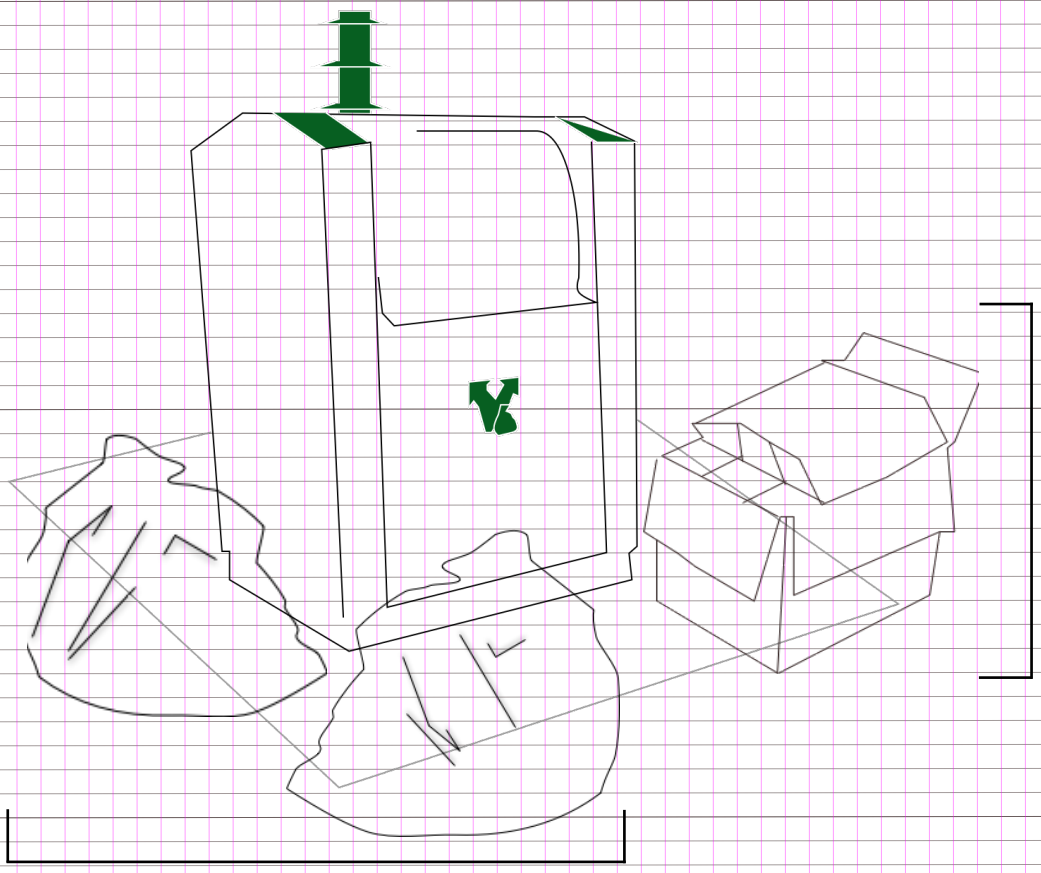
Waste Misplaced

an exploratory study on waste disposed around semi-underground waste containers in relation to the socio-geographical characteristics of four residential areas in Amsterdam.



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Graduation thesis, 2022
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Abstract. Litter disposed next to semi-underground waste containers is a problem many municipalities are dealing with, and is caused by either physical problems or behavioural factors. Various studies have examined the effects of socio-economic factors in relation to waste generation, as they are of significant influence on the quantity and composition of household waste in general. However, there is a lack of existing research addressing the social dimensions of particular areas regarding the problem of waste surrounding these containers. The main objective of this study is to include the socio-geographical characteristics of a residential area to provide more context on the waste disposed around semi-underground waste containers. Waste was observed in four residential areas in the city of Amsterdam in an exploratory qualitative manner, using inductive structured observations. The data shows that most waste was found around vacant, functioning containers and in districts with a lower average household income.

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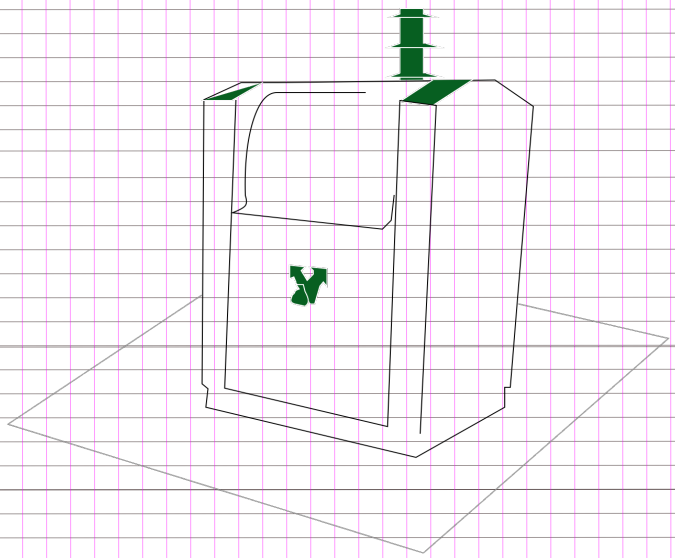
Foreword

As the containers in front of my apartment were surrounded by waste most of the time (for no obvious reason, like being full), the idea to study the waste deposited around the semi-underground waste containers was born out of frustration. Reading about the different tactics that municipalities use to solve this problem not only sparked my interest, but also made me realise that hardly anything has been written about the waste itself and differences between locations.

Now, a few months later, I have cycled, observed, photographed and described many waste items and different environments. I believe this active collection of data and bottom up approach has given me the opportunity to engage myself with this problem and explain the importance of studying this as it has led to the generation of new research questions and approaches that might provide us with more context, important if we want to gain a better understanding of this problem. I hope with this thesis I have shown that understanding the problem can lead to more effective ways to approach it.



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1. Introduction

1.1 The effects of waste

In the Netherlands, most cities have semi-underground waste containers where residents can easily dispose of their household waste, glass and paper. Additionally, city councils offer its residents various ways to get rid of bulk waste by either making an appointment, going to a recycling centre or even a fixed moment each week where people can place their bulk waste in designated areas. Although these services are available to everyone, residual waste is often found outside or directly next to these containers. In Dutch this is known as *bijplaatsingen*, a problem that many municipalities are dealing with.

Research by the municipality of Amsterdam (Gemeente Amsterdam et al., 2022) shows that litter and contamination of public spaces throughout the city is one of the most frequently mentioned factors causing dissatisfaction and nuisance amongst residents in Amsterdam. Despite this frustration and the possible fine that residents may incur if they dispose of their waste in the wrong way, there are locations in the city where waste is illegally deposited around waste containers on a daily basis (Gemeente Amsterdam & Ivens, 2021). Waste surrounding containers also leads to more vermin, unpleasant odours, has direct effects on the environment and our health and leads to higher costs due to extra operations on clearing, processing, reporting and preventing this behaviour (Dijksterhuis & Van Baaren et al., 2010).

1.2 Current initiatives

Various strategies are applied by the municipality of Amsterdam in attempts to tackle the problem. In each district, information on specific container locations is gathered and forms a dataset that is used to alter the frequency of emptying containers or resolve obstructions. Residents are able to report to the maintenance service when a container is full or stuck or if the area around the container is polluted. Additionally, waste containers can be *adopted* by residents. Adopting a container means taking care of it by keeping the container and the surrounding area clean, getting rid of the waste that is placed around it or reporting it to the designated clean-up service of the city's maintenance team. The containers that have been adopted are occasionally part of a project that aims on reducing the amount of waste that is deposited around the waste container by influencing behaviour through placing encircling planters or artificial grass mats around the waste containers (Dijksterhuis et al., 2018).

1.3 Theoretical background

SenterNovem (2009), an agency of the Ministry of Economic Affairs, reported that the reasons why people discard their waste around containers can be divided into four main factors: personal factors, social environment, waste location and the collection system and service. Research by Dijksterhuis and Van Baaren et al. (2010), showed that the amount of waste placed around the containers was significantly higher and observed more frequently around defective and full containers even though surrounding containers are rarely more than one block away. Dur and Vollaard (2014; 2015), argued that when bulk waste is placed before the permitted or scheduled timeframe, this occurs because people do not want to store their waste in their homes for a few days and showed that when municipalities reduce public cleaning services, people start to clean up after themselves.

Previous studies regarding the personal factors and effects of the social environment have shown that an environment polluted by litter is prone to attract more waste that is disposed of incorrectly, as it lowers standards and influences norm-violating and normative behaviours (Cialdini et al., 1990; Kallgren, Reno & Cialdini, 2000; Keizer et al., 2008). This confirms the broken windows theory, which implies that more serious violations are prevented when visible signs of disorder are removed (Wilson & Kelling, 1982). When litter is observed by residents, the concern for social sanctions is reduced as people presume it is tolerated by authorities (Kahan, 1997).

The composition and quantity of household waste that is generated are influenced by the demographic and socio-economic factors of a residential area (Wertz, 1976; Grossmann et al., 1974; van Beukering et al., 1999). However, these studies did not address the role these factors play in the amounts and types of waste that are (wrongly) disposed per neighbourhood or region. Education level, household composition and average household income have been found to increase waste generation, as, for example, higher education is often associated with higher income levels affecting consumption patterns (Collins & Downes, 1997; Kayode & Omole, 2011; Khadka et al., 2020). Although higher education is associated with higher recycling rates, this does not have a significant effect on the amount of waste generated (Jenkins et al., 2003; Ferrara & Missios, 2005). However, the study by Trang et al., (2017) concluded that the districts with a higher average income contained less waste. This information is essential for a favourable waste management strategy as these studies have shown that waste generation is strongly influenced by the social dimensions of a residential area and thus, also play a role in the waste that is disposed per neighbourhood or region (Bandara et al., 2007).

1.4 Research questions

I was curious to see whether there is a relation between the types and amounts of waste deposited around the semi-underground waste container and the neighbourhood in which the waste is disposed. In doing so, this paper is divided into two parts: an exploratory phase where the emphasis is on the composition and amount of litter placed around the containers and a second phase where I have compared these findings to the social factors of four specific residential areas in the city of Amsterdam. The paper therefore has two research questions:

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1) *"What can we learn from identifying and mapping the types, composition and amount of waste that is found around the semi-underground waste containers?"*

2) *"Can adding more socio-geographical context give us more insights into the composition and amount of waste deposited next to the semi-underground waste containers?"*

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2. Methods

I chose to conduct inductive, structured observations (Bryman, 2012, p. 270) during the exploratory phase of this research, as it allowed me to first explore patterns and then move to theory. The data gathered during these observations were analysed using Thematic Analysis (Bryman, 2012, p. 578): an iterative, flexible, qualitative research method that fits the broad scope of this exploratory research considering new hypotheses and theories are generated throughout systematically collected data and analysis. These qualitative research approaches enabled me to identify patterns of litter, and might provide us with indications and expectations on future research.

2.1 Data collection

To examine whether the waste disposed around waste containers differs per residential area, four districts were selected as loci of observation, as they differ in socio-geographic factors such as income; household composition; education levels; and are located in opposite parts of the city. Amsterdam Oud-Zuid, located south from the centre, was selected as it is one of the most affluent, highly educated districts in the city that has more people with children in comparison to the rest of the city (Gemeente Amsterdam, n.d.-c). Here, container clusters at Emmaplein, the Prins Hendriklaan and the Alexander Boersstraat were observed. Osdorp, located in Nieuw-West, a more peripheral area, was chosen because in contrast with Oud-Zuid, they have a lower socioeconomic score and have more residents that are highly educated (Gemeente Amsterdam, n.d.-a). In Osdorp, the Martini van Geffenstraat, Wolbrantskerkweg, Ekingenstraat, Jan Smitstraat and Opmerkzaam were observed. The Indische Buurt in the eastern part of Amsterdam was chosen because it is known for its many cultures and involved community (Sakızlıoğlu & Lees, 2020). Here, three container clusters located at the Riouwstraat were observed. Lastly, containers at the Spadinalaan, Monnikskapweg and the Mt. Lincolnweg were observed at the Noordelijke IJ-oevers-West, included in the observations as it is a newly developed area across the IJ-river, where new communities and networks are still arising (Lange & Waal, 2018, p. 283).

I chose to observe these locations by bicycle (Figure 4) to immerse myself within the data and experience the differences of the geographical patterns between the districts for myself. By cycling the route of approximately 40 kilometres, three times a week, I was able to create a sense of place by observing the rhythms of a place and its inhabitants. Seeing how residents navigate through their neighbourhood, how they appropriate a place and whether there are peak or off-peak times in terms of the waste containers has helped to build a picture of the locations visited. I was able to see how the waste, atmospheres, people, surroundings, shops, diners and even the smells changed as I cycled along the route.

Ultimately, the data set consists of 18 container locations that have each been visited twelve times from March 24th until May 2nd. The average time spent on observations throughout the entire bicycle route is 3,5 hours each time. All waste items that were placed in a two-metre radius around the container were counted per colli (i.e. one liftable unit), described and photographed (a sample of the memos can be found in appendix A).

2.2 Method of analysis

I chose to conduct Thematic Analysis (TA), as it enabled me to identify themes and patterns iteratively (Bryman, 2012, p. 578). As there are various approaches to TA, I followed the approach proposed by Braun and Clarke (2012), which includes six phases: *familiarisation, coding, generating themes, reviewing themes, defining and naming themes,* and *writing up*.

In the first *familiarisation* phase, I immersed myself with the data by making a selection of the 908 photos taken in total (including a number of duplicates and locations that caught my eye along the way). A selection of 319 photos provide an overview of the waste found during the observations (Figure 1).

Secondly, I decided to add the street name, date and time to the photographs; print and cut them in the same size to be able to physically categorise and sort them in the *coding* phase (Figure 2, 3). I allowed myself to play with sorting and filtering the photographed waste by sticking them to the wall and exploring important features, taking the following questions into consideration, proposed by Lofland and Lofland (1994): *"What kinds of data (waste items) are there?; To what (general) category does this waste item belong?; What does this item represent?; What is happening at the container location?"*. This enabled me to go through different variations of categories and really submerge myself into the data.

All photographs were sorted per district and specific container location for the obvious reasons to explore whether there are differences between the locations. Afterwards, I sorted all photographs chronologically, to see whether I could explore differences between the amount of waste found per day, for example if this is related to the days the waste is cleared by maintenance teams. Subsequently, I selected all photographs that did not have any waste around the containers to be able to see what locations had the least waste. Lastly, all photographs where waste was observed were categorised (i.e. cardboard and paper; mattresses; garden and yard trimming) and stuck together per location. This allowed me to *develop and review themes* that evolved after these categorisations. During the generation of themes, I used some of the recommendations proposed by Ryan and Bernard (2003) and looked for: *repetitions (recurring items); transitions (between container clusters and districts) and similarities and differences (of waste items, compositions and amounts).*

In the final phase, I decided on one particular way to sort the photographs on the wall in my living room (per location and category), which gave me the clearest overview and allowed me to compare the data (see Figure 5) by *refining, defining and naming the themes*. This helped me to determine the cope of each category and theme. Additionally, all littered items, dates, locations and times have been kept in a table to provide myself with another way of making comparisons and can be found in Appendix B. The final phase described by Braun and Clarke (2012), *"writing up"*, can be found in the next chapter where I analyse and compare the data to the socio-geographical characteristics of the visited locations and describe the findings in context of the proposed research questions.

Figure 1: sample of selected photographs

Figure 2 & 3: coding phase

Figure 4: my bycicle

Figure 5: photographs sorted on wall

3. Results

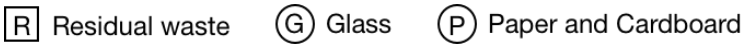
In the process of mapping the waste, I chose to do so along the themes that emerged from the Thematic Analysis: (1) quantity of waste, (2) composition of waste, (3) the functioning and physical state of the container. These themes helped me get a better understanding of the litter itself and allowed me to go into the first research question: *"What can we learn from identifying and mapping the types, composition and amount of waste that is found around the semi-underground waste containers?"*. In section 3.2 I will include the socio-geographical characteristics of the residential areas to provide more context to this trichotomy and attempt to answer the second research question: *"Can adding more socio-geographical context give us more insights into the composition and amount of waste deposited next to the semi-underground waste containers?"*.

3.1 Mapping litter

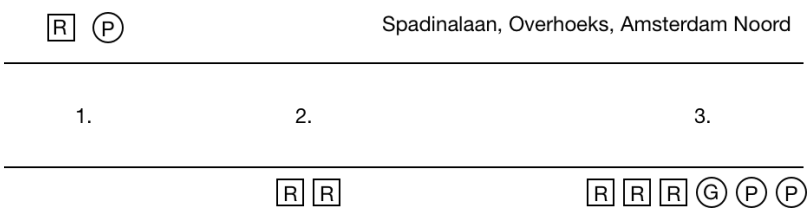
3.1.1 Quantity of litter

The container locations that were surrounded with waste most frequently also counted the highest quantities. For example, at the Martini van Geffenstraat in Osdorp, litter was found around the containers on every visit, and is the location where the highest quantity of litter was found (271 colli). In comparison, at the Prins Hendriklaan in Oud-Zuid only 11 items of waste were found in two out of twelve visits. Additionally, the container locations have once been visited in a sequence of two days to be able to compare the amounts of waste. An increase of the quantity of waste on the second day visit was mostly the case in Osdorp, for example at the Martini van Geffenstraat, the amount of litter increased from three to seven colli when visiting on the 5th and 6th of April, the Wolbrantskerkweg had an increase of waste from Wednesday 20th April, when there was 26 colli, and the next day the waste had increased to a number of 41. These findings are coherent with previous research that has shown that a polluted environment is prone to attract more litter (Kallgren, Reno & Cialdini, 2000; Keizer et al, 2008; Wilson & Kelling, 1982).

Some locations in this research contain multiple container clusters located in one street. As I noticed differences in the quantity of waste between these clusters during my observation, I decided to map the differences, as they might provide valuable insights. To do so, I chose to observe three container clusters in the Indische Buurt (Riouwstraat), three container clusters at the Spadinalaan in Amsterdam Noord and two container clusters in Osdorp. The differences found at the same locations will be illustrated below:



Total amount of waste found at the Spadinalaan, Amsterdam Noord:

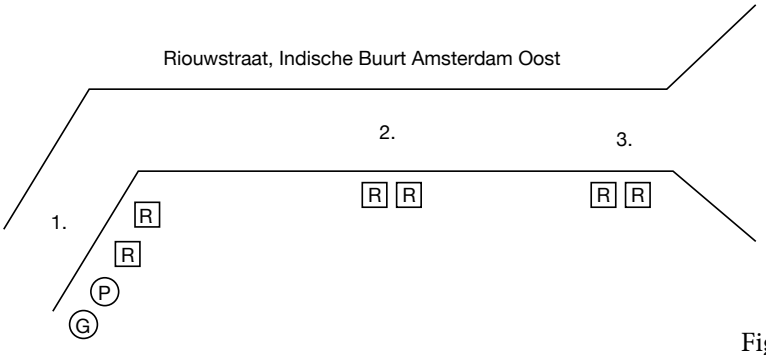


Cluster 1: 3 colli
Cluster 2: 27 colli
Cluster 3: 44 colli

Figure 6: Clusters Spadinalaan

The increase in colli at the third cluster at the Spadinalaan could be explained because it contains every kind of container (glass; paper; residual waste) and as there are six containers in a row, serving more households.

Total amount of waste found at the Riouwstraat, Amsterdam Oost:



Cluster 1: 43 colli
Cluster 2: 38 colli
Cluster 3: 132 colli

Figure 7: Clusters Riouwstraat

The third container cluster is located at a busy crossing point, as it leads to the Javastraat, where all shops are located and the Insulindeweg, a road connecting the neighbourhood to other parts of the city. To see whether this might be of influence on the amount of waste deposited around the containers, it would be interesting to investigate the effects of the container location in the future.

Total amount of waste found at Opmerkzaam, Amsterdam Nieuw-West:

Cluster 1: 43 colli
Cluster 2: 4 colli

Figure 8: Clusters Opmerkzaam

At Opmerkzaam, most waste was found at the first cluster. A reason could be that the first cluster consists of only residual waste instead of cluster two that consists of a paper and glass container. I will further elaborate on this in section 4.1.3 where I discuss the functioning and physical state of the semi-underground waste containers.

3.1.2 Composition and categories of litter

By coding all waste photographed during the observations; an additional spreadsheet helped me keep an overview of the ongoing list of waste deposited around the containers (see Appendix B); together with previous literature (Afon & Okewole, 2007; Dur & Vollaard, 2012; Tsai et al., 2019) the following categories emerged: *Clean state; residual waste; paper and cardboard; household appliances; furniture; mattresses; home improvement materials; yard trimmings and plants; other*. *Residual waste* is used to describe everyday (waste)items like bin bags; plastic bags; foil; food scraps. *Paper and cardboard* needs no further explanation. I expected to find these two categories more than they appeared, as they are items we come across everyday which could imply waste that fits these categories are produced in higher quantities even though residual waste and paper and cardboard have assigned containers where this can be disposed of. *Other* consists of things like shopping baskets and carts; tires; cloths and crates and was found most (114 times), and can be explained as it includes all waste that did not belong in any of the categories or were not observed often enough to dedicate a new category to. The list of *other* waste items can be found in Appendix C.

Additionally, the composition of waste was divided into the following categories: destined and undestined waste (items that do not belong in the containers), as this was helpful to get an overview of, for example, how often waste is deposited that could have been deposited into the containers or should have been deposited as bulk waste. Of all waste items listed, 105 were destined, which means the waste could have been deposited into the containers. Out of 336 undestined waste items, it consisted of bulk waste 116 times.

Cleaning and Household appliances	52
Furniture	78
Home improvement materials	70
Mattress	11
Other	114
Paper and Cardboard	64
Residual waste	47
Yard trimmings and plants	9

Figure 9: overview of waste categories

3.1.3 Functioning and physical state of the semi-underground waste containers

The functioning, accessibility, cleanliness, the condition of the pavement and communication on the containers have been taken into account to see whether it could have any effect on the waste that is deposited around the containers. Research by Dijksterhuis en Van Baaren et al. (2010) has shown a significant difference between the frequency and amount of waste that was observed around waste containers that were full or not functioning. Thus, it was expected to find higher quantities of waste around containers that were either full or defective. During all observations, a container for residual waste has only been full once and the paper waste containers were full 14 times (10 times in Osdorp, 4 in Noordelijke IJ-oevers-West) often this resulted in more waste designated for the full container deposited around the containers, however, more data is needed to see whether this also has an influence on other types of waste.

In Osdorp, the pavement and the containers at Martini van Geffenstraat were the most polluted during all the visits, with a lot of bird droppings on the lids of the containers and stains on the pavement from the waste placed next to the containers. Here, waste was found during all visits and contained the highest quantities of waste. All visited containers were accessible with no marks of vandalism like graffiti or damage that could affect the behaviour of people and have a negative influence on the amount of waste that is deposited next to the container. Additionally, all communication on the containers, the stickers that tell one not to place their waste next to the containers, were visible and clean. A photographic overview of the surroundings is provided in Appendix D. More data is needed to further explore the effects of contaminated containers(surroundings), as this is important to better understand the problem of waste disposal and create better solutions.

3.2 Adding Socio-geographical context

To describe the possible relations between the waste and socio-geographic characteristics of a residential area, the themes that emerged during the analysis discussed in the previous chapter (quantity and composition of the waste; the functioning and physical state of the container) are compared to the following socio-geographic factors: educational level; household composition; average household income; migration background and socio-economic score,as Viera & Matheus (2017), Al-Momani (1994) and Grossmann et al. (1974) demonstrated that these factors are important for the management of municipal solid waste. This allowed me to further elaborate on the following research question: “Can adding more socio-geographical context give us more insights into the composition and amount of waste deposited next to the semi-underground waste containers?”. An overview of the districts is provided in Appendix E.

3.2.1 Noordelijke IJ-oevers-West
Of all 72 visits, waste was found 26 times around the containers in Noord, with a total quantity of 158 colli. Out of all waste items, the majority consisted of furniture, followed by *other* waste and *Cleaning and Household appliances*. Most waste was observed around the containers at the Mt. Lincolnweg and the Spadinalaan 3. As these locations contain most containers (10 at the Mt. Lincolnweg and 6 at the Spadinalaan 3) in comparison to the other locations with 3 containers per cluster, it would be interesting to see if this relates to the amount of waste that is placed around the containers.

Previous literature (Khadka et al., 2020; Collins & Downes, 1977) has shown that the average household income has a positive effect on waste generation. However, the quantity of waste found at Mt. Lincolnweg and the Spadinalaan 3 do not differ as much as the average household income of the neighbourhoods. At the containers at the Mt. Lincolnweg, waste was found 10 out of 12 visits with a total of 54 colli, and located in the NDSM-terrein neighbourhood, has an average household income of 27.900 euro. The Spadinalaan, located in the Overhoeks neighbourhood, has an average household income of 66.100 euro and during 7 out of 12 visits, waste was found around the containers with a total of 44 colli.

3.2.2 Indische Buurt, Amsterdam Oost
At the Riouwstraat, a total of 216 items of wrongly deposited waste have been found 22 times out of all 36 visits. These mostly consist of *Home improvement materials* (177 colli) and *Paper and Cardboard* (66 colli). While paper and cardboard have been found relatively often in comparison to other categories of waste, the waste containers for paper and cardboard were never full. The home improvement materials consisted mostly of furniture panels; wooden shelves and slats. During the observations, some residents took some home improvement materials with them. This could be further investigated as it might encourage people to get rid of their home improvement materials at any time.

The residents of the Indische Buurt are relatively highly educated, which is often associated with a higher interest in recycling and bringing forth less waste (Jenkins et al., 2003; Ferrara & Missios, 2005). However, a rather big amount of waste was observed around the containers at the Riouwstraat, which often contained *Household and cleaning appliances* such as broomsticks; waste bins; laundry racks and a mop. As this study found more cleaning appliances around the containers at the Indische Buurt than other districts, it shows the composition of waste really differs per district. Thus, to get a deeper understanding of the waste disposal problem, it is valuable to further investigate the influences of the social dynamics of a neighbourhood on the composition of waste that is deposited around containers.

3.2.3 Osdorp, Amsterdam Nieuw-West
In Osdorp, the highest amount of waste was found next to the semi-underground waste containers. In total, 642 colli of waste items were observed 45 times during all 72 visits. Most waste was found around the containers at the Martini van Geffenstraat, the Wolbrantskerkweg and the Jan Smitstraat, a reason for this could be that these are the clusters that include most containers. The containers at the Martini van Geffenstraat are located in the middle of a busy car park, surrounded by several apartment buildings serving many households. During every visit almost all parking places were occupied. On one side of the Martini van Geffenstraat starts the shopping area Osdorpplein. This would allow more people to walk past the containers which could be a reason for an increasing amount of waste lying next to the containers, because as mentioned before, litter influences behaviour and attracts more waste (Keizer et al, 2008; Wilson & Kelling, 1982; Kallgren, Reno & Cialdini, 2000). As Osdorp resides slightly more couples with children than Noord and Zuid, this is in line with research by Bandara et al. (2007), that has shown that the bigger the household size generates more waste.

3.2.4 Oud-Zuid, Amsterdam Zuid

Of all 36 visits, waste was found around the containers 10 times with a total of 41 colli. 18 of these 41 waste items consist of cardboard boxes. The data shows that the least waste was found in Oud-Zuid and consisted mostly of cardboard boxes. As Oud-Zuid is the wealthiest residential area observed, with an average household income of 121.400 euro and contains less single-person household in comparison to the rest of the city (Gemeente Amsterdam, z.d.-b), it is essential to study the relation between household size and income and the amounts and composition of waste that is disposed of around containers as these findings are not in line with existing literature. Studies have shown that the household composition and the average household income have a positive effect on the waste generation (Khadka et al., 2020; Collins & Downes, 1977). These findings show that this might not be the case for the amounts and composition of waste deposited, as it might have a negative influence and thus needs further exploration.

No major differences were found between the observed container clusters at Emmaplein, the Prins Hendriklaan and the Alexander Boersstraat. However, at the Prins Hendriklaan the least waste was found, a reason for this could be the location of the containers as they are placed at the centre of a T-junction and people might feel seen. This again shows that the container location might be of influence and needs to be studied if we want to understand why waste is left around the containers and how this varies per location.

Category	Oost	Nieuw-West	Noord	Oud-Zuid	Total
Cleaning and Household appliances	13	23	15	1	**52**
Furniture	10	22	41	5	**78**
Home improvement materials	19	39	10	2	**70**
Mattress	2	3	6	0	**11**
Other	15	80	15	4	**114**
Paper and Cardboard	20	30	10	4	**64**
Residual waste	7	36	3	1	**47**
Yard trimmings and plants	1	2	3	3	**9**
Total	**87**	**235**	**103**	**20**	**445**

Figure 10: overview of waste categories per district

4. Hypotheses

This study uncovered several findings that demonstrate that the quantity and composition of the waste that is deposited around the semi-underground containers are influenced by the social dimensions of a residential area. Additionally, the data showed that this is not in line with many studies that demonstrated how these characteristics play a role in waste generation in general. Therefore it is important to further examine the role of these factors per region, to be able to gain a better understanding of this waste disposal problem. Of all the findings, I have translated the most interesting ones into hypotheses that are explained below.

1. The more containers a container cluster contains, the more waste is disposed around the containers.

The highest quantities of waste were observed most frequently at the container clusters in Osdorp and the Noordelijke IJ-oevers-West which included more than five containers. Therefore, it is important to explore whether the number of containers in one cluster has an influence on the quantities of waste that are placed around the semi-underground containers. A study exploring the influence of the number of containers in one cluster might provide us with essential information on how residents perceive a cluster and can be investigated by asking research questions like: “Is adding a semi-underground container to a cluster effective or does it even lead to more wrongly disposed waste?” or “Are container clusters that include more than two containers attracting more waste that is wrongly disposed of around the containers?”.

2. Residential areas with a lower average household income have more waste disposed of around semi-underground waste containers.

I observed more waste around containers in the districts with a lower average income (the containers were not broken/full). The least waste was found in the district with the highest average income of the city of Amsterdam: Oud-Zuid. This is not in line with existing literature regarding waste generation, as previous studies have shown that the higher the income, the higher the waste generation. This gap in our knowledge shows the importance to elaborate on this to understand what is really going on in these districts regarding the waste disposal problem.

3. The more people who pass the container cluster, the more waste will be deposited incorrectly.

Most waste was observed around semi-underground waste containers that are placed at busy locations. For example, at the Martini van Geffenstraat in Osdorp, the highest quantities of waste were found during all visits. A reason for this could be that this container cluster is located in the middle of a busy car park which is surrounded by either apartments or a large shopping centre. At the third cluster visited in the Riouwstraat, more waste was found than the other two clusters in the same street. It could be argued that this cluster is located at a busy crossing point for many residents, as it leads to a busy shopping street or a connecting road that many people pass. However, at the Prins Hendriklaan in Oud-Zuid, the cluster is located on a pavement-island in the middle of a t-junction where many households look over and, during the visits, most people passed by bicycle or car and fewer by foot compared to the clusters in East and New-West. This shows the location of a cluster will also influence the amounts of waste residents leave around the containers and should be incorporated in new research designs.

5. Conclusion & Discussion

The mapping and identifying of the composition and quantity of waste surrounding semi-underground containers laid bare interesting patterns and allowed for the novel approach of including socio-geographic factors in the analysis.

This study confirms the theory of norm-changing effects of a littered environment, as formulated by Keizer et al. (2008) and Cialdini et al. (1990), as higher quantities of waste were found around contaminated and polluted containers(surroundings). Using destined and undestined waste as an additional category showed that in many cases, waste could have been deposited into the container. This division can be helpful for the development of improved waste management as it could uncover patterns of where and when most destined waste is placed around waste containers. Additionally, looking at the influence of the waste container location and functioning, it can be concluded that most waste was observed when there was no apparent reason for: enough space in the containers; tidy surroundings and one or two timeframes for the collection of bulk waste. This shines an interesting light on the composition and number of containers in one cluster, and is essential to be further investigated as this might be of influence on how a container cluster is perceived by residents. The differences in the composition of the waste found in each district are relatively large and demonstrate the importance of including socio-geographical characteristics. In Oud-Zuid, for example, it was mainly furniture and paper and cardboard that were found, while in Osdorp, compared to all the other districts, more residual waste was found. Khadka et al., (2020) argued that the average household income and household composition have a positive effect on waste generation. However, looking at the amounts of waste found per district, it can be concluded that the waste found around the waste containers in the districts with a higher average income per household (Amsterdam Noord; Zuid), contained less waste than the districts with a lower average income (Amsterdam Nieuw-West; Oost), as formulated by (Trang et al., 2017).

Observing the waste and the different neighbourhoods while cycling has been of important value for this study, not only did it give me time to reflect on what I observed during each visit, it also showed that more qualitative data on this problem will lead to a richer understanding of the waste disposal problem created by residents as this problem really differs per location. This is something that emerged more clearly from observing rather than just looking at data from waste items.

5.1 Limitations

It might have been fruitful to examine more comparable container clusters and locations, taking into account the location and number of containers per cluster, to be able to make better comparisons between the waste observed in different districts. Additionally, the visits of the container locations could be more equally divided over varying times and days to see whether the composition and quantity of waste differs per day or time. The data regarding the clearing of the containers by the maintenance teams would be a great addition to the data, as the municipality of Amsterdam does not share this, it was not included in this research. However, as the lack of data confirms that these findings are the result of exploratory research, these findings are still valuable in the light of future research despite the limitations.

5.2 Future research

To obtain a richer understanding of the socio-geographical context in relation to the waste deposited around the semi-underground waste containers, more qualitative data is needed. Future research should (1) examine the motivations of residents, looking into the role waste disposal plays in their lives; (2) study the decision making of municipality officials, as the collection service, maintenance teams and container locations play a crucial role in this problem and (3) obtain more insights on the socio-geographical characteristics of a residential area on micro level, to better understand the influence of these factors and the perceptions of its residents. A great way to start would be to incorporate interviews with the residents and municipality officials. I recommend those who execute these research opportunities to hop on their bicycles!

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7. Appendix

A. Example of memos kept during the observations

Memo 1 **Osdorp, Nieuw-West** **April 3rd 2022, 16:05**

Where: Martini van Geffenstraat
Container status: the paper containers are full
Total amount: 55 colli
Kind of waste: destined and undestined waste

Cardboard box (35), laundry basket (1), plastic (shopping) bag filled with residual waste (2), bin bags filled with residual waste (9), shopping cart (2), folding chair broken (1), plastic bag (1), textbook malmberg (1), kettle (1), cardboard box filled with residual waste (2).

Note:
Two men in work suits were clearing the waste around the containers when I parked my bike and started to take photographs. They asked me: "Are you sending these photographs to the municipality? Do you think that will work?". I had a conversation about my research and they told me they stopped notifying the municipality because there is new litter added every day and were very annoyed by this, so every now and then they tried to clean it up themselves.

Memo 2 **April 14th 2022, 13:02**

Thoughts on the residents of Amsterdam Oost and Zuid
In Amsterdam Oost and Amsterdam Zuid people had the habit of observing me observing the waste containers, and often looked at me as if they were hesitant to ask me what I was doing. Eventually, they did not approach me.

Memo 3 **Noordelijke IJ-oevers-West, Noord** **May 2nd 2022, 17:44**

Where: Spadinalaan 3
Container status: 1 of the 2 paper containers is full
Total amount: 22
Kind of waste: destined/undestined

Table (1), mattresses (2), wooden boards (3), cardboard boxes (3), cardboard boxes filled with paper (2), cardboard box filled with residual waste (1), stool, sofa cushions (3), folding table with wheels (4), BBQ (broken, 1), plastic bag with residual waste (1)

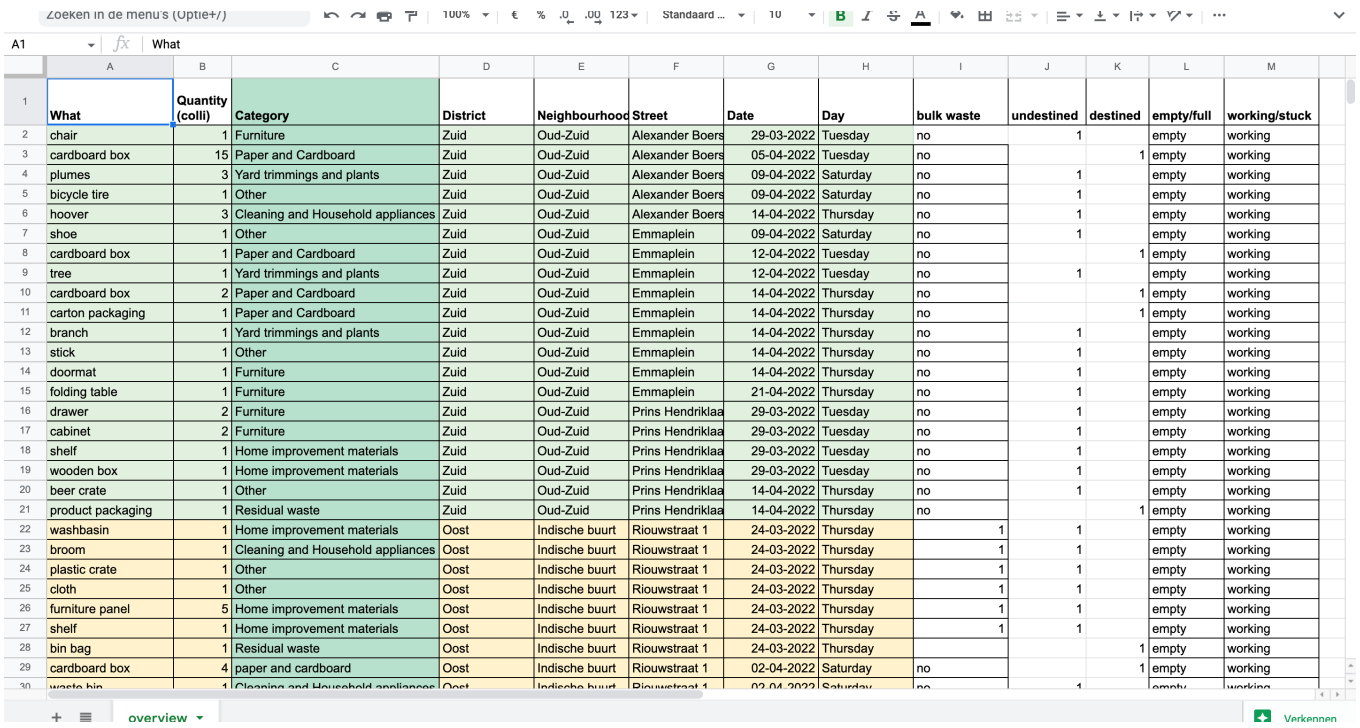
Note:
Today I met someone who was scavenging within the waste around the containers of the Spadinalaan 3, looking for some furniture he could use in his new apartment around the corner or sell at the thrift store where he works. I have the idea that the maintenance team for bulky waste did not come by yesterday, as I've noticed more bulky waste in Noord today than before.

Memo 4 **June 3rd 2022**

Thoughts on the bicycle route
Observing the containers on a bicycle allowed me to see the different characteristics of the city. Often, I started the observations in Noord as I liked taking the ferry from Amsterdam Centraal to cross the IJ river as this allowed me to take a moment to think about the day ahead.

I enjoyed going from Oud-Zuid to Osdorp, as you cycle towards the more peripheral areas and leave the centre of the city. This is really marked by the viaduct you're crossing, that beltway that encircles all central located districts.

B. Sample of table: waste items overview



What	Quantity (colli)	Category	District	Neighbourhood	Street	Date	Day	bulk waste	undestined	destined	empty/full	working/stuck
chair	1	Furniture	Zuid	Oud-Zuid	Alexander Boers	29-03-2022	Tuesday	no	1		empty	working
cardboard box	15	Paper and Cardboard	Zuid	Oud-Zuid	Alexander Boers	05-04-2022	Tuesday	no		1	empty	working
plumes	3	Yard trimmings and plants	Zuid	Oud-Zuid	Alexander Boers	09-04-2022	Saturday	no	1		empty	working
bicycle tire	1	Other	Zuid	Oud-Zuid	Alexander Boers	09-04-2022	Saturday	no	1		empty	working
hoover	3	Cleaning and Household appliances	Zuid	Oud-Zuid	Alexander Boers	14-04-2022	Thursday	no	1		empty	working
shoe	1	Other	Zuid	Oud-Zuid	Emmaplein	09-04-2022	Saturday	no	1		empty	working
cardboard box	1	Paper and Cardboard	Zuid	Oud-Zuid	Emmaplein	12-04-2022	Tuesday	no		1	empty	working
tree	1	Yard trimmings and plants	Zuid	Oud-Zuid	Emmaplein	12-04-2022	Tuesday	no	1		empty	working
cardboard box	2	Paper and Cardboard	Zuid	Oud-Zuid	Emmaplein	14-04-2022	Thursday	no		1	empty	working
carton packaging	1	Paper and Cardboard	Zuid	Oud-Zuid	Emmaplein	14-04-2022	Thursday	no		1	empty	working
branch	1	Yard trimmings and plants	Zuid	Oud-Zuid	Emmaplein	14-04-2022	Thursday	no	1		empty	working
stick	1	Other	Zuid	Oud-Zuid	Emmaplein	14-04-2022	Thursday	no	1		empty	working
doormat	1	Furniture	Zuid	Oud-Zuid	Emmaplein	14-04-2022	Thursday	no	1		empty	working
folding table	1	Furniture	Zuid	Oud-Zuid	Emmaplein	21-04-2022	Thursday	no	1		empty	working
drawer	2	Furniture	Zuid	Oud-Zuid	Prins Hendriklaa	29-03-2022	Tuesday	no	1		empty	working
cabinet	2	Furniture	Zuid	Oud-Zuid	Prins Hendriklaa	29-03-2022	Tuesday	no	1		empty	working
shelf	1	Home improvement materials	Zuid	Oud-Zuid	Prins Hendriklaa	29-03-2022	Tuesday	no	1		empty	working
wooden box	1	Home improvement materials	Zuid	Oud-Zuid	Prins Hendriklaa	29-03-2022	Tuesday	no	1		empty	working
beer crate	1	Other	Zuid	Oud-Zuid	Prins Hendriklaa	14-04-2022	Thursday	no	1		empty	working
product packaging	1	Residual waste	Zuid	Oud-Zuid	Prins Hendriklaa	14-04-2022	Thursday	no		1	empty	working
washbasin	1	Home improvement materials	Oost	Indische buurt	Riouwstraat 1	24-03-2022	Thursday	1	1		empty	working
broom	1	Cleaning and Household appliances	Oost	Indische buurt	Riouwstraat 1	24-03-2022	Thursday	1	1		empty	working
plastic crate	1	Other	Oost	Indische buurt	Riouwstraat 1	24-03-2022	Thursday	1	1		empty	working
cloth	1	Other	Oost	Indische buurt	Riouwstraat 1	24-03-2022	Thursday	1	1		empty	working
furniture panel	5	Home improvement materials	Oost	Indische buurt	Riouwstraat 1	24-03-2022	Thursday	1	1		empty	working
shelf	1	Home improvement materials	Oost	Indische buurt	Riouwstraat 1	24-03-2022	Thursday	1	1		empty	working
bin bag	1	Residual waste	Oost	Indische buurt	Riouwstraat 1	24-03-2022	Thursday			1	empty	working
cardboard box	4	paper and cardboard	Oost	Indische buurt	Riouwstraat 1	02-04-2022	Saturday	no		1	empty	working

C. List of waste items that fall under the category *other*

bicycle tire
shoe
stick
beer crate
plastic crate
cloth
rack
stuffed animals
bicycle tire
mudguard
grill rack
suitcase
tea-light holder
mirror
car seat
canvas
frame
plastic sheet
mirror
shopping basket
shopping cart
cool box
crate
plastic bucket (10L)
styrofoam
shopping cart
plastic bucket (10L)
pram
round decorative frame
plastic plate
shopping cart
wooden box
shopping cart
paint bucket (12.5L)
shopping cart
cassette recorder
bottom part badminton racket
slat
shopping cart
pallet
styrofoam
plastic film
advertising print
shopping basket
shopping cart
bucket
crate
shopping cart
canvas
toy car
bucket
crate
bag with clothes
canvas
big shopper with clothes and toys
polystyrene foam
crate
canvas
pallet
styrofoam
pallet
styrofoam
shopping cart
placemats
placemats
shopping basket
glass plate
glass plate
cloth
car tires
suitcase
plastic crate
polystyrene crate
hiking shoes
scarf
speaker
sock
shisha
pallet
shisha tobacco cup
plastic toy
wooden stick
shisha tobacco cup
pallet
umbrella
umbrella
canvas
wooden stick
glass vase
photo frame parts
metal stick
cloth
wooden crate
crate
styrofoam
canvas
plastic wrap
wooden crate
metal stick
suitcase
metal stick
hula hoop
jumper
CD
crate
bag with clothes
bicycle tire
metal stick
metal stick
crate
Adidas training trousers
plastic lid
glass plate
jerry can

D. Photographic overview of all container locations

Oud-Zuid

Emmaplein

Prins Hendriklaant

Alexander Boersstraat

Indische Buurt

Riouwstraat 1

Riouwstraat 2

Riouwstraat 3

Noordelijke IJ-oevers-West

Spadinalaan 1

Spadinalaan 2

Spadinalaan 3

Monnikskapstraat 1

Monnikskapstraat 2

Mt. Lincolnweg

Osdorp

Ekingenstraat

Opmerkzaam 1

Opmerkzaam 2

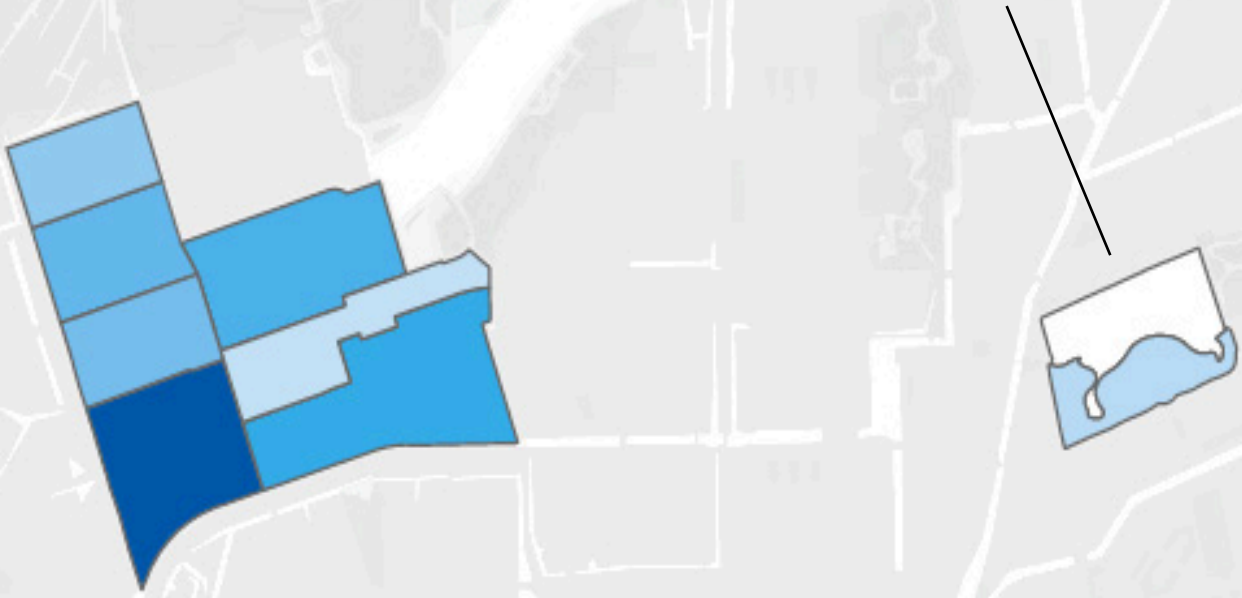
Martini van Geffenstraat

Jan Smitstraat

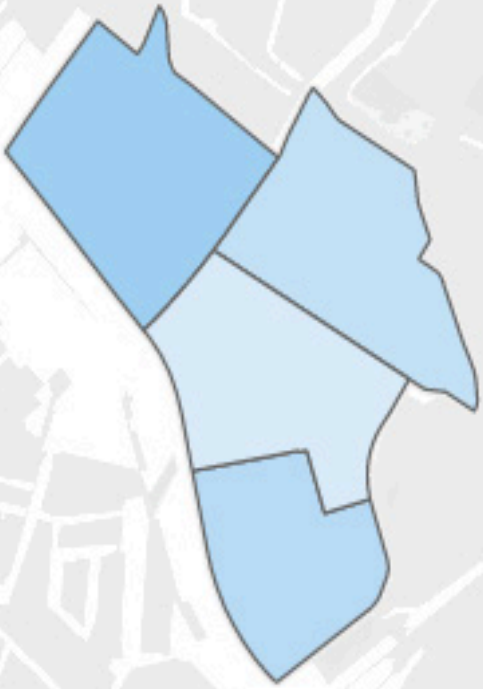
Wolbrantskerkweg

E. Overview and information of selected districts

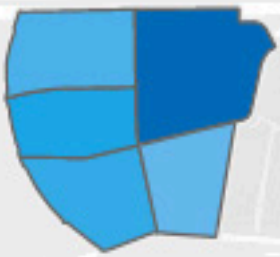
Oud-Zuid, Amsterdam Zuid. In Oud-Zuid, the least waste was observed around the containers in comparison to all other locations. During the visits, it was relatively quiet on the streets and the waste containers and surroundings such as the pavements and small greenery were kept clean and tidy. This fits the known characteristics of the area, as it is one of the wealthiest districts in Amsterdam, Oud-Zuid is a spacious district with plenty of culture, shops, bars and restaurants, such as the Museumplein, the P.C. Hooftstraat and the Vondelpark. The inhabitants of Oud-Zuid are relatively sporty and highly educated (Gemeente Amsterdam, z.d.-b).



Osdorp, Amsterdam Nieuw-West, in comparison to the other districts, was built quite recently in the 1950s and 1960s (Gemeente Amsterdam, z.d.-a), and still, many new constructions and developments take place. Osdorp is known for the Sloterplas; Osdorpplein, a popular shopping centre and the Meervaart theatre. The following locations were included during the observations: the Martini van Geffenstraat, Wolbrantskerkweg, Ekingenstraat, Jan Smitstraat and two container clusters at Opmerkzaam. Osdorp has 17,418 inhabitants with an average family income of 34,500 euros and has slightly higher numbers of couples with children compared to the rest of the city. With 41% they have a lower SES score in comparison to the rest of the city (30%). The household composition is almost similar to the rest of the city and has more inhabitants with a non-Western migration background (Gemeente Amsterdam, n.d.-a).



The Noordelijke IJ-oevers-West, located in the northern area of Amsterdam, is a district that has a history of heavy industry due its location at the IJ river. Many worker's houses were built so that the many workers did not have to cross the IJ too often (Gemeente Amsterdam et al. 2022). Nowadays, these houses are accompanied by iconic buildings such as the A'DAM Tower, the EYE film theatre and many recently built apartment buildings. The following three locations were included in the observations: the Spadinalaan, located in the Overhoeks neighbourhood, the Monnikskapstraat, in Buiksloterham-Noord and the Mt. Lincolnweg, which is located in the NDSM area. The population in the Noordelijke IJ-oevers-West is relatively highly educated: 57% of the people in this area have completed a higher education and only 7% are little to not educated compared to the overall level of 23% in the whole of Amsterdam (Gemeente Amsterdam et al. 2022). The household composition has more one-person households compared to the rest of the city and an average household income of 49,600 euro. 70% of the inhabitants score high in socio-economic terms (Gemeente Amsterdam,



Indische Buurt, Amsterdam Oost, is known for its many cultures that reside there. In the heart of the Indische Buurt, the Javastraat is located and is known for the many Mediterranean shops, cafes and bars. Over the years, this neighbourhood has improved rigorously and is known for the involved community and high engagement with societal issues (Zukin et al., 2015). 48% of the 12.299 inhabitants are highly educated and the average household income is 36.400 euro, which is three times less than the average income of Oud-Zuid. The household composition, socio-economic score (SES) and migration background is comparable to the rest of the city, 48% of the inhabitants that are highly educated and just over 50% consists of a one-person household. 44% of the residents have a non-western migration background, 37% have no migration background and 19% have a western migration background (Gemeente Amsterdam, n.d.-d). Three container locations were included in the observations that are all located in one street: the Riouwstraat.

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With feelings of gratitude, I would like to thank my primary supervisor, Bas Haring, who motivated me to follow my interests and for his helpful advice throughout this project. I would also like to thank my second supervisor, Zane Kripe, who patiently gave me the feedback, confidence and guidance I needed without having to ask. Finally, Olav, thank you for our endless discussions, patience and allowing me to cover our walls with photographs of waste.