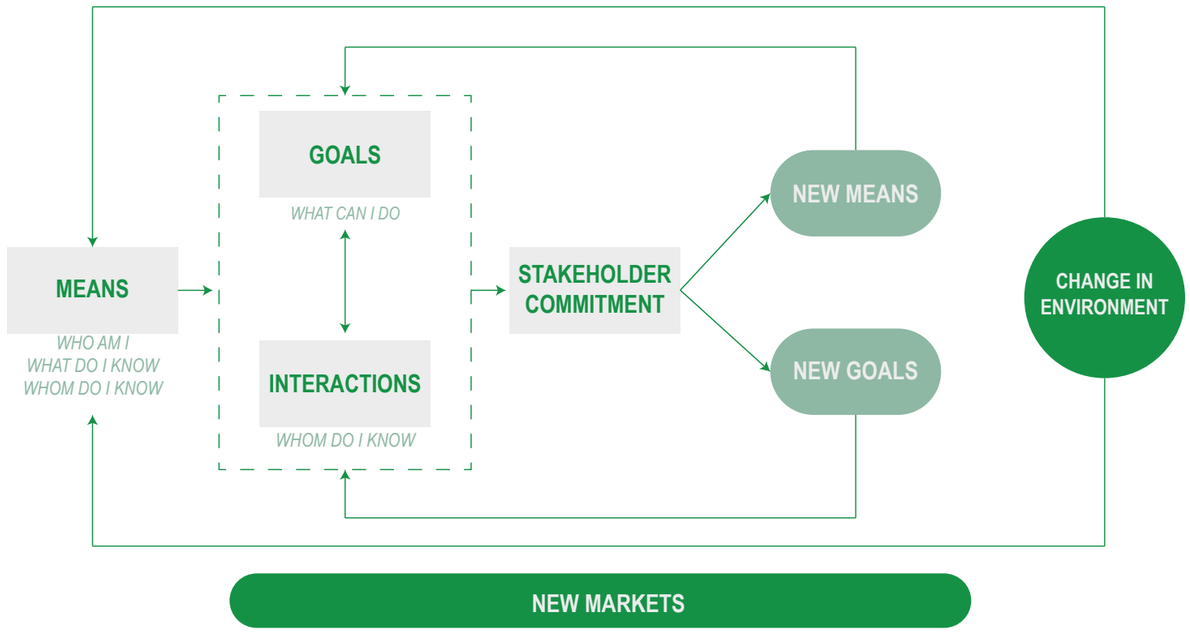


Figure 8: Effectuation in action (Sarasvathy, 2008)

The principles of the Effectuation theory are explained in Figure 7. Effectuation has no linear project timeline. Most entrepreneurs start with the means and find their way through their business model with the use of the other principles.

The affordable loss principle, for instance, emphasises the potential for loss in a given situation. What might be lost in order to achieve success in the long term? The example of the chef is again used here: it resembles a chef using a great amount of ingredients to refine and experiment for a new recipe. The first ten attempts will undoubtedly fail, but eventually a new recipe will emerge.

Effectuation in action

Now the principles of Effectuation are clear, it can come into action. In Figure 8 the principles are plotted in a flowchart to achieve the findings of new markets of the change in environments.

The process begins with an examination of the available resources, namely the means at one's has access to. With these resources, the objectives and known interactions can be formulated and employed to guarantee stakeholder engagement. In the absence of stakeholder commitment, the likelihood of business failure is high.

As a result of sufficient stakeholder engagement, new means and goals will emerge in response to changes in the environment. This is the optimal time to leverage the available resources and diverse objectives to foster greater stakeholder involvement, thereby influencing the emergence of novel markets and the generation of new value.

Effectuation combined with New Product Development

To give more structure to the graduation project, the research of Duening et al. (2012) is also used. The principles of Effectuation are plotted within the New Product Development process (Figure 9). The thesis report is structured according to this framework, each chapter corrospond with one of the phases of the NPD process. This contradicts Sarasvathy who claims that there is no order in Effectuation. This raises the question of whether it is feasible to initiate an enterprise by using effectuation in a methodical linear form as the NPD process. This aspect of the project is also of interest to entrepreneurial designers, who adopt an effective approach to problem-solving but require a structured, time-bound methodology to ensure project success.

Approach in this project

The approach employed in this project is twofold. The principles of effectuation are used as the primary motivating force behind the actions taken within the project. The structure proposed by Duening et al. (2012) is used for the purposes of reporting. Accordingly, the report is structured in a linear and chronological manner.

As outlined in the reader guide, at the outset of each chapter, you will find the phase of the NPD process indicated by the title, accompanied by an explanation of the corresponding Effectuation principles used within this phase. Additionally, at the end of the first 3 chapters, an evolving infographic that illustrates the established means, goals, and opportunities within that phase of the project is shown. As is indicated, each chapter or phase during this project represents a snapshot of the project's status. The means, goals, and opportunities are not rigid; they are employed to facilitate iteration and influence the uncertain environment. This methodology provides no restrictions for isotropy, knightian uncertainty and goal ambiguity, which are essential for a successful use of Effectuation.

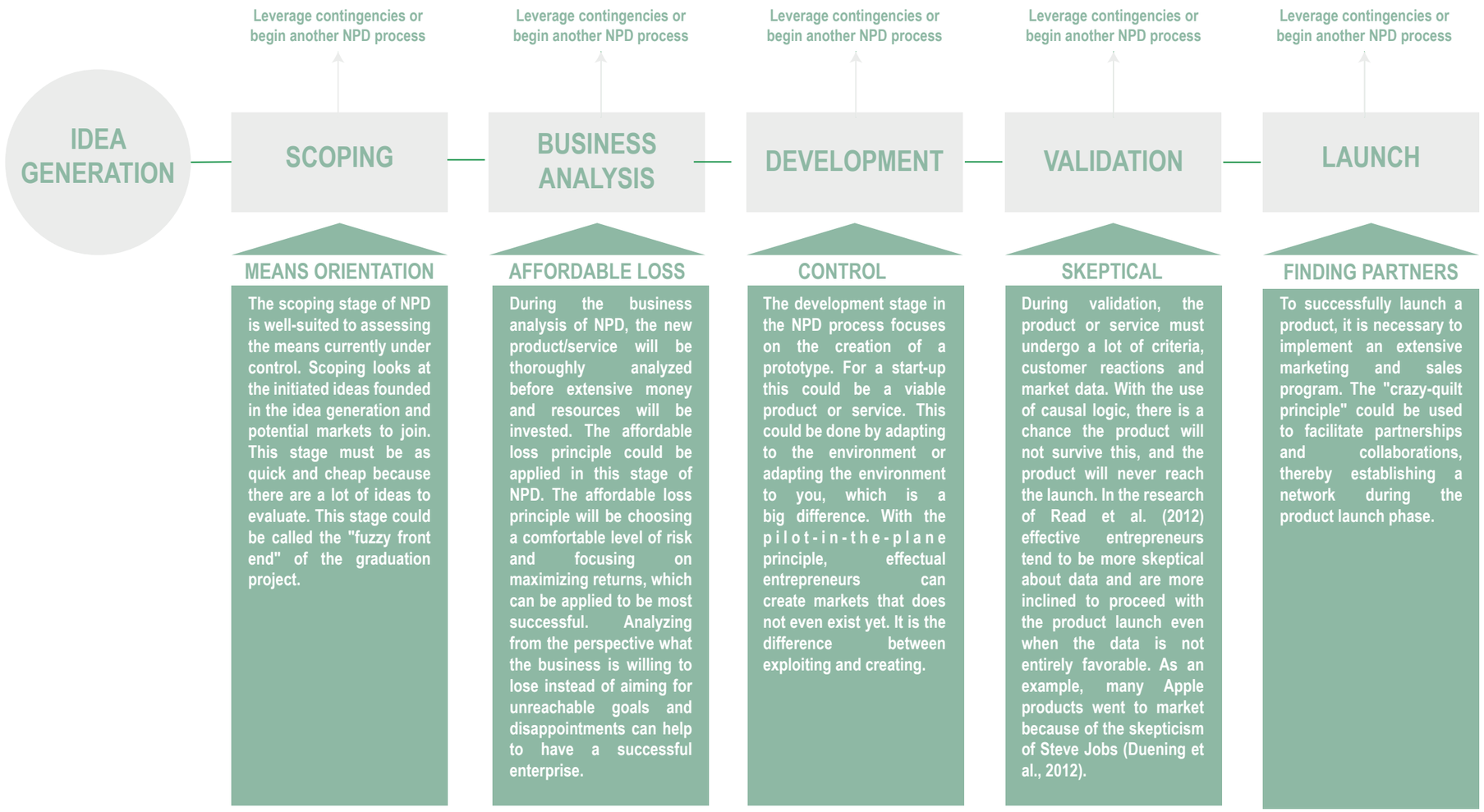


Figure 9: Adapted from Effectuation theory (Sarasvathy, 2008) combined with Effectuatin in New Product Development (Duening et al., 2012)

Methods

To gain a comprehensive understanding and to obtain a holistic view of the current waste management practices, co-design was used. Co-design is a method for instances where collaborative creativity spans the entire design process (Sanders & Stappers, 2012). As Effectuation drives on exploration, collaborative design is most suitable. Several qualitative research methods were preferred over quantitative methods to explore the design problem's complexity and depth. For starters, participatory design is employed to get a hands-on understanding of the situation on the streets and how the citizens behave. The problem of bulky waste on the streets cannot be solved in a passive manner from a distance. It necessitates a more proactive approach, such as action research, to identify the underlying causes and devise innovative solutions. In Table 1 all the research methods are shown and structured.

Participatory design

With this methodology, the municipality, citizens, and other stakeholders will be engaged throughout the entire design process. It is possible to be adaptive and scalable with the collaboration in early stages of the process, making it less difficult to reach or validate prototypes.

Stakeholder involvement

The project supervisors from the organization, gemeente Rotterdam, were involved through regular meetings, featuring creative sessions to share insights, map interests, and collaboratively make decisions, guiding the project through every design phase.

Other stakeholders, policymakers and advisors of the municipality, managers of Wijkhubs, managers of weggeefwinkels, second-hand store Het Goed, potential customers, the citizens and the collectors on the street, participated during all the stages of the project. Their insights helped incorporate their needs and wishes in the project outcome.

Once the final design was complete, the goals and value were validated through a session with the manager of the Projectbureau. This resulted in valuable insights, which served to clarify and to guarantee that the design is a valuable addition to the Projectbureau's future work.

Action research

For this project it was important to be within the level of action. This allowed for a holistic understanding of the service ecosystem, facilitating improvements in both functionality and user satisfaction.

Bulky waste collection

Working for a day with the collectors on bulky waste trucks was one of the participatory experiences. Observations during the day, empathize with them and get insight from unstructured interviews. These interactions provided practical insights into the challenges and practices associated with the current bulky waste collection. These insights can be found in the chapter *What Do I Know?*

Iterative pilot design

Later in the project, different business models were tested in the form of a pilot. This was done with the needed stakeholders which provided rich data on stakeholders' perspectives for final improvement of the service system. This interactive design method aligns with the effectual approach, integrating stakeholders throughout the design process. This inclusive methodology was intended to capture a wide range of perspectives and ideas, contributing to the development of an effective service system for bulky waste collection in Rotterdam. It was an iterative process where participants were engaged in real-time feedback cycles, allowing for continuous improvements and shaping the service, to tailor the collection process based on their needs and experiences.

Qualitative research

Qualitative research was required to validate the assumptions, ensuring that the findings were not only based on experience but also validated. It was necessary to obtain empirical data to identify both areas of success and barriers that require further attention.

Interviews

In-depth interviews have been held with the policymakers and advisors of Schone Stad to gain valuable insights into the current waste management situation. The first part of the interview was to identify the organization's existing capabilities and challenges. The second part was more interactive creation exploring desirable futures, of waste management collection.
Street interviews have been held with the citizens of Rotterdam within Rotterdam Noord and Beverwaard. This was done to gain a firsthand understanding of their thoughts and knowledge of bulky waste on the streets about bulky waste. These insights can be found under *Exploration*.

Observations

On several places in the city observations have been executed. In *Research areas* it is explained why this is done on several neighborhoods in Rotterdam.

A pilot of the municipality of Rotterdam is explored to learn how to manage innovation in waste management. The observations carried out in Beverwaard.
During the street interviews in Rotterdam Noord, observations are daily done to see how bulky waste disposal is done. Insights are in section *Exploration*.

Design Roadmapping

The new product-service system is presented with the use of a strategic roadmap. This is created to communicate the implementation according to a future vision and three horizons (Simonse, 2018).

Desk Research

In addition to the participatory design and qualitative research, desk research was conducted to contextualize the study and address any knowledge gaps. For example, running circularity projects by the government and other municipalities.

Table 1: Co-design methods structured between participatory design and qualitative research

CO-DESIGN			
PARTICIPATORY DESIGN		**QUALITATIVE RESEARCH**	
STAKEHOLDER INVOLVEMENT	**ACTION RESEARCH**	**OBSERVATIONS**	**INTERVIEWS**
COMPANY MEETINGS The supervisors from the municipality were involved using regular coachmeetings with small creative sessions.	**BULKY WASTE COLLECTION** Experienced a day as a collector on the bulky waste truck.	**STREET OBSERVATIONS** During the day as collector During the pilot in Beverwaard During exploration in Rotterdam Noord During the pilot in HIllegersberg/Schiebroek.	**SEMI-STRUCTURED INTERVIEWS** In-depth interviews with policymakers **NON-STRUCTURED INTERVIEWS** Interviews with the collectors on the street **STREET INTERVIEWS** During the pilot in Beverwaard. During exploration in Rotterdam Noord. During the pilot in HIllegersberg/Schiebroek.
EXTERNAL STAKEHOLDER MEETINGS Other stakeholders are involved at the relevant stages of the design process.	**ITERATIVE PILOT DESIGN** In the development phase, different business models were tested in the form of a pilot.		
VALIDATION SESSION With the manager of the Projectbureau of Schone Stad			

Research areas

This research was conducted in various neighborhoods across Rotterdam, chosen strategically for their differences in socio-economic contexts and waste management challenges. These neighborhoods include Beverwaard, Rotterdam Noord, and Hillegersberg-Schiebroek. These areas are selected because of their differences regarding waste management behaviors. The selection of these areas facilitated a holistic approach to observe and address bulky waste disposal practices, which aligns with the project's objective to develop adaptable, neighborhood-specific waste management solutions.

In Figure 10 the different neighborhoods and their revelance can be found. With the use of the Leefbaarometer, the differences between the neighborhoods are shown. This is an online tool used to monitor livability of neighborhoods across the Netherlands. It provides data on livability trends and developments, supporting policy decisions and early detection of declining conditions. The latest 2022 data enables stakeholders to assess and improve neighborhood well-being effectively (Leefbarometer, 2022).

Importance of inclusivity and diversity

The inclusion of multiple neighborhoods enabled the project to extract neighborhood-specific insights and develop tailored recommendations for waste management services across Rotterdam. Comparing different areas revealed insights and patterns that might not have emerged if the research was limited to a single neighborhood. Rotterdam's socio-economic and cultural diversity has no one-size-fits-all approach, as confirmed by in-depth interviews highlighting the need for neighborhood-level adaptations to services. For the end result, this will considered.

A further discussion of the limitations related to this multi-neighborhood approach is presented in the chapter on *Limitations*. Throughout the report, visual representations will be shown on neighborhood-specific findings to provide a clear understanding of how the project's scope adapted to each context and influenced the outcomes.

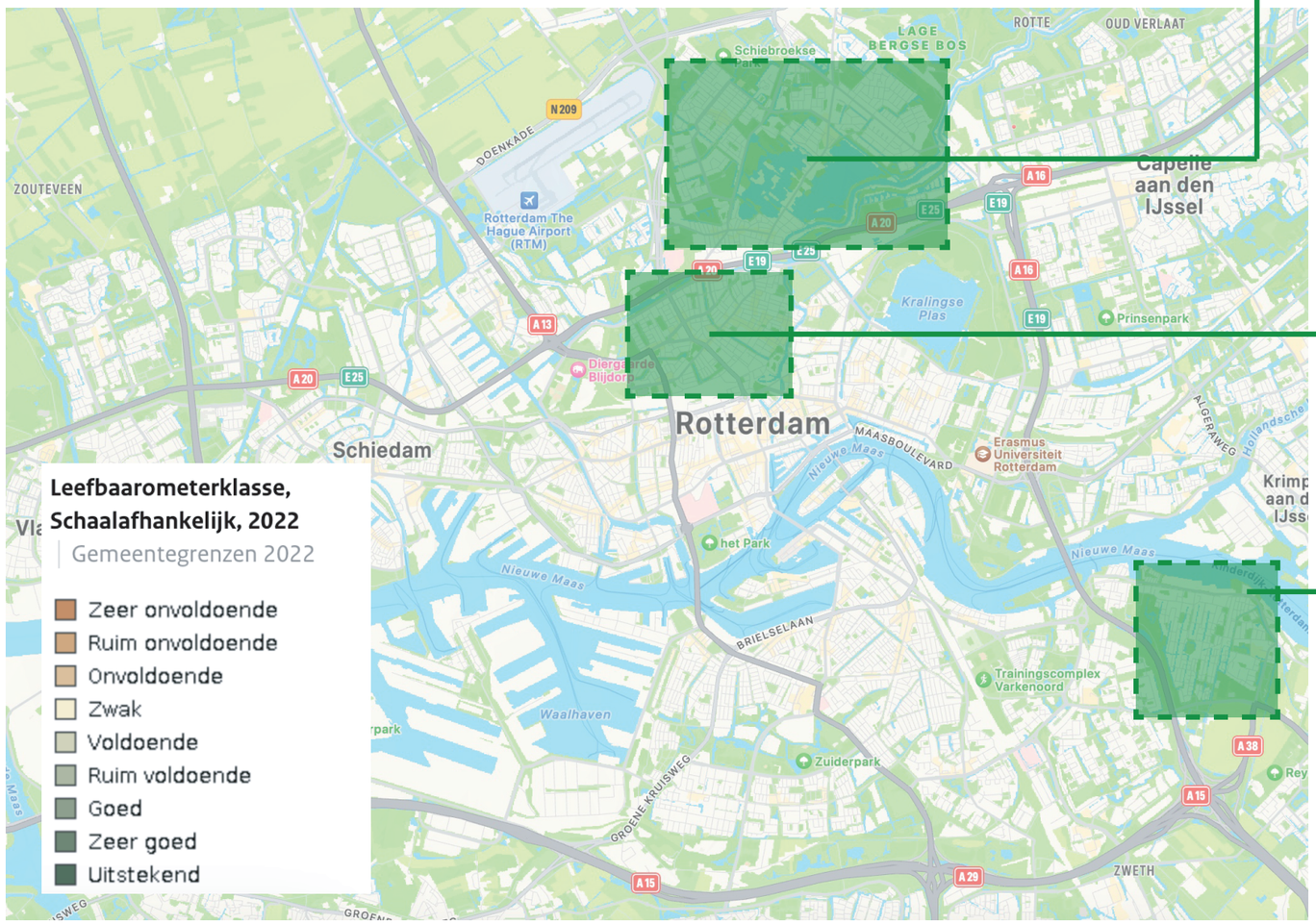


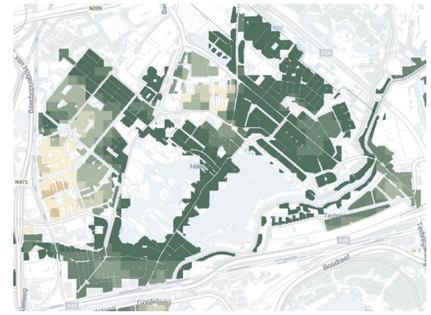
Figure 10: Research areas used in this project (Leerbaromeeter, 2022)

Hillegersberg-Schiebroek

Participants for the pilot

Participating population

Hillegersberg-Schiebroek is an affluent neighborhood with an engaged population willing to participate in innovative initiatives. In this neighborhood is an environmental park available, making it an optimal setting for research.


Leefbarometer, 2022

Rotterdam Noord

Participants for interviews and observation

Diverse citizen approaches regarding waste disposal

Rotterdam Noord represents a socioeconomically mixed area, with a blend of wealth, age, and cultural diversity. Its accessibility and daily integration into my work routine, allowing consistent observation and insight into how citizens approaches waste disposal. This area has no environmental park nearby.


Leefbarometer, 2022

Beverwaard

Participants for interviews and observation

Problems with waste tourism and regular dumping

Beverwaard was chosen for its socio-economically disadvantaged status and high number of bulky waste issues. A municipal pilot on waste disposal in Beverwaard offered the opportunity to gather insights on how communities perceive and handle bulky waste. Making it an ideal setting for observing challenges in waste management and citizen engagement. This area has no environmental park nearby. It is only accessible with transportation.


Leefbarometer, 2022

CHAPTER CONCLUSION

1.1 What is the scope of the project? Why do we need to solve this?

Rotterdam needs to reduce the total residual waste of their citizens. The city aims to do this by better separation, prevention and high-quality processing of the materials. One of this residual streams is bulky waste. Due to its undefined and underdeveloped waste stream, bulky waste ends up in incinerators, despite its reuse and recycle potential.

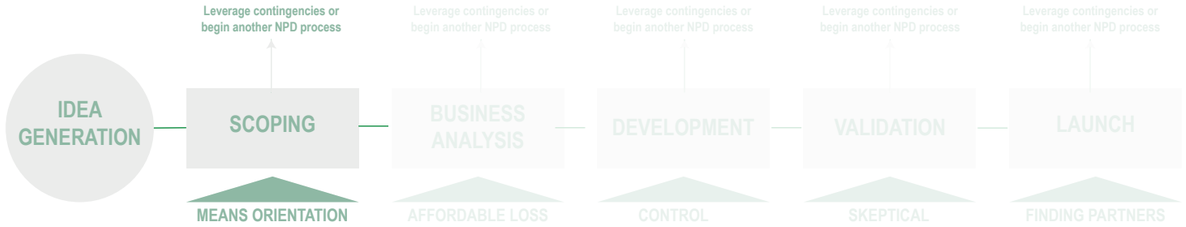
The purpose of this thesis is to design a sustainable service system for bulky waste. The service should integrate citizen behaviour, innovative system-infrastructure and collaborations to redirect the waste for a second life and safe the valuable material from the incinerators.

1.2 Which design approach is most appropriate to handle this type of problem?

The principles of effectuation, as it relates to the structure of the New Product Development process, is employed to address this problem. The bulky waste issue cannot be solved through theoretical methods alone, it necessitates a hands-on and entrepreneurial thinking approach.

Effectuation (Sarasvathy, 2001) is not a design method or a linear or circular method, but it is based on exploration. The future of waste management needs radical change to achieve the status of circularity. The principles of Effectuation are of good use to adaptively influence this environment. The research of Duening et al. (2012) is used to give the thesis strucutre. This is a combination between the stage gate process of New Product Development and the principles of Effectuation.

Complementary to effectuation and the NPD process, articipatory design is needed for this problem. The bulky waste issue is not solved behind a desk and with the use of theory. The chosen research methods are in collaboration with the target group and the employees of the municipality.



2 SCOPING

MEANS ORIENTATION

2.1 What is the current situation of bulky waste collection in Rotterdam?

The collection service is inefficient and environmental harmful. It needs radical change to achieve the predefined goals of Rotterdam. The Projectbureau is an ideal place to push innovation the needed innovation. They have a strategic position within the municipality which allows them to develop sustainable waste solutions.

Who am I? What do I know? Whom do I know?
What can I do?

This chapter explores the means and goals of the municipal environment of the bulky waste collection. It explains the research scope from the perspective of an entrepreneur with ambitious startup aspirations.

OPPORTUNITY SPACES V1

2.2 What are possible value propositions based on the means orientation?

The future of Rotterdam's waste management system hinges on increasing citizen convenience and responsibility. The bulky waste services need to support this through better guidence and facilitation.

In this chapter the explored opportunity areas and the defined means and goals are explained.

MEANS ORIENTATION

As defined by the Effectuation theory of Sarasvathy (2001), the first step in the process is to identify the current means and goals. This involves the following questions: who I am, what I know, and whom I know. This will set the foundation for the rest of the project together with the last question: what I can do. The means and goals explored include the municipalities environment, the current waste collection system, existing projects and their stakeholder commitments related to these projects.

Who am I?

I am a starting entrepreneur with privileges of working in the environment of the municipality of Rotterdam. This will create the freedom to develop a new enterprise with inside knowledge of the municipality. The reason for this chosen perspective is to expand the possibilities and out-of-box thinking and come up with solutions that go further than municipal facilitation.

The municipality of Rotterdam

The municipality of Rotterdam is one of the few municipalities that handle waste collection themselves instead of outsourcing it (afvalwijzer, 2024). The Projectbureau is my client and is positioned as a is a innovative team as part of Stadsbeheer. In Figure 11 the structure of the civil service of Rotterdam is shown. The Projectbureau is part of Schone en Stad and part of Stadsbeheer, one of the six clusters. The strategy of Stadsbeheer ensures that the city is a nice, safe and clean city to live, work and recreate in.

Schone Stad is responsible for cleaning, collection, circularity and maintaining the vehicles. The Project Bureau contributes to innovation and set ambitions of Schone Stad, aiming to become and remain a leader in *Schoon en Circulair*. It is supposed to engage in innovations and translate developments into the practicalities of urban management. This involves two primary objectives:

1) Contributing to the circular economy: reducing waste streams and maximizing the reuse of what remains.
2) Enhancing the execution of primary processes: collection, reuse, and cleaning.

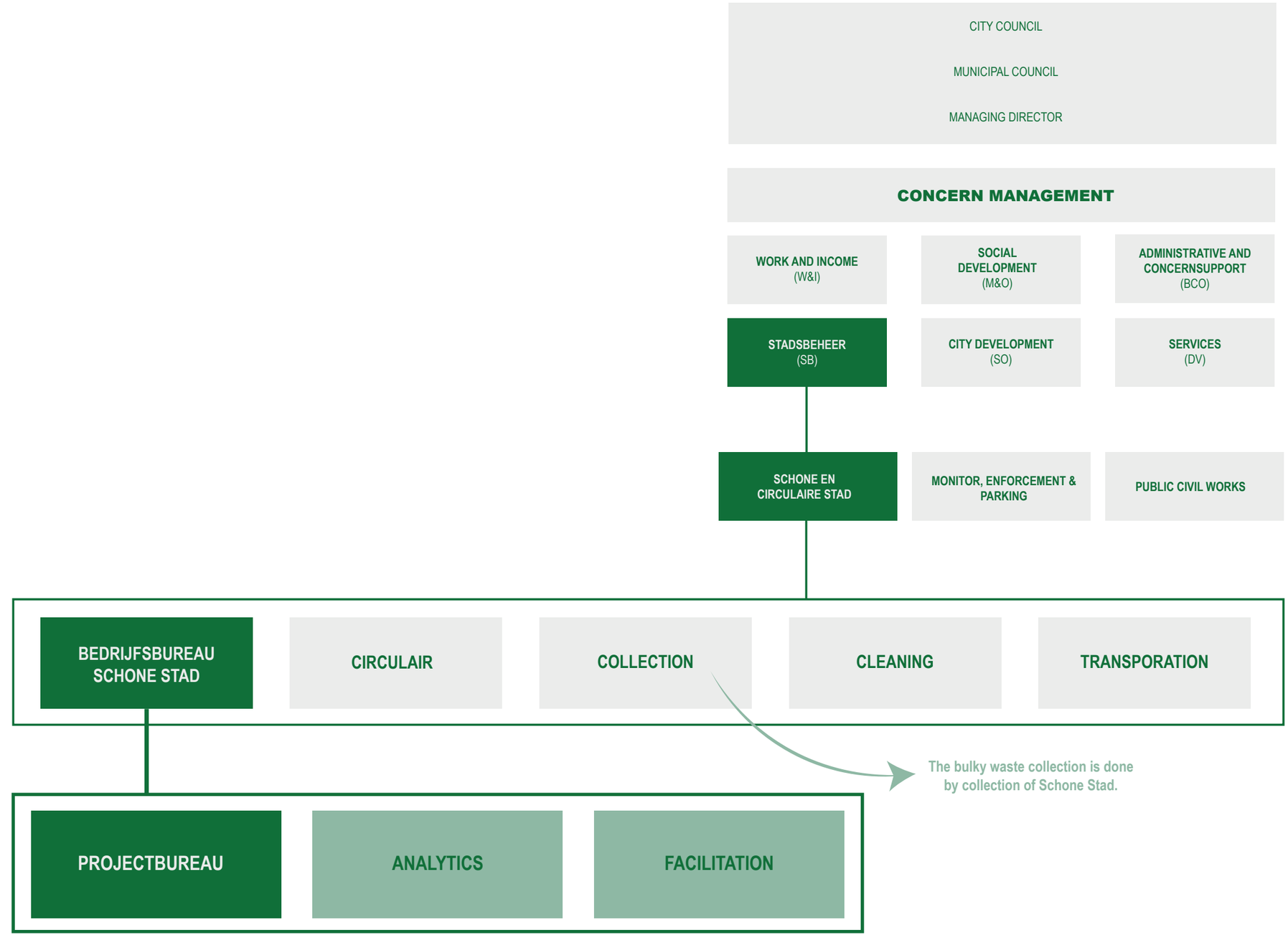


Figure 11: Civil service of the municipality of Rotterdam (RIO, 2024)

Multi-level perspective of Rotterdam

To understand the environment of the city of Rotterdam, we will examine the multi-level perspective diagram (Geels, 2011). The MLP-model of Figure 12 is used to capture some developments regarding waste in Rotterdam. This diagram identifies three levels where companies, governmental bodies, trends, and other entities can exist.

Landscape

Landscape developments can put pressure on existing regimes, creating windows of opportunity for the regime. This section covers major sustainability trends, including the growing trend of becoming a circular city, globalization and the drive for economic growth. This environment also include the R-ladder principles. The Dutch government is using this definition the make the circular movement tangible for municipalities to follow.

Regime

The regime encompasses both market and user preferences. This stage can be considered 'dynamically stable,' but new trends can still emerge by taking advantage of 'windows of opportunity' from the higher landscape regime.

Niche

Niches refer to smaller companies or projects with innovative ideas that aim to fill a gap in the market. Here, developments are made that need to be picked up by the regime. This is operation level for my graduation project. During the research phase a deeper dive will be taken into niche innovations that made it to the regime (or did not make it). Alongside these initiatives, the regulative side of the regime can be felt.

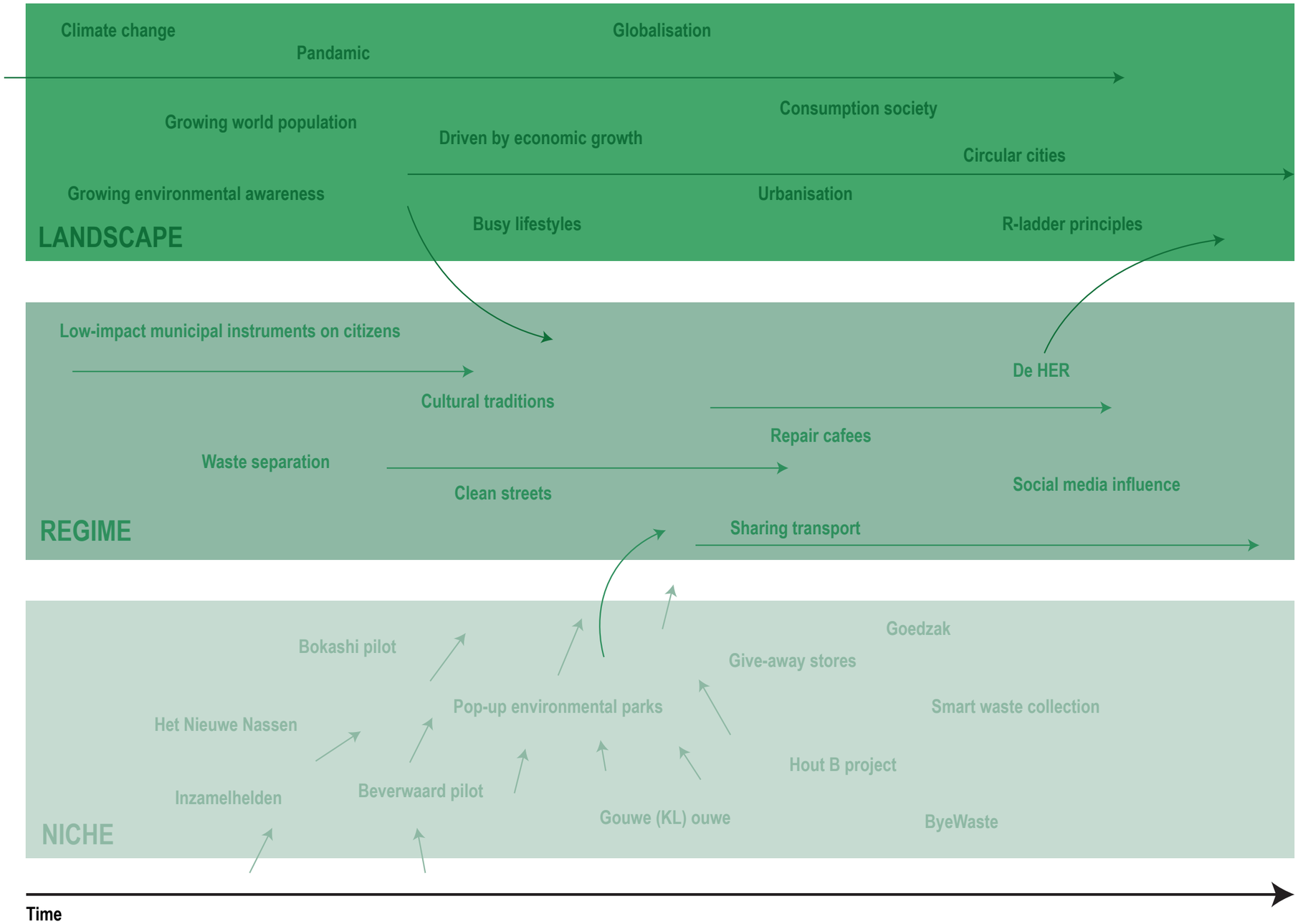


Figure 12: Multi-level perspective of the waste management practices in Rotterdam (Geels, 2011)

Competitive landscape

To understand the trends in the market and potential competitors of the service system, the competition is examined. As this graduation project is about waste, the way how we dispose products, companies that bring products to the consumer are also examined. As the term 'items' can be classified as waste, material, or product. However, it would be beneficial to consult with established companies and initiatives to gain insight and leverage their expertise (Figure 13). This landscape includes; within the inner circle, direct competition from companies that collect used products and waste for subsequent transportation to a new location. The second circle comprises companies that are responsible for the distribution of the old products of users to new users. The third category comprises companies that have experience in the transportation and logistics of new goods. However, from the perspective of reverse engineering, these are interesting businesses to dive into. They are having competitive elements in the planning of the logistics.

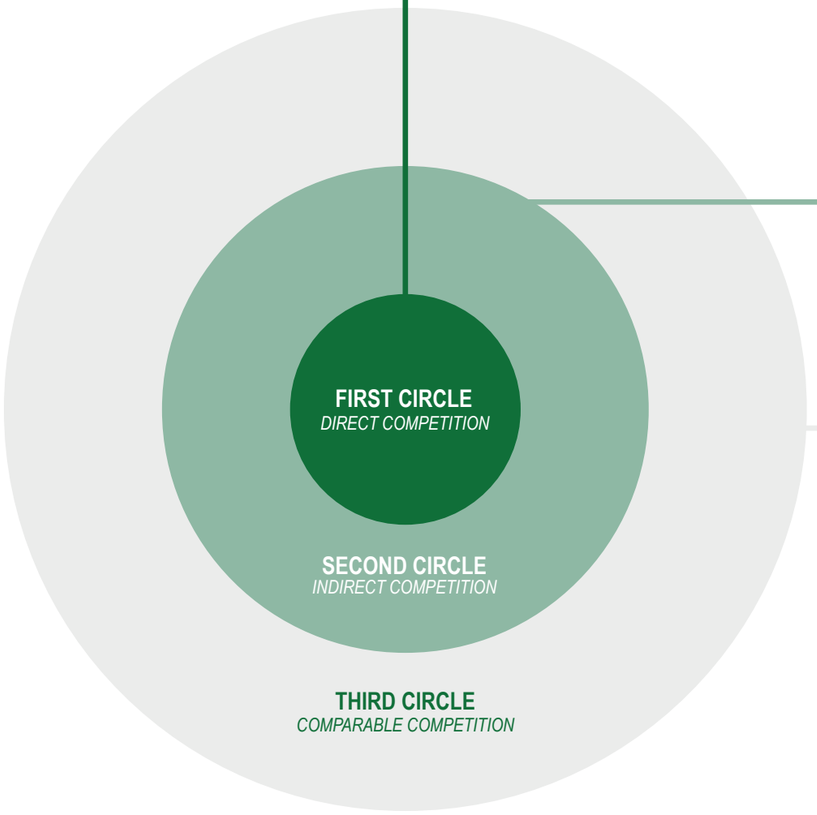


Figure 13: Competitive landscape of the research area

Direct competition

INZAMELHELDEN

A circular service solution that offers door-to-door collection of valuable waste streams, such as paper, cardboard, and packaging, from households, offices, and shops. By eliminating the need for traditional waste containers. Using electric bikes instead of trucks, InzamelHelden lowers emissions and contributes to a cleaner environment, while also providing a cost-effective solution for waste management.

byewaste

A service that collects items people no longer need directly from their home and ensures they are given a second life through a network of sustainable partners.

Spullenbak.nl

This is a service system regarding the collection of reusable household products and used by local circular producers. It was launched in The Hague, and it was tested to be effective, but some issues arise during the experiment.

GOUWE (KL)OUWE. CIRCULAIRE WERKPLAATS CARNISSE

As part of citylab010, an intiative of people living in Carnisse. Gouwe (KL) Ouwe are using disposed bulky waste on the streets for new products. It is a place where the reuse of items goes hand in hand with community interaction and talent development. The focus is on the value of both items and people, using waste as raw material and leveraging the talents and skills of neighborhood residents.

goedzak

Goedzak promotes reuse and sharing of unwanted goods, fostering positive social behavior. Fill the bag and place it in a designated spot for others to take what they find valuable. In collaboration with companies and municipalities, Goedzak adapts to different contexts. They have worked with Amsterdam, Eindhoven, and Albert Heijn, and seeking new partners to expand their initiative.

Indirect competition from distributors of used products

Marktplaats

Consumers can upload their disposed items on the platform and sell or donate them online.

het goed

The municipality has already established a working relationship with Het Goed. As a citizen, you can choose to let your belongings been collected first by the second-hand store van when reporting bulky waste.
Consumers can bring their disposed items to this establishment, where they will be sorted and sold.

Repair Café

The growth of repair cafes, which provide a space for individuals to bring their broken items and receive assistance in repairing them. It is evident that a considerable number of similar initiatives are being established. It is possible to undertake repairs to one's own furniture, electronic devices, and other bulk goods.

Gemeente Rotterdam

Places in the city where you can bring goods and to not want something in return.

Transportation compaties with return logistics potentials

DHL

is a global logistics company known for its expertise in express deliveries, freight transportation, and supply chain solutions. In the Dutch market, DHL is a significant player in the e-commerce logistics sector, providing comprehensive and efficient delivery services. They are already making use of electric delivery vehicles, cargo bikes and collection hubs. This aligns them with environmentally conscious consumers and businesses.

PostNL

a leading logistics service specializing in the delivery of packages across the Netherlands. While not an online retailer, they partner with numerous e-commerce companies, providing nationwide delivery services. Also, PostNL is developing sustainable transport solutions making the company interesting for environmentally friendly delivery.

coolblue

functions as its own distributor, controlling the entire process from warehouse to delivery. By managing their logistics in-house, they maintain high customer satisfaction, with a focus on speed and quality of service. This model gives them greater control over the customer experience, distinguishing them from traditional retailers and other e-commerce platforms. The company's fleet of transportation vehicles encompasses a range of options from cargo bikes to delivery trucks. They have extensive experience in optimization and delivery, which they utilize to maximize consumer satisfaction.

PICNIC

Picnic is an online grocery service that uses a fleet of electric vehicles to deliver groceries door-to-door to customers. With a strong focus on sustainability and efficiency, Picnic minimizes their carbon footprint by their app-based order- and delivery systems. Their data-driven service set them apart in the world of grocery shopping, offering a highly convenient, environmentally friendly option.

Albert Heijn

Albert Heijn, a well-established supermarket in the Netherlands, offers an online grocery shopping and delivery service. Leveraging its extensive store network and partnerships with delivery services. Albert Heijn is integrating return logistics in their delivery service. For example taking back the Heineken crates after delivery.

TAKE AWAYS

The position to work as an employee within the Projectbureau with the perspective of an entrepreneur opens doors to solve the problem. This creates out-of-the-box solutions within a political environment. As the Projectbureau has a clear responsibility to manage waste streams. The Projectbureau's position within the municipality provides unique insights into the organization, allowing for internal navigation of bureaucratic challenges that may otherwise hinder progress. As the Municipality of Rotterdam operates in a landscape shaped by political structures and hierarchical processes, which can sometimes hinder innovation.

The competitive landscape offers valuable lessons on how disposed products, materials and waste can be repurposed for social benefit, rather than simply discarding it. Sustainable and economical benefit from reverse engineering logistic companies highlight the importance of efficiently planning appointments for both waste collection and delivery, which could further optimize the city's bulky waste management system.

What do I know?

To make a comprehensive understanding of the current bulky waste collection, different methods of co-design were used. By observations and non-structured interviews on the streets during a bulky waste collection day and in-depth interviews with policymakers, project leaders and others relevant to the field of bulky waste, the current bulky waste system is identified.

Method

The different research design methods used, are listed in the Table 2 below. The observations and the interviews with the collectors were conducted during a working day as a bulky waste collector in Rotterdam. This research method was chosen to fully engage at the line of action to gather useful insights. It is crucial to consider their barriers and empathize with them to identify opportunity spaces. Additionally, any new design will require the collectors and the citizens, for them it will be the most significant changes.

In addition, seven in-depth interviews were held. The network of Schone en Circulaire Stad was leveraged to recruit participants who provided valuable insights into the current waste management situation. Therefore, purposive sampling was used to find the right participants for the in-depth interviews (Sanders & Stappers, 2012). The target number for recruiting was five in-depth interviews and they were selected based on the different projects that are done by the municipality regarding bulky waste. The interviews were each lasting approximately 60 minutes. These interviews were conducted using a semi-structured format allowing for flexibility in exploring various topics while ensuring that key questions are addressed. The purpose of the in-depth interviews was twofold: firstly, to determine the current system and to validate my assumptions derived from the field research; secondly, to identify the challenges and possible future scenarios. The path of expression was used for the second part of the in-depth interviews (Sanders & Stappers, 2012). It started by discussing the current situation, focusing on the present. Then, we moved back to past experiences and memories, helping the interviewees reflect on how things have developed. Finally, we shifted to their hopes for the future, exploring different possible scenarios. By gathering these insights, I was able to get into their and the latent needs and wishes and to create an ideal future vision based on the project leaders' perspectives.

Bulky waste collection

The current system of the bulky waste collection is created through observations, non- structured interviews and the in-depth interviews. In Figure 14 the area of the research is highlighted with the green dotted line. The customer journey map of the collectors gave interesting insights in the current system. In the collector's journey map (Figure 15), the most common pain points of the collectors are listed.

Journey of the bulky waste

The day started with a lot of inconvenience. The truck drove out before 7:00, but the citizens are allowed to drop off their waste for their doorstep until 8:00. The first hour was a lot of missed appointments we needed to come by later that day. Additionally, they must switch between different apps for route navigation and report management. This leads to the fact that the route for collecting registered bulky waste is inefficient and often hard to locate. No consideration is given to the potential benefits of convenient intermediate routes or the optimal strategies for combining multiple appointments in a single location. Also, collectors frequently struggle to find the reported waste and are not authorized to see the comments left by citizens. Despite these challenges, collectors are open to learning and working with new innovations. The assumption is that citizens need a simple and quick method to get rid of their waste, and many lack knowledge about waste policies or simply want to dispose of their waste without concern.

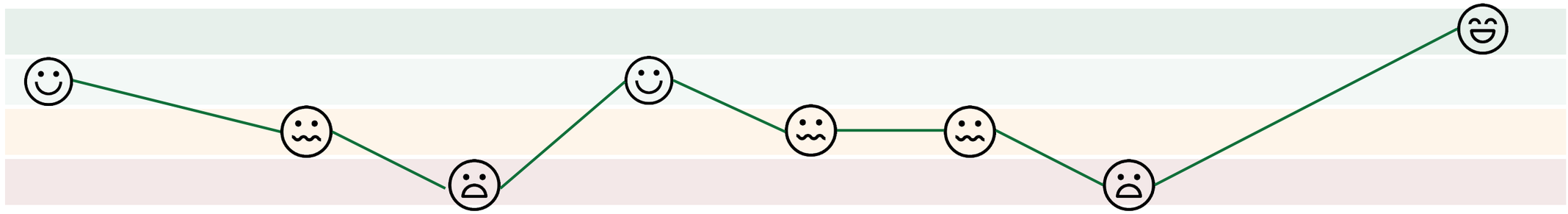
Table 2: Research methods of What do I know?

RESEARCH METHOD	#	Duration	Documentation	Data analysis	Location
Observations	35 appointments of citizens	6 hours	Pictures and direct note taking	Structuring of the notes and pictures in the online tool MIRO to create a journey map	Rotterdam Noord
Interview with collectors	2	6 hours	Direct note taking	Structuring of the notes in the online tool MIRO to create a journey map	Rotterdam Noord
In-depth interviews	7	45-60 minutes	Recordings, direct note taking, pictures, annotated pictures and workbook darta	Transcribing, coding and clustering with the analysis software Atlas.ti	Headquarters of Schone Stad Kleinpolderplein

Figure 14: Area of research

	6:30 START AT KPP		7:00-13:00 DRIVING ALL THE APPOINTMENTS			13:00 TO LANDFILL	14:00 BACK TO KPP
OBJECTIVES	***Equipement ready for the collection day***		***Collection of the registered bulky waste of the citizens***			***Bring the waste to the landfill***	***Return equipement***
ACTIONS	Distribution of the routes and appointments, iPad and keys for the truck.	First hour driving without finding bulky waste.	Appointments are found and the collection of the bulky waste is started.	A lot of bulky waste is found but not registered as it. We drove further and left it.	Conversations with citizens about the reusability of the registered bulky waste.	The compacted waste is brought to the processor.	Back to the headquarters and handeling in the contract, iPad and keys.
TOUCHPOINTS	Daily gathering and start with coffee and morning talks.	A regular start of the day without much appointments ready.	Making use of the iPad the chauffeur is switching between the application for the route and the application to see what kind of waste is registered.		Explaining the citizens that everything is crushed in the truck and brought to the landfill for after separation.		The day has come to an end.

EMOTIONS
of the collectors



PAIN POINTS

Timing issues
The first hour of the route was unproductive as residents typically only put their bulky waste out at the last minute.

App switching
During the route, the collectors had to frequently switch between two different apps, which complicated the process.

Batch sizes
Typically, larger batches of bulky waste are collected, but this route involved many small, individual items.

Registration confusion
There was confusion among citizens about how to register their bulky waste, what items needed to be registered, and the correct procedure for doing so.

Recycling indifference
Both citizens and waste collectors appeared indifferent to whether items were not suitable to be processed and collected by the compactor truck.

Public awareness
Citizens seemed unaware of the significant effort and logistics involved in the waste collection process. Frequently asked questions why they are not taking away everything.

Figure 15: Collectors journey map

Reusability of bulky waste

There appeared to be thrown away a lot of useful bulky waste according to my observations of the day with the collectors. To validate my assumptions on whether something is still useful or reusable during the in-depth interviews it has been asked in an interactive way. In Figure 16 the bulky waste that has been thrown away by inhabitants of the neighborhood Rotterdam Noord can be found categorized in reuse, repair and recycle. In Appendix C all the bulky waste found on the street is presented.

It was remarkable that everyone had their own definitions of what qualifies as reusable, repairable and recycle. Therefore, I had to equalize it after coding the interviews. In the figure on the right the definitions of the the assigned categories by the policymakers in the in-depth interviews can be found.
There is significant value in the bulky waste disposed of on the street, with a large portion being reusable.

- Of the total waste, 32% is composed of actual bulky materials that should be recycled, preferable brought to the environmental parcs.
- However, 68% consists of valuable materials, with a lot of doubts if it is reusable, repairable or in the recycle category by the participants.
- Within this percentage, 36% is made up of reusable items that only require minor repairs, and even a few high-quality pieces that could have been directed to thrift stores or online platforms like Marktplaats.
- Additionally, 32% of the waste consists of materials suitable for repair and remanufacturing.

After validating these assumptions with experts through in-depth interviews, it was concluded that 68% of the bulky waste collected is marked as reusable and is not suitable for the collection service of the compactor truck.

Causes of this behaviour

It is evident that the way we manage bulky waste, and the factors that influence this disposal behavior, have a significant impact on waste management practices. Additionally, they play a crucial role in determining how we handle products that are still suitable for a second use. Many products are discarded too soon, even when they remain functional. Our consumption-driven society encourages people to buy new items, resulting in unnecessary waste and environmental harm. The research of van den Berge et al. (2021) stated that replacement decisions are not solely based on logic. Emotional attachment, perceived usefulness, social influences, knowledge, and circumstances all play a role.

The collection service in Rotterdam can be used without being confronted by any of these factors, making it logic that there were usable products disposed.

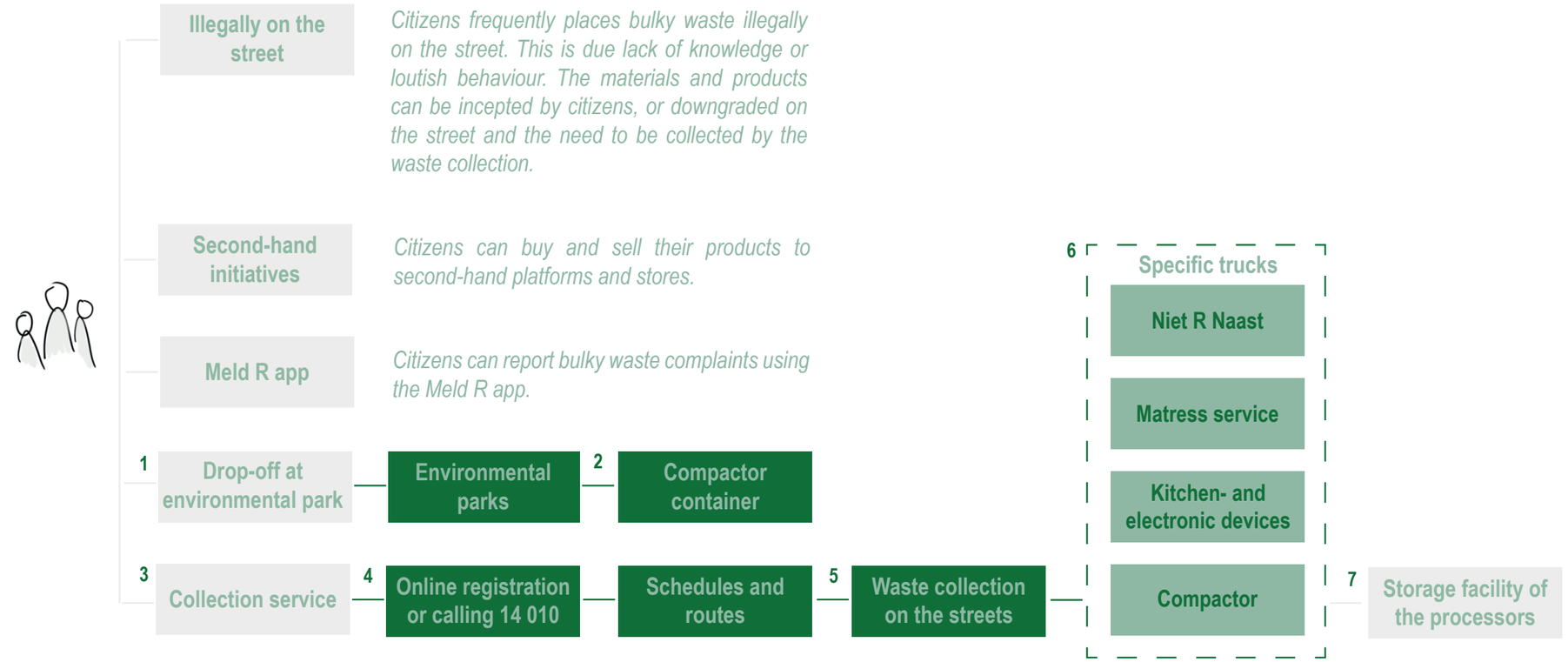
Many consumers are motivated to care for their products due to their appreciation for the product's functionality or their desire to consume sustainably (Ackermann et al., 2018). They often possess the necessary knowledge and tools or are willing to acquire them. However, what is frequently lacking are triggers that encourage product care. Triggers can enhance consumers' motivation or ability, consumers frequently overlook the option of repairing their malfunctioning products due to limited knowledge, perceived poor value, and lack of repair skills (Van den Berge et al., 2023).

The results of the research done by Fachbach et al. (2022) highlighted the trade-off between environmentally friendly actions and economic factors like repair cost and time. Government interventions, such as establishing a repair network, convenient replacement services and providing financial support, could also significantly influence this trade-off. These factors are not in use in the waste management system of Rotterdam. The new service system needs to take these factors into account.

Figure 16: Randomly chosen foundings of bulky waste during the working day on the truck

In Figure 17 the whole system can be found. The visualization describes the flow of the current waste management. The numbers correspond to the extra information about that step in the process.

Some interesting assumptions were made during the in-depth interviews. It occurred the policymakers that the citizens are currently using the Meld R app, which is intended solely for complaints, to report their bulky waste. This is because, the registration process for bulky waste involves long waiting times, and the existing processes at Schone Stad are facing issues that create integration problems. Another issue is that citizens often do not register specific waste streams, such as whitegoods, mattresses, and electronics, whi ch leads to everything being categorized as bulky household waste. As a result, there is no separation, even though, the municipality has the facility of different trucks for the different goods.



1 Citizens can bring their waste to the environmental parc or to a pop-up environmental parc.

2 At the environmental park, the waste is source-separated and crushed for volume reasons.

3 Citizens can register for the bulky waste collection service.

4 Registration can be done via the website or the municipality's phone number. Unfortunately, the waiting time can sometimes be long. After that, a route and collection schedule for street collection is created.

5 Street collection consists of officially registered appointments, complaints from the Meld R app, and everything illegally placed on the street.

6 Specific trucks are used for separating. This includes mattresses, white goods, and brown goods. There is also a truck for illegal placements.

7 The collectors drive to the storage facility of the processor. At the storage facility, the waste will be sorted and distributed it to various processors.

Figure 17: Current bulky waste management system of Rotterdam

TAKE AWAYS

Value of bulky waste
Despite the value in disposed bulky waste, a significant amount of reusable materials still ends up in compactor trucks. The in-depth interviews revealed that only 32% of collected bulky waste is actual waste suitable for recycling and crushing, while 68% consists of materials that could have been reused.

Inefficiencies in collection service
Schone Stad's processes have integration issues, leading to inefficiencies and difficulties on the streets by the collectors. The collectors only receive the registered waste, without citizen comments and must switch between apps for routes and remarks. The illegally placed, and waste registered via the external app for complaints, are handled with different trucks and routes.

Need for education on separation
Citizens and collectors miss categorize waste streams. The whitegoods, mattresses, and electronics are frequently categorized as general bulky household waste, resulting in all items being compacted together and destroyed in the truck. Effective separation of waste streams at home is necessary to avoid crushing valuable bulky waste. Therefore, citizens and the collectors need to be educated about proper waste disposal. Citizens desire a simple and quick approach to waste management and are lacking in knowledge regarding waste policies and dispose their waste without consideration.

Assumptions about behaviour of the citizens
The interviews revealed a common theme: many assumptions were made about what the citizens of Rotterdam desired in terms of waste management, but there was a lack of concrete knowledge. Understanding the needs of the citizens is crucial for developing effective and sustainable waste management strategies that align with the citizens' expectations and contribute to the city's circular economy goals.

Whom do I know?

In this section the internal and external stakeholders are examined. To identify potential stakeholder commitments and collaborations it is assessed whether the current stakeholders can guarantee value. Through interview meetings with project leaders and various potential stakeholders, their means and goals have been mapped.

Out of the in-depth interviews an overview of all the internal projects and stakeholders of the municipality regarding bulky waste are listed. This can be found in Table 3. The external stakeholders, the municipality of The Hague, founder of the Spullenbak, the manager of second-hand store 'Het Goed' and representatives of educational institutes were included during networking events and meetings. The external stakeholders can be found in Table 4.

Internal projects

The municipality is engaged in efforts to achieve the goals set for the year 2030. A multitude of initiatives pertaining to bulky waste and environmental awareness have been undertaken.

- Projects regarding the collection of bulky waste is the one in *Beverwaard*. The citizens requested a specific time, place and date to collect their bulky waste because of the amounts of illegally dumping. This project effectively utilized citizen participation, allowing for collaborative creation and interviews with citizens. During my research and exploration, this pilot was still in progress, it is used as a case study and the insights can be found in the chapter *Exploration*.
- The project of *Leenvervoer* is tackling a barrier of environmental parcs. Transportation and distance are making them impractical for small items and people without transportation.
- Further, the project of *Kasten voor Rotterdam Zuid* is one of social entrepreneurship. Using and repurposing the furniture left on the streets for the people who need it. This noble idea was not going much far because of the waste policies.
- Where the *pop-up environmental parks* will handle the problem by bringing the park to the citizen.
- The *Hout B pilot* is rooted at the environmental parks, to gain as much value out of wood as possible. Separation only occurs at environmental parks, where guided facilitation and containers for all the different waste streams are available. Therefore, that pilot can be a success with the help of the personnel of the environmental parks.

These current projects offer significant potential for further development and improvement in waste management innovations. Two projects, Beverwaard and Leenvervoer are used as means during my project. Because of the knowledge of waste management innovation in Beverwaard and the possibility to use the cargo bikes of Leenvervoer.

Table 3: Internal projects of Schone Stad regarding bulky waste

PROJECT	DESCRIPTION	SUCCESSES	SETBACKS
BEVERWAARD PILOT	**Initiated by local government and citizens' request to address frequent illigal dumpings, by setting a regular, no-signup-need collection once a week in Beverwaard.**	Effectively collected large amounts of waste.	Overwhelming amouts of waste, often inappropriate for the category Dumping by non-citizens. Dumping on the day it is not supposed to.
LEENVERVOER	**Provides borrowed transport to help people who cannot reach the environmental parks on their own.**	Widely used; available at several public locations in the city.	Convincing staff at the storage of the bikes and environmental parks to add this to their duties is difficult.
KASTEN VOOR ROTTERDAM ZUID	**Utilizes still usable furniture discarded on the streets for those who cannot afford it, focusing on reducing waste.**	Addresses the need for affordable furniture and the availability on the streets	Legal issues with reusing items designated as waste. Need for storage and a manager.
POP-UP MILIEUPARKEN	**Temporary environmental parks created to raise awareness and lower barriers due to transportation issues and lack of citizen knowledge.**	Increased drop-offs and understanding of environmental parks.	Communication to the public about what can and cannot be disposed. Staffing issues because of the need of licenses
HOUT B PILOT	**Seeks to find channels for wood collected at environmental parks to be reused instead of discarted.**	Collected usable wood and found distribution channels.	Wood must be donated, not discarded as waste. Public indifference between donations and discards.

External projects and stakeholders

The concept of circularity and its relationship with business collaboration is both complex and multifaceted. Many businesses (Marktplaats and Het Goed) want to achieve sustainable or social responsibility because it offers an social accepted brand image, in a market increasingly concerned with the environment (Spullenbak, 2024). However, most businesses remain driven by profit. This focus on profitability influences how their business model is managed.

Various organizations in Rotterdam are interested in utilizing materials disposed of by citizens, like *Buurman*, *educational institutes* and *Rotterdam Inclusief.* A key gap is the lack of a collaboration system or a facilitator to manage this stakeholder engagement. It is critical, if you want to set up this system, that it ensures the interests and needs of different parties are considered. This leaves an unaddressed opportunity for more effective collaboration and innovation in managing such materials. On the other hand, for many circular producers, handling large quantities of material can be challenging. According to Spullenbak, many producers often prefer smaller production batches, which align more closely with their capacity and sustainable practices. At the same time, consumer demand plays a significant role in shaping the market, influencing both production decisions and material flows.

The supply and demand between providers of reusable waste, circular producers, and buyers of circular products are closely intertwined. The primary challenge will be to connect these stakeholders and create a system where all their needs are effectively met. This is something that will be added to my design challenge. By mapping out all the internal projects and combining the means and goals of the stakeholders, it became evident that there is need for an external facilitator to bridge the gap of supply and demand.

Table 4: External organizations with interest in bulky waste practices

ORGANIZATION	MEANS	GOALS
Spullenbak.nl	• **Spullenbak: new circular initiative** • **Nearly five hundred households have a 'Spullenbak' at home.** • **There are ten entrepreneurs linked to it.** • **Waste collection process** • **New projects regarding waste management** • **Personnel for new iniatives**	• To start the circular entreuneurial way of thinking • Waiting for the market to adopt this
Marktplaats	• **Locally loved, international company** • **Creating matches of goods on an online platform**	• Healthy planet and society, shaped by sustainable commerce • To help everything and everyone to find a new purpose • Sell as much products as possible on their second-hand platform
het goed	• **Stores with second-hand goods** • **Work facilities for people with distance to the working market** • **Only goods which are clean, not damaged and complete**	• To keep products as long as possible in the loop • Making work through reuse • Social entrepreneurship
hmc Houtschool Rotterdam, Zadkine, WDKA	• **Education on reuse, repair and remanufacture** • **Talent development**	• Access to used materials for their courses • Expositions of student work
Rotterdam Inclusief Leren • Werken • Ontwikkelen	• **Personnel with distance to the working market** • **Workplaces for wood, gardens, etc.** • **A lot of storage space**	• Repurpose of materials in the city for the city • Learning, working and developing of goods and persons
Werkplaats Buurman Materialen	• **Working place facility** • **Reusable wood**	• Close the material loops and everything should be reused • Give materials new life through shop and workplace

TAKE AWAYS

Social value versus economical value
Profit is often chosen above sustainability. It is a challenge to balance sustainability in businesses driven by profit. At the other side, most circular initiatives are not focused on profit but on saving material. The consideration how to combine economic value with social value is crucial to sustain viable.

Question and demand constraints
Addressing these challenges requires a nuanced understanding of both production constraints of the market and consumer behaviors, paving the way for a more effective transition towards circularity.
To match question and demand will be the biggest challenge. This means to engage into the needs of the provider (citizen with the reusable bulky waste), the producer (the organization who wants to reuse the bulky waste) and the customer (the person who will assign value to the product). The new start-up needs to be the facilitator for the first step in connecting the stakeholders.

What can I do?

The current system of bulky waste collection, the goals and means of the stakeholders are defined. To explore the next session, project leaders from the Schone Stad have shared their insights on the existing goals and how to improve the system to make it future proof for Rotterdam and its citizens. In Figure 18 the graphical summary of the desired bulky waste management system is shown. This summary is developed by an examination of all the suggestions combined in one big representation. The thick green box is indicating the part of this system where my service system will focus on, the collection service.

Future vision

Everything in this system (Figure 18) is a new suggestion derived from the in-depth interviews. Only the material station is already in development. In February 2025, a new environmental park (De HER) is opening. This environmental park have the option to donate the materials for reuse.

System changes and awareness

The possible future system requires a lot of cooperation from citizens. It is the duty of the municipality to facilitate everything seamlessly, but the big challenge also lies in changing citizens' mindsets. This is also stated by the research of Albarracín et al. (2024). It emphasizes the importance of considering both communication and system changes. While communication campaigns can be effective in raising awareness and influencing attitudes and beliefs System changes, such as modifying the environment can play a significant role in driving the desired behavior change. Therefore, it is essential to tailor the new interventions to the specific behaviour and bulky waste context, considering a combination of strategies to maximize effectiveness in promoting positive behaviors in society.

In the desired future scenario, a significant portion of the responsibility will fall on citizens. The term "waste experts," frequently mentioned during in-depth interviews, can refer to individuals supported by external parties and organizations—not just the municipality. It is not necessarily the municipality's role to single-handedly implement a system and ensure citizen involvement. Instead, the municipality can be supported by design interventions and system changes that encourage citizens to adopt behaviors aligned with those of waste experts, thereby easing the municipality's burden.

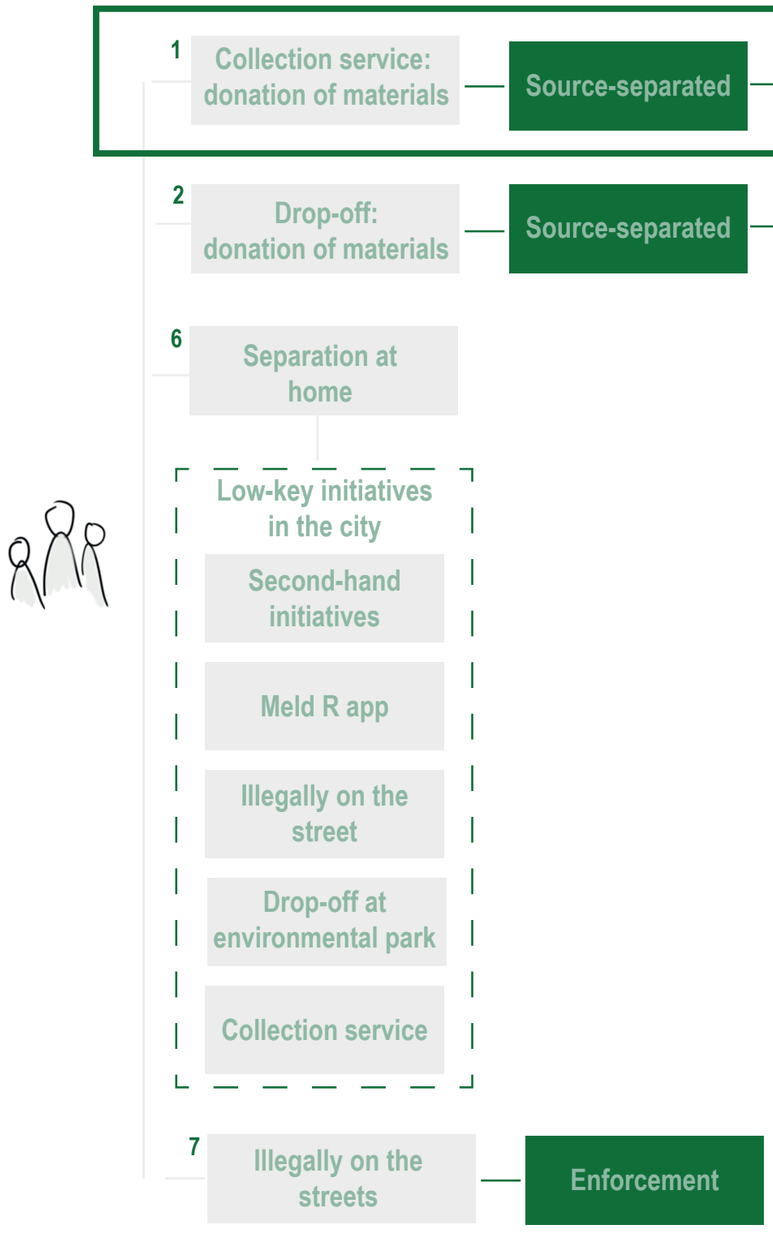


Figure 18: Desired situation of the bulky waste management in the future

1 The collection service becomes a donation to the city. To make an appointment for collection, you must fill in a questionnaire. The materials need to be source-separate at home and waste experts will reassign the goods to the specific collection truck and route. Different trucks will come and collect your materials separately.

2 The drop-offs at environmental parcs are encouraged and seen as the default option. Your stuff is checked by waste experts, and you take it to the right place at the park.

3 The environmental parks are called material stations and are made up of different hubs with repair workshops, swap areas, disassembly halls for reusable materials and other giveaway corners.

4 The materials will be used by educational institutions and entrepreneurs who use it for circular purposes. Circular products are made and go back in the loop of consumption.

5 All the material that is not used in the material stations, will be source separated and are ready for high-quality processing.

6 The citizens are well educated about the use of old products and materials. They can make the right choice themselves and leave products longer in use by repurposing their products. There are low-threshold initiatives in the city such as giveaway corners, pop-up environmental parks, swap days and repair cafes to repurpose your products easily.

7 Illegal placement on the streets will be an option in the future. There will be a lot of enforcement.

Changing behavior

From in-depth interviews citizen's behaviour is important for the a succesful waste management process. The project leaders were asked about the best options for the citizens versus what they are doing now. In the current waste management system on page 26, the considerations of citizen behaviour can be found too.

During the interviews, a lot of assumptions about citizens in waste management have been suggested. These assumptions centered around convenience, ignorance, lack of knowledge, and time constraints. It is assumed that many citizens prioritize convenience, opting for the easiest methods of waste disposal, even if they are not environmentally friendly. Ignorance plays a role, as some citizens may be unaware of proper disposal methods or the importance of separating recyclable materials. Additionally, there is a lack of knowledge about available waste management resources and processes, leading to improper disposal practices. Time constraints expand these issues, as busy schedules make it challenging for citizens to engage in more sustainable disposal methods. These assumptions highlight the need for better education, accessible services, and efficient systems to encourage responsible waste management behaviours.
Another point that was made about the disposal behaviour is the structure of the environment. In waste management practices, the environment often dictates how waste is disposed of, with strategies and interventions working in several neighborhoods. In high-rise buildings, citizens typically have shared bins located downstairs, while in neighborhoods with gardens, individual bins are more common and offer greater convenience.

Responsibility

From in-depth interviews it is stated that the primary driver for citizens is convenience in waste management, which often leads to improper disposal when knowledge is lacking, rules are ignored, or financial costs are not a significant factor. Municipalities, though equipped with the most power and knowledge to improve waste systems, face limitations in directly influencing citizens. Active public participation is needed for successful waste management systems (Knickmeyer, 2020). The recycling behaviour of the citizens is based on trust in local authorities and waste separation programs. Citizens who have good relationships with their local government are more likely to comply with the needed requirements. On the other hand, the question that must be addressed is that of responsibility. Is it reasonable to hold the citizen responsible for their actions, because citizens tend to have more intuition thinking instead of rational thinking about the consequences (Shiv & Fedorikhin, 1999). The citizen will undeniably opt for the option that offers the greatest convenience, driven by emotional and affective factors. The easier and more convenient the system is, the more likely it is to be used. The first reaction that occurs will be the one that is eventually acted upon. If a straightforward solution is immediately apparent, then the rational intended procedure will often be overlooked. Ultimately, waste collection facilities play a key role in shaping disposal behaviours. To design systems that address information gaps and effects from the emotions of citizen's perspective is crucial to fostering responsible waste management. At the same time, convenience must be balanced with efforts to motivate citizens toward responsible waste practices. This points out the importance of education and new initiatives to increase public awareness.

Shift to sustainable behaviour

To identify areas of opportunity within the citizen behavior spectrum, several sustainable design strategies will be used. The first strategy is to *rethink* and reduce the negative environmental effects by transitioning to an entirely new system (Haffmans et al., 2018). Most examples for this strategy pertain to packaging issues. From the use of plastic packaging to the reuse of a shopping bag, there are many opportunities to reduce waste. This strategy is particularly effective for bulky waste collection. We can significantly alter our approach to products and materials that can be put to good use again. The next strategy is more practical applied in this sector: *design for contin-use*, also known as *reuse* (Haffmans et al., 2018). The ever-increasing growth in the fast-moving consumer goods sector has led to a trend among consumers to replace products more frequently, which has had a negative impact on the perceived value of products and materials (source). The strategy of contin-use allows products that move extremely fast can be used repeatedly.
The strategy of contin-use can be executed in different ways for this project:

1) It could be done in the form of flow management, it involves maintaining a complete overview and control of materials or products throughout their lifecycle, ensuring continuous traceability of all inputs and outputs. This system requires collaboration among stakeholders to identify inefficiencies and optimize resource use.
2) The second one is reverse logistics, it applies traditional supply chain principles in reverse, focusing on retrieving and redistributing used products or materials for reuse.
3) Separation and sorting services. Current processes are often inefficient and focused on developing better technical sorting methods. There could be more focus on the transportation to let the products and materials 'flow friendly' throughout their lifecycle

Last but not least, the SHIFT-framework, it is not a design strategy but rather a framework designed to guide sustainable behavior. White et al. (2019) created the SHIFT framework, emphasizing the necessity for strategic interventions for sustainable behaviour change. The framework is represented by the acronym SHIFT, which suggests that consumers are more likely to engage in environmentally conscious behaviors when the message or context leverages the following psychological factors:

1) Social influence is about norms, identities and desirability to change.
2) Habit formation to discontinue with the bad habits. Use of penalties or incentive or design interventions.
3) Individual self to play into the self-concept of the citizens.
4) Feelings and emotions to guide them toward the desired behaviour.
5) Tangibility for communicating the importance on a tangible level to understand.

Understanding how far consumers are willing to shift their behavior towards sustainable practices is an ongoing process. In the next section *Exploration*, the behavior of citizens will be analyzed to develop new sustainable interventions in waste management.

TAKE AWAYS

Causes of improper disposal
Citizens' waste management behavior is influenced by ignorance, convenience, lack of knowledge, time constraints and emotional factors. Many prioritize convenience over environmentally friendly practices. This highlights the need for targeted education, efficient systems, and new initiatives to shift behaviour.

Involving citizens in the research
It is crucial to develop a waste management system that actively includes the citizen's perspective and participation. There remains much to learn about citizens' behavior and needs. This can be effectively addressed through qualitative research. Many current assumptions about citizen behavior are based on assumptions rather than comprehensive data.

The future of waste management
Waste management facilitation should be a seamless process, integrating system changes with communication campaigns to ensure that citizens are well-informed and engaged. In the desired future scenario, significant responsibility lie by the citizens. A collaborative approach to enhance the motivation is needed to ensure the citizens manage waste proper. The following criteria is compiled out of the in-depth interviews:

- More enforcement against illegal dumping.
- Reframing waste collection as a donation, removing the concept of 'waste'.
- Encouraging drop-offs at environmental parks.
- Improved citizen participation in separating waste for repurposing, supported by waste experts.

Design for contin-use and shifting behaviour
The shift toward sustainable behavior requires rethinking existing systems to reduce negative environmental impacts and employing strategies such as contin-use and reverse logistics. These strategies facilitate more effective use and reuse of products and materials throughout their lifecycle. The SHIFT framework supports this by guiding sustainable behavior through strategic interventions. Understanding consumer willingness to adapt to sustainable practices remains a continuous process.

OPPORTUNITY SPACES V1

After comprehensive analysis, various value propositions are listed and later formed into opportunity spaces by me. An extention of the R-goals is found in Figure 19. The recovery of the materials and repurposing the useful goods are added.

The opportunity spaces will evolve over time, as the knowledge on the subject will grow. Eventually, they are selected during ideation. The first three opportunity spaces are listed in Figure 20. For the formulation of the first three, the knowledge on citizen behaviour, the current bulky waste management system and stakeholder engagement are used.

Enhanced convenience for citizens and collectors

Due to the obstacles encountered during the day at the bulky waste collection service, several new opportunity spaces are found. An example of real-time tracking of the truck, integration of the applications and the need to improve the citizen's experience.

Improved bulky waste management

The current bulky waste system is inefficient for citizens to report and for collecters to collect. Considering the insights gained from the observation day and in-depth interviews. Four suggestions are presented that could be implemented to enhance the system. The proposal includes the introduction of new services in the areas of transportation, infrastructure development, and reverse logistics, with the aim of improving the overall system. This opportunity area will be explored using a creative, out-of-the-box approach.

Community engagement and participation

There are enough external parties interested in collaborating on this issue. Furthermore, there are several initiatives or design interventions in place to encourage citizen participation.

Gap exploitation

The transition towards sustainable behavior is crucial for fostering a circular city, various business opportunities can be used to design the needed interventions for such changes. For this project the business perspective of **gap exploiter** will be used (Haffmans et al., 2018). It is focused on recognizing opportunities to make money by bridging gaps. It consists of creating a service by connecting different stakeholders and keep the products flow. As there is enough material that is suitable for pumping up the value, especially in the sector of bulky waste. This mindset is driven on entrepreneurship together with the knowledge on strategic design. There will be a focus on continuation by rescuing waste, products and materials and turn them into something useful again, without scrapping the material. The bulky waste will be opportunistically handled, with the goal of closing the loop by bridging the gaps and save the material and costs. For circular business models, two distinctions are made: *slowing down* and *organizing the loops*. By slowing down, it is meant to design products that last, sustaining the value rather than allowing it to drop. Organizing the loop is concentrating on the whole flow and to minimize the effects of the materials in the environment. These both circular business models will be evaluated together with the design for contin-use and SHIFT.

3 RECOVER

The bulky waste is recovered as much as possible in the future. This means high-quality recycled or reused.

4 REPURPOSE

The useful bulky waste is directed for a second life within the city.

Figure 19: Extention of R-goals after Scoping

ENHANCED CONVENIENCE FOR CITIZENS AND COLLECTORS

- A real-time tracking of the bulky waste collection trucks for citizens, enhancing trust and cooperation.
- Integration of citizen comments and locatable bulky waste, ensuring timely and accurate pickups.
- The use of better user experience in the registering application for waste reporting that integrates all necessary functions, reducing the current complexity and improving accessibility.

IMPROVED BULKY WASTE MANAGEMENT

- Develop shuttle services or partnerships with transportation providers to improve access to environmental parks. To overcome transportation challenges and encourage proper disposal practices.
- Supportive waste infrastructure on community level to facilitate proper bulky waste disposal. These facilities should be easily accessible and provide guidance on waste separation.
- Implement educational campaigns and provide clear guidelines to citizens on proper waste separation, emphasizing the environmental and economic benefits of reusing products and materials.
- Play into the gaps found in the citizen behaviour. Make use of strategies like flow management and reversed logistic to design a service system for bulky waste for sorting and separation.

COMMUNITY ENGAGEMENT AND PARTICIPATION

- Partner with organizations like Marktplaats, Spullenbak, Het Goed, and repair cafes to create a robust network for reusing and repurposing bulky waste.
- Introduce incentive programs that reward citizens and businesses for bulky waste give-away practices.
- Education on the principles of the circular economy and how they can contribute, emphasizing the value of reducing, reusing, and recycling waste to be part of the circular city.

Figure 20: Opportunity spaces listed after Scoping

MEANS

- Data of waste
- Registration for collection service by telephone or online portal
- Sharing transports with cargo bike or trailer
- Facilitation of environmental parks
- Information system of waste in Rotterdam
- Waste collectors
- Different vehicles to transport bulky goods

- Online selling platforms
- Online safety for sellers and buyers
- Stores and storage space capacity

GOALS

- Waste prevention
- Better waste separation
- High-quality processing

- The business need to be viable and driven by profit
- Producing with used materials, no matter the economic growth
- As many matches and sells on the platform
- To create work for people

Figure 21: Means and goals structured for Schone Stad and the external partners

Given means and goals

After the first chapters, several means and goals for the bulky waste collection were found. In the visual on the left (Figure 21), the given means are defined based on insights from the first phase of the project. The goals in the figure represent the main objectives that Schone Stad is currently pursuing (Grondstoffennota, 2023).

CHAPTER CONCLUSION

2.1 What is the current situation of bulky waste collection in Rotterdam?

The collection service is inefficient and environmental harmful. It needs radical change to achieve the predefined goals of Rotterdam. The Projectbureau is an ideal place to push innovation. Their strategic position within the municipality allows them to navigate challenges and develop sustainable waste solutions.

Out of the observations on the street and the validation in the interviews it is concluded that there is still a lot of value in the bulky waste registered for collection. With 68% of collected materials being reusable, yet destroyed due to the current procedures and regulations of the collection service. This points to *a need* for a innovative and sustainable bulky waste collection service, ensuring valuable items are repurposed rather than crushed in the compactor truck and incinerated.

Citizen behaviour is important to realize the objectives. The assumptions made about citizens, such as primarily focusing on convenience and a lack of knowledge, need validation. This suggest extra research and more engagement with the citizens to align waste management strategies with their needs.

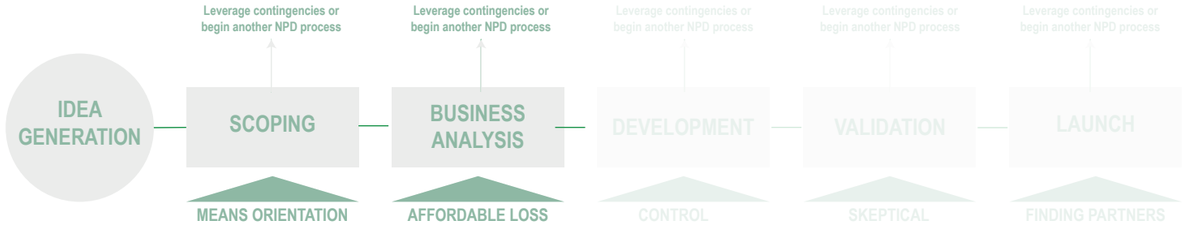
2.2 What are possible value propositions based on the means orientation?

The future of Rotterdam's waste management system hinges on increasing citizen convenience and responsibility. The bulky waste service need to support this through better guidence and facilitation.

Project leaders propose reframing waste collection as a form of donation and encouraging drop-offs at environmental parks. The system must seamlessly integrate citizen and stakeholder participation with efficient waste separation processes, leaded by waste experts. A collaborative approach between citizens, the municipality, and external stakeholders is key to creating a circular economy and ensuring the success of future waste management.

In this project I will have the perspective of a social entrepreneur working in the environment of the municipality of Rotterdam. This position opens doors to unconventional solutions with the use of entrepreneurial thinking, with the needs of the citizens and collectors as focus.

3 BUSINESS ANALYSIS



EXPLORATION

3.1 Which challenges of the bulky waste management system can be used as opportunities?

The challenges of bulky waste management include the integration issues of the different applications, limited access to the environmental parks and lack of knowledge of the citizens. However, they have potential to be resolved in future innovations. The lemonade principle is used to perceive challenges as potential opportunities for business and innovation.

Challenges of Schone Stad

The lemonade principle (Sarasvathy, 2008) (Duening et al., 2012), forms the foundation to turn the challenges of Schone Stad into business opportunities.

3.2 What citizen behaviour can be used to develop a new bulky waste collection system?

The redesign of the bulky waste collection system should consider natural citizen disposal behaviors. They have a desperate need for convenience and a lack of consideration for environmental consequences.

Citizen behaviour in Rotterdam Noord and Beverwaard

The observations in Beverwaard and Rotterdam Noord provide insights into how citizen involvement could be better integrated by changes in the municipal waste management environment. The disposal behaviour of citizens will serve as a starting point for developing a new collection system that better aligns with the circularity goals of Rotterdam.

OPPORTUNITY SPACES V2

3.3 What are new value propositions based on the exploration?

The new value propositions are relieving municipal services and citizens and using robust communication strategies. The proposed design challenge enhances accessibility to environmental parks by managing proper waste disposal through an external enterprise.

During the business analysis, the means and goals are updated and new opportunity spaces are added to the list.

FROM RESEARCH TO DESIGN

3.4 Does the design challenge align with the predefined goals?

The proposed on-demand bulky waste collection service supports Rotterdam's circularity goals by promoting reuse, preventing waste, and ensuring high-quality processing through material collection and delivery to the environmental park.

Design challenge and criteria

In this chapter the outcomes of the research are aligned with the needs of the municipality, citizens and external partners. A design challenge is formulated with corresponding criteria.

EXPLORATION

During the in-depth interviews four clusters of challenges of Schone Stad are exposed during data analysis. These challenges are structured into more specific sub-categories that reflect the nature and focus of each challenge. Furthermore, the challenges are plotted into the network of all the factors that influence the problems that are faced on the streets. It is important to have a holistic view of the waste management practices to ensure strategic sustainable innovation. With the use of this network I can use the helicopter view on the problem.

Challenges

All the challenges and their sub-challenges are listed in Figure 22 on the right.

Operational efficiency is hindered by staffing and storage space issues, significantly impacting the infrastructure management of bulky waste in the city and its accessibility for citizens. The lack of optimal collaboration between operational processes and waste facilitation has led to incorrect disposal practices, resulting in chaos within the system.

Additionally, the municipality's efforts to influence citizen behavior regarding waste disposal remain a persistent challenge. Effective communication regarding waste separation is crucial for the system to function smoothly. The economic sustainability of waste management projects must be prioritized. Government grants are not a long-term solution because of the changes with councilors, strategies can change from time to time. The system needs to be self-sustaining and capable of adapting to these changes. This underscores the necessity for strategic innovation, as a comprehensive transformation of the entire system is required to achieve meaningful change. All these challenges are interconnected, influenced by various needs, rules, and standards. To better understand this complex system, the network of all factors and interconnections can be found at the next page (Figure 23).

OPERATIONAL EFFICIENCY

STAFFING

- addressing the need for adequate personnel for waste management operations.
- having the right licenses or intention to add some worktasks for innovation.

STORAGE SPACE

- managing and optimizing physical storage spaces for reusable materials for distribution channels.

INFRASTRUCTURE MANAGEMENT

INCORRECT DISPOSAL

- dealing with the side placements beside containers or on the wrong places. This may involve better communication placement strategies.

THE CORE BUSINESS ON HIGH LEVEL

- ensuring that foundational infrastructure and practices are on level managed.

BEHAVIOURAL INFLUENCE

COMMUNICATING THE IMPORTANCE OF WASTE SEPARATION

- developing and implementing communication strategies to educate and motivate citizens about the benefits of waste separation.

CITIZEN BEHAVIOUR

- influencing, stimulating and improving how citizens engage with waste management practices.

ECONOMIC SUSTAINABILITY

PROMOTING CIRCULAR THINKING

- encouraging the adoption of circular economy principles, which focus on reusing, sharing, repairing of resources to minimize waste.

MAKING THE MODELS PROFITABLE

- ensuring that waste management models are economically viable and self-sustaining.

Figure 22: Challenges of Schone Stad found in the in-depth interviews

Framework of bulky waste challengess

To comprehend the bulky waste management system in Rotterdam and to establish connections with the identified challenges, a network was developed (Figure 23). This network highlights three key players that significantly influence the observed waste disposal behaviors on the streets: the municipal organization Schone Stad and the facilitation of bulky waste collection in the city (dark green boxes), and the citizens themselves (light grey box). The *needs and regulations* of these key players are represented by light green boxes, which collectively illustrate the reality of waste disposal practices, depicted as dark green circles in the middle. This network serves as the foundation for examining the core issue: *why* do citizens dispose reusable bulky waste, and what factors are contributing to this behavior.

Schone Stad's facilitation

Schone Stad's core operations are currently underperforming, making it difficult to implement innovations.

The Projectbureau is currently performing a lot of new initiatives, so there is potential for innovation, but the lack of personnel poses significant challenges. Staff must be convinced to adopt new approaches, which will require training and potentially increase their workload. Additionally, legal issues arise when waste is registered; once classified as waste, the municipality is required to process it, accordingly, leaving less space for circular innovation. Furthermore, the registered bulky waste collection service is inefficient. In some cases, it is difficult for the collectors to find the place of disposed bulky waste due to the lack of integration of the different applications Schone Stad. The collectors are unable to view the comments submitted by citizens; however, the team leader, situated behind his desk, is able to do so. Also, due to the long waiting times and the free service this results in a significant number of appointments being made that ultimately prove to be unnecessary.

Registered bulky waste is collected by a crush-compacter truck and brought to the landfill storage to be incinerated later. Ideally, the bulky waste streams should be separated and brought to the environmental parks by the citizens themselves. At the environmental parks, it will be source-separated. However, the environmental parks are in locations that are inconvenient for most of the citizens, which leads them impractical to reach. For example, individuals without access to transportation and the distance is a significant obstacle to the transportation of smaller items and time constraints. The current projects, such as leenvervoer and the pop-up parks, are designed to increase public awareness and accessibility of the environmental parks.

Citizens

Citizens need education on proper disposal methods, as many seek quick and easy ways to get rid of waste without understanding or caring about waste policies. Registered bulky waste is often placed together, underscoring the need for at-home separation.

It has been observed that a lot of valuable materials are picked up from the bulky waste laying on the streets. In an article in NRC magazine of Van Rossum (2024), the ten most popular free things were listed. Number one was shopping in the bulky waste laying on the street for collection.

There is still value in bulky waste, since a lot of bulky waste is taken by other citizens after disposed on the streets. This presents opportunities for establishing a profitable service system for reuse of the materials.

Further investigation is needed into citizens' preferences and needs regarding waste management, and influencing the desired behavior remains a challenge.

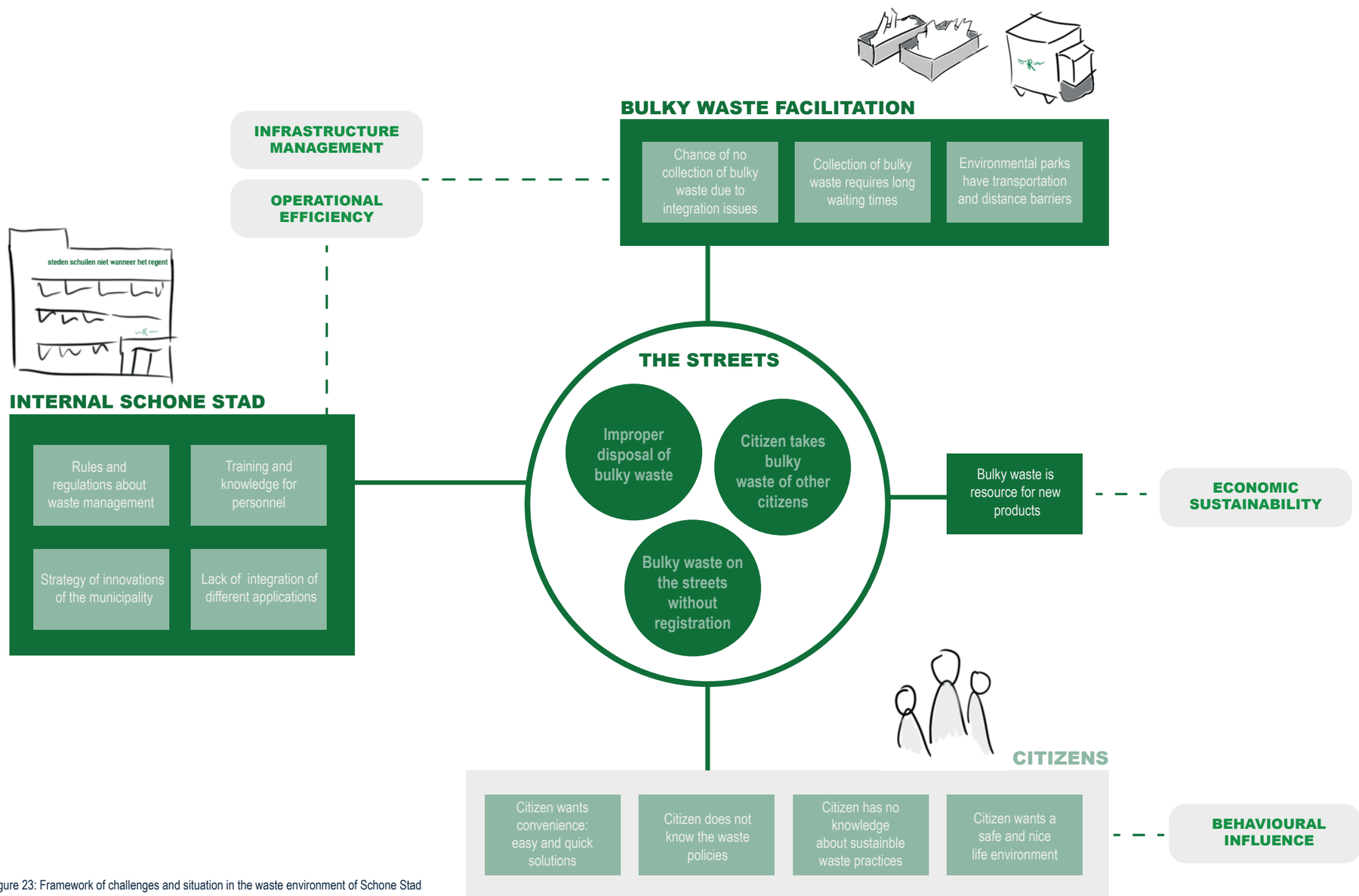


Figure 23: Framework of challenges and situation in the waste environment of Schone Stad

TAKE AWAYS

Schone Stad faces **operational inefficiencies** and challenges in **infrastructure management.** The operational inefficiencies and staffing challenges, hindering innovation in waste management. The legal constraints limit circular innovation, while there are solutions focusing on improving the access and awareness of the environmental parks.

Bulky waste collection is inefficient and environmental harmful. It is inefficient due to **poor integration of applications and the long waiting times** to schedule an appointment. The collected items are crushed and transported to the processor. There are no reuse or recycle streams in use.

Citizens lack knowledge on waste policies and sustainable disposal practices. It is assumed that the citizens only seek convenience and a nice living environment.

Citizen behaviour

In this chapter the assumptions of the citizens behaviour will be verified. It is important to understand the meaning and perceived responsibility of the citizen about waste management. The tested collection day in Beverwaard and the daily walk through Rotterdam Noord offers a case study to provide insights into how citizen behaviour is integrated for bulky waste management innovation.

Understanding citizen behaviour and the factors behind their waste management choices is crucial for system improvement. To determine the desirability of an innovation, it is necessary to validate the assumptions made about the citizens. These assumptions include convenience, ignorance, lack of knowledge and time constraints. The test whether these factors are contributing to improper waste disposal is crucial for the development of effective interventions.

Method

The assumptions are validated through one-month-long street observations and -interviews. In Table 5 the methods can be found. The research is conducted in the same neighborhood as the collection day on the crush-compactor truck. The route is walked four times a week and is marked by the thick green line in Figure 24.

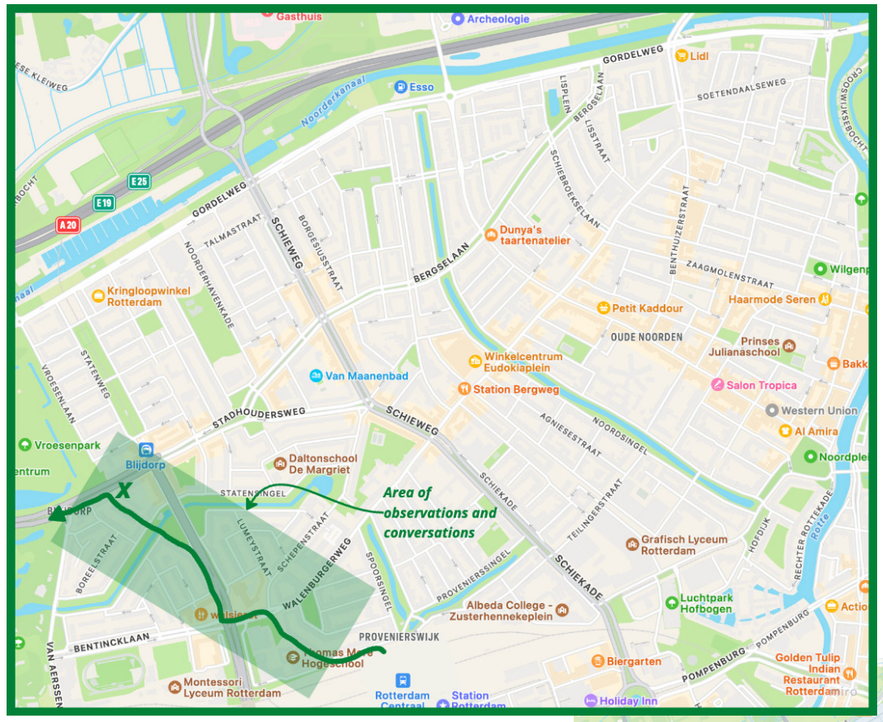


Figure 24: Research area of citizen behaviour

Table 5: Research methods of citizen behaviour

RESEARCH METHOD	#	Duration	Documentation	Data analysis	Location
Street observations	10	In the month June 4 times a week	Pictures and direct note taking	Structuring of the notes and pictures in the online tool MIRO	Rotterdam Noord Van Beuningenstraat, Walburgerstraat en Bentinkplein
Street interviews	11	5 minutes	Direct note taking	Structuring of the notes in the online tool MIRO	Rotterdam Noord Van Beuningenstraat, Walburgerstraat en Bentinkplein

Results of observations and conversations

In most cases, the intersection of Van Beuningenstraat and Stadhoudersweg, most bulky waste was found. This is indicated by the X on the map (Figure 24). Furthermore, this location afforded the opportunity to engage in most conversations, given its position at the periphery of the neighborhood. According to mostly everyone, bulky waste typically refers to large items that cannot be disposed of in standard waste receptacles. Citizens show varied behaviors when managing this waste. While some individuals choose to take their items to environmental parks, others leave them on the street, often with the assumption that someone else will collect them or that the municipal services will handle the disposal.

1) Lack of awareness and modes of transportation

One of the primary reasons for improper bulky waste disposal is a lack of awareness about the available disposal processes. Many citizens are unaware of what to do with their bulky waste or which disposal options are available to them. Additionally, logistical challenges contribute to improper bulky waste disposal. Limited access to environmental parks, either due to a lack of personal transportation or the distance involved, makes these facilities less accessible to some citizens.

2) Ease of disposal

Convenience plays a significant role in their decision-making, as many individuals seek to avoid the *perceived* hassle associated with proper disposal. The time required to bring items to an environmental park is seen as a barrier, leading to improper disposal in many cases. While options like second-hand stores, platforms such as Marktplaats, or repair cafees exist, many view them as a long, time-consuming and difficult process. Municipal bulky waste collection services can be seen as convenient, but are also perceived inefficient, with long waiting times and estimated times of placement, discouraging citizens from using them.

3) Place of disposal

Disposal of bulky waste frequently occurs at the periphery of neighborhoods, often next to underground waste containers. Specific locations, such as lampposts and trees, are commonly used for depositing bulky waste, as evidenced by documented pictures (Figure 25). When bulky waste has already been left on the street, others are more likely to add something to it, creating a larger, (unregistered) waste pile. This results in both registered and unregistered bulky waste in these common disposal spots. Several results of daily walk are illustrated in Figure 25. The results are provided by a variety of objects, including chairs, wooden objects, and pieces of furniture. All items were categorized as either reusable or repairable. Most of the time, the materials were proper bundled, and the citizen experienced no nuisance from it. One day in the morning a chair was found, a little dirty, but with some refinements, still reusable (Figure 25). At the end of the day two cupboards and a broken mirror were put besides it, this validated the insights gathered from the street interviews.

4) Convenience over environmental motivation

A significant proportion of citizens are unaware of the importance of separating materials when disposing of bulky waste. Even when people possess knowledge about the environmental benefits of responsible disposal, many find the process too inconvenient to prioritize sustainability. Awareness of environmental impacts varies widely, with some individuals opting for ease of disposal over environmentally friendly practices.

"Disposal of bulky waste frequently occurs at the periphery of neighborhoods. Often next to trees, lampposts and underground waste containers. Also, waste piles creates the idea of placing more waste besides it."

Those places are not proper disposal places. If there is standing something next to an underground container, it is not possible to empty that container. The same applies for bulky waste positioned next to lampposts and trees. Despite of the change of damage, if a gripper hook is needed for removal, this cannot be done. Although, there is an explanation for this behaviour. Many years ago, it was the rule, for all the waste for collection, to place it next to purposely placed waste posts on the pavement.

Trees

Lampposts

Underground containers

The same day

Figure 25: Observations of citizen behaviour in Rotterdam Noord

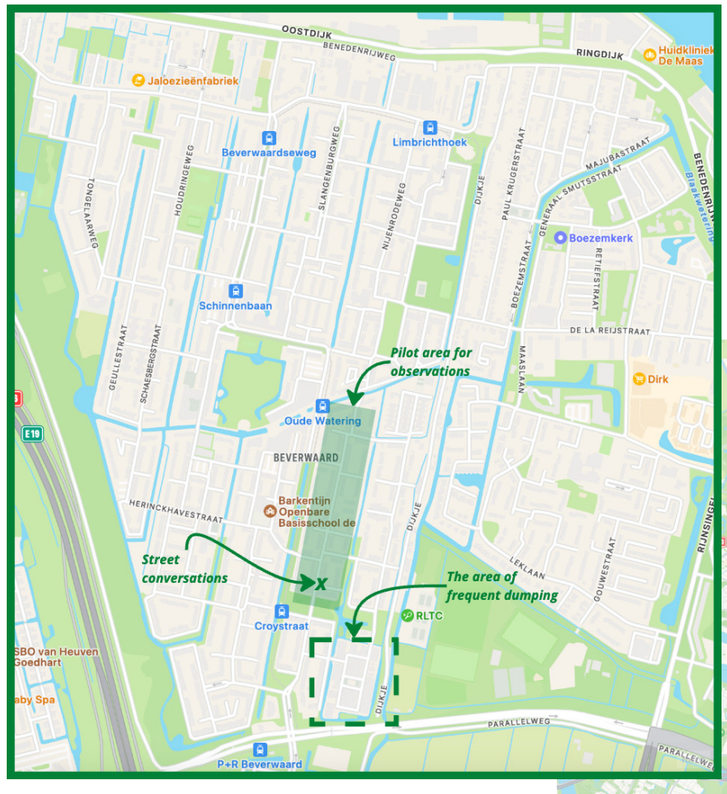
Case study: Beverwaard

To gain insight into how citizens would respond to changes in waste management, a program of the municipality was researched. The municipality of Rotterdam initiated a test project in Beverwaard, whereby bulky waste is collected at a fixed time each week in designated areas. The goal of this pilot was twofold: firstly, to prevent the illegal dumping of bulky waste, and secondly, to promote a structured approach to the collection. Ten locations were marked within the Cannenburghstraat, only within those areas citizens were permitted to deposit their bulky waste. The waste will be collected on a weekly basis on Thurday, with the intention the designated areas to be utilized exclusively on Thursdays.

The objective for my exploration was to observe how citizens handle changes of their bulky waste disposal habits. It is important to learn from other projects. I will make use of the successes and learn from the obstacles.

Method

All the observations are done several times in Beverwaard. To make sure the observations were reliable, the area was visited several times on different moments in the week to overcome coincidence. In Table 6, the sign # means how much observations of bulky waste were seen. 10/10 means that on all the 10 marked spots bulky waste was found. After the observations on the different days during the pilot and after the pilot. The results were discussed with the wijknetwerkers and citizens for validation.



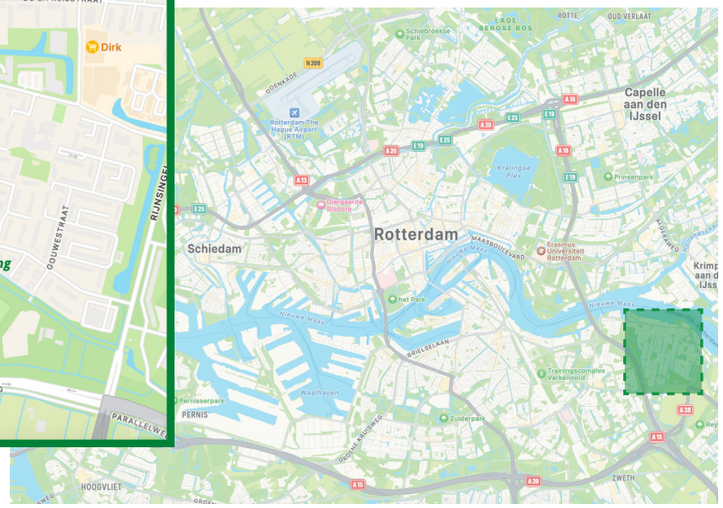


Figure 26: Research area of case study

Table 6: Research methods of case study in Beverwaard

RESEARCH METHOD	#	Duration	Documentation	Data analysis	Location
Street observations	10/10 spots	30 minutes	Pictures and direct note taking	Structuring of the notes and pictures in the online tool MIRO	Thursday during the pilot Cannenburgstraat
	10/10 spots	30 minutes	Pictures and direct note taking	Structuring of the notes and pictures in the online tool MIRO	Saturday during the pilot Cannenburgstraat
	1/10 spots	15 minutes	Pictures and direct note taking	Structuring of the notes and pictures in the online tool MIRO	Weekday after the pilot Cannenburgstraat
	0/10 spots	15 minutes	Pictures and direct note taking	Structuring of the notes and pictures in the online tool MIRO	Thursday after the pilot Cannenburgstraat
Street interviews	4	30 minutes	Direct note taking	Structuring of the notes in the online tool MIRO	Thursday after the pilot Cannenburgstraat
Interview with wijknetwerker	3	30 minutes	Direct note taking	Structuring of the notes in the online tool MIRO	Wijkhub Beverwaard

Results of observations

In Beverwaard, designated framed areas were established for citizens to deposit their bulky waste. A sign (Figure 27) provided specific instructions on when to place the waste, indicating the designated day and time. However, despite these instructions, bulky waste was frequently found throughout the week, rather than being restricted to the allocated collection times. Observations during the pilot revealed that the area resembled a living landfill, with waste rising continuously. Notably, despite the landfill, citizens tended to deposit their waste within the framed collection zones. This suggests that when clear boundaries and dimensions are provided, citizens can do right with placement guidelines. Unfortunately, due to weather changes, scavenging from certain citizens, and the activities of animals, the waste often spread beyond these areas and over the streets.

1) Centralized collection

The concept of a fixed collection time and location was generally well received by the citizens. They appreciated knowing exactly when and where to dispose of their bulky waste. The convenience of not needing to make appointments or transport their waste to environmental parks was seen as a clear advantage. Additionally, the frequent collection associated with the pilot was viewed positively, as it allowed for regular waste removal. The system provided a practical solution for those who might otherwise struggle with transporting bulky items themselves.

However, despite the theoretical advantages, there were significant communication and logistical challenges. One of the most critical issues was ineffective communication, particularly with non-Dutch-speaking citizens. Language barriers and cultural differences contributed to misunderstandings about the correct procedures, leading to improper disposal throughout the week.

2) Challenges from the outside

The presence of scattered waste, visible waste piles, and the frequent scavenging by passersby negatively impacted the neighborhood's appearance. The issue of *waste tourism* also emerged, where individuals from outside Rotterdam took advantage of the test, depositing their bulky waste in the designated areas in the Cannenburghstraat. Waste tourism is a problem in all outside neighborhoods of Rotterdam. This is due the fact that for Rotterdammers disposing their bulky waste is free*. In other neighborhood the wate taxes are differently regulated. This extra waste exacerbated the problem, leading to increased street clutter and safety concerns, especially for children. During periods of bad weather, waste often scattered across the streets, creating additional piles also outside the designated areas.

*Free means they are not additionally charged for the bulky waste disposal. Citizens of Rotterdam are paying an annual all-inclusive price for waste management and a clean city.

3) Dissatisfaction by citizens

Complaints from citizens were frequent, with six to eight complaints being received daily regarding the visibility and mismanagement of waste. Many citizens expressed frustration, feeling that the system was not working effectively and was bad for the appearance of their neighborhood.

4) Recommendations by citizens

Despite these concerns, some citizens actively proposed solutions to improve the pilot. They suggested placing large bins at multiple strategic locations throughout the neighborhood, to support those unable to transport waste themselves, further enhancing the convenience of the system. Additionally, they recommended shifting the collection day to Monday, it would align with neighborhood needs, with more frequent emptying. At last, citizens underscored the importance of avoiding placement at entrances where enterprises and *waste tourists* were likely to deposit their trash. Furthermore, residents called for increased supervision to prevent misuse of the system.

The municipality ultimately decided to terminate the pilot due to the extreme waste on the streets. To address this, they implemented an aggressive communication strategy aimed at halting waste dumping. Remarkably, within two weeks of ending the pilot, the streets were free of dumped waste. This outcome demonstrates the effectiveness of strong communication strategies during times of systemic change in waste management. While there were clear challenges, the framed collection areas were positively received by many citizens, as they provided a sense of structure for waste disposal.

"Framed areas where to dispose your bulky waste is perceived as convenient. Although, the shattering waste across the streets and the corresponding developed living landfill is the reason why the pilot was no success."

Framed areas for bulky waste

Shattered waste across the streets

Figure 27: Observations of case study in Beverwaard. All the observations are presented in Appendix C.

TAKE AWAYS

Disposal locations
Bulky waste is often found at neighborhood ends or beginnings, particularly around underground containers, where the presence of waste lowers the threshold for adding more, including unregistered items. Popular spots for registered waste include lampposts and trees. The concept of a fixed central collection time and location is positively received, as it provides clear guidelines on when and where to deposit waste. Additionally, extreme communication has proven to be effective in change of waste management practices.

Challenges of disposal behaviour
- Many citizens face difficulty accessing environmental parks due to transportation issues and distance.
- There is a significant lack of knowledge about what to do with bulky waste and the proper disposal process.
- The long waiting times for municipal collection services discourage proper disposal, and mixed experiences with these services contribute to frustration.
- The preference for convenience leads to avoidance of second-hand stores, Marktplaats, or environmental parks, which are perceived as a hassle, due their time required to bring items.
- Ease of disposal is prioritized over sustainability. As a result, despite understanding the benefits of proper waste management, convenience often takes precedence, leading to less sustainable behaviour.

Strategic placed large bins
The citizens of Beverwaard suggested large containers placed at strategic locations to reduce visible waste on the streets. This should support citizens who cannot transport waste themselves. Additionally, standard collection days and areas have been viewed positively.

OPPORTUNITY SPACES V2

Out of the idea generation and scoping phase various value propositions like enhanced convenience, improved bulky waste environment and community engagement were listed. After the exploration phase the new R-goal is presented (Figure 28) and the following opportunity spaces could be added and are structured in Figure 29.

Enhanced accessibility to environmental parks

Following the research into citizen behaviour in Beverwaard and Rotterdam Noord, it became evident that there is a lack of knowledge, awareness and motivation regarding sustainable waste disposal practices. As previously stated, the desired default option for waste disposal is at environmental parks. There is a need to focus on promoting the use of the parks, instead of dumping waste on the streets or calling the collection service. Given that knowledge, awareness and motivation remains a challenge, it is desired to design an intervention to bridge those gaps and promoting or providing access to the environmental parks.

Extreme communication strategies

Based on observations in Beverwaard, it can be concluded that a extreme level of communication is an effective method for influencing the desired behavior of citizens. Additional channels, including large billboards, can be utilized to communicate the new product-service in the pilot areas.

5 RELIEF

The citizens and the municipality are relieved of the steps required for the proper processing and distribution of bulky waste.

Figure 28: Added R-goal after business analysis

ENHANCED CONVENIENCE FOR CITIZENS AND COLLECTORS

- A real-time tracking of the bulky waste collection trucks for citizens, enhancing trust and cooperation.
- Integration of citizen comments and locatable bulky waste, ensuring timely and accurate pickups.
- The use of better user experience in the registering application for waste reporting that integrates all necessary functions, reducing the current complexity and improving accessibility.

IMPROVED BULKY WASTE MANAGEMENT

- Supportive waste infrastructure on community level to facilitate proper bulky waste disposal. These facilities should be easily accessible and provide guidance on waste separation.
- Implement educational campaigns and provide clear guidelines to citizens on proper waste separation, emphasizing the environmental and economic benefits of reusing products and materials.
- Play into the gaps found in the citizen behaviour. With the use of strategies like flow management, reversed logistics, a service system for bulky waste sorting and separation.

COMMUNITY ENGAGEMENT AND PARTICIPATION

- Partner with organizations like Marktplaats, Spullenbak, Het Goed, and repair cafes to create a robust network for reusing and repurposing bulky waste.
- Introduce incentive programs that reward citizens and businesses for bulky waste give-away practices.
- Education on the principles of the circular economy and how they can contribute, emphasizing the value of reducing, reusing, and recycling waste to be part of the circular city.

ENHANCED ACCESSIBILITY TO ENVIRONMENTAL PARKS

- Develop shuttle services or partnerships with transportation providers to improve access to environmental parks. To overcome transportation challenges and encourage proper disposal practices.
- Introduce convenient waste disposal options for the citizens. For example, doorstep collection services or community drop-off points, for ease and quick solutions. Or strategically placing large containers at key locations.
- Implementing a fixed central collection time and location, along with clear guidelines on when and where to deposit waste. Popular spots like lampposts and trees, and at the ends or beginnings of streets, can help reduce visible waste and provide more accessible disposal options.

EXTREME COMMUNICATION STRATEGIES

- Use extreme communication techniques, as proven effective in the Beverwaard pilot, to engage citizens and ensure they are informed about waste management practices.

Figure 29: Updated opportunity spaces after business analysis

MEANS	Data of waste Registration for collection service by telephone or online portal Sharing transports with cargo bike or trailer Facilitation of environmental parks Information system of waste in Rotterdam Waste collectors Other vehicles to transport bulky goods Trucks for the matress-service On-timeslot services for collection of the matresses	Online selling platforms Online safety for sellers and buyers Stores and storage space capacity	Storage behind the front door Money to pay for the service Places where they like to dispose their waste
GOALS	Waste prevention Better waste separation High-quality processing	The business need to be viable and driven by profit Producing with used materials, no matter the economic growth As many matches and sells on the platform To create work for people	A convenient way of disposing their products, materials and waste.

Figure 30: Updated means and goals after business analysis

New means and goals

In the updated infographic on the left, the new means and goals are found based on insights from *Exploration*.

An additional column has been incorporated into the infographic. The new information provides an overview of the citizens' means and goals. The citizens have storage space located behind their front door, which they utilize until they have finished using the products. They can wait a little longer until sustainable after-care options are available, if they know why they are doing that. Furthermore, they become frustrated when the collection service is not available on their time constraints or whether due to the lack knowledge on proper disposal options. They would likely be agreed to paying for a collection service that can be scheduled at their convenience. Additionally, it should be noted that there are popular spots for citizens to leave their items in public areas. These insights allows to capitalize on the natural behaviour of the citizens.

The goal of the citizen is clear. The citizen desires a convenient method of disposing of their unwanted products. Environmental considerations are not a priority.

FROM RESEARCH TO DESIGN

After the extensive research on bulky waste, internal procedures and citizen behaviour a design challenge is formulated. Additionally in this chapter, the possibilities to tackle the founded problems and the wish of the municipality is discussed.

Municipality's wish

During various meetings with municipal supervisors, discussions centered on identifying the most effective area for solutions. For example, what happens on the street, internal policies, citizen behavior, and current waste management facilitation. These are the issues related to Figure 23.

Furthermore, potential solutions, emerging issues and methodologies were discussed. Effectuation theory was proposed as a novel perspective. This resulted in consensus on the project's objective. In line with the municipality's preferences, the project will focus on an external intermediary to facilitate the new bulky waste collection service. This will align with citizens' natural waste behaviour patterns.

This can be organized in the form of a tender, the municipality works with this quite often. This means for this project that the '*new designed enterprise*' oversees bulky waste collection in a designated area. The enterprise is responsible for the waste management of the citizens in the area with compiled rules of the municipality. These contain general rules, national regulations and licenses the enterprise need to comply with.

Criteria for the external enterprise

Facilitating waste disposal through a user-friendly and accessible service removes barriers for citizens, making proper disposal more convenient and encouraging participation. However, internal challenges within Schone Stad's waste management system highlight the urgent need for innovative solutions. The business analysis reveals inefficiencies such as fragmented integration between operational systems and logistical issues faced by citizens. Partnering with an external agency to implement an innovative service can address these obstacles, leveraging expertise to foster a more efficient, sustainable process.

The ideation and validation phase, serving as the foundation for the ultimate outcome. It is agreed to begin at the neighborhood level, with plans for eventual expansion across Rotterdam. The pilot design will follow an iterative process, prioritizing trial and error to achieve effective outcomes swiftly, even if the ideal scenario is not fully realized from the start. To align these efforts with Rotterdam's goals out of the Grondstoffennota, the proposed solutions must emphasize

waste separation, waste reduction per citizen and high-quality processing.

The municipality also expressed a strong preference for future partnerships due to ongoing staffing challenges and the desire to explore new markets focused on reusing rather than merely processing materials.

The criteria can be found in Figure 31. The criteria is compiled during the research phase. Most criteria is based on the experiences on the bulky waste collection day or the company meetings.

The role of an intermediary in facilitating waste disposal for citizens is aligned with the objective the municipality of Rotterdam. The proposed service is designed to relieve the hassle of proper disposal and offer convenient solutions, thereby increasing citizen participation. Conversely, the business analysis reveals that Schone Stad is confronted with significant challenges pertaining the bulky waste collection service. It would be advantageous for the municipality to engage the services of an external agency to facilitate the desired innovation.

Design challenge

After the research and various scoping meetings with the municipality, the design challenge and criteria were established:

"Launch a start-up offering an** on-demand **bulky waste collection service by** relieving **the citizen and municipal collection services. With implementing zero-waste policies the material will be circular recovered as much as possible by connecting stakeholders."

The on-demand bulky waste collection service will focus on the collection of products and materials that might otherwise be discarded. The items are transported to environmental parks for further processes or second-hand platforms for reuse. This strategy fosters a sustainable waste management model by prevention of valuable materials from the landfills but extension of the lifecycle of products.

The design challenge is sub-divided into three main challenges:

1) Relieving the citizen and municipality

The start-up will facilitate the transportation of bulky waste from the previous owner to the new owner. This on-demand service will attract citizens who value convenience and relieve municipal collection services of the challenge of integrating and optimizing their systems for waste separation on the streets.

2) Circular recovering

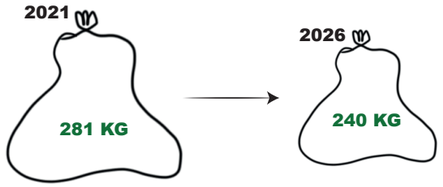
The implementation of a bulky waste collection solution will facilitate the reuse products and materials. The valuable products and materials will be delivered to the citizens and producers who require them. The less useful materials will be transported to environmental parks for recycling and processing in accordance with the highest quality standards.

3) Connecting stakeholders

A user-friendly service system will facilitate stakeholder participation, increase awareness, and encourage the donation of old products and materials among citizens. This will lead to the more efficient utilization of valuable materials. The system will guarantee that stakeholders can effortlessly engage with it, thereby ensuring a smooth and coherent interaction between the supply and demand chains, as well as the collection process.

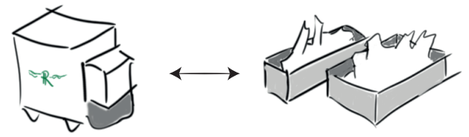
All the goals and criteria of the project are structured in Figure 31 on the right.

CRITERIA AND GOALS OF THE PROJECT



1 REDUCE

The citizens of Rotterdam need to reduce their waste generation. The goals are set on a decrease of 41 [kg] per citizen in 2026.



2 RETHINK

It is needed to rethink the way we use the collection service. To increase the use of the environmental parks.

3 RECOVER

The bulky waste is recovered as much as possible in the future. This means high-quality recycled or reused.

4 REPURPOSE

The useful bulky waste is directed for a second life within the city.

5 RELIEF

The citizens and the municipality are relieved of the steps required for the proper processing and distribution of bulky waste.

Figure 31: R-goals listed together

INTERNAL OPERATIONS

Seamless collaboration with the operational teams of Schone Stad
Enthusiastic, resilient and innovative employees
Employees need to be open to training for new processes and technologies
Possibility of hiring the employees external
External employees need VIHB certification
Compliance with occupational health and safety (ARBO) guidelines

EFFICIENCY OF COLLECTION SYSTEM

User-friendly reporting for the citizens
User-friendly disposal options for the citizens
Reducing waiting times for the citizens

User-friendly scheduling system for operational employees
Seamless integration with all Schone Stad's other collection operations
Clear communication between citizens and collectors
Real-time updates and location tracking of registered bulky waste for citizens and collectors

Easy to access locations for drop-off and collection
Minimal trips to the environmental park
Recover as high as possible on the R-ladder (R-ladder - Strategieën van circulariteit. (n.d.))

Low-threshold for collaboration for potential new stakeholders
Ensure low-key participation for all stakeholders

CONVENIENCE OF WASTE SEPARATION

Easy-to-understand guidelines for citizens, stakeholders and collectors
Guidance of importance to separate bulky waste streams for citizens
Trackability of the amount of kilograms collected
Trackability of distribution of the collected items per waste stream
Quarterly evaluations with citizens about the service

CHAPTER CONCLUSION

3.1 Which challenges of the bulky waste management system can be used as opportunities?

The challenges of bulky waste management include the integration issues of the different applications, limited access to the environmental parks and lack of knowledge of the citizens. However, they have potential to be resolved in future innovations. The lemonade principle is used to enable perceive challenges as potential opportunities for business and innovation.

The challenges of Schone Stad that could be used as opportunity are:

- The lack of integration between the applications can be used to enhance the convenience for the citizens and the collectors.
- The limited access to environmental parks and lack of knowledge on proper disposal can be an opportunity. By increasing the accessibility to the environmental parks and creating innovative bulky waste facilitation with education elements.

3.2 What citizen behavior can be used to develop a new collection system?

The redesign of the bulky waste collection system should consider the natural citizen disposal behaviors. They have desperate need for convenience and lack consideration for environmental consequences.

Citizens prioritize convenience over proper disposal, often lacking awareness or motivation to engage with existing waste policies. Bringing items to places for reuse are perceived as too difficult or time-consuming. Also, the municipal bulky waste collection services, while convenient, are viewed as inefficient due to long waiting times. Even with knowledge of environmental benefits, the inconvenience of proper disposal often leads to unsustainable practices.

3.3 What are new value propositions based on exploration?

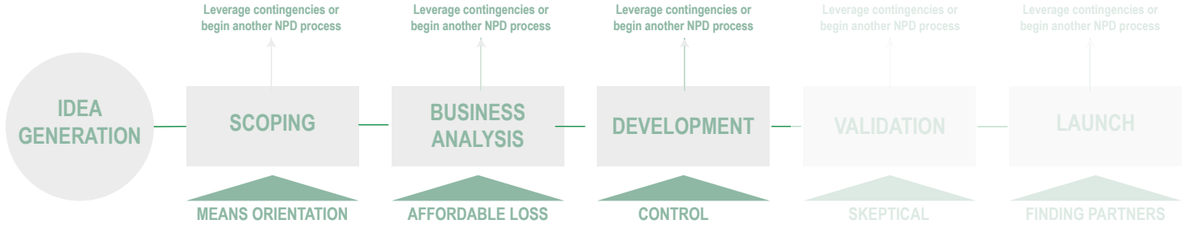
It is beneficial to relieve municipal services and the citizens, by taking over the practices needed for a proper waste disposal. The accessibility to the environmental parks is enhanced by collection and delivery of the items by an external enterprise.

3.4 Does the design challenge align with the predefined goals?

The proposed on-demand bulky waste collection service supports Rotterdam's circularity goals by promoting reuse, preventing waste, and ensuring high-quality processing through material collection and delivery to the environmental park.

The five R-goals are used as the basis for the design challenge and form the building blocks of the criteria of the design. These R-goals are reduce, rethink, recover, repurpose and relief.

4 DEVELOPMENT



IDEATION

4.1 What are the potential concepts that can fulfill the goals while aligning with the needs of citizens and the municipality?

The chosen concepts are a material platform, a sponsor system and a second-hand transportation platform. They are based on the accessible means, design challenge, criteria and the R-goals, with the objective to fulfill the needs and wishes of the citizens and the municipality.

Selected opportunity spaces and concepts

The opportunity spaces used are explained together with the three concepts that fulfill the predefined goals.

PILOT DESIGN

4.2 What is the purpose of the pilot?

The purpose of the pilot is to test the concepts on feasibility of the logistics, preference of the citizens, attractiveness of the execution for the collectors and the financial viability.

4.3 What ensures a successful validation?

To guarantee the successful validation of the pilot, a number of critical control factors and organisational requirements are arranged. These factors include recruitement of the participants, cargo bike use and storage space.

Purpose and organization

The purpose of the pilot and the organizational steps are presented.

REVISED OPPORTUNITIES

The used opportunities are plotted and explained within the designed pilot to ensure the inclusion of all of them.

IDEATION

During the research phase, several opportunity spaces for designing an improved bulky waste collection service system occurred. Together with the municipality the design challenge and criteria were defined. This leads to the focus on an on-demand collection service where the citizen and the municipal services will be relieved from the hassle of handling proper disposal of bulky waste. From the perspective of the entrepreneur, a new enterprise can be designed that will stand in between the municipalities waste services and the citizens.

Selected opportunity spaces

Several opportunity spaces are prioritized for their potential to create high-impact solutions that can make a difference within a bulky waste collection service. The selected opportunity spaces are feasible within the constraints of means of the municipality, external parties and the citizens. These are selected for further development, with the approach of iterative effectual design. Also, time constraints and accessibility to the resources is considered by making the choices on which opportunity spaces to focus on.

The chosen opportunity areas aim to create a more efficient and accessible waste management system that benefits the municipality, collectors and the citizens. The visual on the following page illustrates the various opportunity spaces. The green button indicates that the space is currently in use, while the red button denotes that it will no longer be considered. In Figure 32 the reason why is presented. The chosen areas, with the green button, will form the starting point of the ideation phase to create a comprehensive strategy that will result in an on-demand collection service for bulky waste, to achieve a more sustainable inner-city environment.

Convenience for citizens and collectors

It is proposed that real-time tracking of collection vehicles be implemented to foster cooperation and ensure trust in the collection process. Furthermore, integrating citizen feedback and locatable waste tracking will enhance the precision and scheduling of collection services. The user experience of citizens will be a primary focus in the development of the waste reporting application.

Bulky waste management improvements

A focus is placed on establishing supportive infrastructure at the community level. The facilitation should be accessible in your own neighborhood without needed knowledge on proper disposal practices. It should be naturally guided how to manage your unwanted bulky waste. Furthermore, leveraging citizen behavior through reverse logistics or service systems for sorting and separating bulky waste to fill in the gaps in their current practices.

Participation and communicty engagement

Through partnerships with organizations such as Marktplaats, Spullenbak, Het Goed, and repair cafes it is aimed to create a network for reusing and repurposing bulky waste. By forming partnerships with these organizations, more opportunities to participate in a circular system that preserves the value of reusable items is provided for citizens.

Accessibility of environmental parks

This opportunity space will address existing logistical challenges. As if it will be possible to reach the awareness of the parks by shuttle services or partnerships with transportation providers, to promote proper disposal practices. Additionally, the ideas of convenient disposal options, such as doorstep collection services or strategically placed community drop-off points, aims to make waste disposal more straightforward and accessible.

Unselected opportunity spaces

The reason why five opportunity spaces are unselected is because of their current focus of the municipality. Education and communication campaigns are done by the municipality. It is good to consider its importance, but my focus will be on designing an intervention for bulky waste collection. The elements of communication and education are seen as by-products.

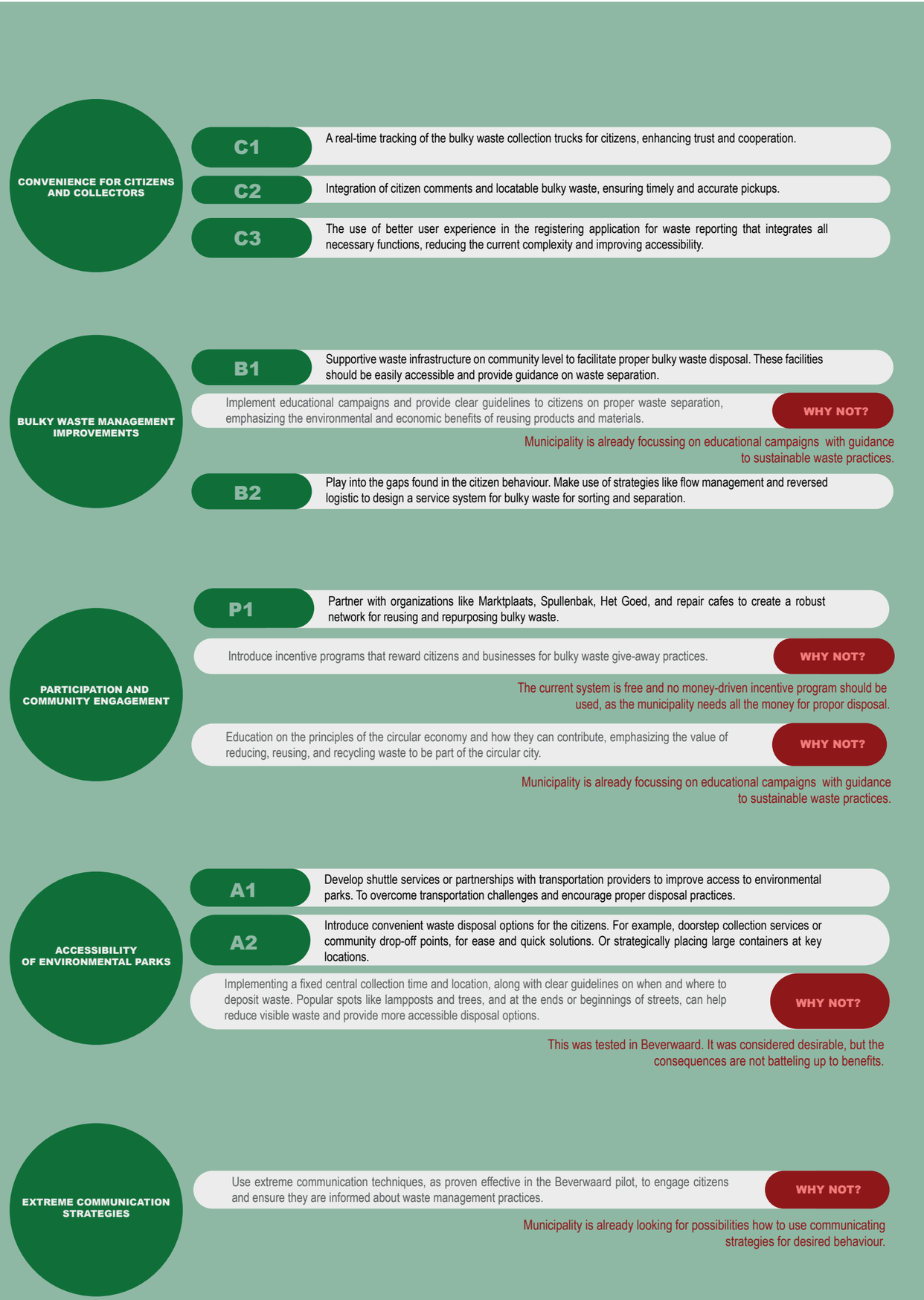


Figure 32: Selected opportunity spaces

Concept design

The uncertain future of the bulky waste environment will be controlled by the creation and execution of a pilot. This pilot will act as a Proof of Concept to test the proposed concepts. Three concepts are selected out of a range of ten ideas, in this chapter the selected are presented. The concept are intended to fulfill the design challenge, R-goals and criteria. The accessible means and design strategies are used in the concepts to influence the environment as much as possible to achieve the desired behaviour.

The selected concepts have the most logistic features in common, as the use of a cargo bike for transportation. This mean is used from the project Leenvervoer. The vision and perspective of the entrepreneur differ.

1) The material platform focusses on pricing for transportation and claiming the products subscription based.
2) The sponsor system is a more socially responsible model which will thrive on government grants and donations from other citizens.
3) The second hand transportation platform will play into the gaps of the citizens regarding the hassle of using secondhand platforms and thrift shops.

Concept 1 | Material platform

In the future, this service will function as a platform that manages the supply and demand of products, materials and bulky waste. If you want something collected, you can simply register it on the platform, becoming a *provider*. It is also possible to use the platform to buy products or materials, you will be a *customer*. The collection and delivery are fluctuating prices, depending on your location.

How does the claiming system work?

The flowchart of the material platform is shown in Figure 33. To register the product/materials, the register page of the municipality is used. Scheduling, routes and conformation will be done by the start-up. The time and date will be communicated with time slots and on the day of collection this will be communicated with a decreasing time slot and real time tracking of the cargo bike.
Once the registration process is complete, the product or materials in question will be uploaded to the platform. Once the collection location and time have been defined, they will be displayed alongside the product, indicating on which day and route the product will be transported by cargo bike. All the members of the platform can claim the uploaded product/materials. If you are in the neighborhood, you can claim the product and it will be directly transported to your location, where the transportation will be free of charge. Otherwise, the product will go to the storage space and later put on a paid delivery. The material or product will be kept for claims no longer than two weeks, after this deadline it will be brought to the partnering wijkhubs, weggeefwinkels and second-hand stores. The status of the product will be examined during the registration and by the experts on the cargobike. If the status of the material or product is too low, it will be directly brought to the environmental park. There it will be source-seperated and the material will be processed to high quality new materials.

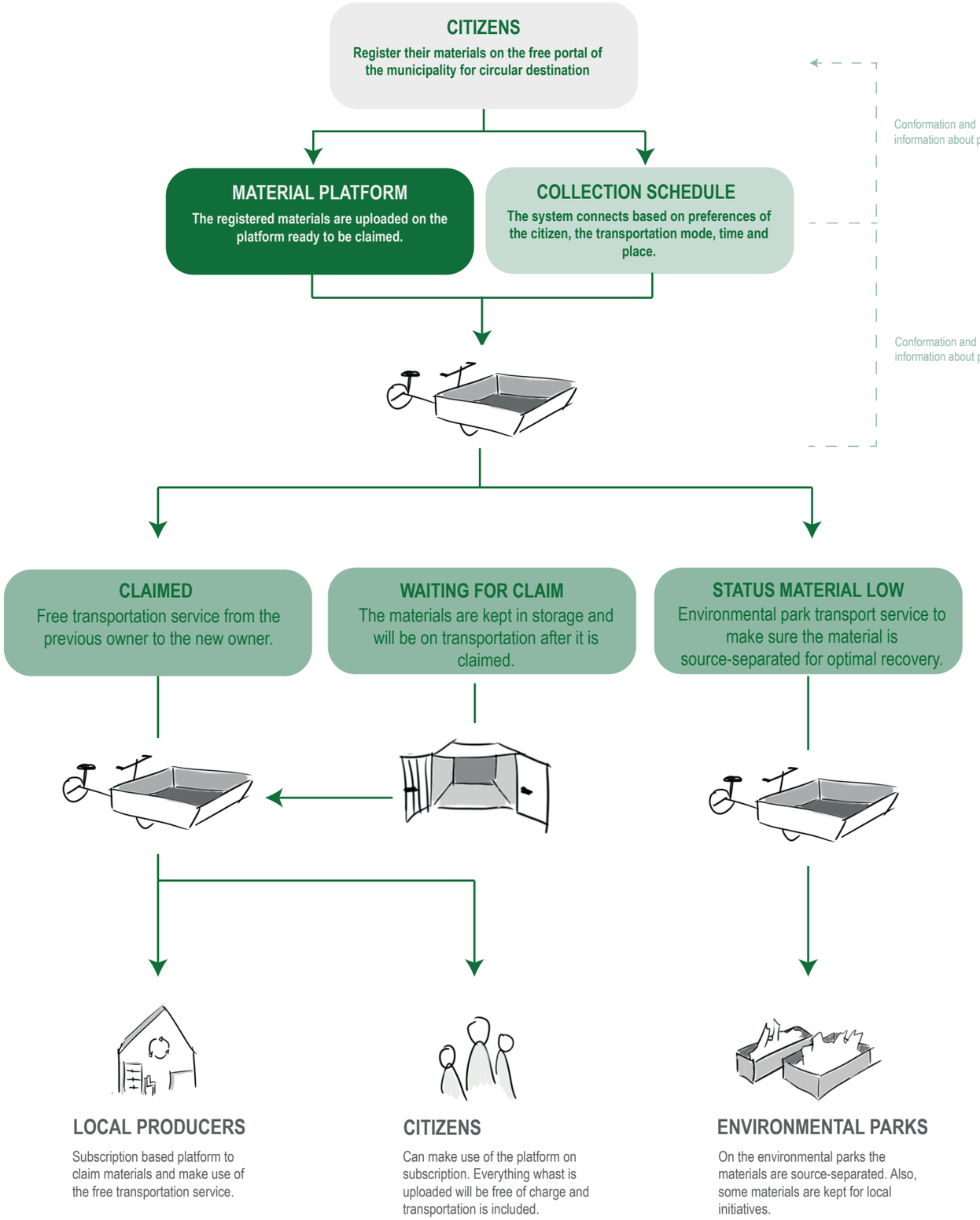


Figure 33: Flowchart of concept 1: material platform

Concept 2 | Sponsor system

Concept 2 (Figure 34) enables neighborhoods with surplus materials and products to support others in need, particularly low-income citizens struggling with basic needs like food and essential goods. Households can register their bulky waste with extra notes on the reusable items, which are then collected via cargo bikes. Low-income neighborhoods can claim these items for free if they are nearby, promoting local reuse. Unclaimed products are redirected to second-hand stores, wijkhubs or weggeefwinkels. This system reduces waste, supports citizens in need, and encourages collaboration across communities.

How does the sponsor system work?

The registration and of the product/materials will be the same as for the material platform, the execution is different. It will be still possible to register at the website of the municipality. Scheduling, routes and conformation will be done by the start-up. The time and date will be communicated with time slots and on the day of collection this will be communicated with a decreasing time slot and real time tracking of the cargo bike. One notable distinction between the material platform and this one is the ability to draw neighborhoods in your city where you wish to sponsor. These are locations where other citizens can claim discarded items.

The platform is supervised by the start-up with the help of municipal services with knowledge of the financial status of the citizens in their neighborhoods. With the use of wijkhubs and weggeefwinkels the products and materials can be held in storage for the citizens to collect. The procedure for products with low status is the same, that is brought to the environmental park.

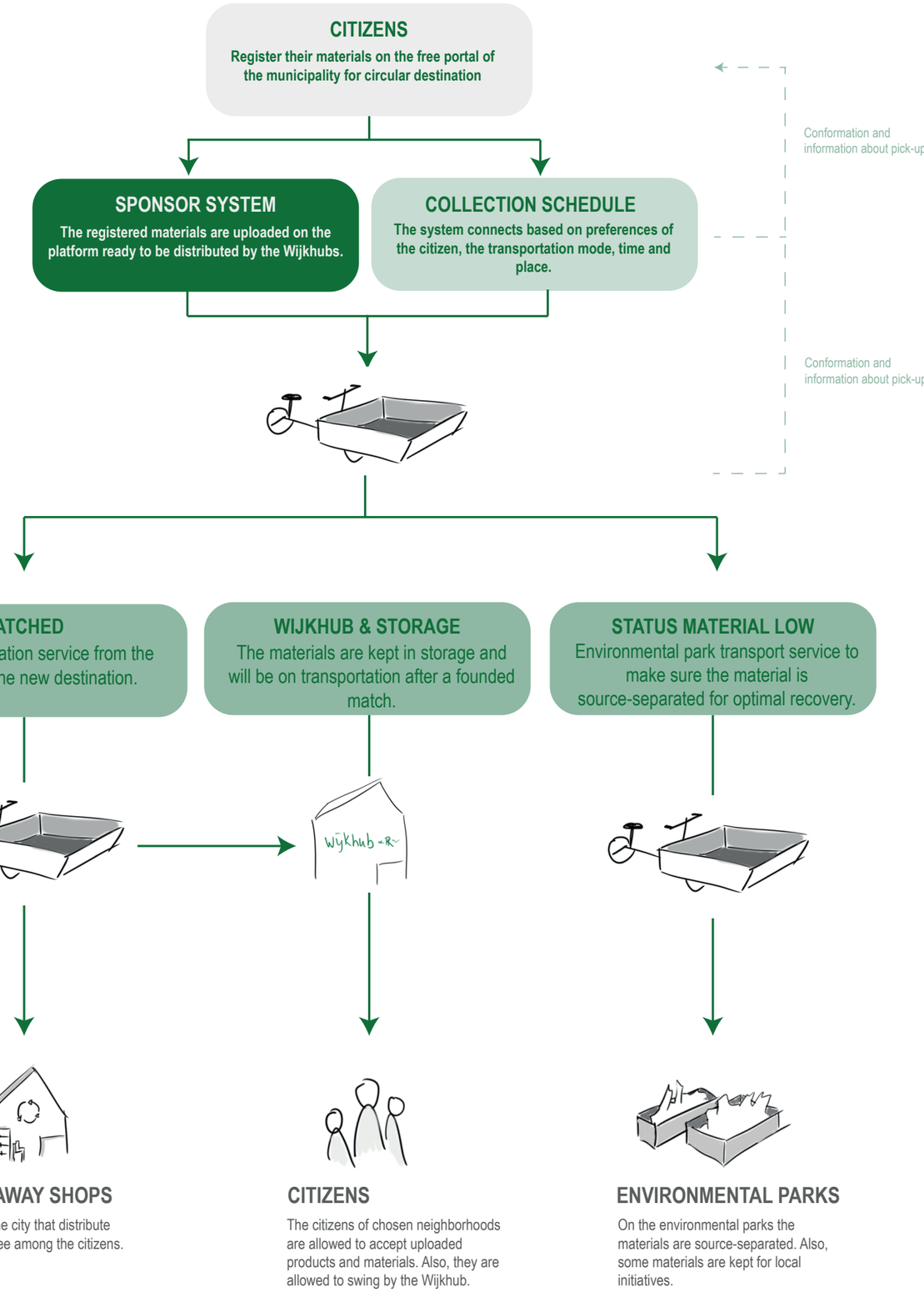


Figure 34: Flowchart of concept 2: sponsor system

Concept 3 | On-demand thrift shop

This third service concept aims to address the common frustrations of using platforms like Marktplaats and thrift stores, where citizens often find the process of selling or donating items cumbersome and time-consuming (Figure 35). Instead, this service takes on the hassle, allowing citizens to simply give away their unwanted items while we handle the rest.

Once items are on-demand collected via cargo bikes, the service searches for potential buyers or donation opportunities, removing the difficulties of trust issues and scams often associated with online marketplaces. Citizens can offload their items with confidence, knowing the service will give it a second life or handle it environmentally friendly.

How does the on-demand thrift shop work?

The register page of the municipality is still used. Scheduling, routes and conformation will be done by the start-up. The time and date will be communicated with time slots and on the day of collection this will be communicated with a decreasing time slot and real time tracking of the cargo bike. Once the registration process is complete, the product or materials in question will be uploaded to the marketplace platform. Once the collection location and time have been defined, they will be displayed alongside the product, indicating on which day and route the product will be transported by cargo bike. Everybody can make use of the platform, if you live around the service area, it is possible to buy the product and it will be directly transported to your location. Otherwise, the product will go to the storage space and later put on a delivery. The material or product will be kept for claims no longer than two weeks, after this deadline it will be brought to the partnering wijkhubs, weggeefwinkels and second-hand stores. The status of the product will be examined during the registration and by the experts on the cargobike. If the status of the material or product is too low, it will be directly brought to the environmental park. There it will be source-seperated and the material will be processed to high quality new materials.

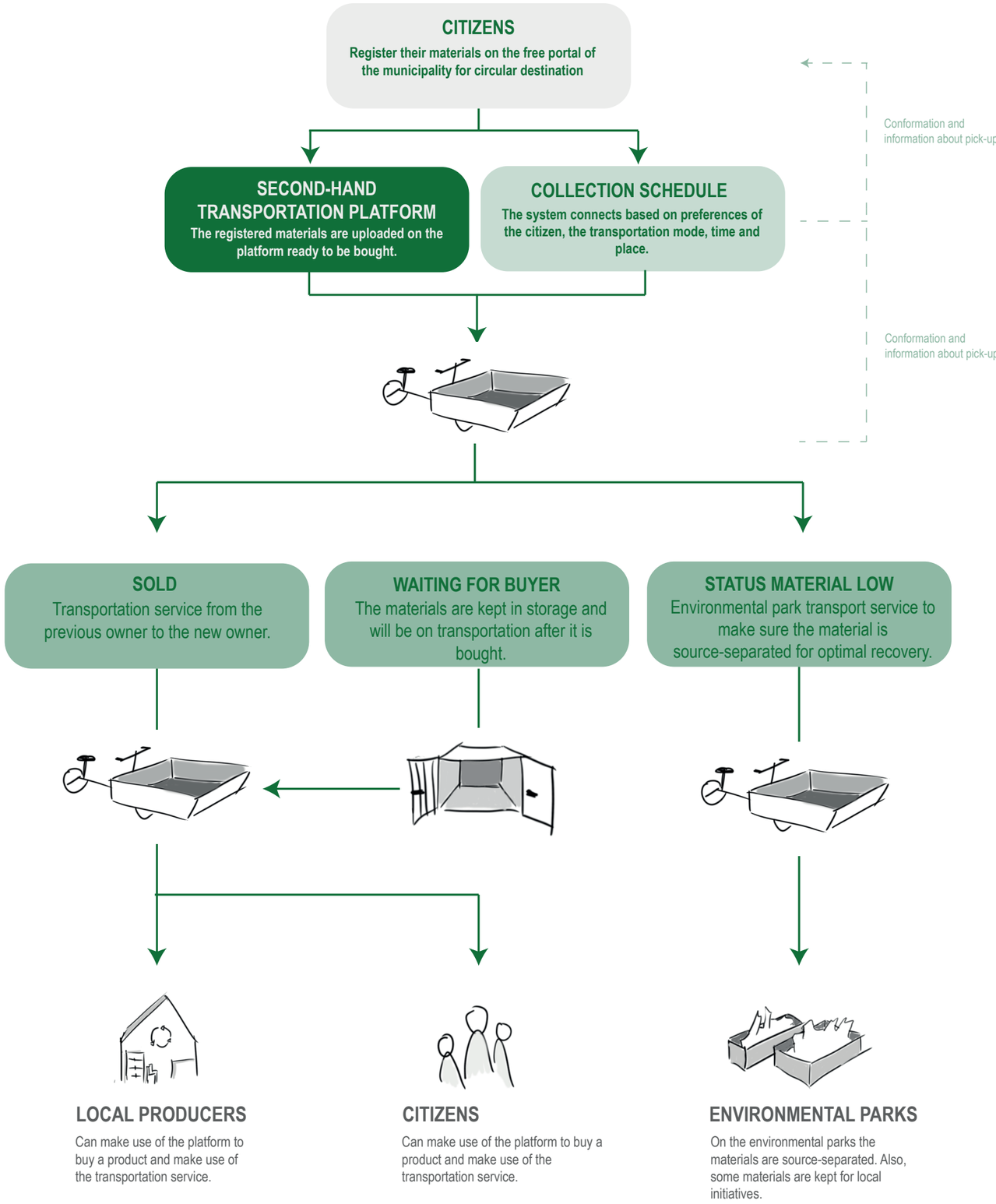


Figure 35: Flowchart of concept 3: second-hand transportation platform

PILOT DESIGN

The pilot is designed to test the concepts on a small scale, as a proof of concept. The following chapter will provide further details on the pilot. At first, the purpose of the pilot will be presented, followed by the method how to controll the pilot and as last the detailed organization.

Purpose of the pilot

The success of the pilot is dependent on the results of some variables, the identification of which is essential to ensure the success of the pilot. The means of Schone Stad are reserved in advance for a smooth organization. The used means and tested variables can be found in Table 7.

1) Convenience for collectors

It can be reasonably assumed that the convenience and the execution of extra tasks of the collection service on the cargo bike need be perceived positively by the collectors. It is essential that the range of the tasks is attractive for future employees.

2) Feasibility and logistics

One of the main objectives was to assess whether the collection and distribution processes using cargo bikes were logistically *feasible*. It is intended to test how much material could be transported per trip and how scheduling could be optimized to ensure smooth operations. For example, to test the possibilities to efficiently transport waste and materials from citizens homes to environmental parks, second-hand stores, or incorporate the selling process on Marktplaats.

3) Financial viability

As for the secon-hand platform and the material platform, it is also aimed to determine the financial viability of the service. This included assessing how much revenue would be needed to make the service profitable.

4) Preference of the citizens

Another key focus was to test whether citizens were willing to use this type of service and whether local producers or distribution channels saw value in partnering with the service. This helped refine the business model, aligning it with the needs of both consumers and producers. Also, it is important to understand how much consumers were willing to pay for waste collection and redistribution.

Table 7: The used means and variables of the pilot.

CONCEPTS	MEANS	VARIABLES
	Cargo bike Storage space Acces to environmental park 20 appointments at households with bulky waste External phone for contact with clients	Time needed for appointment with cargo bike Time needed for transportation The status of products and materials Volumes of the bulky waste in the cargo bike Price the consumer is willing to pay for the transportation service Perceived positive experience of collector
MATERIAL PLATFORM The registered materials are uploaded on the platform ready to be claimed.	Personal Marktplaats account	Price the consumer is willing to pay for a subscription based platform
SPONSOR PLATFORM The registered materials are uploaded on the platform ready to be distibuted by the Wijkhubs.	Wijkhubs and weggeefwinkels in my network to bring products	To what extent consumers want to donate products
SECOND-HAND TRANSPORTATION PLATFORM The registered materials are uploaded on the platform ready to be bought.	Personal Marktplaats account	Price the consumer is willing to pay for a second-hand delivery service

From concept model to action

In this chapter it is explained how the pilot is organized and how all the means are put into place. This was a part of the ideation, because this was an adaptive and explorative and changed the pilot. As the principles of Effectuation were intensively used during the organization of the pilot. Therefore, the methodology is already explained here.

Method

The pilot employed a combination of purposive and convenience sampling methods to ensure that participants were representative of the chosen neighborhood (see Figure 36). The criteria for participation required that individuals live within the designated pilot area, ensuring that the project was viable to do. The method used for the pilot was participatory and action research design. It was an iterative process where participants were engaged in real-time feedback cycles, allowing for continuous improvements and shaping the service, to tailor the collection process based on their needs and experiences. This allowed for a holistic understanding of the service ecosystem, facilitating improvements in both functionality and user satisfaction. In Table 8 the research methods for the pilot are listed. 20 appointments with citizens were selected for participation. After the collection, 12 appointments for delivery with a selection of the useful items were distributed.

Recruitment strategy

To engage participants, multiple recruitment strategies were employed. At first, social media platforms managed by the municipality were used to share information about the pilot and invite citizens from the neighborhood to participate. Additionally, the municipality's internal social platform (RIO, 2024) was utilized to further extend outreach efforts by uploading detailed requests for participation. Second, local neighborhood councils and managers played a crucial role in disseminating information. They shared the pilot in various community WhatsApp groups, which facilitated the distribution of information and allowed for word-of-mouth referrals and forwarded messages, broadening the reach of the invitation. At last, physical flyers were distributed in areas where citizens frequently pass by, such as grocery stores, libraries, and public bulletin boards. This approach aimed to reach individuals who may not have access to digital platforms or those who prefer offline communication.

Participants were asked to register through a secure Microsoft Forms link, hosted on the municipality's server. The form collected essential information, such as: items or materials they wished to offer, their availability for the pilot collection and contact details for confirmation and follow-up communication. This digital process ensured that all data was safely stored while simplifying the participant management workflow.

Distribution strategy

To test the various business models, four distribution strategies were examined in advance, to ensure their cooperation. Initially, the commercial business models were distributed via the Marktplaats platform. My personal account was ideal to test consumer interest and determining the value of the products. To ascertain the value of the products, it was only after a deal, it was mentioned that they were part of a graduation research project. The Marktplaats buyer was therefore given the option to cancel the deal or participate in the research. If they accepted to participate in the research the product would be free, in exchange for answering questions and completing an evaluation that will be in a form of a questionnaire.
Secondly, the wijkhubs and weggeefwinkels were selected in the neighborhood to facilitate the delivery of good products what will not be placed on Marktplaats. In addition, the managers of the environmental parks were contacted to inform them of the daily visits and the materials that would be dropped during the pilot days.

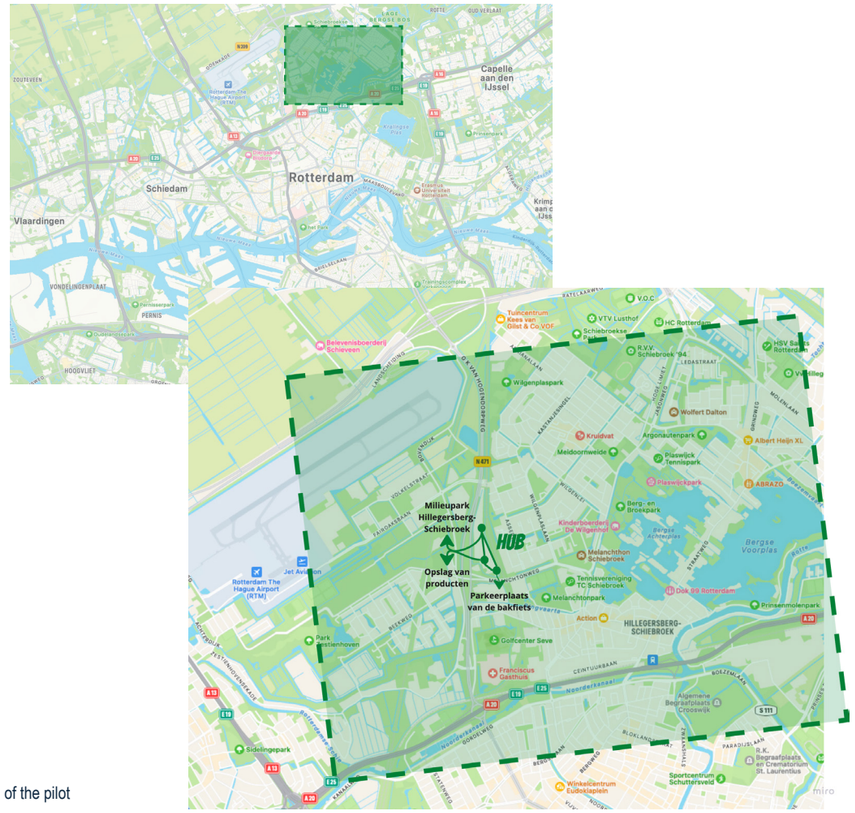


Figure 36: Research area of the pilot

Table 8: Research methods for the pilot

RESEARCH METHOD	#	Sort of appointment	Transportation	Documentation	Data analysis	Location
Collection of the bulky waste	20 appointments	20 collection moments at households	Cargo bike collection service	Observation, experience, pictures and direct note taking. Microsoft Forms for evaluation about collection services.	Structuring of the notes and pictures in the online tool MIRO Microsoft Forms analysis in Excel.	Hillegersberg and Schiebroek
		15 street conversations		Direct note taking.	Structuring of the notes in the online tool MIRO.	Hillegersberg and Schiebroek
Distribution of reusable bulky waste	12 appointments *of distribution with a certain amount of items.*	3 deliveries to Weggeefwinkel Noord	Cargo bike delivery service	Observation, experience, pictures and direct note taking. Microsoft Forms analysis in Excel.	Structuring of the notes and pictures in the online tool MIRO Microsoft Forms analysis in Excel.	Hillegersberg, Schiebroek, Noord and Schiedam
		2 deliveries to Wijkhub Noord	Cargo bike delivery service			
		1 delivery to thrift shop 'Het Goed'	Cargo bike delivery service			
		4 collection appointments from 'Marktplaats'	-			
		2 deliveries from 'Marktplaats'	Cargo bike delivery service			

Organization

In Figure 37 the details of the pilot design are presented. In the previous paragraphs the purpose, and method were explained. In ths chapter the organization for the collaboration and the needed steps method will first address how all the controlled means are put into place.

The figure on the next page provides a visual representation of the pilot organization. This model allows for the testing of all three business models. The registration, schedule, and route will be done manually, because of the small scale. Subsequently, all materials and products that are registered, will be collected. Products and materials of low value will be transported directly to the environmental park. The remaining products of value will be stored in the container (storage space). In this storage space, the distinction will be made between items that could be of value on the selling platform Marktplaats (concepts 1 and 3) and items that would be of good use for the weggeefwinkel (concept 2). For certain Marktplaats appointments, the delivery service will be included (concepts 1 and 3). Subsequently, they would complete an evaluation form to ascertain the success factors and potential obstacles associated with this service model. This concept allows to distribute all products within the pilot period. Furthermore, the model allows for the storage of products if sales on the platforms are not as rapid as expected.

To ensure a smooth collaboration between multiple stakeholders, several meetings in advance and throughout the pilot were held. The various groups made sure that there was access to the needed resources are listed below:

- *Policymakers: provided support and access to contact the right people.*
- *Municipal officials at the environment parks: offered insights into logistical considerations and helped refine the operational process. They offered me the cargo bike and the storage space, the most important means of the pilot.*
- *Municipal wijkmanagers at the wijkhubs and potential distribution channels: engaged to explore future collaboration opportunities that could enhance the scalability, sustainability and social interactions of the service.*
- *Citizens: participated in the collection of bulky waste and took time for short street interviews to share their perspectives on the service and its value.*

The pilot followed an iterative design process, with each phase informed by participant and stakeholder feedback. This allowed for continuous improvements in both the collection process and the overall service design, ensuring that the concept remained responsive to user needs and operational challenges. The organization of the pilot provided valuable insights into the logistical, financial, and operational aspects of a circular waste collection service.

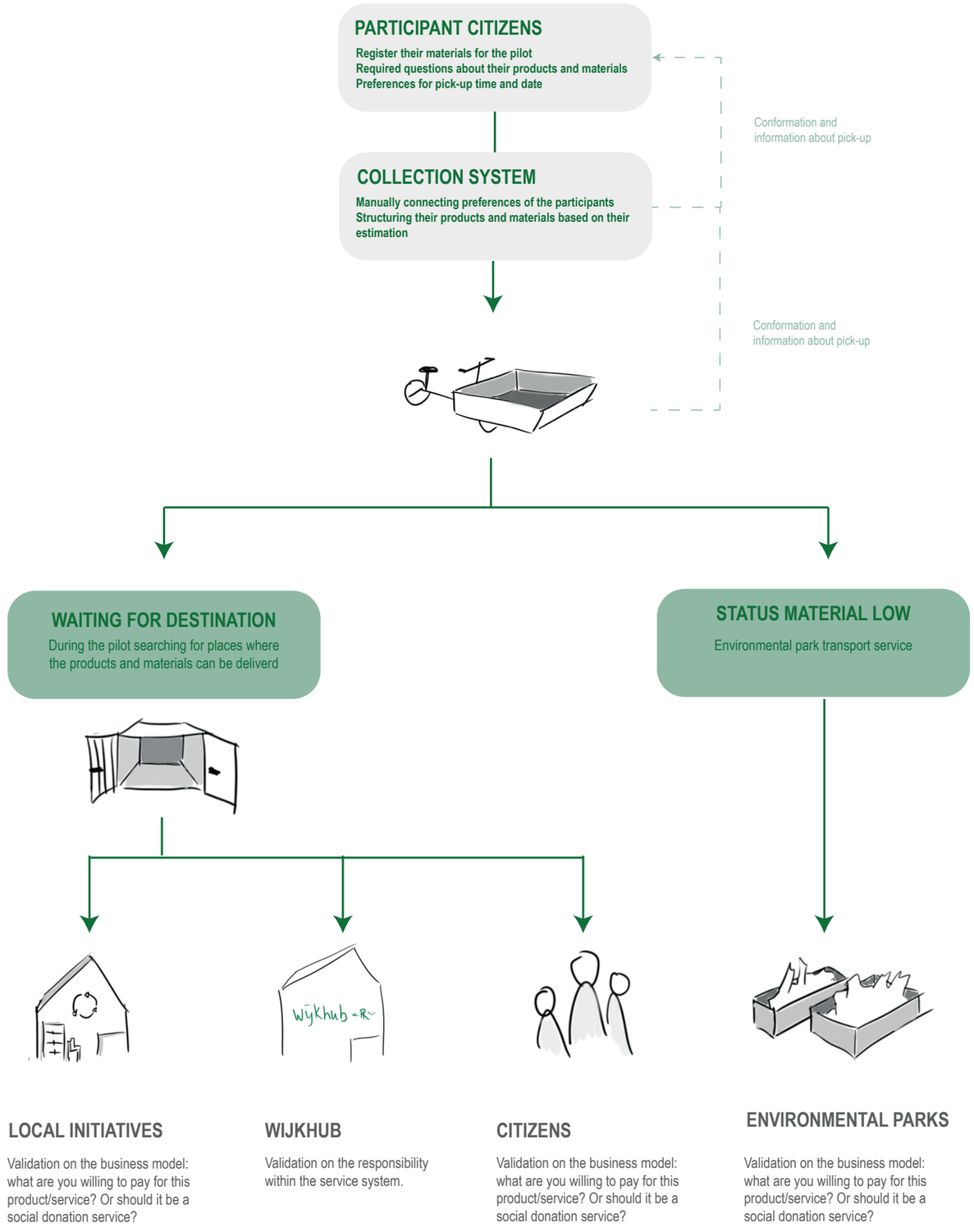


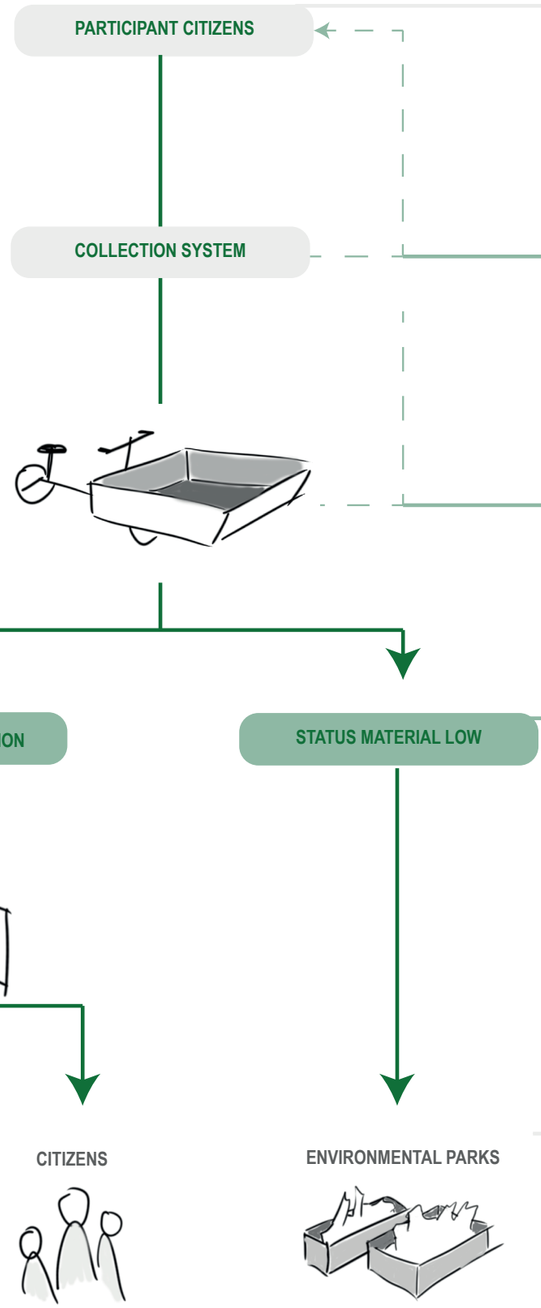
Figure 37: Flowchart of the executed pilot

REVISED OPPORTUNITIES

In the ideation phase, all selected opportunity spaces are investigated and explored. As illustrated in the visual on the right, the opportunity spaces utilized in the pilot design are shown within the flowchart system (Figure 38).

As can be observed, the utilized opportunities contain the transportation service, doorstep collection, and a supportive infrastructure. These represent the primary focus of the new service design.

Additional opportunity spaces are illustrated within the specific phase of the system. This incorporates the citizen's satisfaction, real-time tracking, and the organization of the system to facilitate the closure of material loops.



USED OPPORTUNITIES

A1 Develop transportation services to improve access to environmental parks. To overcome transportation challenges and encourage proper disposal practices.

A2 Introduce convenient waste disposal options for the citizens. For example, doorstep collection services for ease and quick solutions.

B1 Supportive waste infrastructure on community level to facilitate proper bulky waste disposal. These facilities should be easily accessible and provide guidance on waste separation.

REGISTRATION

The citizen registered their bulky waste by answering the required questions. This includes the waste streams they like to have disposed and their preference for time and day of the collection.

C3 The use of better user experience in the registering application for waste reporting that integrates all necessary functions, reducing the current complexity and improving accessibility.

Conformation of the appointment will be send with information about the pick-up. The first contact will be with email and on the day itself this will change to SMS or WhatsApp, based on the citizen's preference. A picture is required on the day of collection to locate and indicate the volume of the products and materials.

C2 Integration of citizen comments and locatable bulky waste, ensuring timely and accurate pickups.

DAY OF COLLECTION

Real time tracking of the cargo bike to give transparency and a detailled pick-up time. As citizen it is possible to ask questions to the waste experts.

C1 A real-time tracking of the bulky waste collection trucks for citizens, enhancing trust and cooperation.

ORGANIZATION OF THE LOOPS

The loops are closed organized to make sure all the materials will end up at a place that is environmental friendly.

B2 Play into the gaps found in the citizen behaviour. Make use of strategies like flow management and reversed logistic to design a service system for bulky waste for sorting and separation.

DISTRIBUTION

The loops are closed by partnering up with organizations.

P1 Partner with organizations like Marktplaats, Spullenbak, Het Goed, and repair cafes to create a robust network for reusing and repurposing bulky waste.

Figure 38: Pilot combined with the used opportunity spaces of ideation

New means and goals

In the final column of Figure 39, the startup's means and goals are developed. The startup's means include a fleet of cargo bikes, an integrated application platform, and expertise in the handling of materials.

The goal is to establish a circular collection service system that will facilitate the recovery of maximum value from disposed products and materials.

MEANS	Data of waste Registration for collection service by telephone or online portal Sharing transports with cargo bike or trailer Facilitation of environmental parks Information system of waste in Rotterdam Waste collectors Other vehicles to transport bulky goods Trucks for the matress-service On-timeslot services for collection of the matresses	Online selling platforms Online safety for sellers and buyers Stores and storage space capacity	Storage behind the front door Money to pay for the service Places where they like to dispose their waste	Cargo bike Application platform Knowledge on how to separate products and materials
GOALS	Waste prevention Better waste separation High-quality processing	The business need to be viable and driven by profit Producing with used materials, no matter the economic growth As many matches and sells on the platform To create work for people	A convenient way of disposing their products, materials and waste.	Creating a circular closing loop of products and materials A viable business model to make profit for existence

Figure 39: Means and goals after the development of the pilot

CHAPTER CONCLUSION

4.1 What are the potential concepts that can fulfill the predefined goals while aligning with the needs of citizens and the municipality?

The concepts are based on the accessible means, design challenge, criteria and the R-goals, with the objective to fulfil the needs and wishes of the citizens and the municipality.

1) The material platform
...offers an online or app-based marketplace that connects citizens that like to dispose their items with others interested in reusing or repurposing them. This approach supports the municipality's circularity goals by promoting material reuse, minimizing waste, and reducing the strain on bulky waste collection services.

2) The sponsor system
...is based on community engagement. Citizens can support the other neighborhoods by registering their items for donation, helping citizens in need of those items. This model also aligns with Rotterdam's goals by building community investment and reducing waste.

3) The second-hand transportation platform
...aimed at offering a direct marketplace for items collected. It could drive high revenues and ensure quick turnover of reusable items. The model can be organized to meet citizens' convenience preferences and municipalities' sustainability criteria.

4.2 What is the purpose of the pilot?

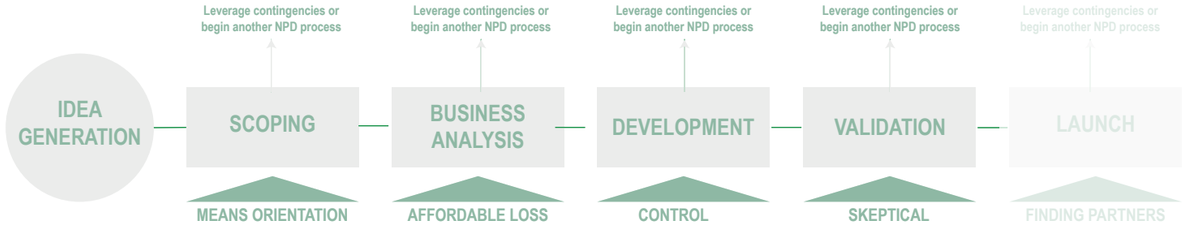
The purpose of the pilot is to test the business models on feasibility of the logistics, preference of the citizens, attractiveness of the execution for the collectors and the financial viability.

4.3 What ensure a successful validation?

To guarantee the successful validation of the pilot, a number of critical control factors and organisational requirements are arranged.

1) Recruitement of the participants
The recruitement of participants is done with the use of local social networks, neighborhood WhatsApp groupchats, and physical flyers proved to be effective to ensure enough participants for the pilot.

2) Use of the cargo bike and storage space
The cargo bike was collected and the container for storage space was prepared and checked. Together with the coordination with environmental parks managers and potential distribution channels it was ensured to be a smooth operation.



5 VALIDATION

VALIDATION OF THE SERVICE

5.1 How did the evaluation of the pilot refine the service system?

The evaluation's data provided valueble insights that refined the collection service on feasibility of the logistics, financial viability for the enterprise and preference of the citizens.

In this chapter all the data gathered from the pilot is analysed according to the four points of purpose: feasibility of the logistics, preference of the citizens, attractiveness for the collector and the financial viability.

FINAL DESIGN

5.2 What is the final design: RepurposeRide?

The final design is a transportation network by cargo bike to redirect bulky waste, suitable for a new life, within your neighborhood. It will encourage the reuse of items through Wijkhubs and give-away stores, as it strengthen community engagement.

5.3 What is the identity and organizational structure of RepurposeRide?

RepurposeRide identifies itself as a social enterprise dedicated to achieving circular economy goals through community engagement and environmental impact. It offers tailored solutions for bulky waste collection. Starting in Rotterdam, RepurposeRide aims to establish itself as a key facilitator in municipal waste management, with ambitions for broader expansion.

The final design wil be chosen based on the insights of the executed pilot. The organizational identity and structure of the start-up is presented.

VALIDATION OF THE SERVICE

In this chapter, the validation the pilot will be presented in detail (and a snapshot of pictures in Figure 40), provided with answers to the key questions posed during the pilot. The four defined puroposes of the pilot were the convenience for the colllector, feasibility of the logistics, financial viability and the preferences of the citizens.

As previously stated in the Method chapter at the beginning of this thesis, this problem cannot be solved from behind a desk. Accordingly, an iterative pilot program was organized and executed based on the designed business models. The viability, desirability, and feasibility of the new startup is substantiated through this proof of concept (Hennipman et al., 2008). The benefits of using a proof of concept (PoC) in the context of prototyping and design include:

Validation of ideas and explorative evaluation

A PoC allows designers to validate their concepts and ideas before full-scale development. It helps in assessing whether the proposed solution meets the intended requirements and user needs. Using a PoC in a real-world setting enables explorative evaluation, where the designer can discover new features and functionalities that may not have been initially considered. This can lead to innovative improvements to the design.

User feedback and enhanced communication

By creating a tangible pilot, citizens can interact with the new service, providing valuable feedback that can lead to improvements and refinements. This feedback is more creative and insightful because it is gathered in a real-world context. Next to that, a PoC serves as a visual and functional representation of the service, making it easier to communicate the concept to stakeholders, citizens, and the municipality itself.

Risk reduction, cost-effectiveness and scalability insights

Developing a PoC helps identify potential issues and challenges of the ideas. This can be a cost-effective way to test the first concepts without the need for extensive resources or fully developed products. It allows for quick iterations and adjustments based on user interactions and feedback. A well-designed pilot can demonstrate how the new collection service can scale and iteratively improved. This is also in line with the principles of Effectuation. The affordable loss and crazy quilt principles encourage experimentation and risk-taking. In the event of an unsuccessful outcome, the potential consequences are relatively minimal, given that start-up was never launched on a big scale.

As for the pilot, it is important to not only explore the functionality of the service, but also monitor the experience of the citizens and the collector. It is unclear whether this service will have a significant impact on the creation of sustainable behaviors and whether it will effectively facilitate the implementation of sustainable lifestyles (Aarts & Diederiks, 2006). A proof of concept is a crucial step in this design and development process, providing these insights that can significantly improve the final design.

Figure 40: Snapshots from the pilot

Evaluation of the pilot

1: The convenience for the collector

The journal of the collector (Figure 41, Appendix D) on the cargo bike afforded insights into the optimization of the service, as well as the identification of both successes and challenges. During the pilot phase, the majority of iterations have already been completed. When an issue occurred on day one, it was addressed and resolved on the following day. Accordingly, it was an iterative pilot. The concluding days of the pilot program offered insight into the potential operationalization of the service upon its official launch. After the pilot was done, all the participants received an evaluation and with these insights the last iterations have been carried out.

The collectors journey showed what was the objective of each day. Together with the fluctuating emotions, insights and duration of all the collection days.
It should be mandatory to upload a picture and detailed information on where to obtain the registered items, as well as the volume of the batch. With this information, it is possible to estimate an optimized route. If it is feasible to complete two or three appointments in a single trip, this could result in overall efficiency gains.

Another noteworthy observation is the prevailing weather conditions. The cargo bike is not equipped with a cover, which could result in downgrading of the collected products and materials in the event of rain. Furthermore, this is not an optimal situation for the collector. This resulted in the conclusion that the cargo bike should be equipped with a cover to protect the collected items, and that one criteria of the collector should be resilient to withstand adverse weather conditions. To protect materials from adverse weather conditions, the cargo bike must be equipped with a cover during rain. This feature is essential to prevent water damage to collected items, ensuring they remain in good condition for delivery or donation.

	TESTDAY	DAY 1	DAY 2	DAY 3	DAY 4	DAY 5	DAY 6	DAY 7	DAY 8
OBJECTIVES		Collection of registered bulky waste							
		Drop-off at environmental park							
		Storage of reusable bulky waste							
					Products on Marktplaats for sale				
						Deliveries for thriftshops, give-away stores and Marktplaats			
ACTIONS		Learn how to cycle with the cargo bike. Some latest flyering and introduce myself in the Wijkhub and other municipal buildings in the neighborhood.	The first two items could be transported together in the cargo bike, while the third needed to be taken directly to the environmental park. The last two appointments contain a significant portion of items of considerable value.	Each participant provided a photo in advance, allowing me to assess that everything would indeed fit in the cargo bike. This made the day more effective than the previous day.	A highly effective day. The first two appointments were ready in the front yard, and the third involved a large container filled with moving waste, and was still suitable for collection with a cargo bike.	Two trips were made to Stichting Natuurtalent, facilitating the collection of various reusable materials after their second-hand market in the weekend. After that, a single pick-up from a couple for old lamps and boxes for moving were collected in one take.	Only one appointment was scheduled for collection, and heavy rain presented additional challenges. . Additionally, two appointments were arranged via Marktplaats.	Three pick-up appointments, one visit to the environmental park, one delivery appointment, and a trip to the giveaway store were completed.	Today, all items were delivered to Het Goed, a local thrift store. In addition, two further appointments were completed via Marktplaats.	All remaining items were delivered to the neighborhood hub on Teilingerstraat and the giveaway store in Noord. The container was emptied today, and the final items were taken to the environmental park.
DURATION		5 APPOINTMENTS 4 HOURS	4 APPOINTMENTS 2 HOURS	3 APPOINTMENTS 1 HOURS	4 APPOINTMENTS 3 HOURS	1 APPOINTMENTS 1 HOURS	3 APPOINTMENTS 3 HOURS	3 APPOINTMENTS 2 HOURS	5 APPOINTMENTS 4 HOURS
EMOTIONS of the collector									
INSIGHTS		**Pictures** Photos are needed for estimating how many appointments with the volume of one cargo bike.	**Service costs** It could be normalized to ask for service costs for this service.	**Efficiency** Efficiency and route optimalisation is essential for success. All the materials could fit in one cargo bike. Through the photos, it was possible to return to the hub early.	**App switching** The route planned, navigation advice, pictures, notes from citizens and real-time location sharing by texts should be integrated in one application.	**Initiatives in the city** The service can be used for households, but also for organized markets of citizens with reusable materials left.	**Weather conditions** When weather conditions are unfavorable it is needed to have options to keep the products and materials dry. Also, the biker needs to be resilient to all weather conditions.	**Logistics** The feasibility was demonstrated, making it a highly successful day.		**Residual streams** Almost everything was allowed in container 10*, the dedicated bulky waste container – a highly satisfactory outcome.

*Container 10 is the real “bulky waste” container. All the material what is not suitable for the other 32 fractions, is disposed in that container. This is the container is after-separated and processed for the incinerators.

Figure 41: Collectors journey from the journal used during the pilot

Categorization of the products and materials

In Figure 42 a all the items that are collected are shown. They were stored in the container at the hub.

Data analysis

During the pilot phase of the cargo bike, all the pictures of the collected goods were structured in MIRO. As a result a comprehensive visual representation (Figure 42) is made of all collected items. In addition, out of this categorization an alluvial chart with the material flow is created (Figure 43).

The items could be purchased from Marktplaats, delivered to a second-hand shop, give-away store or as brought to the environmental park. The categorization is employed for the purpose of monitoring the destinations of the items. The insights derived from categorizing all collected materials focus on requirement of sorting, identifying valuable items, mapping their destinations in advance, and allowing for real-time adjustments.

Sorting the items requires considerable effort, making it more efficient to send desirable item directly to the specific places, where there is demand for these items. This approach minimizes the labor involved in sorting while ensuring items are directed to channels where they are needed. For example, clothes are appreciated at thrift stores and products with plugs are desired at the Wijkhub in Noord.

An effective sorting process requires experts or coaches with the ability to quickly identify items with resale potential (platforms like Marktplaats) and distinguish these from items more suited for donation or recycling at the environmental park. This skill set is essential for maximizing the value generated from the collected items, as it enables better decisions about which items need to keep in storage, and which are best sent directly to specific distribution channels.

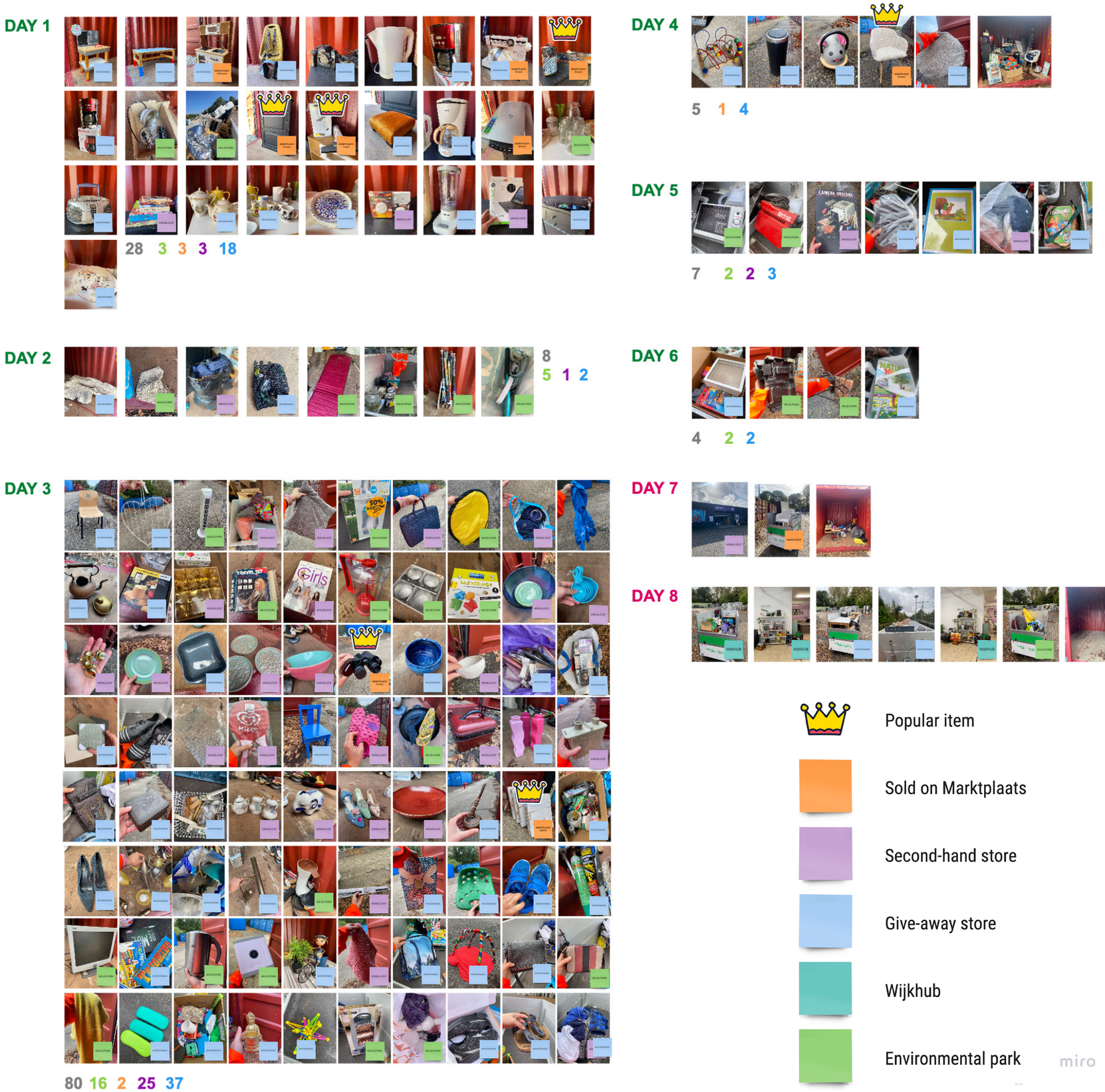


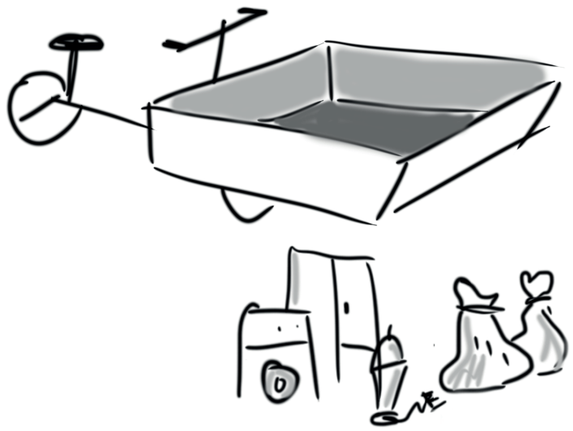
Figure 42: Categorization of the collected reusable items

The alluvial chart shows the route of material flow of the pilot. It is crucial to focus on the material flow to ensure that the environmental impact will as low as possible (Haffmans et al., 2018). The conclusion of these chart is that 80% of the collected items are repurposed within the city. The other 20% is brought to the environmental park were it is source-separated. Nothing is brought directly to the processor and everything is examined to check if it is reusable.

Cargo bike versus compactor truck

The amount of items that is safed from the compactor truck can not be exactly stated. Although, it is possible to make an estimation of how much this service reduce yearly.
With the use of the photos and experience during the pilot my estimation is that approximately 300 [kg] of bulky waste was collected in six days. This gives me an average of 50 [kg] per day. If you were to run the cargo bike for 350 days a year, you would collect 17500 [kg] of products and materials. This is a significant quantity that will not be lost with the use of the compactor truck.

This is an estimation based on the pilot. This estimation can not be validated because a majority of the collected items in the pilot were an extra donation after the participants knew the purpose and destination of their registered products and materials. It is not certain that those products they gave up for donation would have ended up in the compactor truck.



***The % are corresponding to the collected items. For the sponsoring this means that 74.2% of the items are given away to the Wijkhubs and second hand stores.**

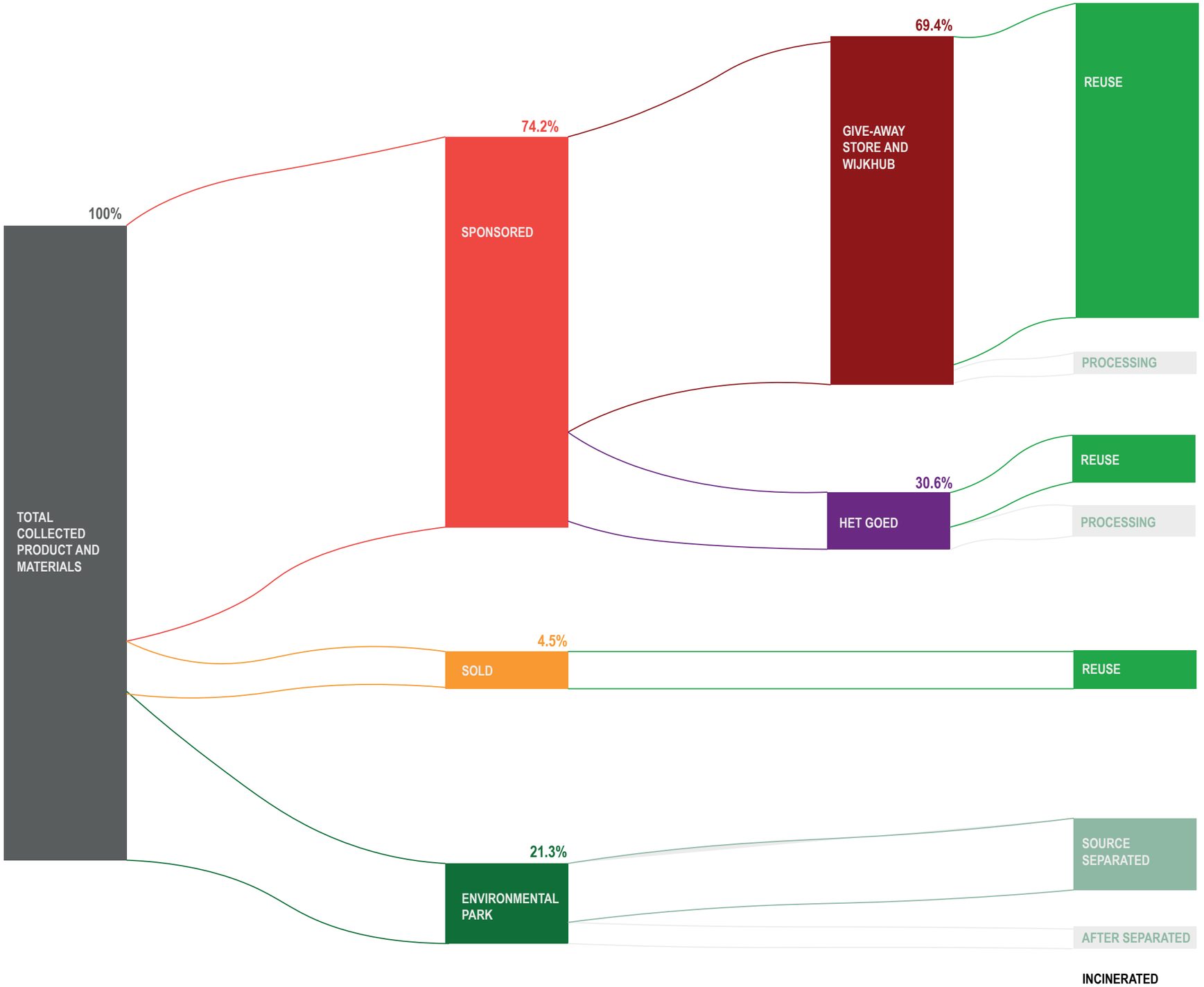


Figure 43: Alluvial chart of the distribution of the product and materials during the pilot

Data analysis

The logistics of this pilot program are carefully monitored using a Garmin sports watch, allowing for an analysis of route duration, appointments done, and cycling distance. This data (Figure 44) is essential for optimizing routes and identifying the ideal schedule for completing multiple appointments within a shift. Each day's logistical feasibility is assessed based on the duration and distance of the cycled routes, leading to valuable insights about operational limits and the physical demands for the collector.

The pilot proofs that a maximum of five or six appointments can be completed per shift. The duration of a shift is limited to four hours. It was experienced that the state of exhaustion and a decline in motivation occurred after four hours of cycling on a loaded cargo bike, which underscores the importance of maintaining shorter, manageable shifts to sustain performance.

Profile of employees

Given the physical and social demands, collectors should have some characteristics to be suitable for the role. The collector should ideally be sociable, resilient, interested in circular waste management and a preference for cycling during the day. Cycling with cargo bike requires stamina and the ability to adapt to the environment. Additionally, it could be possible to incorporate multiple transport options to accommodate varying preferences and capabilities among different employees, enabling the inclusivity the municipality is suggesting.

Combination of collection and delivery

It is logistically viable to combine pick-up appointments with delivery appointments, provided that the bike is equipped with two compartments: one for items being delivered and another for newly collected goods. Route optimization can be enhanced by utilizing photos and detailed descriptions of the bulky waste provided by participants, allowing bikers to plan in advance and avoid unnecessary stops or excess travel time.

Locations of delivery and disposal

In the sponsor system, where items are collected in one neighborhood and delivered to a sponsor neighborhood, it is recommended that these areas be located near each other. This will reduce travel time, optimize route planning, and increases efficiency in the distribution of reusable items. For example, the thrift store Het Goed, although a suitable partner, has proven to be slightly too far for efficient integration into the routes, as this distance requires additional time and energy. However, they accept all items and conduct their own inspections, making them a valuable partner, when feasible. On the other hand, the give-away store and the Wijkhub Noord are within an optimal range of the container and environmental park, making them highly accessible drop-off points. Future logistics will need to adapt as the environmental park location shifts due to the upcoming HER. The environmental park is relocated further away, travel distances will increase, impacting route feasibility and requiring adjustments in operational planning to maintain efficiency.

4 appointments in 1:36:13

This route was optimized because of the pictures send by the participants. The volume and products could be estimated in advance.

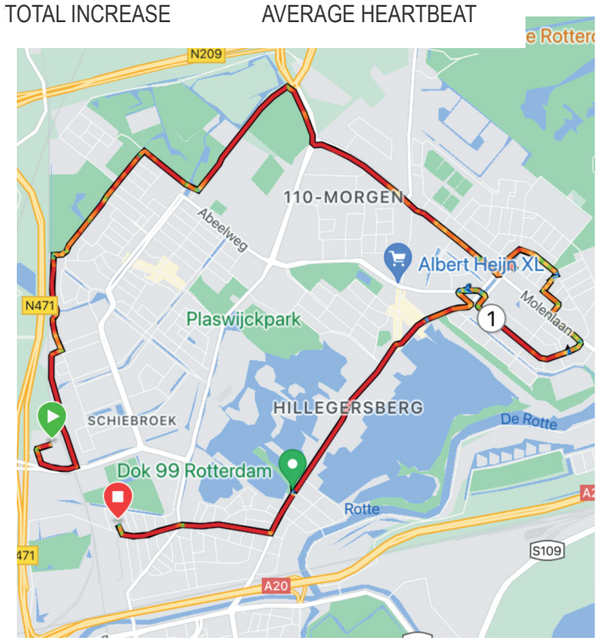
11,91 km
Afstand

1:36:13
TOTAL TIME

7,4 km/u
AVERAGE SPEED

14 m
TOTAL INCREASE

78 bpm
AVERAGE HEARTBEAT



3 appointments in 1:23:34

The first appointment was a lot of volume and needed to redirect to the environmental park directly. That costs time and energy. Appointment two and three could be done together due the pictures and estimation of the volume.

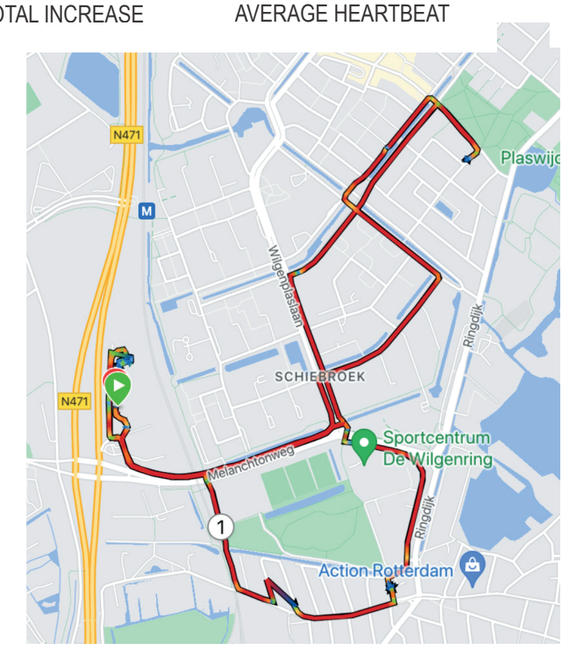
8,66 km
Afstand

1:23:34
TOTAL TIME

6,2 km/u
AVERAGE SPEED

12 m
TOTAL INCREASE

82 bpm
AVERAGE HEARTBEAT



2 appointments in 46:26

A convenient route without stops to the give-away store and Wijkhub. On the way there is with a full stacked cargo bike. Its way back is empty, which can be seen as a relaxing moment.

6,70 km
Afstand

46:26
TOTAL TIME

8,7 km/u
AVERAGE SPEED

16 m
TOTAL INCREASE

82 bpm
AVERAGE HEARTBEAT

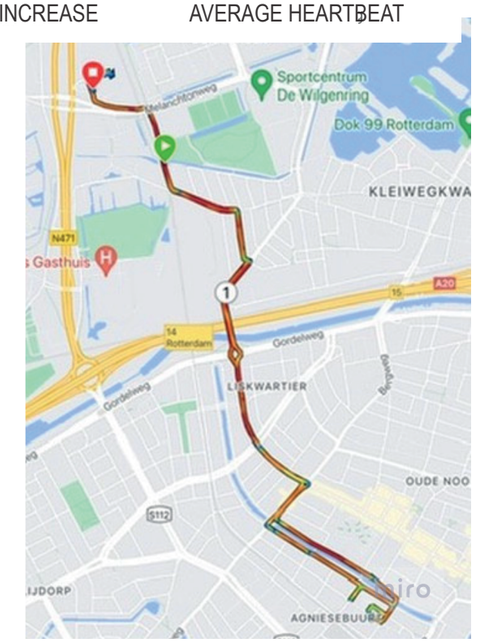


Figure 44: Routes cycled during the collection of items

3: Financial viability

The financial viability of the pilot is estimated with the use of the revenue stream conducted out of the material and or second-hand transporation platform. The other one is an estimation of the price of the current collection service versus the price the cargo bike repurpose service will cost.

Data analysis

1) The participants of the collection service were asked about their "willingness to pay for this service". The optimal price for transportcosts is conducted out of the market instruments of Leeflang et al. (1981).
2) To imitate the second-hand and material platforms, the items were traded on Marktplaats.

1) Price for the transport service

The estimation of the transportion fee of the service is done with the use of the market instruments of Leeflang et al. (1981). The price range is found by asking the consumers (n=18) four questions:

a) what is the price that you consider it cheap?
b) what is the price you consider it expensive?
c) what is the price you think it is too cheap, the quality of the service will be low?
d) at what price the service is too expensive you will not use it anymore?

These questions were asked in the evaluation form given to the participants. In figure 45 the results of their answers are shown in the two graphs on the right.

The first graph explains the questions when the service is considered cheap (a) and expensive (b). The cumulative frequency shows the percentages of respondents who find the service expensive or cheap at a certain price. The intersection of both cumulative frequencies is called the indifference point (IDP). This indicates the price level at which an equal number of respondents find the product expensive and cheap. The IDP has educated that this price is the average market price. For the collection service this is €10.

To answer the last two questions, when the service is considered too cheap or too expensive, the graph will be mirrored (1-a and 1-b). Together with the cumulative frequencies of responses to questions c and d, the optimal pricing point (OPS) is identified. This price corresponds to the point where the resistance to a product being too cheap and too expensive is equal. However, this definition can be misleading, as the optimal price should be determined using multiple metrics. Therefore, the marginal cheap point (MGP) and marginal expensive point (MDP) indicate the acceptable price range. For the collection service, this acceptable price range lies between €2.50 and €20, with an OPS of €10.

In conclusion the acceptable price is €10 for average citizens. It should be kept in mind, that a lot of respondents thought the service should be provided for free. This is due the fact that the current collection service of Rotterdam is free* of charge.

The current bulky waste service is provided free of charge to citizens, with no additional charges for its use. These charges are already included in the annual waste fee. However, the current bulky waste service (the use of the compactor truck) and the costs are converted to €88 per appointment (confidential Appendix B). The new designed collection service by cargo bike is estimated to cost €45 per appointment. The new service represents a significant cost saving opportunity and has the potential to generate additional revenue.

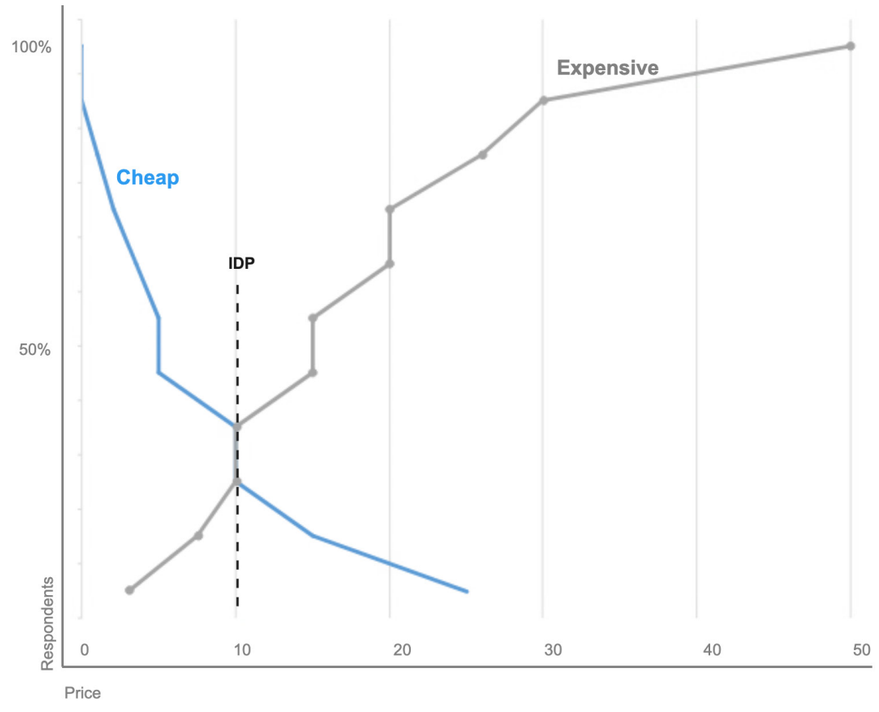


Figure 45: Optimal pricing points from evaluation with citizens (Leeflang et al., 1981)

2) Revenue stream of the second-hand platform

The external revenue stream was the sale of items that had been collected and were expected to generate value. Fourteen items were uploaded on Marktplaats, a Dutch online marketplace for second-hand items. When the transaction was intended to come to its conclusion, the customer was informed that the sale was part of research. Instead of the agreed-upon price, I proposed that they answer a series of questions and complete a questionnaire. The steps, products uploaded and consent text are shown in Figure 46.

The results are based on the perceived experience of the customers. It became evident that the process of making deals and finding the necessary items on Marktplaats is perceived as a burdensome task. It requires a significant investment of time. The reason for this is that it is an anonymous platform which is used by a significant number of individuals with criminal intent and by a considerable number of ghost users.

"You are always dealing with someone you do not know. There are many scammers on Marktplaats, so I find it quite difficult to buy anything."

Despite the negative experience of the use of second-hand platforms, this initiative successfully brought in €189.50 during the pilot. Out of 14 items uploaded on Marktplaats, half of the items were sold within a week. This positive outcome highlights the potential for a continuous revenue stream. This makes it an essential component of the second-hand platform, which generates direct revenue, was tested to be very effective.

For the delivery service the four questions of Leeflang et al. (1981), are asked to the consumers in their evaluation form. The low response rate and the unwillingness of Marktplaats participants to pay for the transportation service leaves the pricing estimation unsuitable for research purposes. It is concluded that Marktplaats is a platform where the consumers like to have everything as cheap as possible. It is nearly a game to buy things for the lowest price possible. Therefore, a paid delivery service can be of extra value, but it is considered not that effective, as the participant customers were not willing to pay for the transportation service in the future.

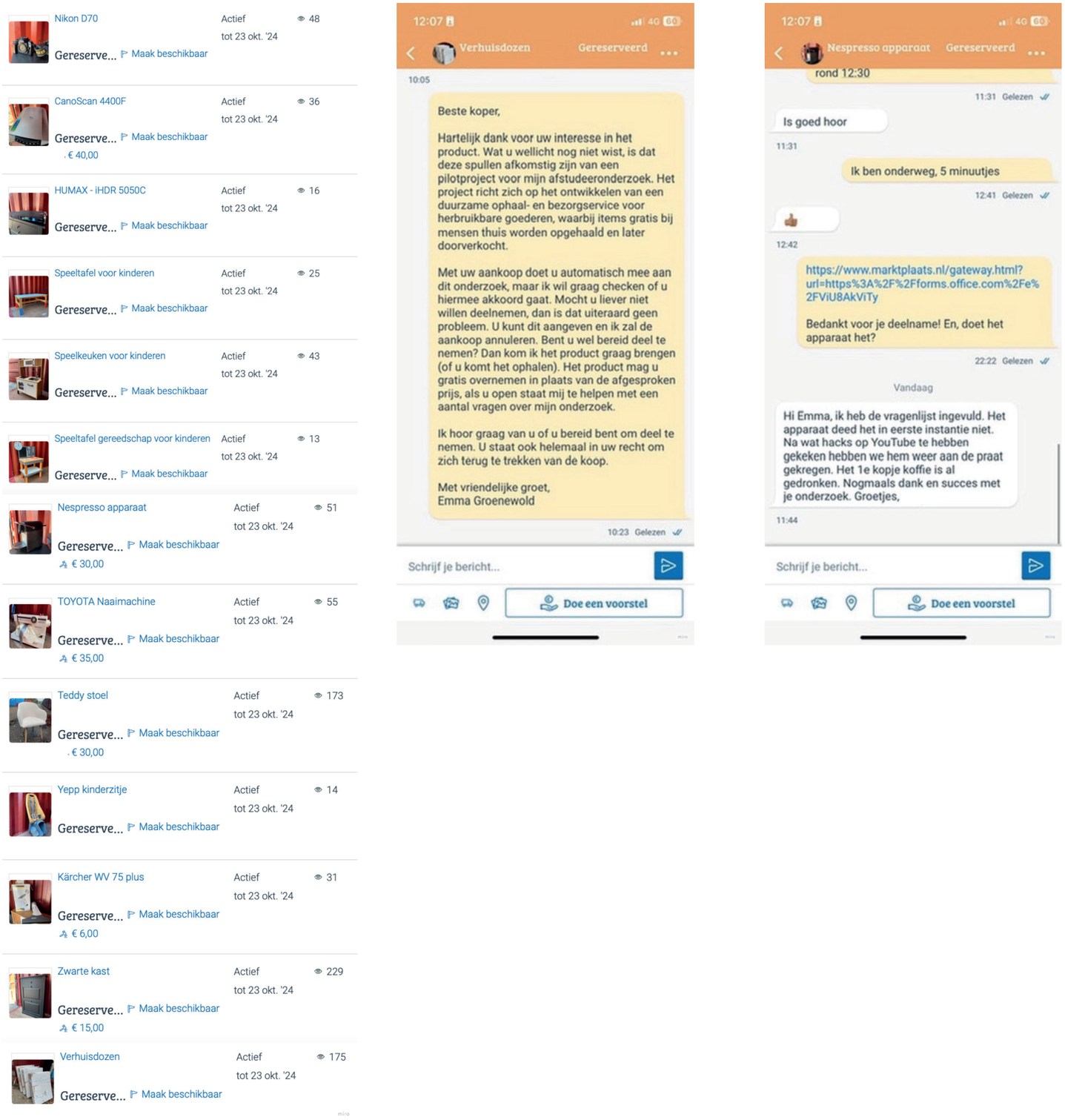


Figure 46: Marktplaats steps during the pilot

4) Preferences of the citizens

Data analysis

All the notes from the street interviews and observations were structured in MIRO. After the appointments and deliveries, the participants received a Microsoft Forms for evaluation. These forms contained questions about their satisfaction of the service, definitions of the collected or delivered items, the pricing of the service and their preference for further implementation. The forms are analyzed in Excel and in Microsoft Forms.

The findings of the evaluation are presented in the form of quotes per cluster identified (Figure 47). The total data collected from the forms is presented in Appendix E. Six clusters were found through the course of the street interviews and subsequent analysis conducted as part of the evaluation.

1) Knowledge

The participants in the collection service demonstrated a satisfactory level of knowledge and above average in the proper handling of bulky waste. The on-demand collection service with the real-time tracking and updates through SMS or WhatsApp are perceived as convenient. The participant felt engaged and trusted the service through the easy access to contact and advice regarding their bulky waste.

2) Definitions

For waste intended for the environmental park, terms like “bulky waste” or “bulky material,” are commonly used. When referring to reusable items, the term “products and materials” is primarily used to emphasize their potential for reuse. For items specifically suitable for reuse, the term “product” is often applied. This nuanced use of definitions helps clarify the categorization and potential of different types of waste, aiding in better management and communication within waste collection and recycling systems.

3) Volumes

The participants knew only small items and materials can be accommodated in the cargo bike. For example, during a renovation, the cargo bike will be of no utility. It was concluded by the citizens that this service may be of benefit for smaller volumes, that otherwise end up in attics.

4) Sustainability

The importance of sustainability is widely acknowledged, and there is a willingness to take additional steps, despite that it will take more time. However, when the cargo bike service was available, it was perceived as more convenient than take the additional steps. The appeal of a convenient solution is a key factor in the decision-making process.

5) Emotions

The emotional aspects were found to be a greater influence than had been anticipated. Some participants possessed a lot of useful products yet were (emotionally) unable to discard them because of the fact that compactor truck distroys it. The participants in the pilort expressed satisfaction with the knowledge that their products would end up in the hands of a new owner. They were prepared to give even more away, when they found out the products were given to people in need. This insight guarantees that citizens are eager to prevent waste from being transported and distroyed with the compactor truck and are willing to donate items.

Satisfaction and preferences

The satisfaction of the service is rewarded with a five-star rating. Also, the general reviews were considered as very positive and a service they are willing to use in the future. Consequently, the sponsor system was selected as the optimal solution.

Figure 47: Quotes and insights of evaluation with citizens

TAKE AWAYS

Feasibility and convenience for collector
The pilot highlighted the importance of route optimization using item photos and descriptions, allowing multiple pickups per shift. However, shifts should be limited to four hours to prevent collector fatigue. Weather-proofing the cargo bike with a cover is essential to protect items from damage, ensuring they remain suitable for reuse. Items should be categorized by condition and directed immediately to appropriate channels (e.g., second-hand stores for clothes and wijkhubs for electronics).

Financial viability
The current service is double the price of the cargo bike service. It is financial viable to start the change to cargo bikes. The optimal pricing point (OPS) was identified as €10 for the collection service. Although, some participants expected a free service due to the existing municipal offering. Clear communication about the service's added value and environmental benefits will be crucial to justify its costs. The external revenue stream of sales was tested to be very effective, what makes the service even more viable.

Preference of citizens
Participants appreciated the on-demand, real-time tracking collection service, with many valuing the assurance of the trusted partner that items would be reused. Emotional attachment to their products reinforces the appeal of a reuse-oriented service. This emotional value on the products is a signifact factor in the choice of the final design. Therefore, the sponsor system was selected as the optimal solution due to the favourable perception of citizens towards community engagement and the potential for product avoidance from incineration.

FINAL DESIGN

The chosen concept for this project intertwines several innovative components of all the tested concepts. A new service branded as RepurposeRide was chosen. This start-up is based on the results of the pilot on the four areas: (1) feasibility of the logistics, (2) preferences of the citizens, (3) convenient execution for the collector and (4) the viability of the model.

The preferences of the citizens became an evident factor in the choice for the sponsor system. The positive perception of the service through community engagement and donations of products for citizens in need. This experience was of great importance in shaping their future intentions to utilise the service.

In this chapter RepurposeRide is introduced. The brand's key components, their purpose, as well as the organizational structure. A critical aspect of this service is the integration of the material platform with the sponsor system. This combination not only facilitates the collection and distribution of the items but also encourages community involvement. Insights from an article in a Dutch newspaper NRC (Rosenberg, 2024) was used for the choice of service. This research article examined the neighborhood of the pilot area Hillegersberg-Schiebroek on liveability, engagement and assistance from the municipalities or other organizations. This underscored the potential for new initiatives thriving on social entrepreneurship to enhance the possibilities for these neighborhoods in Rotterdam.

RepurposeRide

Figure 48 shows a flowchart of all the steps of the service handled by RepurposeRide. A paid collection service and complimentary transportation to Wijkhubs, give-away stores, and citizens in sponsor neighborhoods is provided. To participate in the program, Wijkhubs must reserve a suitable storage area at their location for the products and materials. The managers of the Wijkhubs are in the position with knowledge of the needs of citizens within their neighborhoods and are thus entrusted with the responsibility of distributing the products. Additionally, they are responsible for the contact with cargo bikers and sorting personnel to ascertain the list of desired items for their Wijkhub.

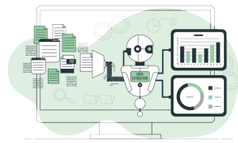
RepurposeRide aims to position itself as a social enterprise dedicated to the well-being of the city and its citizens. This involves implementing a sponsor system that not only manages waste efficiently but also gives back to the community. RepurposeRide will strive to combine environmental responsibility with social impact, establishing an identity rooted in sustainable entrepreneurship.

The transportation costs of the service will be €10 each ride of the cargo bike. The price is an estimation of the current costs for bulky waste collection and the acceptable price range derived form the evalutation with the citizens.

1 CITIZENS OF ROTTERDAM WANT TO DISPOSE THEIR BULKY WASTE

Gemeente Rotterdam

2 REPORTATION AND INTAKE THROUGH PORTAL OF THE MUNICIPALITY CONNECTED TO REPURPOSERIDE



3 ROUTE SCHEDULLING AND CATEGORIZATION OF ITEMS BY REPURPORSERIDE

4 COLLECTION OF REGISTERED BULKY WASTE FOR DONATION BY REPURPOSERIDE

5 THE COLLECTED ITEMS WILL BE DISTRIBUTED TO THE MOST SUITABLE PLACE

Gemeente Rotterdam

ENVIRONMENTAL PARKS

At the environmental parks the materials are HIGH-QUALITY PROCESSED ensuring the recovery of the materials.

Gemeente Rotterdam

WIJKHUBS

The wijkmangers/netwerkers and employees know their neighborhood. They have the knowledge to repurpose the items. The items are REUSED BY CITIZENS.

GIVE-AWAY SHOPS

Give-away shops make sure everything will be distributed throughout the neighborhood.

SECOND-HAND SHOPS

Second-hand shops give the materials new economic value by directing it into the store.

Figure 48: Final design: RepurposeRide

Organizational identity

RepurposeRide – ready for some (re)cycling

The main focus is the sustainable transportation of bulky waste in the inner-city environment. There are already some waste collection service brands on the market, but the combination of bulky waste disposal and reusable products is one that is still missing. Brands in this sector contains ByeWaste for reusable products, Inzamelhelden for sorting waste streams for industrial waste and Spullenbak for purposeful collection of products for circular producing. RepurposeRide will emphasize factors such as citizens convenience, sponsor by neighborhood, municipalities criteria and the circular appearance of the cargo bike to effectively target customers seeking circular options for bulky waste disposal. At RepurposeRide you can register all the bulky waste, not only the items that we have processing partners for. We take care of all the citizens unwanted materials.

The brand identity of RepurposeRide can be found in Figure 49. In the new created market, the identity of RepurposeRide will be a facilitator with tailor-made solutions for municipalities and their bulky waste management. The purpose of RepurposeRide is therefore empowering to repurpose, even when the citizens have no transportation, motivation and time, RepurposeRide is the solution. RepurposeRide is positioning itself different to citizens, municipalities and other stakeholders, to connect all the needs and wishes to one overall solution with social and environmental impact.

RepurposeRide is positioning itself on the market as a capacity function in this world. The strategic functions of Simon, the research of Dedene & Snoeck (n.d.) was used to define it for RepurposeRide. The services that RepurposeRide provide are based on comprehensive research and genuine knowledge about the client (municipality) and the client's clients (citizens and stakeholders). The use of their expertise on the usage of techonology to improve the bulky waste infrastructure. The routes are optimized with the power to establish a network of distribution channels in a unknown environment. RepurposeRide is able to make tailor-made solutions for other municipalities with the use of advanced technology driving on community engagement and environmental impact..

Way of Working

As the capacity function is defined to be the purpose of RepurposeRide, there is an complementary way of working for the new enterprise. As defined, there is a standard service of the transportation of bulky household waste from citizens to locations for reuse or environmental parks for recycle. However, the way this is orginized differ from neighborhoods and municipalities.

For example, in Rotterdam, the service will start and create awareness in the neighborhood of the new environmental park the 'HER'. The service will start in this neighborhood, due to the fact that the citizens there are already in the middle of a change. It is the intention to slowly extent to other parts of the city. In Rotterdam this capacity function will be used as the service need to be slightly changed on neighborhood-level. This is also a capacity of RepurposeRide, it will be possible to have different models used in parts of the city.

The words 'client', 'external party' or 'contractor' are not used by RepurposeRide, the service will be based on a collaboration by finding a way to work together to achieve both our goals, to make the most environmental impact with the use of community engagement.

PURPOSE

Tailor-made circular solutions for community engagement and environmental impact.

POSITIONING

For the citizens, RepurposeRide offers an on-demand collection service that will responsibly repurpose your bulky waste to rearrange the products to citizens in need and sorting the materials for optimal recovery.

For municipalities, RepurposeRide offers an collection service to handle the transportation of bulky waste from citizen to environmental park, making the current collection unnecessary.

For Wijkhubs and distribution channels, RepurposeRide offers a transportation service to repurpose products from previous owner to a new one to fostor reusability of products.

PERSONALITY

Innovative | Resilient | Social | Responsible | Circular

Figure 49: RepurposeRide organizational DNA

Organizational structure

To design a suitable organizational structure for RepurposeRide the components of an organization of Mintzberg outlined by Lunenberg (2012) are used to make a proper consideration. The structures will support a clear division of roles, ensuring the service will aligns with its identity. According to the research of Mintzberg on organizational structures (1980), it is stated that an organization's strategy and structure are linked. This structure is around three dimensions: (1) the most important part of the organization, (2) how the organization coordinates its activities, and (3) how much the organization lets subordinates decide. The organizational structure for RepurposeRide is a simple structure as it will be a small corporation in a new government department. In the future it will be organized around the technostructure, as RepurposeRide will be leaning on its data. The company is flexible and without a strict hierarchy organized (Ramaer, 1994). In this way employees are capable of rapidly changing into customers specific wishes to ensure high quality and satisfaction.

Components of RepurposeRide

In Figure 50 this organizational structure is shown. The strategic apex of RepurposeRide is formed by its board, which holds ultimate responsibility for the company's direction. Middle management is led by the municipality's project leader, ensuring decisions are collaboratively made between RepurposeRide and the municipality. The middle management is chosen in collaboration with RepurposeRide and the municipality they are consulting for.

The technostructure is RepurposeRide's key differentiator, serving as its unique selling point. This system optimizes, schedules, and redirects bulky waste within the city, forming the company's main operation. Even after implementation, these functions remain under the management of RepurposeRide, maintaining control over the system's efficiency.

The operational core and support staff are provided by the municipality. In Rotterdam, this includes utilizing their cargo bike fleet and partnering with organizations like Het Goed and the Wijkhubs to support and execute operations effectively.

Use of means

An other important consideration is the use of means. For the pilot period the cargo bike, intended for sharing transports to the environmental parks was used. It is essential to consider whether owning a fleet of cargo bikes is a necessary investment to deliver the desired value for future implementation. The same principle applies to the utilization of storage spaces, as the municipality has the ownership of the registered and donated bulky waste items after collection. It is the responsibility of the municipalities to provide storage facilities. A sorting center can function as a collection point for items, which can then be distributed from there to other locations.

After implementation

Once all the principles of RepurposeRide have been implemented and integrated, the Projectbureau will assume responsibility for further development in collaboration with the collection department. As this will be an additional service provided to citizens, it will be managed and executed by the collection department.

The collection department of the municipality needs to consider using electric vehicles in the future. The transport requirements of the cargo bike may not align with the skills of the employees collection plans to involve in the service. By using electric vehicles, the municipality can broaden the range of potential employees for the service.

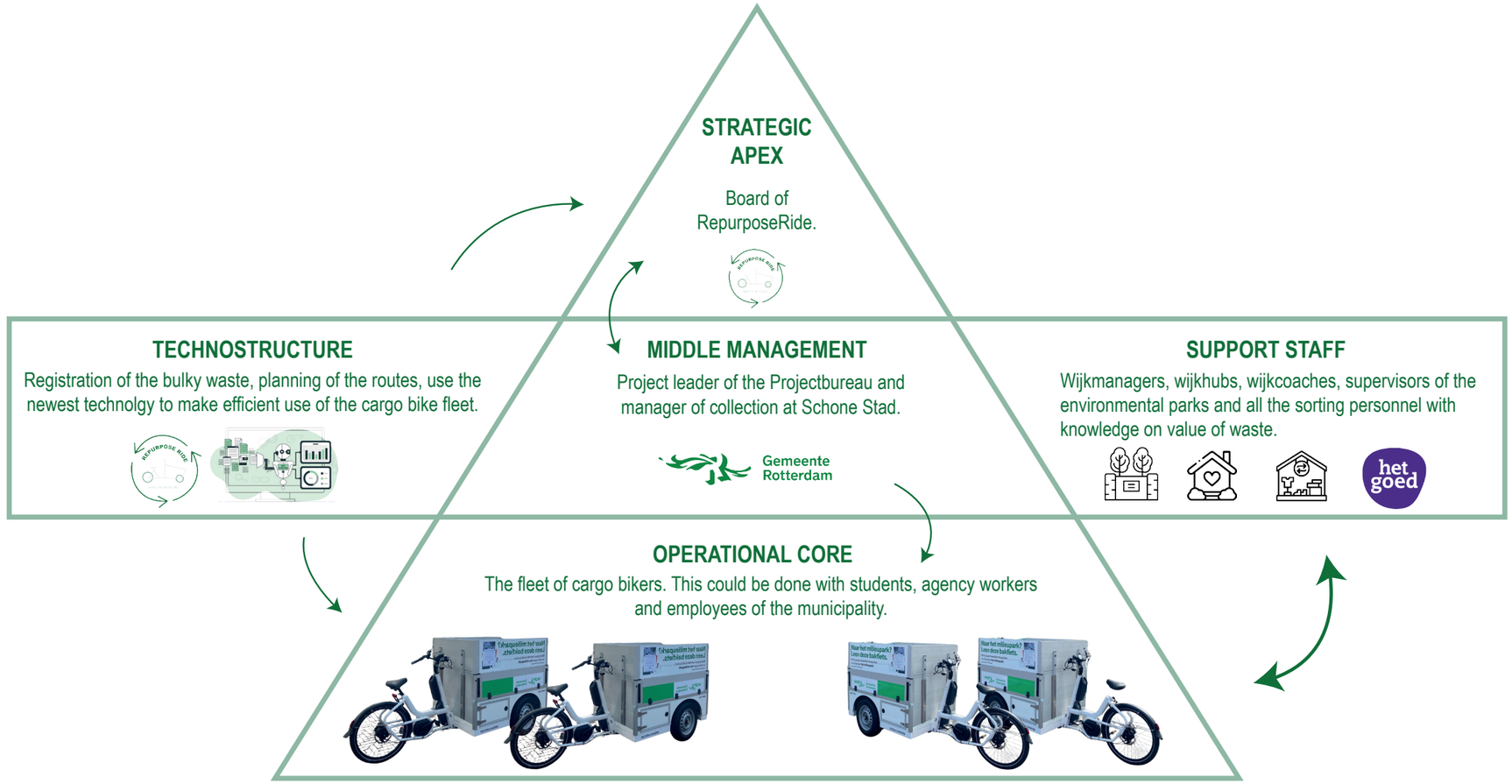


Figure 50: RepurposeRide organizational structure

TAKE AWAYS

RepurposeRide focuses on community engagement and environmental impact. As it strengthen neighborhood engagement and optimal value recovery of the bulky waste.

RepurposeRide positions itself as a social enterprise dedicated use the community to achieve a circular economy. The brand aims to provide municipalities with tailored solutions for bulky waste, emphasizing citizen convenience and circular practices. Beginning in Rotterdam, RepurposeRide seeks to become a unique facilitator within municipal waste management, with potential for broader expansion.

RepurposeRide is a simple structure as it will be a small corporation in a new government department. In the future it will be organized around the technostructure, as RepurposeRide will be leaning on its data. The organization adopts a simple and flexible structure, enabling operatinal employees suitable for on-the-ground decisions to enhance customer satisfaction. Means include cargo bikes and storage in loan of the municipality, with future considerations for cargo bike fleet ownership and electric vehicles. After implementation the cargo bike recovery of material service will be managed and executed by the collection department of the municipality.

CHAPTER CONCLUSION

5.1 How did the evaluation of the pilot refine the service system?

The evaluation's data provided valueble insights that refined the collection service on feasibility of the logistics, financial viability for the enterprise and preference of the citizens.

Feasibility and convenience for the collector
Key logistical improvements were identified, such as limiting shifts to a maximum of four hours to reduce collector fatigue and designing cargo bikes with rain covers and dual compartments for collection and delivery. Appointment scheduling based on uploaded pictures allows better volume and location estimation, optimizing the number of pickups per route.

Financial viability
Categorizing items by condition and directing them to appropriate channels, such as second-hand stores or wijkhubs, boosts reuse rates while reducing labor. The pilot revealed that transitioning to cargo bikes is financially viable, with a collection service pricing point of €10 identified as optimal. Clear communication about the added value and environmental benefits will be crucial, especially since some participants expected the service to be free. Additionally, testing external revenue streams from item sales proved highly effective, further enhancing financial viability.

Preference of the citizens
Citizens expressed high satisfaction with the on-demand collection and transparent communication, emphasizing the importance of aligning the service with user preferences. Emotional attachment to collected items and trust in their reuse contributed to the service's appeal, making reuse-oriented solutions more desirable than traditional disposal methods. This emotional connection played a significant role in shaping the final design.

5.2 What is the final design: RepurposeRide?

The final design is a transportation network by cargo bike to redirect bulky waste, suitable for a new life, within your neighborhood. It will encourage the reuse of items through Wijkhubs and give-away stores, as it strengthen community engagement. The materials that are of low status, are brought to the environmental parks where it will be source-separated for high-quality processing. The materials and products are safed from the compactor truck, as it contributes to waste prevention, separation and high-quality processing.

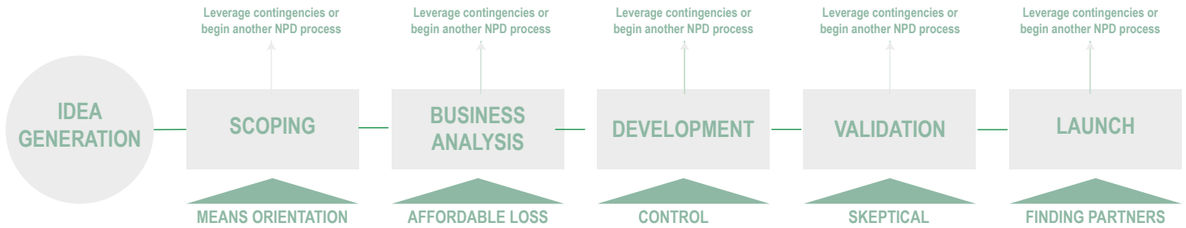
5.3 What is the identity and organizational structure of RepurposeRide?

RepurposeRide identifies itself as a social enterprise dedicated to achieving circular economy goals through community engagement and environmental impact. It offers tailored solutions for bulky waste collection. Starting in Rotterdam, RepurposeRide aims to establish itself as a key facilitator in municipal waste management, with ambitions for broader expansion.

The organizational structure is designed to be straightforward yet adaptable, empowering operational employees to make ground-level decisions that improve service efficiency and customer satisfaction. By relying on municipal resources such as cargo bikes and storage facilities. After its implementation, the cargo bike service will be managed by the municipality's collection department.

6

LAUNCH



LAUNCH STRATEGY

How is the circular collection system implemented for the municipality of Rotterdam?

Implementation is communicated through a strategic and tactical roadmap. The strategic roadmap provides a tangible representation of the developments that will occur over time and provides a clear understanding of each phase. The first phase is to prepare the citizens for the circular services of the municipality. The second phase is to extend these normalities, and the last phase is to create ultimate satisfaction with the new service. The tactical roadmap explains this in more detail. The roadmap elements provide a guide to the steps necessary to achieve the future vision of the service system.

With the use of the future vision of RepurposeRide and a strategic and tactical roadmap the implementation is explained. The key stakeholders and the municipality are the focus of the roadmap.

EVALUATION

To what extent are the initial project goals achieved, and what limitations are present in this research?

The initial goals of the project were significantly achieved, as evidenced by the pilot outcomes and evaluation sessions. Key stakeholders, including citizens, municipal advisors, and Wijkhub employees, validated the proposed service system's potential. The pilot demonstrated that RepurposeRide can reduce waste, improve reuse, and foster community engagement, contributing to Rotterdam's circularity goals.

In this chapter the predefined goals are validated through evaluation sessions.

LAUNCH STRATEGY

Roadmap design

The landscape of waste management is evolving rapidly (Spullenbak, 2024), due to circularity goals of the Ministery of Infratstructure and Water Management (2024). It is needed to adapt on several axes to get this change done. For example, the way we are disposing our items and how the facilities are managed. RepurposeRide can offer insights and efficiencies we could not access before. Their service, founded in the access to transportation and convenient disposal options, the entire system can be designed.

Rotterdam's mission on waste management is ambitious:

"Waste-free by the year of 2050, where there is a significant waste reduction, excellent waste separation and what all the materials that remains will be high-quality processed and recycled."

(Daan Vermeer, Program Manager of the Grondstoffennota at the Municipality of Rotterdam).

However, this mission does not provide a clear picture of how bulky waste will be managed in the Rotterdam in 10 years or what role the citizens will play in this future.

As introduced in the *Validation* chapter, the purpose of this roadmap is to outline the necessary steps for the collaboration between the municipality of Rotterdam and RepurposeRide to implement the on-demand collection service for bulky waste. In Figure 51 the activities of the Design Roadmapping process in relation with mapping sessions is shown (Simonse, 2018). This is an adapted model as the roadmapping session of this project required other activities.

Future Vision

In a design roadmap, the future vision is an expression of a desired future. The roadmap visualizes as a pathway towards this vision (Simonse, 2018). RepurposeRide is established as organization with tailor-made solutions for municipalities, the future vision has been developed for the desired urban environment. Through the comprehensive research during the different stages of the design process and execution of the pilot, the future vision is formulated:

"A tailor-made transportation network driven by community engagement for an optimal value recovery of bulky waste"

By 2035, Rotterdam will have achieved their circularity goals where citizens actively participate in reducing, reusing, and recycling. Through a network of Wijkhubs, a digital platform, and the on-demand collection service, citizens can easily repurpose or responsibly dispose their bulky items. In this future, bulky waste is no longer a challenge but a resource, continuously used within the city. If the quality of the materials is too low, it will be high-quality processed as recycled materials.

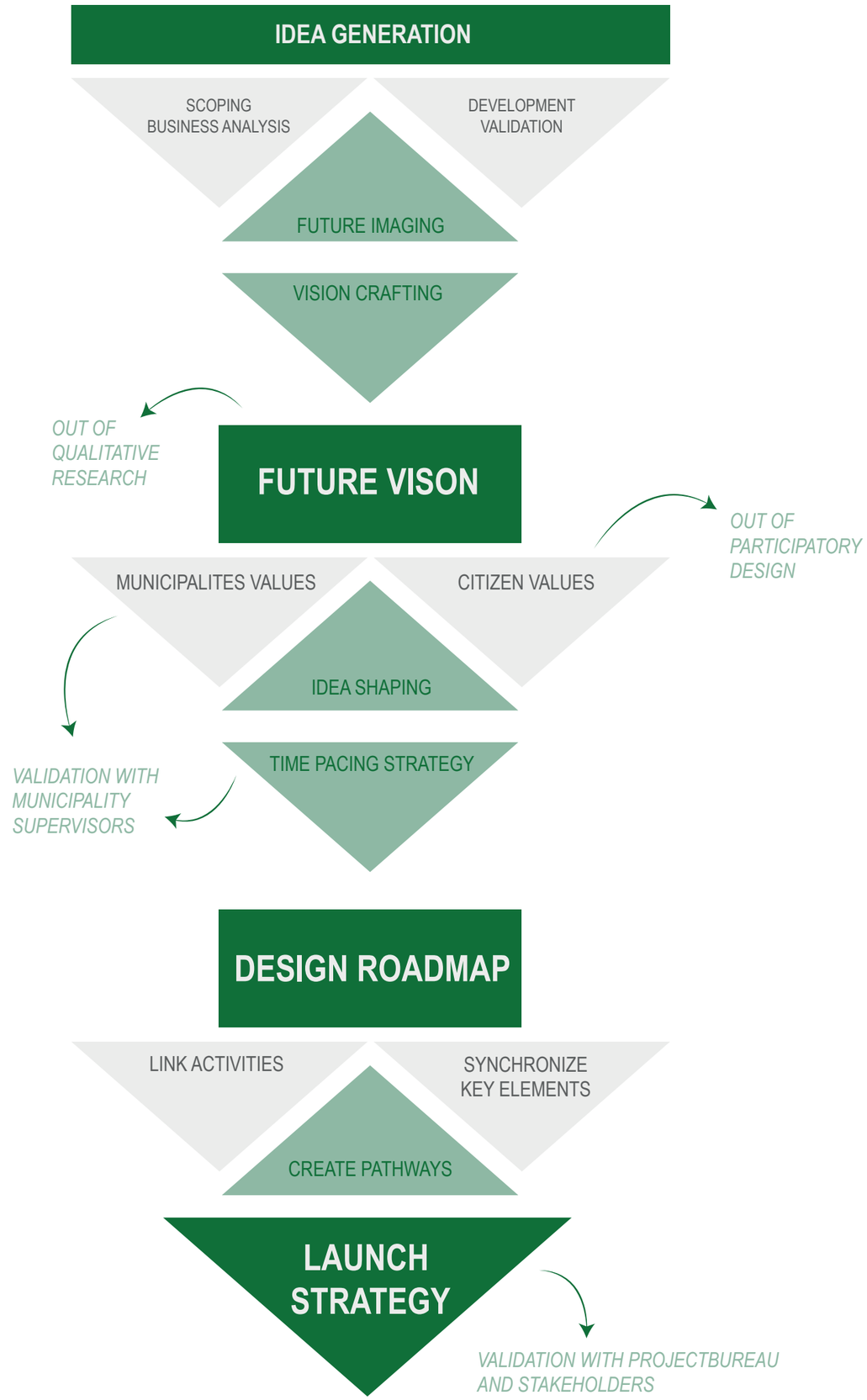


Figure 51: Adapted from method for design roadmapping (Simonse, 2018)

Roadmap elements

A strategic and tactical roadmap are created, it is a visual portray of design innovation elements plotted on a timeline (Simonse, 2018). Where the strategic roadmap is a visualization of the execution of the strategy and the tactical roadmap outlines in detail what needs to be done to come to achieve the future vision. There are key elements, in this research they are called the roadmap elements. They are chosen and structured over the y-axis of the tactical map, and across the pathway in the strategic map. The roadmap elements are essential to set direction towards the composed future vision.

The roadmap is compiled out of the in-depth interviews, stakeholder meetings, street- interviews and observations. The pilot, to test whether this new way of the collection of bulky waste would disrupt the market, formed the basis for the roadmap design. An early concept of the roadmap and the proposed horizons were given to the supervisors of the municipality, Ab Hoogesteger and Daan Vermeer. In the form of an all-in-one interactive mapping session was organized. The objective of this session was to combine the steps of value mapping, idea mapping and pathway mapping (Simonse, 2018). In Appendix E the designed roapmap from this session can be found.

To achieve the future vision in 2035, crucial elements are defined to highlight the most important steps for implementation and development. The elements are chosen by me and are based on the insights of pilot and a variety of meeting with project leaders of the municipality. In collaboration with the supervisors of the municipality the elements were validated. The roadmap elements can be found on the right (Figure 52).

OBJECTIVE

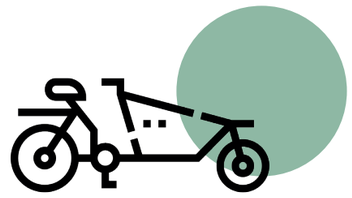
The objective of each horizon will be summarized in a powerful sentence that is easy to understand for communication within the organization.

MARKET

Niche innovations of Schone Stad's waste management together with the other competitors will be plotted in the roadmap. It is based on collaborations instead of competing, as everybody has the same interests.

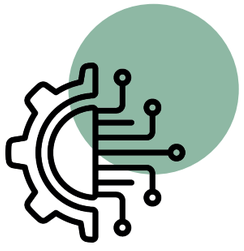
RULES AND REGULATIONS

The rules and regulations made by governments play a key role in the future of waste management. The developments regarding circularity of materials will be explained in this roadmap element.



REPURPOSERIDE

It is important to take the deforming business of RepurposeRide into account in the roadmap.

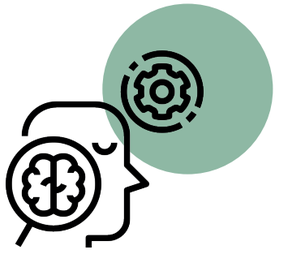


TECHNOLOGY

The techonology of RepurposeRide will be one of the main focus point for development. It is needed to create a integrated route, scheduling and estimation system.

STAKEHOLDER ENGAGEMENT

The network of stakeholder engagement will be expand within the years. In the first phases it start with the needed collaborations, as the service will be iteratively developed the stakeholder engagement will develop accordingly.



BEHAVIOUR

With the use of RepurposeRide the behaviour change will come into action. It is not possible to change the behaviour of the citizens within one take, it requires a long process of small changes at the time.

VALUES

The values of the citizens, second-hand stores, give-away shops, Wijkhubs and the municipality are shown to play into for a succesful implementation.

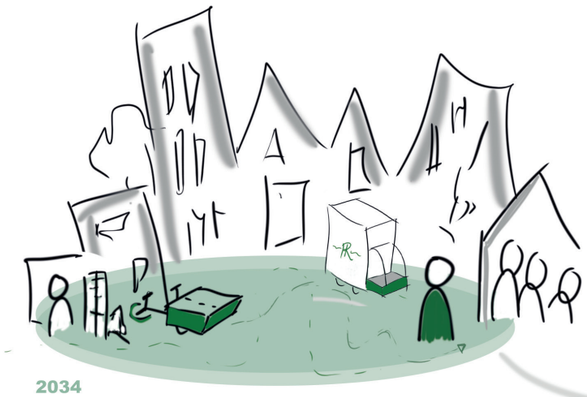
Figure 52: Roadmap elements

STRATEGIC ROADMAP

AN ON-DEMAND BULKY WASTE TRANSPORTATION NETWORK DRIVEN BY COMMUNITY ENGAGEMENT FOR REUSE OF COLLECTED ITEMS.

Horizons

The horizons are the building blocks to foster the development towards the future vision in three strategic life cycle scenarios. The first life cycle is about design value enhancement, to design the business that will mature over time. The second cycle is about creating new user-value to ultimately be disruptive in the third cycle: real value creation. For RepurposeRide and the municipality of Rotterdam three horizons have been defined. Each horizon explains its objective and development steps according to the strategic life cycles to ensure its disruptiveness.



2034

"A tailor-made transportation network driven by community engagement for optimized value recovery of bulky waste"

HORIZON 2

"NEW STANDARDIZED NORMS FOR BULKY WASTE COLLECTION AND DISTRIBUTION"

HORIZON 3

"A CIRCULAR BULKY WASTE COLLECTION SERVICE FOR ULTIMATE CITIZEN COLLECTOR AND STAKEHOLDER SATISFACTION."

2024

"An inefficient and environmental harmful bulky waste collection service."

HORIZON 1

"GET THE CITIZENS OF ROTTERDAM READY FOR CIRCULAR BULKY WASTE MANAGEMENT"

Figure 53: Strategic Roadmap

“get the citizens of Rotterdam ready for circular bulky waste collection”

Value proposition

In the first step of the strategy, it is focused on the citizen. The citizens are not used to circular practices regarding their bulky waste. As the current collection system is still separating and incinerating the registered items. Therefore, the aim for this horizon is to get the citizens of Rotterdam ready for the new way of bulky waste collection.

Market

To get all the citizens on board this will be done with only small changes and playing into the barriers of today, the new service will be no hassle to use. It plays into already existing projects like the sharing transports and the pop-up parks. Accordingly, it will start in the neighborhood around the new circular environmental park De HER. This environmental park will open its doors in February 2025 where citizens can drop off and donate their materials and products. Local producers, can open a location on the environmental park and make unlimited use of the donated materials for their circular production. This donating feature is only for the drop-off at the environmental park, but this is not incorporated in the collection service.

Rules and regulations

The first horizon focuses on current policies and regulations. The objectives set by the circularity programmes will be followed to ensure that RepurposeRide can be successful. In addition to the policy, a change in Rotterdam’s waste taxes will be initiated. Nowadays they pay an annual fee to have everything all-inclusive. This will change and they will pay for their contribution to residual waste. RepurposeRide will charge per use instead of an average for the whole city in your annual price. For example, citizens living in the starting area of the service, will have a reduction in their annual waste tax and are able to use RepurposeRide’s paid collection service.

RepurposeRide

In the first horizon, RepurposeRide will implement the service in the starting area of Rotterdam. The storage and cargo bikes will be used by the municipality, only the employees will come from RepurposeRide. This is because the employees of the municipality need more time to prepare for the change.

Technology

The first features added to the collection are real-time tracking of the collector and uploading of images in advance. The applications are integrated to increase the collector’s convenience. With the added value of the collector’s convenience, transparency to the citizen is improved, leading to higher citizen satisfaction and cleaner streets.

Stakeholder engagement

The network of stakeholders needs time to develop. The Wijkhubs that already have a give-away corner in their hub can be the start of this network. The extra benefit for the Wijkhubs is luring more citizens inside. This can create more engagement and connection. The Second-Hand shop Het Goed, which has a contract with the municipality, is also involved from the start and their sorting employees can help to sort for the redirecitons of RepurposeRide. De HER is the circular centre of Rotterdam, the perfect neighbourhood to start the community of reusing useful things.

Behaviour change

The desired behaviour change in the first phase is to gather knowledge for the citizens, the municipality and the market. For the citizens, it is important to understand why proper disposal is necessary. For the market it is important to see the economic value of residual waste. For the municipality, it is necessary to raise awareness of the value of residual waste and to put it higher on the strategic agenda.

Figure 54: Horizon 1

“new standardized norms for bulky waste collection and distribution”

Value proposition
The aim of the second horizon is to establish a wider range of neighborhoods making use of RepurposeRide. This is only possible if the citizens have become familiar with the new collection service their behaviour is changing accordingly.

Market
De HER is the circular headquarters of the city with entrepreneurs producing with disposed materials of the citizens. A lot of more circular start-ups have start the use of the materials donated from the citizens. The market is adapting to the fact that marketing is not only practising how to play consumer behaviour, but we are also starting to help consumers do the right thing after the purchase.

Rules and regulations
Given that all the new nota’s are introduced in 2026, a significant number of goals could have been rephrased and the priorities could be set in a different manner than they are currently. It is crucial to remain flexible in order to accommodate the potential uncertainties of the political environment. Additionally, the regulations regarding to waste taxes are emerging as the new standard. The rules of the utilisation of waste as a resource are becoming increasingly normalised.

RepurposeRide
For RepurposeRide, this means expanding its network. This expansion involves rolling out the service throughout Rotterdam. Not only RepurposeRide employees are used for this, but also employees of the municipality start as bikers. The municipality does not have enough cargo bikes for this expansion, so RepurposeRide’s cargo bikes can be used.

Techonology
With more advanced technology and more employees to work with, a more efficient and optimised on-demand collection system is created. With the use of AI recognition for volume estimation and product categorization, cargo bikes are used to their full potential and trips can be redirected to partners. In parallel with efficiency, more tailor-made solutions for specific neighbourhoods and environmental parks in Rotterdam are being designed and developed as the service expands.

Stakeholder engagement
New circular entrepreneurs, more Wijkhubs and second-hand initiatives are included in the network of RepurposeRide. An integration team of the municipality and RepurposeRide is formed to ensure a smooth transition to managing and running the service alone in the future by the collection department of the municipality.

Behaviour change
There has been an increase in the utilisation of RepurposeRide by citizens, as well as the usage of give-away stores and drop-offs at environmental parks. The market is undergoing a transition from a linear to a circular economy, driven by the growing economic viability of circular enterprise models. The municipality is demonstrating a growing commitment to circular projects in pursuit of sustainability and circularity goals.

Figure 55: Horizon 2

“an efficient transportation service for citizen, collector and stakeholder satisfaction”

Value proposition
In the last horizon it is the goal of having the capacity to design tailor-made solutions for all the needs of specific neighborhoods in Rotterdam. and to expand to other municipalities.

Market
The marrket is fully adapted to circularity. All the environmental parks are headquarters of circular producers and it is even possible to consider a marketplace of materials. The question of who is responsible for the cost of disposal is dependent on the market. It depends whether the citizen or the reuser has to pay for disposal. Materials are becoming scarce and the fact that materials are still worth real money is going to be able to turn this market around.

Rules and regulations
The market is uncertain. Therefore, it is important to remain flexible. It is an uncertain future with changes in the political environment. With the help from organizations as Circulaw the regulations regarding circular practices can be monitored.

RepurposeRide
RepurposeRide has created an on-demand, zero-waste, established network throughout the city to ensure optimal recovery of bulky waste. All the values of the citizens are taken into account, resulting in an efficient and satisfactory waste transport system. This is the handover moment for the municipality of Rotterdam. At this moment of handover, the idea of expanding with electric cars should be considered. Electric cars to increase the number of employees who are willing to work as circular collectors on the cargo bikes. The cargo bike is perfect for small volumes and good weather. In bad weather, a small electric car is needed to ensure the satisfaction of their collectors. Also, the municipality is a social work organisation and needs to create jobs for all kinds of employees.

Techonology
AI is used for estimation of the volume, categorization and route schedulling. It knows the preference lists of the Wijkhubs and take that into account when redirect the items.

Stakeholder engagement
An efficient transportation network requires the involvement of numerous stakeholders. The municipality is assuming responsibility for the service, which has led to the establishment of a foundation. This foundation will facilitate the connection and maintenance of the repurpose-network’s alliances and collaborations. The foundation’s primary objectives are to maintain the collaboration between existing partners and to recruit new partners.

Behaviour change
For citizens, community engagement creates an increase in sustainable waste management habits. The market is better adapted to circular practices because it has become economically viable. The municipality focuses on circularity, not only in Schone Stad, but in the whole municipal service.

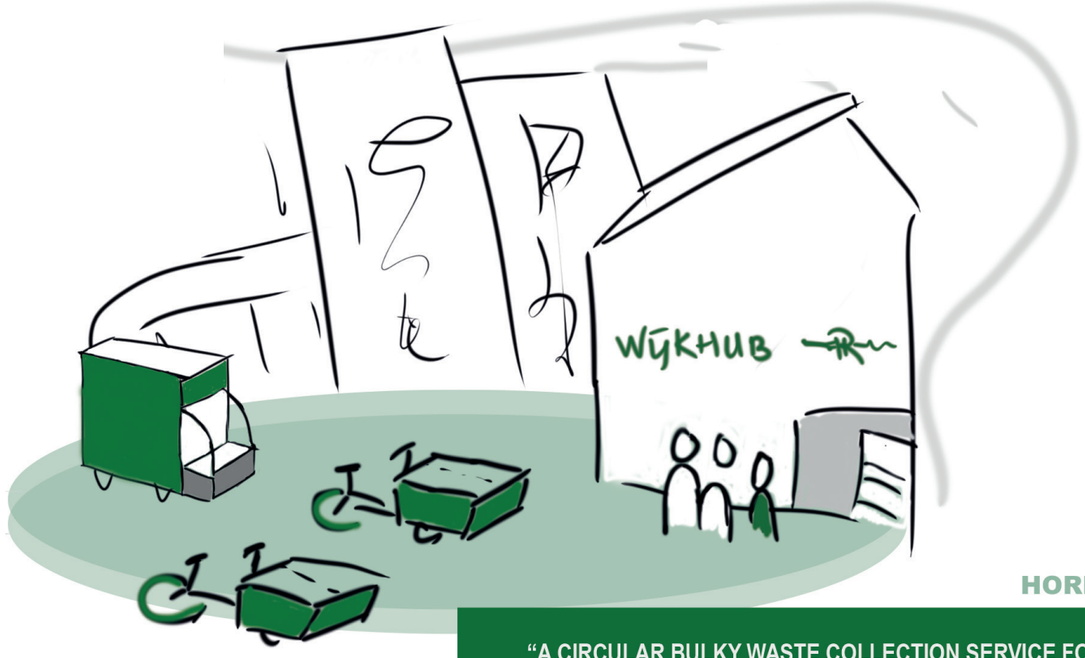
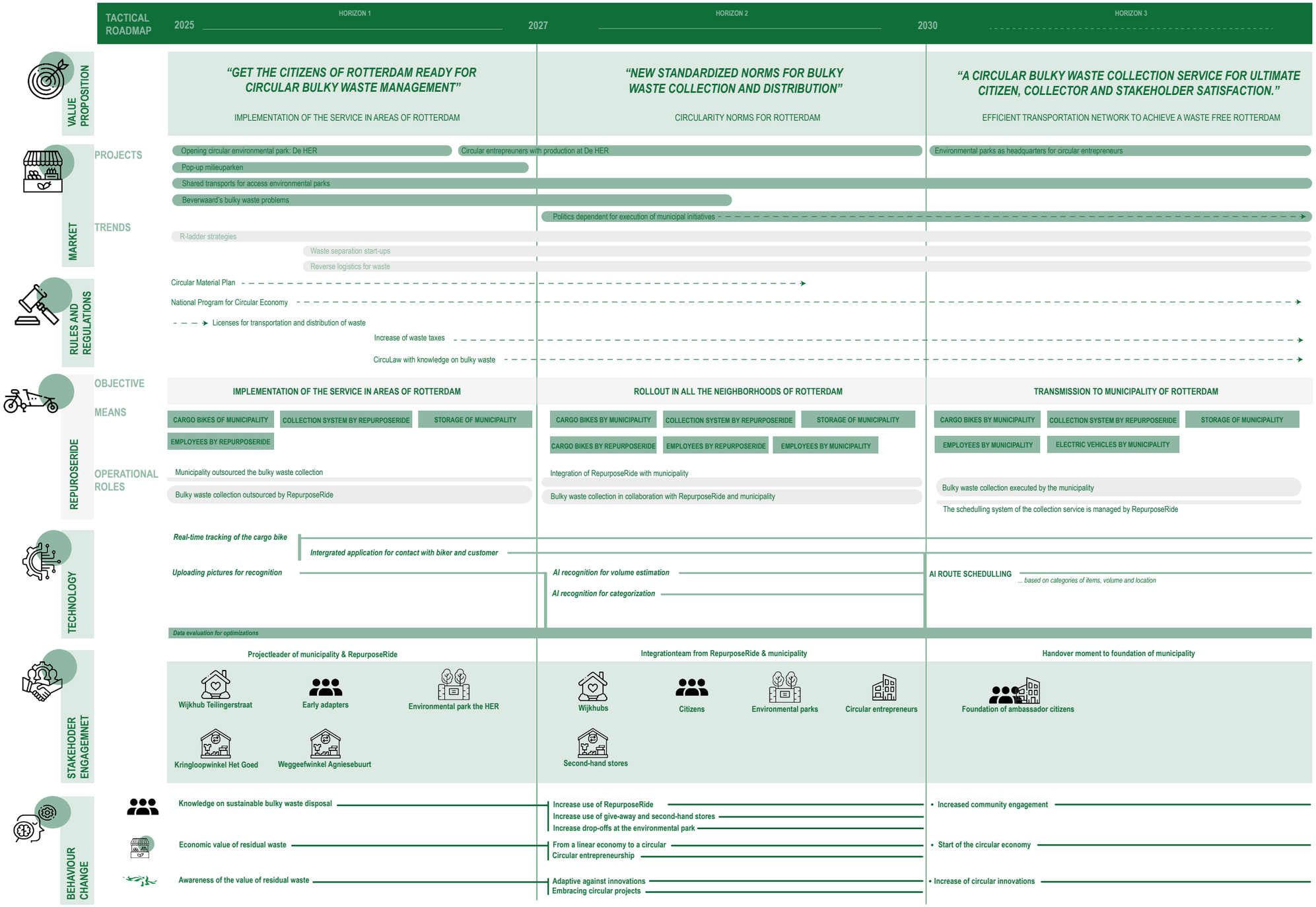


Figure 56: Horizon 3

TACTICAL ROADMAP



2035

REPURPOSE RIDE

X

Gemeente Rotterdam

FUTURE VISION

"A tailor-made transportation network driven by community engagement for optimized value recovery of bulky waste"

WASTE FREE IN 2050

Figure 57: Tactical Roadmap

EVALUATION

The conclusion is based on the results of the project and two evaluation sessions. The first session is with Rorik Viola, a Wijkhub Employee to verify to what extent the Wijkhubs can play the crucial role in the system. The next session is with Rinske van Goslinga, the manager of the Projectbureau. This session has an objective to question to what extent the predefined goals are achieved and what should be done to implement this into the main tasks of Schone Stad.

In the discussion interesting insights, which remain still open after this project, are discussed. The limitations of the project are presented with recommendations for future research.

Conclusion

At the start of this project a problem definition and goals were formulated. A research question was compiled with sub-questions. In this chapter these questions are answered, according to the evaluation sessions and the conclusions of the project.

Who are the current and potential stakeholders in the system and what are their needs and wishes?

The current stakeholders are the citizens of Rotterdam and the municipality of Rotterdam. In the area of waste management, it is Schone Stad, where the Projectbureau is a division working on contributing to innovations for the execution of waste management. The executers of the waste management on the streets are the collectors and the environmental parks. Wijkhubs, second-hand stores, give-away stores and RepurposeRide are potential stakeholders in the system. In the following section the needs and wishes of the stakeholders are presented.

The municipality of Rotterdam

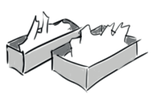
Schone Stad and its Projectbureau wants to reduce the generation of waste. Everything what remains should be separated and high-quality processed.

Citizens

Require convenience, a safe and clean street to live in. They want clear and transparent communication for bulky waste management. Many are motivated when their contribution benefit other citizens in need.

Collectors

They need more knowledge on waste separation and sustainable processes. More practical tools are needed to perform their tasks flawlessly, without much hassle.



Environmental parks

The environmental parks are used to dispose the all the products and materials of the citizens. Due rules and procedures everything must be processed by partners and can not be reused again.

De HER

In 2025 a new environmental park is opening, with a donation part at the park. Reusable products and materials can be donated to circular producers.

Wijkhubs

The Wijkhubs are brought to life to offer accessible contact where citizens can share their stories and ask for help of the muncipality. Wijkhubs want a fine livable society where everyone can live happily together.

External partners

Giveaway stores want access to items suitable for community use and protome social and environmental impact. Thrift shops want access to valueble items for resale.

RepurposeRide

RurposeRide wants to offer an on-demand transportation network to achieve circularity goals of the municipality with the use of community engagement.

How should the municipality of Rotterdam and RepurposeRide position itself in the complex stakeholder context of bulky waste collection?

In Figure 58 the adapted structure of the organization is shown (Mintzberg, 1980). In the future, the municipality will oversee the organization as it is leaded by the Projectbureau in collaboration with a manager of the collection department. The operational core and support staff are employees of the municipality, only RepurposeRide remains for organizing the techonostructure.

The municipality of Rotterdam is positioned as the client of RepurposeRide, with the ability of organizing the service internal over time. RepurposeRide is positioned as a social, tech-transportation start-up enterprise with knowledge on waste separation, optimization through technology and most important: to connect the citizens of the city through circular practices.

"The question of legality arises as to whether this can be carried out within the municipality or by the market. This is because the responsibility for the collection and processing of household waste lies with the municipality. "

(Rinske van Goslinga, Manager of Projectbureau)

It is crucial to acknowledge the significance of this issue. The municipality has ultimate responsibility for ensuring the proper disposal of bulky household waste. The government oversees the process to ensure that it is conducted in an appropriate and satisfactory manner.

Positioning the municipality of Rotterdam

The municipality of Rotterdam should therefore position itself as a waste facilitator and enabler. By fostoring collaboration between citizens, collectors and external partners. The municipality should adopt the leadership role by promoting circularity by setting clear goals and providing logistical supppt through their resources like cargo bikes and storage spaces. Next to that ,they need to support innovation by actively collaborating with RepurpseRide and their suggested partners to enhance the successes of the new system.

Positioning RepurposeRide

For RepurposeRide, it is of importance to ensure that the service is entirely reliable and capable of fulfilling the government's requirements. RepurposeRide will engage as a integrator by bridging gaps between stakeholders, ensuring that all parties' needs are considered in the design and execution in the initial system. They start citizen participation through communication campaigns, framing waste disposal as a form of donation, and fostering trust in the new system. They can provide a tailored service that aligns with the needs and preferences of the municipality.

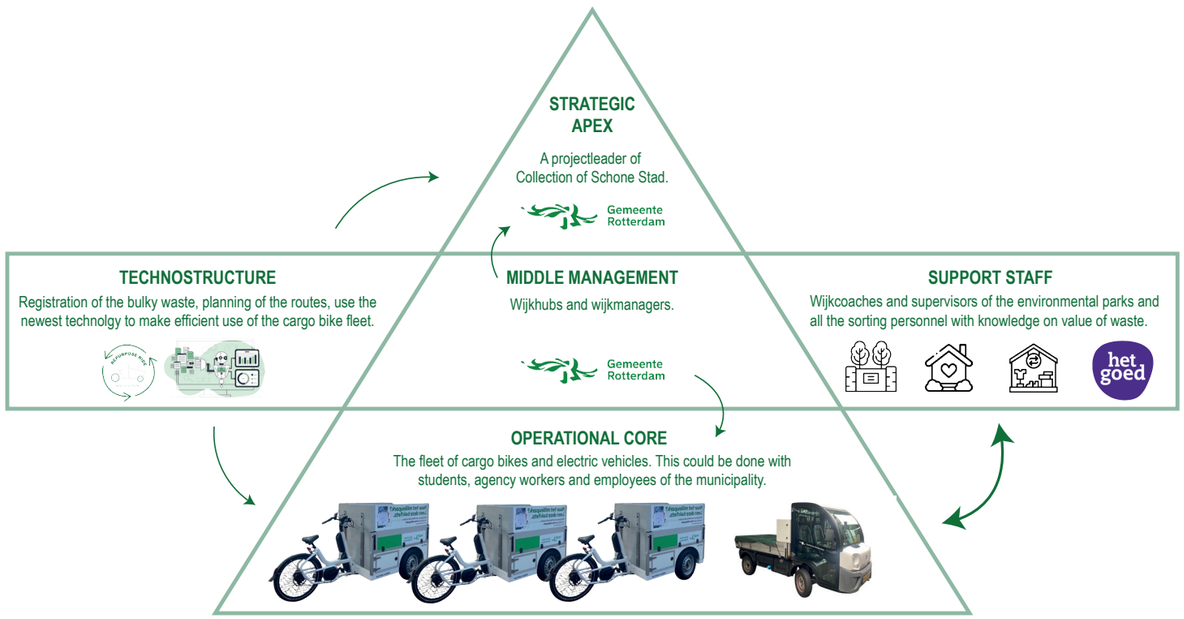


Figure 58: The desired organizational structure of RepurposeRide and the municipality in the future (Mintzberg, 1980)

How can a service system for the reuse of bulky waste be designed and validated?

The issue of bulky waste in Rotterdam was not a problem that could be solved from a behind a desk. With the use of the combination of the Effectuation principles with New Product Development and the participatory design methodologies the issues were researched at street level.

Design phase
In the initial phase of the project, all the insights of research with municipal advisors, observations of the citizens, and conversations with potential partners lead to understanding and prioritizing the needs and preferences of the stakeholders involved. All the insights are combined into the design challenge. The design challenge was the project's primary objective. Three concepts were designed based on accessible means (cargo bikes, Wijkhubs and existing partnerships).

Pilot phase
The pilot was conducted for a period of three weeks to ascertain whether the service was capable of sustaining itself. The three concepts were combined to one testable pilot and were adaptively changed and iterated during the pilot. The participatory methods helped to gather real-time feedback from citizens, me as collector and stakeholders during the pilot. Evaluation resulted in the chosen concpets and a next iteration of the collection service by cargo bike.

Validation phase
The alignment with stakeholders was ensured by pilotting for three weeks and the following validation sessions regarding the outcomes of the final design.

How can the municipality of Rotterdam apply the insights from this project to realize and implement the proposed service system?

The refinements and creation of the final design are communicated through the implementation of a strategic and tactical roadmap. The strategic roadmap provides a tangible representation of the developments that occur over time and offers a clear understanding of the significance of each horizon. The tactical roadmap is more detailed, with roadmap elements to provide a comprehensive guide through the critical steps to achieve the future vision of bulky waste management.

Horizon 1: getting citizens ready for circular bulky waste management
Raise awareness among citizens about the new service and its benefits. RepurposeRide consults the municipality to start the new service up and running. This external assistance is necessary to facilitate the transformation. It is all about building trust by highlighting the reuse potential of items and emphasizing community impact.

Horizon 2: normalization for bulky waste collection and distribution
The service will expand to select neighborhoods. RepurposeRide and the municipality are collaborating closely to expand the network of partners in the neighborhood.

Horizon 3: ultimate citizen, collector and stakeholder satisfaction
The last phase is to embed the service into municipal operations, ensuring it becomes a regular feature of the collection. The department where the service should land is the collection department of Schone Stad. They are responsible of managing the ways of the collection service. The employees of the municipality working for the second-hand store Het Goed, can be used as the categorization employees for redirecting to the partners in the network.

What value does it deliver?

The value of RepurposeRide is to combine social value and environmental impact. The circularity goals of Rotterdam, (waste prevention, waste separation and high-quality processing), are achieved through community engagement. The proposed service has value on multiple levels. In Figure 59 the levels of value are shown in the model of desirability, feasibility and viability.

Environmental value
The first level of value is the environmental impact. The new service prevents valuable materials from being incinerated. This contributes to waste reduction and increase resource recovery. Two of the important goals of the city of Rotterdam.

Social value
The service strengthen community engagement by encouraging reuse and redistribution, especially for your neighbor citizens in need. The system fosters trust and emotional satisfaction among citizens, as they see their contributions making a tangible difference.

Economic value
As a result of the increased number of citizens utilising the Wijkhub for the free products, the municipality is able to reach a demographic that represents a significant financial burden. This approach can result in significant long-term savings. These costs can not be estimated after only one pilot for three weeks but has potential to have viable impact. Although, the new service does not directly creates revenue, through collection fees it can create a financially stable model. Additionally, it already reduces municipal costs by minimizing transportation costs, waste processing and landfill use.

Operational value
The operational efficiency is improved for the collectors. The applications used will be integrated and managed by RepurposeRide. This gives the municipality the time to improve their own logistical efficiency and prepare the for the change.

Comparison with competitors.
To distinguish RepurposeRide from its competitors an comparison with ByeWaste and Spullenbak has been carried out. ByeWaste and Spullenbak have a systematic approach and specification of the collection of items.
Spullenbak provides consumers a container for the storage of specific items for disposal. The container is send to the house of the individual. Once the container is full or the consumer wishes for the box to be emptied, an appointment with the collection service can be scheduled. Subsequently, the items are redirected to partners in their network for reuse and recycling. Byewaste is responsible for the collection of unwanted items from the consumer's house and subsequent delivery to one of their designated partners. Only products can be put in the box that can be reused by one of their partners. It is the responsibility from the individual to place the items in a box and place the provided stickers in a manner that clearly identifies what is in the box. Subsequently, the items are transferred to the partners for further utilization.

The distinguishing feature of RepurposeRide is that it accepts all types of materials. This includes items that would otherwise be destined for the environmental park. This eliminates the necessity for targeted collection and dedicated space within the home. RepurposeRide wants to combine the wanted convenience of the citizens with the requirements of the collection service of the municipality.

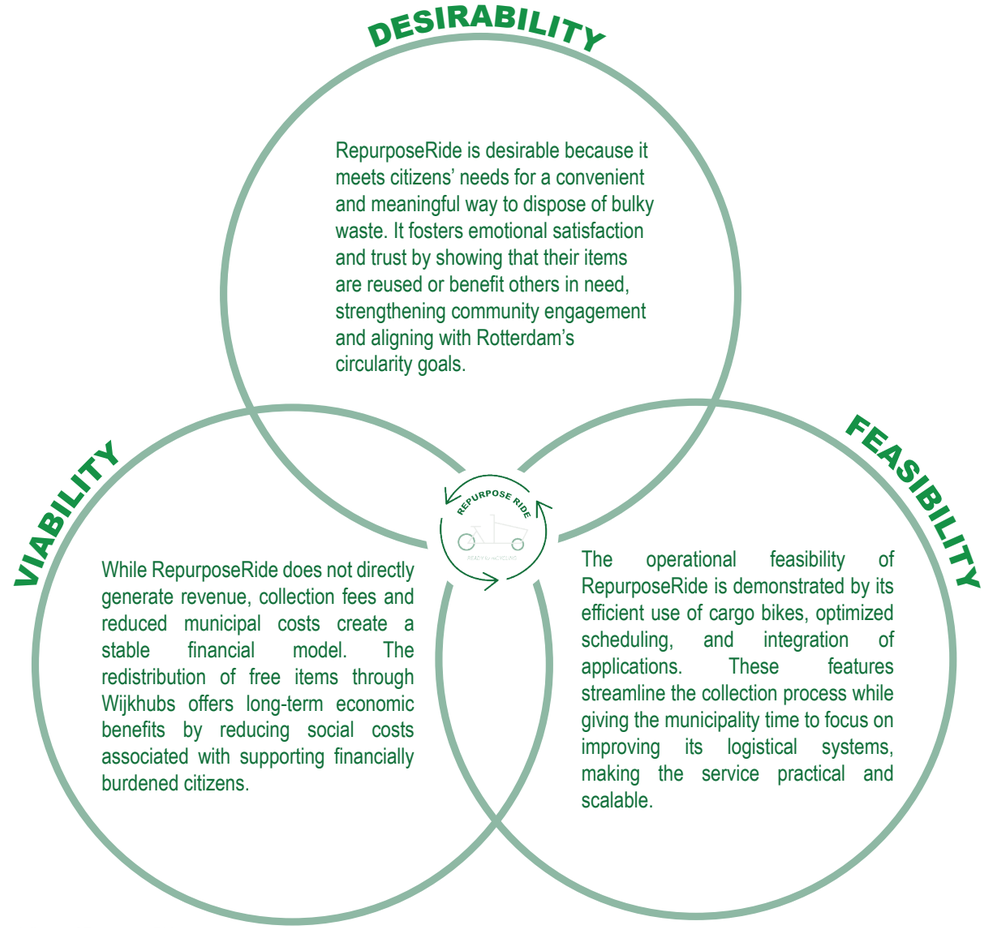


Figure 59: Value delivery of RepurposeRide

Responsibility of Wijkhubs

Some Wijkhubs, especially the one at the Teilingerstraat, aims to expand their swap/give-away corner, where you can take products for free, because of its success.

"Since the use of swap and give-away initiative, a lot more citizens stop by and come inside. This has lead to more engagement with the citizens in the neighborhood and knowledge of what happens in their lifes. We are better able to help them."

(Rorik Viola, Wijkhub employee)

The role of the Wijkhub will increase during the implementation of the service. It is even possible to work with wish lists to better meet the needs of citizens. As a give-away store and meeting point, the Wijkhub attracts more cititzens and strengthens social cohesion. By connecting citizens with items and involving neighborhood coaches, the Wijkhub helps bridge the gap between rich and poor. With initiatives such as delivering items via RepurposeRide instead of vouchers, the Wijkhub provides practical and social support. This also contributes to long-term cost savings.

Emotional attatchment

It was concluded that citizens' emotional attachment to their belongings is higher than previously imagined. Many items are stored in rarely accessed parts of the house, often remaining untouched for years—sometimes over a decade. These products, kept with the thought that they might be used someday, often lose their value over time. Clothes go out of fashion, electrical devices stop working, and these items eventually end up discarded as waste. This "just in case" mindset becomes a stay of execution for the items. The research of Kréziak et al. highlighted the dimensions that affect the decision to keep or dispose an item (2020). It is concluded that attachment to the object can hinder its recirculation, leading to retention after replacement and disposal. Although my pilot indeed indicated that emotional attachment to products may hinder recirculation. The pilot resulted in controversial outcomes, when it was evident that citizens were willing to donate their products if it would be distributed to those in need. In Figure 60 this lifespan expansion is visually presented how this could be integrated with the knowledge of this research.

The service offered during the pilot acted as a trigger for citizens to donate these unused items, knowing they would be passed on to citizens who truly need them. This not only extended the lifespan of these products but also reduced the demand for new purchases, conserving the raw materials that would have been required for manufacturing these items. By simplifying the donation process, RepurposeRide enabled items that were gathering dust in attics or storage spaces to be reused, preventing them from becoming obsolete or contributing to residual waste.

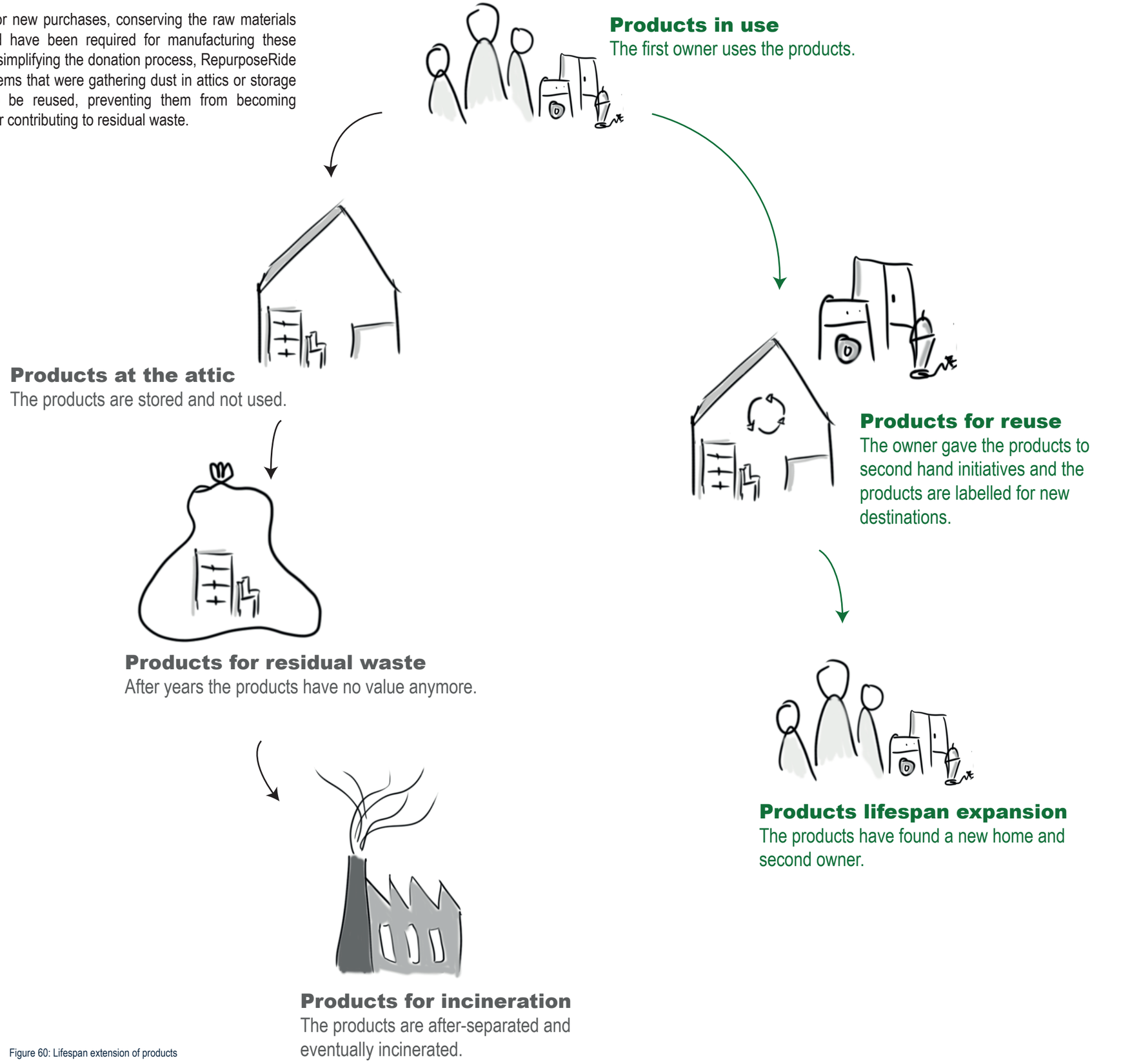


Figure 60: Lifespan extension of products

Discussion

My chosen approach, the use of Effectuation combined with New Product Development (NPD), proved to be very useful to come to a desirable result. This method directly empowered the design process, providing practical insights how to make effectively use of participatory design. Effectuation, with its focus on the definition of your means, goals and leveraging on your network, complemented by the emphasis of participatory design, it was possible to engage stakeholders and do the research at the level of direct action. Together, these methods created a basis of knowledge that allowed for adjusting to needs and wishes of the key stakeholders. This approach resulted in the creation of a new enterprise, validated by the users of the future. Without the combined method of NPD with an entrepreneurial mindset, many steps were taken differently, and the result were not that effectively tested with the future clients.

Secondly, the NPD process was used in this project to provide structural coherence and clear guidance for the thesis. This was perceived as a highly effective approach, the combination helped to use the core Effectuation principles while remaining bounded with the use of a linear method. This is particularly beneficial for projects with a clear start and finish, as my graduation project. A linear framework keeps the project on track and simplifies reporting. This structured approach is recommended for similar time-bound projects, as it balances the flexibility needed for entrepreneurial insights with stage-gate choices. Although, the linear method was used with opportunistic elements, Sarasvathy argued that there is no order in Effectuation. However, within these boundaries, Effectuation has been integrated and applied in a way that resulted in a desirable and validated new enterprise.

At last, working from inside the municipality, as an entrepreneur gave certain privileges. For example, the use of certain means, knowledge and the contacts. If somebody from outside the municipality had been given the same task, the Effectual principles should be used in a more intense way. The use of available networks and the chance of running a pilot with municipal resources, had required a lot of more effort.

Limitations

The research is reliable and viable, but it has certain limitations. These will be presented in the following section.

Differences in research areas

The research area was very diverse: Beverwaard, representing the lower-income section of Rotterdam. Rotterdam Noord, a mix of demographics and on a distance from the environmental parks. Finally, Hillegersberg-Schiebroek, which had voluntary participation in the pilot and included citizens eager to adopt a circular approach and already take extra steps toward sustainability.

A broad perspective was applied across all of Rotterdam, providing insights that do not necessarily require an immediate city-wide solution. Instead, this approach was the start of the insights that tailor-made solutions were needed for the desired behaviour change, where the solution can organically spread to other areas if it proves effective.

Utilization of voluntary participants

The final design is validated with voluntary registered participants. It is possible that the participants were already biased and positive toward circular and sustainable solutions for bulky waste.

Subjective perception of the collection

The perceived convenience for the collector is based on my experience. This is an example of a subjective approach to the concept of attractiveness. If I define myself as an athletic, intelligent and flexible person, it is likely that I have experienced situations that cause stress in an average person, whereas in the study, this was not the case.

Translation of the roadmap for the municipality

It is evident that the municipality should start with an examination of the significance of the proposed steps outlined in the roadmap. It is needed to make a translation of the existing roadmap to align it with the adapted plan, where the municipality is positioned at the forefront of implementation. Otherwise, it could be considered to provide additional financial assistance to start-ups like ByeWaste and establishing further contractual obligations for them to fulfill in order to ensure success.

Recommendations

Throughout the project, there were numerous lessons learned that I would recommend to my future self. These recommendations apply to both the successes and challenges encountered during the process, and offer strategies to improve the project goals. By reflecting on these experiences, I aim to provide continuous learning and improvement.

Network of entrepreneurs

Develop a plan to identify circular entrepreneurs, engage them through targeted outreach and events, and connect them within the network.

Choice between compactor truck and cargo bike

To gain further insight into the probability of citizens selecting the cargo bike or compactor truck, a stated-choice experiment could be conducted. The findings of this study could inform conclusions regarding the likelihood of the cargo bike being selected over the truck.

Definition of bulky waste

The by-product of this study is the definition of bulky waste. When the term was not used, but products or materials were specified, it became much more attractive to also hand in products (which may or may not worked) instead of leaving them in the attic forever. Bulky waste is defined as rubble, renovation and moving waste. Modifying this definition could clarify a great deal for citizens.

Estimation of costs and waste reduction

Estimation of the the detailed costs of RepurposeRide in comparison with the current collection system. There were already significant opportunities for cost savings revealed in this thesis. However this was based on an estimation. To draw reliable conclusions a more extensive cost calculation should be made.

The same applies for the waste reduction. It is not possible to draw conclusions because it is not comparable. Besides, the real effects will only be measurable after a few years.

Feeling of shame

Another by-product of this thesis was the feeling of shame by a lot of citizens stopping by the Wijkhub. There is often a sense of embarrassment or hesitation when people need to ask for products they need, especially if they cannot afford them. Addressing this issue and creating a system that normalizes the act of asking for or receiving donated items can help reduce this stigma and make the process more inclusive and accessible for everyone.

CHAPTER CONCLUSION

6.1 How is the circular collection system implemented for the municipality of Rotterdam?

Implementation is communicated through a strategic and tactical roadmap. The strategic roadmap provides a tangible representation of the developments that will occur over time and provides a clear understanding of each phase. The first phase is to prepare the citizens for the circular services of the municipality. The second phase is to extend these normalities, and the last phase is to create ultimate satisfaction with the new service. The tactical roadmap explains this in more detail. The roadmap elements provide a guide to the steps necessary to achieve the future vision of the service system.

RepurposeRide is implemented according a strategic and tactical roadmap. On these roadmaps the crucial steps are plotted against the time. With the use of the roadmaps the important stakeholders, trends and developments of the collabortation between RepurposeRide and the municipality are defined. By following the indicated horizons, the goals will be achieved.

6.2 To what extent are the initial project goals achieved, and what limitations are present in this research?

The initial goals of the project were significantly achieved, as evidenced by the pilot outcomes and evaluation sessions. Key stakeholders, including citizens, municipal advisors, and Wijkhub employees, validated the proposed service system's potential. The pilot demonstrated that RepurposeRide can reduce waste, improve reuse, and foster community engagement, contributing to Rotterdam's circularity goals.

The service successfully prevented valuable materials from being incinerated by redirecting them for reuse and high-quality processing, aligning with Rotterdam's goals of waste prevention and resource recovery. Simultaneously, it strengthened community engagement, as citizens expressed satisfaction in knowing their contributions would benefit others, particularly those in need. This fostered trust in the system and increased interaction at Wijkhubs, reinforcing their role as community hubs. Operationally, the pilot validated the feasibility of using cargo bikes, identifying efficiencies such as improved scheduling and route optimization, and demonstrating RepurposeRide's capability to integrate seamlessly into existing municipal logistics.

Despite the successes, several limitations were identified.

- The research included neighborhoods with varying demographics and behaviors, making it ideal to draw city-wide conclusions, but not all conclusions apply to every neighborhood. Tailored approaches are necessary for different areas.
- Participants were self-selected and may already have had a positive attitude toward sustainability, potentially biasing the results.
- Operational efficiency was partly based on personal experience, which may not reflect the average collector's challenges.
- The three-week pilot provided valuable insights but was insufficient to measure long-term impacts, such as cost savings and waste reduction.

PERSONAL REFLECTION

Reflecting on the biggest project in my life so far: my graduation project. I realize how much I have grown, both personally and professionally. This reflection is just a snapshot of the first things that come into my mind. However, this project has taught me way more than Effectuation, working alone, stakeholder management and the hands-on pilot.

Effectuation

This project was my first introduction to the method of Effectuation. A method grounded in entrepreneurship and I had never learned how to work with during my time at the Faculty of Industrial Design Engineering. It challenged me to learn from uncertainty, focus on what I could achieve with the means at hand. This entrepreneurial mindset gave freedom for iterative design which leaded to a lot of adaptation along the way. I would be lying if I said I did not struggle with Effectuation. During the first weeks and up until the Midterm, I felt like I was drowning and lacked the tools to navigate this approach. With Sander's guidance, the principles of Effectuation were combined with the NPD process, which I was familiar with. This provided me with the necessary tools to effectively apply the method. In the end, I am truly proud of what I accomplished, and the methodology has opened my eyes to a new way of thinking.

Working alone

Working on a project entirely on my own was a challenge in itself. I had no teammates to brainstorm or share the workload with, which sometimes made the process feel overwhelming. On top of that, personal circumstances throughout the entire project created setbacks, I had taken this into account in the planning. Despite this, I managed to find my way forward, with the help and space from my supervisory team. This past seven months taught me a lot about balancing work and life, and how to prioritize without losing sight of my goals.

Stakeholder management

The municipality of Rotterdam is an enormous organization with own set goals and way of working. Next, I had to ensure my project aligned with academic requirements of the TU Delft. Last but not least, I used a citizen-centered perspective and included a lot of stakeholder in my research and design.This made the project much more complicated to balance. Balancing the needs of the all stakeholders was challenging, as their needs were not always aligned. However, this experience taught me how to prioritize, structure my approach, communicate effectively.

The pilot on the cargo bike

One of the most exiting aspects of this project was the pilot using the cargo bike. It was hands-on, adaptive, and sometimes (most of the time) messy, but it was an experience I will never forget. Unlike the traditional co-creation sessions and brainstorming marathons I was familiar with, this project required a '*just do it*' mentality. From logistical challenges to engage directly with citizens in the neighborhood. It was all about getting things done and learning by doing. It showed me the power of taking action and to accept that you can not plan everything. I showed myself I am adaptive enough to figure things out along the way.

Now, this project became more than just a thesis. I have learned so much more than I can think of right now. If you ask me to write this reflection again over two years it will be filled with things I do not know right now. With a big smile on my face, I am closing this thesis and looking forward to what the future holds. This project taught me that an uncertain future demands adaptability, a skill I have truly developed along the way.

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