An experiment to evaluate the vices and opportunities of micro-targeted advertising in public policy.

AN EXPERIMENT TO EVALUATE THE VICES AND OPPORTUNITIES OF MICRO-TARGETED ADVERTISING IN PUBLIC POLICY.

Master Thesis

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by

Emmanouil LEONTARIS

Faculty of Technology, Policy, and Management,
Delft University of Technology, The Hague and Delft, Netherlands, To be defended in public on September 18, 2020

Graduation committee

Chairperson:	Dr. M.E. Martijn Warnier
First Supervisor:	Dr. Hadi Asghari
Second Supervisor:	Dr. ir. T. Trivik Verma
External Supervisor:	Jaap Dinkelman, MSc

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EXECUTIVE SUMMARY

The focus of this work is the creation and application of an experimental framework that tests the effectiveness and the impacts of micro-targeted ads. Micro-targeted ads have been used extensively by both political and retail carriers to sway peoples' opinion, but there haven't been any academic studies (in an environment which is not controlled) that explore the impacts and the effects of micro-targeted ads. To this end the idea is to use a measurable variable (in this case the misplaced trash in The Hague) and throw generalized (non micro-targeted) ads along with micro-targeted ads, both of them aiming to reduce misplaced trash-bags. The ads will be sent to specific neighborhoods in The Hague through Facebook. The ad itself is considered a "nudge"(an intervention that hints towards behavioral change without forcing it). The end goal is threefold:

- Measuring the effectiveness of a micro-targeted ad versus a generalized one.
- Checking the impact of privacy respecting and ethical micro-targeted ads used for social welfare improvement.
- Giving public policy advice ideas based on the results of the work.

The first phase has to do with analyzing existing misplaced trash data and demographic data in order to find which demographics affect the misplacement of trash. Then three hot-spots of misplaced trash were identified that were similar in the demographics of interest and are the ones that are used for the experiment.

After the identification of the hot-spots, data collection on misplaced trash was done through field research. Data and input from the municipality was used, to ensure the validity of the analytical methods that were used. A modified K-means algorithm was used to find similar misplaced trash hot-spots and the results from a negative binomial regression combined with the results of a recursive feature elimination technique, were used to find demographics that affected misplaced trash.

The second phase has to do with creating the scripts and videos that are used for the Facebook ads. The script was written first and the video content used that script along with the pictures that were taken by the primary investigator in the previous phase. The script was translated into three more languages so the ads were shown in four languages total. Using the Facebook ad manager the targeted areas and targeted demographics were chosen as well as the budget for ads. The monitoring of the effectiveness of the ads was done through the ad manager. A website was created to support the research and surveys in the same languages as the ads were posted on it, in order to have more data points for the research. The results that came from this phase were, the Facebook ad manager data that included Key performance indicators about how the Facebook ads performed. In this phase misplaced trash data from the identified hot-spots were collected by the principal investigator and counted in order to be used later to see the effectiveness of the interventions.

An important part of this work is to use micro-targeting for social good, while mitigating any risks and issues that can be caused by such an experiment. To this end two Ethical impact assessments were done. One was mandatory for this study to be approved by the university and used the template from the human research committee from TU delft and the second one was more detailed and used a template Deloitte is currently developing. The results from these assessments showed that care has to be taken in the implementation of informed consent, how to mitigate privacy issues regarding personal data, be careful when implicitly targeting minorities with ads and taking care not to exclude some groups of users from the benefits of such an intervention.

The third phase is about analysing the qualitative and quantitative data that was generated by the experiment and the field data collection.

Quantitative analysis is based on a statistical significance test called Wilcoxon signed rank test and another binomial regression. Through these tests it was shown that the micro-targeted ads more effectively reduced the amount of misplaced trash bags compared to generalized ads. Namely the Wilcoxon test showed significant distributional change in the areas where the two interventions were done and no distributional change in the control group area. The area where the generalized ads were run had 22% decrease(on average) after the intervention while the area in which the micro-targeted were run had a 38% decrease. The standard deviation reduction for the area that had generalized ads was 12% and the for the micro-targeted area was 13%. The binomial regression showed that the intervention was most effective in the micro-targeted are (regression coefficient equal to -1.62 with a standard deviation of 0.544) and less effective in the generalized ad area (-1.29 with a standard deviation of 0.488).

The qualitative data showed that users interacted more with the micro-targeted ad and the Facebook ad manager KPIs showed more people clicking on the micro-targeted ad and visiting the website created for this research. Specifically the micro-targeted campaign ads had 2.2 times more clicks (people clicking on the ad to to go to the website that it redirects) and an above average conversion rate (an indicator of how much action was taken by the viewers of the ad.) compared to the below average conversion rate of the generalized ads.

Overall the results point to micro-targeted ads being more effective, in both having people watch them and changing their behavior to increase public welfare, with the caveat, that this was a pilot work and more data would be required to get a definitive answer.

Policy advice that was produced from this work includes:

- Improvements on the misplaced trash counting methodology of The Hague.
- Ways to utilize social media in order to further awareness increasing interventions done by the municipality.
- Increasing the collaboration of the city of The Hague with other organizations that are taking action against misplaced trash.

PREFACE

This report is the result of six months of hard work, both mental and physical, as a lot of the data collection had to be done by myself. This work was done while the Covid-19 pandemic was at its peak. This resulted in a lot of challenges, but also showed that we can adapt to difficulties and become stronger through adversity.

This work was done with the help of Deloitte, since I was a thesis intern there for its duration. From Deloitte, I would like to thank Wouter, my coach, who was always there for me, sharing his experience and his advice, not only this work but also on my future in the industry. I would also like to thank Bas for his help on managing Facebook ads. Iris my thesis coordinator was always there to keep me honest with deadlines and offer assistance on any problems that I had. Finally, I would like to thank all the thesis interns, who helped me have a good time even though I was mostly confined at home due to the pandemic.

Since this work required the creation of audio and visual material, which is somewhat outside my expertise, I would like to thank Alex and Katerina for helping with the videos and the website visuals.

I would also like to thank Connor, Irem, Fatima and Amerens for becoming actors for a day and participating in the videos that made this work possible.

My deepest thanks go to my thesis committee. Martijn was a great chair who offered advice and organized everything perfectly and assisted in finding funding for this research. Trivik has some great insights on the writing as well as on the data analytics methods of the work and took the time to listen to my concerns. Jaap's help was invaluable in completing the work and without knowing what the misplaced trash situation in the Hague was; without him this work would not have had realistic results. Last but not least, I would like to thank Hadi, my first supervisor, who spent a lot of time with me on calls guiding me and sharing his feedback. I believe our exchange of opinions and healthy disagreements helped this work become a lot more interesting.

Finally, I would like to thank my parents, Anna and Alexander, for supporting me though these difficult times, as without their support this work would have been a lot more difficult. I need to thank my brother John as well, both for helping me with the proof reading of my thesis as well as for being there for me when I needed him. I would also like to thank my girlfriend Faye for her support and company; everything would have been just that little bit tougher without her.

1

INTRODUCTION

In the advent of the 21st century the use of social media, especially Facebook, has increased dramatically. Ad micro-targeting through social media has undoubtedly affected the decisions of users but the impact of it is yet unclear. Micro-targeting people through social media has always had a negative connotation, as it is used by political carriers, retail sellers, corporations etc. to push their agenda (being changing people's mind into buying a program, changing their vote and in general steer the public to a direction of their choice. Multiple ethical issues arise including, but not limited to, the use of personal information acquired without informed consent, targeting vulnerable groups that might not have the capacity to completely understand the message, misinforming the public in order to persuade etc.

Micro-targeting has been proven to be a powerful tool in the above cases, so can this tool be used for the benefit of society instead of manipulating the public for personal gain?

1.1. LITERATURE REVIEW ON MICRO-TARGETING

It has been shown that micro-targeting is very effective with the right conditions (Metcalf *et al.*, 2019). The creation of effective advertisements is paramount, different methodologies and theories have been used to create effective advertisements in social media (Dwivedi *et al.*, 2015). Since this research will focus more on the impact of micro-targeting in an experimental level and in ways to mitigate it is good to see what has been done up to now. An experiment on 122 participants, all from the University of Amsterdam, has shown that exposure to a political personalized ad on Facebook activated voters' persuasion knowledge compared with a regular Facebook post and that even if the participants were informed that their personal information was used it did not change the way they responded. This of course happened in a controlled environment in a survey like manner, so participants were informed of what they were going to see (Kruikemeier *et al.*, 2016).

Another work used machine learning to cluster Facebook users in groups and identified "hot" political topics that they would respond to if they were targeted (Papakyri-

akopoulos *et al.*, 2018). This paper has shown that effective micro-targeting can be applied to Europe as well as in the US, since most of the literature has been focusing on applications in the latter country. Another paper shows, by experiment, that, using the publicly available advertisement campaign targeting interface by Facebook, someone can obtain private information on users(Korolova, 2011).

Specifically they create different "attack" algorithms so they can infer a friend's age, a non-friend's sexual orientation, a user's relationship status, political and religious affiliation, presence or absence of a particular interest, as well as exact birthday. Facebook has been informed about this and if we look at a newer paper by the same author, we can see that not much has changed. New attack vectors were identified that can be used to get the private information of users (Faizullabhoy and Korolova, 2018).

Another work does a systematic analysis of online advertisers in the US (Edelson *et al.*, 2019). It is a large-scale analysis of online political advertising based on the data recently made transparent by Facebook, Google, and Twitter. They provide an initial understanding and taxonomies of online political advertising strategies for both honest and possibly dishonest reasons and point out limitations and weaknesses of the policies and current implementations of these archives.

Overall, there is limited research done on micro-targeted ads due to the fact that it is a relatively new phenomenon and that measuring its impact is difficult.

1.2. PUBLIC POLICY, NUDGING & SOCIAL MEDIA

Public policy has been paying serious attention to what prevents individuals or groups from adopting beneficial practices or abandoning harmful ones(Bicchieri and Dimant, 2019). Nudges are a popular behavioral approach that alter people's behavior in a predictable way without forbidding any options or significantly changing their economic incentives. To count as a mere nudge, the intervention must be easy and cheap to avoid. Nudges are not mandates and basically try to subtly influence peoples' behavior by taking into account their cognitive biases (Thaler and Sunstein, 2008),(Hansen, 2016).

Examples of nudges implemented by governments include graphic warnings for cigarettes, labels for energy efficiency or fuel economy, "nutrition facts" on food packaging and the design of governmental websites in such a way that they list certain items first and in larger fonts (Sunstein and Reisch, 2018).

Nudging in public policy should try to uncover 'what drives human behaviour and how to change it for the common good' (Ewert, 2019) and the results should be used to redesign public policy to help social welfare. A very effective medium to deliver "nudges" are social media. Digital nudging through Facebook, Twitter and other social media has been very effective in delivering nudges to users (Kroll and Stieglitz, 2019). Social media are used,by governments to gain insight from user engagement and to do broad sentiment analysis of conversations about specific issues. Data from social media can be used as evidence that can inform social and economic policy. It has value for government, the policy community and public service delivery organisations (Leavey, 2013).

This means that, social media can be used to deliver "nudges" that help formulate public policy and improve social welfare. To this end, micro-targeted or personalized nudges could represent a powerful tool for decision-makers, as, depending on the audience and the type of penalization used, the effectiveness of the nudge can be enhanced

(MILLS, 2020).

1.3. KNOWLEDGE GAP

y looking at the existing literature, the practical impact of micro-targeted ads has not been investigated thoroughly enough. Most of the existing work has concentrated in the US (Bodó *et al.*, 2017) so it would be interesting to see how the existing results work for Europe or other regions. The concept has been tackled either from a theoretical point of view or a machine learning / data analytics point of view, but a combination of analytical techniques and social sciences has not yet been used (Ward, 2018).

On the experimental side of things, Tovo labs engaged a large independent adtech firm that had never previously offered its services to a political campaign. Using a DSP (demand side platform, the main delivery mechanism behind online advertising) and other tools like Facebook Connect enabled them to place ads throughout the web, both on social (e.g. Facebook, Twitter) and digital (e.g. nytimes.com, drudgereport.com). They began work on a "proof of concept" to determine if Tovo's strategy, insight, and creativity, supported by strong adtech and data, could shift the outcome in a hotly contested election. They targeted specific districts and managed to increase republican turnover while reducing democrat turnover (Tovo Labs, n.d.). However the focus was only "on the numbers" and the results were not elaborated on or explained. Considering that their results are not published, so the experiment cannot be replicated, as well as the fact that it was done in the US, merits further investigation about the impact of micro-targeting.

The impact of a micro-targeted intervention or "nudge",delivered through social media, in order to increase social welfare has not been experimentally measured yet. Few empirical works on digital "nudging" have used social media for its delivery (Hummel and Maedche, 2019), so this leaves a lot of room to study this topic.

Finally, the policies and advice for mitigating the negative impacts of micro-targeted ads that have been proposed are quite limited (Bodó *et al.*, 2017), as it it difficult correctly estimate the risks of micro-targeted messages and the positive opportunities that they have.

1.4. RESEARCH QUESTIONS

Given the gaps in current research in the ways that micro-targeted messages can be harnessed to help increase social welfare and the fact that there is little academic research in experimentally measuring the revealed preferences of people in response to micro-targeted messages the focus of this work will be to design and run an experiment that helps answer the following research question:

What are the impacts of micro-targeted advertisements through social media and how can they be used to influence public behaviour in the context of an awareness campaign in a positive way?

From this main question the following sub-questions originate:

1. Can the impacts of micro-targeted advertisements be identified from both a theo-

retical and experimental standpoint?

2. Is micro-targeting able to positively influence public behaviour in an ethical manner?

3. Can the results from such a study be used to formulate policy advice?

1.5. SOCIETAL BENEFITS OF THE RESEARCH

Understanding the implications of micro-targeting is important because micro-targeting is a social phenomenon that has a huge real world impact (US elections, Brexit etc.) The goals of this work are also aligned with the sustainable development goals as the results from this work will help to safeguard the democratic process, especially goal sixteen; peace, justice and institutions of which democracy is an integral part of. Experimentally testing if a micro-targeted intervention can lead to higher increase in social welfare than a non-targeted one might pave the way in changing other types of similar interventions.

Exploring the use of social media in order help public policy is another benefit that could come from this research. The use of social media to formulate public policy has been gaining ground but practical research is scarce (Leavey, 2013).

Since ethics and compliance are an integral part of this study, similar interventions can be formulated based on these principles. By doing so the privacy and the decency of the subjects can be efficiently safeguarded.

The objective of the intervention is to reduce the amount of misplaced trash and litter in The Hague as well as implicitly reducing the complaints about misplaced trash and litter filled by citizens. This frees up some resources in order to be used by the Municipality for other endeavours. The results of the experiment will be used to formulate public policy advice and these ideas will give the municipality extra information on future interventions and solutions for not only the misplaced litter problem but other similar issues.

1.6. RESEARCH SCOPE

The effects of advertisement micro-targeting are not clear. There is not a lot of supporting theory and not many experiments have been done, especially in Europe (Bodó *et al.*, 2017). The experiments done are mostly under controlled conditions or cannot be validated so the results about the impact of micro-targeting are not clear (Kruikemeier *et al.*, 2016),(Tovo Labs, n.d.).

This work will focus on reducing the misplaced trash and litter in the city of The Hague. A generalized ad campaign refers to ads that are indiscriminately delivered to an audience. The idea is that a generalized ad campaign and a micro-targeted one will be "pitted against each other" to see which is successful. The social media platform that will be used for this work is Facebook.

The success of each campaign will be measured by several Key Performance Indicators (KPIs) such as ad interaction, Facebook KPIs, complaints submitted to the municipality about trash and misplaced trash amount in the areas of intervention. Three areas in the Hague have been selected. One of them will be treated with the generalized ads aimed to reduce misplaced litter, another one will be treated with micro-targeted ads

with the same goal and the last one has no treatment (a control group). A more detailed explanation of the experimental design can be found in chapter 4.

It should be kept in mind that trash reduction is not the direct objective of this work but a positive byproduct. The methodology, with some tweaking and data change, can be applicable to any intervention that uses a social media platform to improve social welfare.

1.7. THESIS STRUCTURE

This work is divided into seven chapters. The first chapter is an introduction to the work. The second chapter discusses what micro-targeting is, in both political context and its usage to sell products. It briefly talks about the ethical issues and the regulations that govern micro-targeted ads. The third chapter is about the misplaced trash situation in the Hague and the demographics of littering. The fourth chapter details how the experiment was designed including data use and preliminary data analysis along with the locations of the experiment along with the ethical impacts of the project and the key findings from the ethical impact assessments done.

The fifth chapter talks about how the experiment was run, how the audio and visual material was created and how Facebook ad manager was used to run the ad campaigns. Chapter six presents and discusses the results which both of qualitative and quantitative nature. Chapter seven briefly summarizes the results, expands on policy advice ideas, outlines the scientific contribution of the work, identifies its limitations and showcases ideas for future work

2

MICRO-TARGETING

2.1. INTRODUCTION

This chapter aims to define what micro-targeting is. The focus will be on micro-targeted messages that are delivered through social media. A definition will be given and its roots will be discussed. Cases in which micro-targeting was used will be highlighted and real-world examples will be stated. Its negative connotation will be investigated and positive opportunities will be discussed. An overview through the lens of ethics will be applied on micro-targeted messages and a brief review of existing regulations on micro-targeted ads will be done.

2.2. DEFINITION

Micro-targeting can be defined as a way to successfully create personalized messages or offers, correctly estimating their impact (in regards to sub-grouping) and delivery directly to individuals (Agan, 2007).

Looking at it in a more modern perspective another definition is: "Micro-targeting can be defined as advanced psycho-geographic segmenting which is based on an algorithm determining a series of demographic and attitudinal traits to distinguish individuals for each targeted segment" (Barbu, 2014).

A more concise and simple way to define micro-targeting and the definition that will be primarily used in this work is: "The transmission of a tailored message to a subgroup of people on the basis of unique information about that subgroup."

2.3. APPLICATIONS

In this section a discussion on the applications of micro-targeting will be done. Micro-targeting is widely applied in political ads and in marketing campaigns. Each application will be paired with a real world example.

2.3.1. POLITICAL MICRO-TARGETING

Political micro-targeting (PMT) campaigns are tailored marketing campaigns targeted to specific groups of people to influence their voting behaviour. The first problem with PMT, is that PMT has been used among other things to (dis)encourage political participation, (dis)encourage donations and contributions to candidates and campaigns. It can be employed to create energy and interest in a candidate, campaign and election , but it can also be used to create disinterest and apathy (Bodó *et al.*, 2017).

There are a lot of claims that intensive micro-targeting could harm the democratic process (Barocas, 2012). We should also consider that if criteria for micro-targeting become too precise we can reach granularity levels of individuals also known as nano-targeting (Barbu, 2014). This creates a lot of ethical issues as anyone using Facebook's platform to advertise can access private information on a very granular scale and find personal information about voters (Korolova, 2011).

Recently with the Cambridge Analytica and Facebook scandal on the 2016 US elections and on the Brexit referendum, political micro-targeting sometimes reaches the level of propaganda and creates privacy violations (Edelson *et al.*, 2019).

CAMBRIDGE ANALYTICA CASE

One reason that micro-targeted ads have such a negative connotation, are the scandals that involved Cambridge Analytica (CA). On May first 2018 CA declared bankruptcy. This company was a political consulting firm which used data analytics and psychological profiling along with questionably obtained data from social media platforms, especially Facebook, to identify the "persuadable", that is people who could be tipped into changing their vote, and subsequently bombarded them with digital advertisements through social media platforms that were tailored, based on the person's psychological profile, to sway their vote towards the party that CA was consulting for (Grassegger and Krogerus, n.d.).

The two most well known incidents were the US elections in 2016 and the Brexit referendum. Using people's data without their consent to profile them and then target them with ads in order to manipulate them is a serious threat to democracy.

2.3.2. MICRO-TARGETING ON MARKETING

Micro-targeted advertisements are extensively used for marketing purposes and selling goods or services.These ads generally fall under the radar mostly either because users are not explicitly informed about the data that is collected about them or because they do not mind sacrificing their privacy in order to get more personalized offers and deals. Due to the level of precision that micro-targeting has consumers can ignore the quality of the product or service deliver. This in turn could lead to damaging the brand and decreasing sales.

2.4. POSITIVE OPPORTUNITIES FOR SOCIETY

PMT could increase political participation and therefore strengthen democracy. People spend a lot of time on social media and increasing the chance that potential voters get relevant information through targeted ads can increase participation (Borgesius *et al.*, 2018). PMT can help with public opinion as well. It can help with increasing the

diversity of political campaigns and since voters have limited time to spend on being informed about parties and politics provide concrete and condensed information to them that is relevant to their voting decision(Borgesius *et al.*, 2018). In this work the idea is to leverage these opportunities not in a political context but a social welfare improving one to see if a micro-targeted intervention is more a effective than one that is not targeted.

2.5. ETHICS OF MICRO-TARGETING

In this section a brief discussion on ethical concerns of micro-targeting will be pinpointed and a short discussion on social welfare improving micro-targeting ethical concerns will done.

2.5.1. ETHICAL ISSUES THAT BESET MICRO-TARGETING

The word "micro-targeting" in almost all cases had a negative connotation. This is because of the many ethical issues that are created when implementing it. When used to market products, the issues that arise have to do with personal data privacy and manipulating users' intent (Barbu, 2014). Social media platforms offer a wealth of information about their users and marketeers can use this information to create customizable audiences of their products. It has been shown that, specifically through the use of Facebook ad manager, by using information that is publicly available private information can be extrapolated (Korolova, 2011). Facebook has since then fixed this issue. The liberalization of people's private and public life through social media, has led many marketeers "digging" into people's profiles in order to make "contagious" campaigns, that do not have much to do with information about the actual product but instead try to connect the product with the individual characteristics of potential consumers in order to increase sales (Kraus, 2018).

Manipulation of citizens is another major ethical concern. This is done by both companies and political parties. When done by political parties it is especially dangerous since, in most cases fake information (Costa, 2018) is used to either sway public opinion towards the party's favor or smear opposing parties so voters stay away from them. Often the messages have racist and sexist content (**Wilson**) and are created specifically to invoke negative emotions to "persuadable" groups. These ads can also highlight specific issues to groups that would be interested in them, in a sense making them think that this is the main problem that the party is tackling essentially misinforming them. (Borgesius *et al.*, 2018).

2.5.2. POSSIBLE ETHICAL PITFALLS, WHEN MICRO-TARGETING IS USED TO IMPROVE SOCIAL WELFARE

One of the goals of this work is to see if micro-targeting can be used to improve social welfare, in this case reduce the amount of misplaced litter in the Hague. While reducing the amount of misplaced trash and litter is an ethically just goal which would help society and , carving a path to that goal might have ethical and legal consequences if care is not taken. Briefly the main concerns are:

- Respecting the privacy of people who take part in the intervention.

- Making sure the message is created in a way that no offense is taken.
- Those who partake should have the option to opt out whenever they want.
- There should be an easy and fast way to provide feedback on the intervention and contact the people who coordinate it.
- The intervention should not create discriminate against different groups.
- Special precautions should be taken if the intervention affects vulnerable groups (children,people with disabilities etc.)

To this end an Ethics impact assessment was conducted and the results can be found in chapter 5.

2.6. EXISTING REGULATION ON MICRO-TARGETED ADS

This section will focus on how micro-targeted ads are regulated in Europe. The General Data Protection Regulation (GDPR) will be referenced as it is the major piece of regulation that influences how micro-targeting should be done.

2.6.1. GENERAL DATA PROTECTION REGULATION

The GDPR is a legal instrument that aims to ensure that personal data are only used fairly and transparently. The GDPR imposes obligations on organisations that use personal data (data controllers) and grants rights to people whose personal data are used (data subjects). Compliance with the GDPR is overseen by independent Data Protection Authorities (DPAs)(Dobber *et al.*, 2019). The GDPR does not explicitly reference micro-targeting but but it implicitly affects it in different ways. Before these ways are discussed the definition of sensitive data needs to stated: Sensitive data is defined in GDPR as data consisting of racial or ethnic origin, political opinions, religious or philosophical beliefs, or trade union membership, genetic data, biometric data, data concerning health or data concerning a natural person's sex life or sexual orientation.

The GDPR is very strict with the possession or the processing of sensitive data and data about political opinions fall into this category, there are a few exceptions to this rule but in general it is strictly enforced. Secondly sensitive data cannot be processed without explicit consent and this greatly has affected marketing campaigns. Finally tracking cookies cannot be set on someone's computer unless he gives explicit consent.

3

TRASH & LITTER

In this chapter the definitions that will be used for trash and litter will be shown. How the misplaced trash and litter situation is in the Hague, the types of trash identified through the field research, how the trash is counted by both the Hague and another more detailed way that is done by the researchers. Finally what kind of demographics drive littering and trash are discussed.

3.1. DEFINITIONS

By misplaced what is meant is that the trash or litter in the street, pavements or anywhere else than trash containers. Trash refers to large amounts of waster bundled together. Litter refers to small waste like paper cups, half-eaten food etc. that usually a person just throws on the while walking. Sometimes the words "trash" and "litter" are used interchangeably. This is not the case in this work. An illustration is given below:

Fig 3.1: Misplaced Trash

Fig 3.2: Misplaced Litter

3.2. TYPES OF TRASH

In this section the different types of trash that is identified by the municipality Hague will be discussed. The three broad categories are Trash bags, Cardboard boxes and Bulky trash.

3.2.1. TRASH BAGS

Trash bags are usually plastic bags filled with organic waste.In reality these bags also contain plastic, metal or glass usually in the form of food packaging. The focus of the social media intervention of this work will be to reduce the amount of trash in this category.Reduction of trash bags will be the main focus of the ad campaign. The main reasons that this type of trash needs to be reduced are the following:

- Misplaced organic waste gives birth to rodent infestations in houses which is already an issue for the Hague
- Seagulls and other avians destroy the bags and all the contents spill in the street, making it especially difficult for the HMS to pick up and making the city look very dirty.
- Since the Hague has is quite windy due to its close proximity to the sea, the spilled litter can travel to water canals and either contaminating or getting to the sea and creating "plastic soup".
- Organic trash and litter can create issues for public health.(Velis and Mavropoulos, 2016)

Fig 3.3: Trash bags and seagulls

3.2.2. CARDBOARD BOXES

Cardboard boxes is another important trash category. These boxes can contain almost anything but a lot of times are empty as well. They are misplaced due to the fact that their shape might not fit in the trash bin. Most of the times there is non organic trash inside them.

Fig 3.4: Cardboard Boxes

3.2.3. BULKY TRASH

Bulky trash is the third trash category identified by the municipality. This category encompasses trash that is too bulky to even fit the bin.The proper method for disposal is either taking them to the garbage and recycling stations or if it is too much, get an appointment with the municipality so the HMS can come and pick it up. In this category trash found includes old furniture, house appliances, household items etc.

Fig 3.5: Bulky Trash

3.2.4. LARGE TRASH PILES

To make counting easier, if there is a pile of trash that is impossible to count each piece individually, these pieces of trash are counted as a large trash pile. There are two types of large trash piles organic ones which are mostly comprised of trash bags and non organic ones which are mostly comprised of cardboard boxes and bulky trash.

Fig 3.6: organic large trash pile

Fig 3.7: non organic large trash pile

3.3. TRASH IN THE HAGUE

Misplaced trash in the Hague is a big issue for the city. About seven million euros are spent by the municipality per year to clean misplaced litter. Usage of underground trash bins is thirty percent lower in the Hague city than in other cities in the Netherlands(Verkaik, 2019). Due to these facts misplaced trash presents a challenge for the municipality and more creative solutions and policies are needed to combat the problem.

In which way households dispose of their trash primarily depends on area the household belongs to. In some areas there is a garbage collection day in which people take out their non-recyclable trash and a garbage truck from HMS comes and picks it up in the morning between 8:00 am and 11:00 am. In other areas trash is disposed by the occupants themselves using the underground bins that are scattered in the area they live in. These bins are emptied twice per week early in the morning around 7:00 am and the day of the week they are emptied depends in which area they are in. In this study the focus is on the areas that use the underground bins. There are recycle bins as well which are used for plastic/mental glass and paper. These usually have small openings so it is hard to dispose trash in them in bulk. The recycling bins were not considered for this study.

The heat-map below, provided by the municipality of the Hague shows the concentration misplaced trash in the Hague. The heat-map shows, for the year of 2019, the total amount of instances of misplaced trash for the three categories the municipality recognises (trash bags, boxes and bulky trash. Blue means about 0.8 to 1.5 misplaced trash instances per week (on average) in the area, yellow 1.5 to 3, red more than 3 and a red flag means more than 4. These areas are centered around underground bins as most of the misplaced trash is in close proximity to the bins.

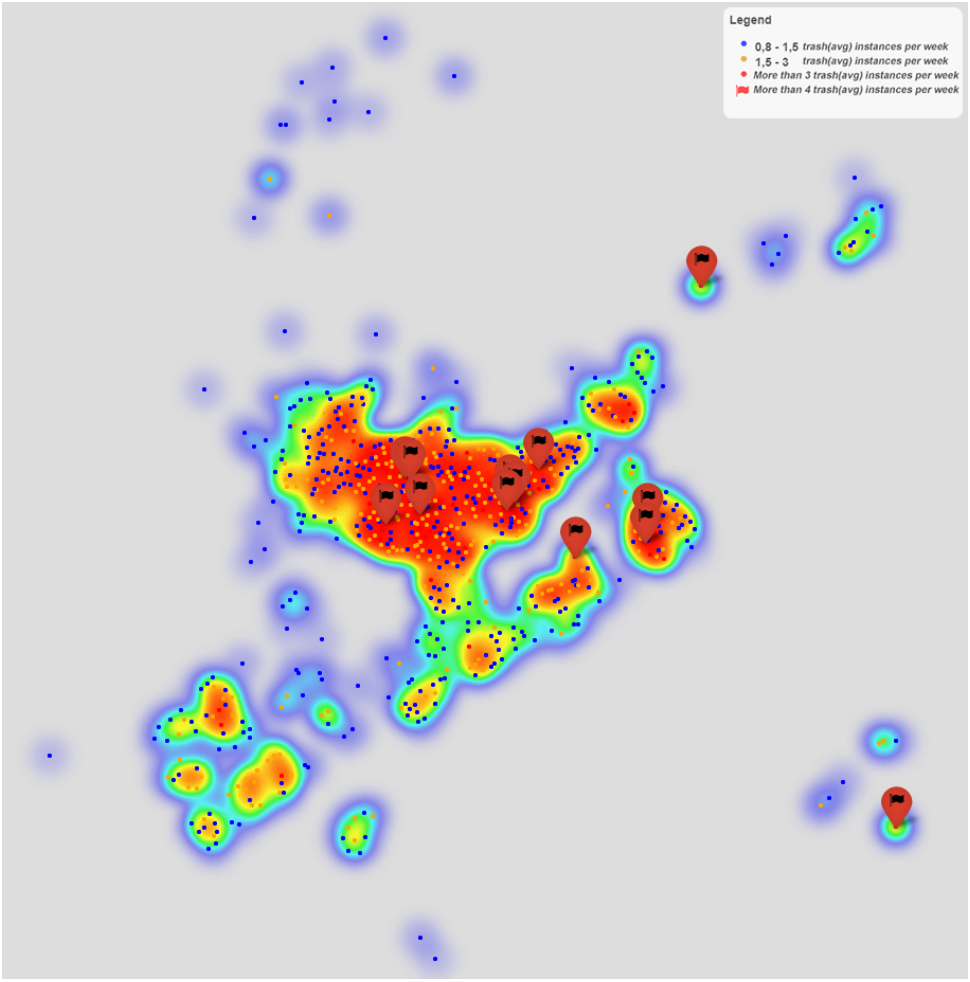


Fig 3.8: Misplaced trash heat-map of the city of the Hague

3.4. COUNTING THE TRASH

Since one of the KPIs that will that determines the success of the experiment is the amount of misplaced trash and litter before and after the intervention through Facebook counting the trash must be consistent throughout the process. Two methods of counting are presented here and used, the way the municipality counts the trash and a method that was developed for this research since there was need for a more accurate method. Both are described below.

3.4.1. THE MUNICIPALITY'S WAY OF TRASH COUNTING

Since it is admittedly difficult to exactly count the trash in a city like the Hague, counting is done by two actors. One is the HMS and the second one is a trash collec-

tion organization working with the city which goes around in small vans and removes misplaced trash. Both of these carriers also collect data on the previous trash categories mentioned.The caveat is that the collected data from both of the aforementioned sources is collected on instance basis, that means that the amount of each type of trash found in each distinct place is counted only once.

This can be better understood via an example.

Fig 3.9: Image used to exemplify different methods of trash counting

In figure 3.9 above it can be clearly seen that in this particular cluster of trash, four trash bags can be counted. But if the counting method that the Hague has is used, only one bag would be recorded as they record the existence or not of types of trash in each cluster of trash. This leads to counting less trash than there actually is but it is easier to do.

3.4.2. DETAILED WAY

Just counting instances of garbage can lead to misleading results especially when the area covered by the primary investigator is small. Since this is the case the trash is counted piece by piece (per garbage back found per box found etc.). The same categories that the municipality identified will be used. There will be some exceptions, specifically:

- Empty trash bags found will not be counted unless there is evidence of litter spillage around them, this almost always happen because seagulls and other avians peck them open in search of food.
- Sometimes huge piles of garbage are found and thus it is impossible to count individual pieces of garbage. These piles will be counted separately, and the reason of their existence will be recorded as well (for example the nearby trash bin might be broken).
- The principal investigators always check if the nearby trash bins are full or are out of order and records it.
- The general cleanliness (in respect to litter) of the area will be recorded as well. The following degrees of cleanliness have been identified:
  - 0 for clean: No more than one significant cluster of litter was photographed by the principal investigator.
  - 1 for relatively clean: Less than 3 significant clusters of litter were photographed by the principal investigator.
  - 2 for somewhat dirty: More than 3 significant clusters of litter were photographed by the principal investigator.
  - 3 for unhygienic: More than 5 significant clusters of litter were photographed by the principal investigator.

3.5. DEMOGRAPHICS OF LITTERING

An interesting thing to look at briefly is previous research that tries to find which demographics correlate with littering.

- Environmental participation: If a person participates in environmental activism they are significantly less likely to litter (Torgler *et al.*, 2012) .
- Age: It is argued that age can be used as a proxy for the social positions of a person (Torgler *et al.*, 2012). Potential costs of non compliance are increased and it has been observed that compliance increases with age.
- Gender: Similar to age women have been found to be more compliant than men due to existing culture norms (Torgler *et al.*, 2012).
- Marital Status: Married people have been found to be more compliant than singles and the “parent effect” makes them more likely to be concerned with local environmental problems, for the welfare of their children(Schultz *et al.*, 2013).
- Income: The idea behind using this demographic is to consider a clean environment a good, so demand increases with income (Torgler *et al.*, 2012).
- Existence of Trace receptacle: If a bin is close at hand people with most likely use it (Schultz *et al.*, 2013).

- Smokers: People who smoke have been found to litter more and not only with cigarette buds (Schultz *et al.*, 2013).
- Property value: Property value can be used as a proxy for the appeal of an area. Studies have shown that if an area is clean and appealing people tend to litter it less(Schultz *et al.*, 2013).

These theories and insights will be tested in practice though the Facebook experiment and see if they hold on the depending on people's interactions with the ads created.

4

EXPERIMENT DESIGN

4.1. DATA

In this section a discussion will be had about the data used in this research work.A lot of different data is used for both the preliminary analysis and as KPIs to see the success of the intervention and compare the two different ad campaigns.

4.1.1. TRASH DATA FROM THE MUNICIPALITY

As mentioned before the decision on which parts of the Hague will take part in the experiment as well as finding out which demographics are correlated with misplaced litter. The data was given in a csv format and a heat-map which focused on misplaced trash near specific trash bins. The data spans from 6/2018 to 12/2019 so 19 months of data. This data was collected using the instance method of the municipality and is the aggregated data from both the HMS and the collection organization collaborating with the HMS who is also handling the removal of misplaced trash. It entails the amount of misplaced trash per month and has multiple granularity levels, urban district(stadsdeel),district(wijk) and neighborhood (buurt). The trash categories identified are trash bags, cardboard boxes and bulky trash.

4.1.2. DEMOGRAPHICS OF THE HAGUE

In order to see which demographics are correlated with misplaced trash and to have an idea which demographics should be targeted with the ads, data from denhaagincijfers was used. The data used includes population age, population gender,population ethnicity, shops, catering facilities, average income, unemployment ratings and complaint data. The granularity of the data is the same as the trash data granularity so urban district(stadsdeel),district(wijk) and neighborhood (buurt).

Special mention should be given to the ethnicity demographics that were used, they were used a proxy for the mother language of the people who live in these areas and the nationality itself is not considered to be a cause of misplaced trash and litter.

4.1.3. FACEBOOK AD MANAGER DATA

To measure how well the different ad campaigns did, the interaction with each ad campaign as well as the demographics of the people that interacted with the ads, data was taken from Facebook ad manager. The data used includes link clicks (how many times the ad got clicked on and the user was redirected to teh website), impressions (how many times the ad appeared on someone's screen), reach (unique people that the ad appeared on screen), quality rating, engagement rating, conversion rating, average video watch time, gender of the people who interacted, age of people who interacted, reactions on ads (likes, haha etc.) and comments on the ads.

4.1.4. FIELD RESEARCH DATA

To see if the intervention was effective in reducing misplaced trash and litter, the principal investigator went to the places where the intervention was done and snapped pictures post intervention and after the intervention. The procedure is detailed in section X.

4.1.5. COMPLAINT DATA

Any citizen of the Hague can send a complaint to the municipality through phone, mail or e-mail. These complaints can be found online in denhaagincijfers. There is a special category of complaints that has to do with trash and these are the ones that are used in this work. The data granularity is the same urban district(stadsdeel),district(wijk) and neighborhood (buurt). Complaints starting on 6/2018 until 12/2019 are used for the preliminary analysis and afterwards complaints that match the post intervention and after intervention data collection dates are used.

4.1.6. WEBSITE ANALYTICS

A website that informs users on how the different types of trash should be handled according to guidelines from the municipality has been created for the purpose of this research more on on that can be found in section X. The data used from the website are the number of visits to the website, if the visits came from Facebook,Instagram,twitter or directly and the type of device used to visit the website namely desktop or handheld.

4.1.7. SURVEYS

The last type of data used are surveys. They are embedded in the site mentioned before and come in four different languages English, Dutch, Arabic and Turkish. They are comprised of 5 questions and are used for qualitative analysis and checking if the ads went to the correct neighborhood basically checking if the targeting through Facebook is as accurate as it is claimed to be.

Fig 4.1: Data points used for this work

4.2. OUTLINE OF THE EXPERIMENT

The experiment was designed to have three phases. These phases are: preliminary data collection and analysis, message creation and running the campaign and post intervention data analysis and results.

The first phase has to do with analyzing existing misplaced trash data and demographic data in order to find which demographics affect the misplacement of trash. Then three hot-spots of misplaced trash were identified that were similar in the demographics of interest and are the ones that are used for the experiment. After the identification data collection on misplaced trash was done through field research. In this phase the project was submitted for ethics approval as well as a second more detailed ethics impact assessment was done based on methodology from Deloitte, these will have their own chapter. This section of the experiment will be detailed in this chapter.

The second phase has to do with creating the scripts and videos that are used for the Facebook ad. The script was written first and the video content used that script along with the pictures that were taken by the primary investigator in the previous phase. The script was translated in to three more languages so the ads were done in four languages total. Using the Facebook ad manager the targeted areas and targeted demographics were chosen as well as the budget for ads. The monitoring of the effectiveness of the ads was done through the ad manager as well. In this phase the website and the surveys were created as well.

The third phase is about analysing the qualitative and quantitative data that was generated by the experiment and the field data collection. After this analysis the results will be discussed and explained. Depending on the results policy advice ideas will be created.

4.2.1. SPECIAL LIMITATIONS OF THE RESEARCH DUE TO COVID-19

This research coincided with the surge of the COVID-19 pandemic. This created severe problems that had to be worked around in order to proceed with the experiment. The most prevalent of those was the data availability on misplaced trash data. While the experimental component of this work was first planned ,the misplaced trash data was supposed to be provided by the municipality of the Hague and data for the whole Hague would be available. Due to the COVID-19 outbreak said data could not be gathered by the municipality anymore so the idea of scaling down the experiment to three manageable areas and collecting the data manually was implemented. This of course meant

that:

- Less data was gathered than originally intended making statistical analysis more difficult.
- A lot of time spent on this research by the primary investigator was data gathering. It took about three hours per day including Saturdays for eight weeks of data collection.
- Smaller scale experiment with just three neighborhoods being used as intervention and data collection spots.

On a more behavioural note the COVID-19 pandemic might have also have affected the behaviour of citizens. Luckily all the measurements were done while the threat of COVID-19 still existed in the Netherlands so at least the results before and after are consistent with each other.

4.3. ETHICAL IMPACTS

An important part of this work is to use micro-targeting for social good, while mitigating any risks and issues that can be caused by such an experiment. To this end two Ethical impact assessments were done. One was mandatory for this study to be approved by the university and used the template from the human research committee from TU delft and the second one was more detailed and used a template Deloitte is currently developing. Both of these can be found in the appendix . In this chapter the findings from both assessments will be detailed and the mitigation measures that were taken will be discussed.

4.3.1. INFORMED CONSENT

Informed consent is a process for getting permission before conducting an intervention on a person, or for disclosing personal information. In this work while informed consent could be given by people before they participate in one of the surveys, it could not be given by people when they saw the ad. In general this is not a big risk as they could just ignore the ad on Facebook and the ad itself did not have any content that could cause reasonable negative impacts on the people who saw it. Furthermore the ads were vetted by Facebook before they were allowed to be shown. Overall the implicit consent of people (ignoring the video) is enough for this work.

4.3.2. PRIVACY CONCERNS

Great care was taken to keep the identities and personal data of people safe in every part of the experiment. No personal data is collected or stored by the researchers explicitly. An issue that comes up here is that the ads are essentially Facebook posts. These posts are tied to a Facebook page and people commenting or liking those posts do so through their Facebook profile. This is personal data and the comments themselves will be used in this research. To mitigate the privacy breach this the comments are anonymized and the profiles of the commenters are never visited. The same happens if people react to the ad (like, angry etc.). If the users visit the website of the research they are informed about this procedure there as well.

4.3.3. IMPLICIT TARGETING OF MINORITIES

In order to approach people in a language they are most comfortable with, ethnic group data was used as a proxy. This could lead to misunderstandings from people seeing this ad and believing that their ethnic group is specifically targeted as it is the "cause" of the problem. One way this is prevented from happening is by showing that this is done for accessibility purposes in the website and informing that the study is in four different languages. The other more interactive way is by monitoring the comments on the ads and the research feedback given by the people who see the ads. This way if people misunderstand the situation, the explanation can come fast and diffuse the situation.

4.3.4. IMPLICIT EXCLUSION OF GROUPS

Participation to this work benefits the users on the long term and also broadens their awareness about the trash situation in their City. Seeing the ads and visiting the website requires connection to the internet and a Facebook account. This is not a big issue for this research as it is a pilot project but if this work was to be applied in a larger scale different ways of including people who do not have access to social media and the internet should be found.

4.4. PHASE I: PRELIMINARY DATA COLLECTION AND ANALYSIS

The objective of this phase was to first identify demographics that affected misplaced trash and to find demographically similar parts of the city that had a large amount of misplaced trash in order to run the social media interventions.

4.4.1. DATA PREPARATION

In the first phase the data used are the complaints data, the Hague demographic data and the misplaced trash data from the municipality. There are three different levels of granularity urban district(stadsdeel),district(wijk) and neighborhood (buurt). In the Hague there are eight urban districts fourty four districts and a hundred and twenty one neighborhoods. Unless otherwise noted the analysis was done on district level. The more granular the data becomes the less amount of demographic data is, for example data on the population of Moroccans had three entries missing on a district level and and twenty seven entries missing on the neighborhood level. Furthermore the missing data on the district level was in almost all cases from the districts of Forepark, Oostdeinen and Zuiderpark. These three district have very few inhabitants as well specifically hundred and twenty five, zero and hundred and seventeen so they have been removed from the analysis. The district of Willemspark has been removed from the analysis as well because there was misplaced trash data for it. So in total forty of the forty-four districts of the Hague have been considered.

The data was then normalized by dividing its values by the respective population of the district. A snapshot of the final data can be seen below:

This results to numbers which are always positive and less than zero. The only exception is the average income as it is not divided by the population since it is already the average of the population.

	Wijk	Misplaced_Litter_pp	Complaints_pp	0_19_yo_pp	20_64_yo_pp	65_above_yo_pp	male_pp	female_pp	Native_pop_pp	T
0	Archipelbuurt	0.112731	0.052154	0.189504	0.590703	0.219793	0.474733	0.525267	0.574830	
1	Belgisch Park	0.065732	0.028154	0.218101	0.578903	0.202997	0.490092	0.509908	0.626390	
2	Benoordenhout	0.031722	0.035534	0.236800	0.497195	0.266005	0.471299	0.528701	0.602503	
3	Bezuidenhout	0.075523	0.048273	0.192624	0.686340	0.121036	0.484379	0.515621	0.505344	
4	Binckhorst	0.025641	0.067797	0.056497	0.926554	0.016949	0.750109	0.249891	0.286397	
5	Bohemen, Meer en Bos	0.046914	0.027731	0.126147	0.491451	0.382402	0.441827	0.558173	0.732277	
6	Bomen- en Bloemenbuurt	0.071385	0.042831	0.207389	0.586034	0.206577	0.461127	0.538873	0.682320	

Table 4.1: Demographic misplaced trash data snapshot

4.4.2. SPEARMAN CORRELATION

In order to get insight on the data the Spearman correlation index was used to see which of the demographics were correlated with misplaced litter. Using the Python programming language the demographics which are the most correlated with misplaced trash are shown below:

	Misplaced_Trash_pp
Turkish_pop_pp	0.701682
Maroccan_pop_pp	0.590803
Surinamese_pop_pp	0.578206
Complaints_scaled	0.441096
East_euro_pop_pp	0.431058
Unmarried_pop_pp	0.383625
65_above_yo_pp	-0.452281
Average_income_pp	-0.527065
Indonesian_pop_pp	-0.680657
Native_pop_pp	-0.686591

Table 4.2: Correlation of demographics and misplaced trash

4.4.3. RECURSIVE FEATURE ELIMINATION USING RANDOM FORESTS

The recursive feature elimination method (RFE) is a recursive process that ranks features (in this case the demographic data) in how important they are in affecting a target variable (in this case misplaced litter) (Granitto *et al.*, 2006). The idea behind the method is that the model starts by including all features and then features are removed based on some metric (in this case the Root mean square deviation). (Kuhn and Johnson, 2019) The RMSE is, in essence the standard deviation of the residuals (prediction

errors) summed up. What it tells here is how "far off" is the prediction if a set amounts of features are included. This means that the RMSE needs to be "low" in general. What is important to understand here is that balance needs to be struck between the amount of features selected and a relatively low RMSE.

Random-forests is a machine-learning method for classification, regression and other tasks. Coupled with RFE it can be used to find feature importance (Kuhn and Johnson, 2019). The reason for using random-forests in this work has to do with multicollinearity. In the demographics data set variables have high correlations with each other which means they are collinear. This can create problems in some predictive models so they do not effectively identify important features, like regressions. The random-forest method in general handles multicolinearity well so it can be used to (Kuhn and Johnson, 2019) get useful insight on which demographics affect misplaced trash.

APPLICATION OF RANDOM FORESTS RFE IN R

In order to find the important demographics the R programming language was used. Specifically the libraries mlbench and randomforests. The most important features out of forty demographics according to the method mentioned above are the following (in order of importance).

Variable name	Description
Turkish_pop_pp	Turkish population per person
Indonesian_pop_pp	Indonesian population per person
Average_income	Average income
Native_pop_pp	Native population
Unmarried_pop_pp	Unmarried people per person
Complaints_scaled	Complaint amount per person scaled to the dates of trash data
Antillean_pop_pp	Antillean population per person
East_euro_pop_pp	East European population per person
Other_west_pop_pp	Other western minorities per person
0_19_yo_pp	People aged from 0-19 years old per person
Married_pop_pp	Married people per person
Surinamese_pop_pp	Surinamese population per person
20_64_yo_pp	People aged from 20-64 years old per person
Moroccan_pop_pp	Moroccan population per person
Other_non_west_pop_pp	Other non western minorities per person
Complaints_pp	Non scaled complaint amount per person

Table 4.3: Ranking of demographics based on importance

The change RMSE can be seen in this figure, it should be noted that adding one extra feature might increase the RMSE but the combination of features might decrease it.

4.4.4. K-MEANS CLUSTERING

This section will use a variation of the k-means clustering method. A cluster refers to a collection of data points aggregated together because of certain similarities.After defin-

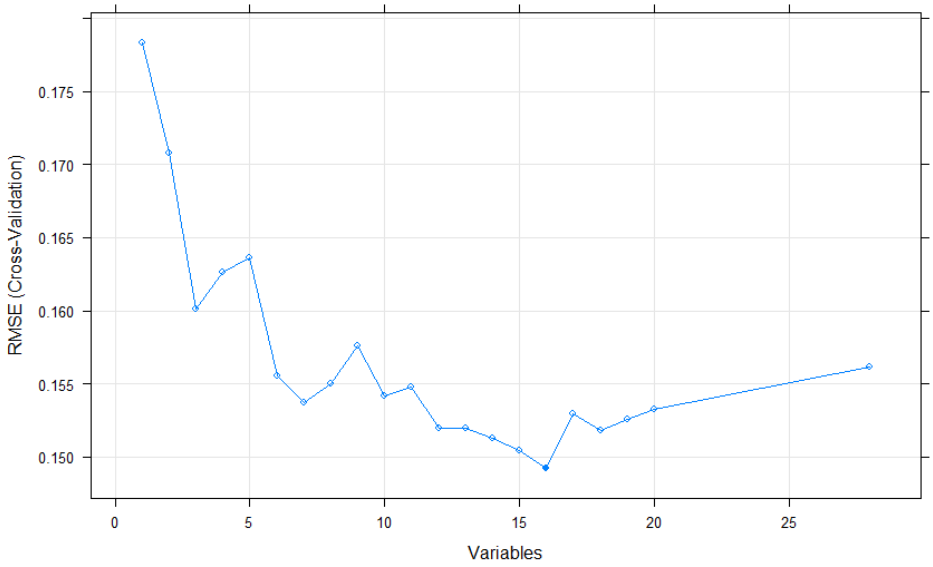


Fig 4.2: RMSE change by the introduction of new variables

ing a number K, which refers to the number of centroids needed in the data-set,every data point is allocated to each of the clusters through reducing the in-cluster sum of squares.So the k-means clustering method allocates every data point to the nearest cluster, while keeping the centroids as small as possible. The variation used here is called k-means++ (Arthur and Vassilvitskii, 2007), what this variation offers is that the initialization of the algorithm is more effective so it always converges to a good enough solution (usually it's not optimal as the k-means clustering problem is NP-complete) in polynomial time.

FEATURE SELECTION FOR CLUSTERING

In the previous sections the Spearman correlation and the random forest methods were used to find demographics that affected misplaced trash. From both methods it can be seen that low income high minority areas have a higher amount of misplaced trash. Areas with a lot of unmarried people and young people have more misplaced trash. Also the complaints give a good indication where the misplaced trash is. This of course is not a causal relationship but these demographics can serve as a guide on how the micro-targeting campaign should be set up. The table below shows the demographics that have been used for clustering and the reason.

What should also be mentioned is the reason why the Indonesian population and the Eastern European population were not included. The Indonesian population was not included because it is quite a small fraction of the total population compared to the other minorities and the research team did not have anyone who spoke Indonesian so it

Demographic	Reasoning
Turkish population	high correlation and important in RMSE analysis
Average income	high correlation and important in RMSE analysis
Surinamese population	high correlation
Unmarried population	literature and important in RMSE
Moroccan population	High correlation on of the biggest minorities in the Hague
Scaled complaints	High correlation and high RMSE
Population over 65	High correlation and literature

Table 4.4: Demographics used for clustering

would have been difficult use language targeting. The Eastern European population was not included as we did not know oh which specific ethnicities it is comprised in order to target the correct languages.

K-MEANS CLUSTERING IN PYTHON

The python programming language was used to develop the k-means++ model in order to find similar clusters of districts based on the selected demographics. The within-cluster-sum-of-squares (WCSS) method was used to find the correct amount of clusters. WCSS is the sum of squares of the distances of each data point in all clusters to their respective centroids. The goal is to find the least amount of clusters needed in order for this sum to be very low. This accomplished by using the "elbow method" so the algorithm is initialized and plot it against the WCSS for each K value (K being the amount of clusters). The plot is shown below:

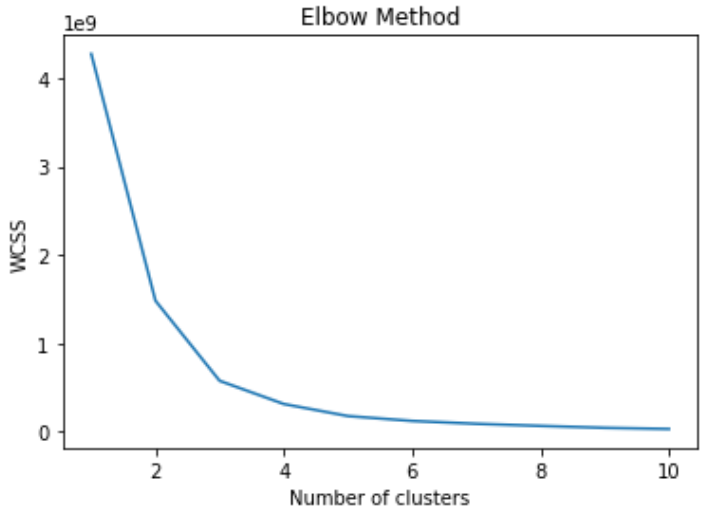


Fig 4.3: WCSS plot vs number of potential clusters

The rapid decrease of the WCSS stops at K=3 so three clusters will be used. After

running the k-means++ algorithm the location of the centroids of each cluster is shown below:

	Turkish_pop_pp	Maroccan_pop_pp	Surinamese_pop_pp	Native_pop_pp	Average_income_pp	65_above_yo_pp	Complaints_scaled	Unmarried_pop_pp
0	0.003189	0.003428	0.008780	0.611039	46633.333333	0.295554	0.099481	0.44349
1	0.135529	0.089908	0.114442	0.321118	16715.384615	0.103720	0.168473	0.61020
2	0.019119	0.020343	0.045980	0.598526	27733.333333	0.193319	0.126282	0.54189

Table 4.5 The centroids of each cluster

It is no secret that the Hague is socially segregated.

Cluster 0 represents the well off districts of the Hague high average income more older people and less trash complaints. The districts that belong in this cluster tend to have low amounts of misplaced trash.

Cluster 1 represents the districts that have high amount of minorities low average income and a lot of unmarried citizens. The demographics that are positively correlated with misplaced trash are high in this cluster and the ones that are negatively correlated are low.

Cluster 2 represents the middle ground of the two previous clusters. It should be stressed again that this is not a casual relationship but rather observations on the data that will be used for the experiment.

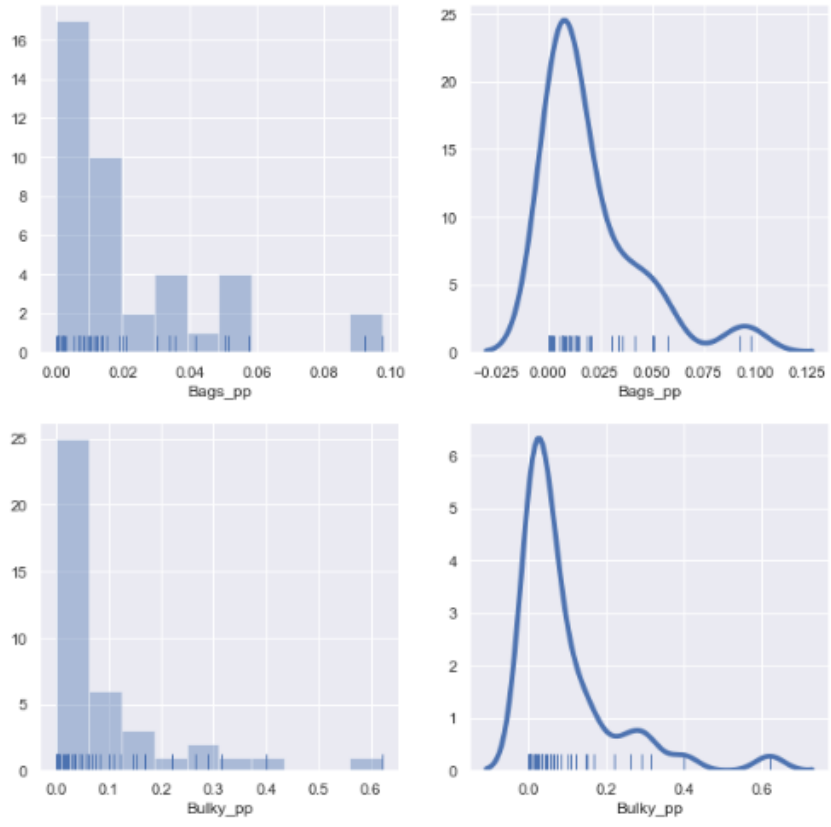
The complete list of which district can be found in which cluster is shown in Table 4.6:

4.4.5. NEGATIVE BINOMIAL REGRESSION

Another methodology was used to look at the demographics that affected misplaced trash in the Hague and that is a regression. After plotting the misplaced trash data mentioned before the distributions in the histograms below resulted:

Cluster 0	Cluster 1	Cluster 2
Archipelbuurt	Binckhorst	Belgisch Park
Benoordenhout	Bouwlust/Vrederust	Bezuidenhout
Van Stolkpark en Schev. Bos	Valkenboskwartier	Bohemen, Meer en Bos
Vogelwijk	Duindorp	Bomen- en Bloemenbuurt
Westbroekpark/Duttendel	Transvaalkwartier	Centrum
Zorgvliet	Groente- en Fruitmarkt	Duinoord
	Laakkwartier en Spoorwijk	Geuzen- en Statenkwartier
	Leyenburg	Haagse Bos
	Moerwijk	Hoornwijck
	Morgenstond	Kijkduin en Ockenburgh
	Rustenburg en Oostbroek	Kraayenstein en Vroondaal
	Schildersbuurt	Leidschenveen
	Morgenstond	Loosduinen
		Mariahoeve en Marlot
		Regentessekwartier
		Vruchtenbuurt
		Waldeck
		Scheveningen
		Wateringse Veld
		Ypenburg
		Zeeheldenkwartier

Table 4.6: Districts of the Hague and their respective cluster



By looking at the plots and understanding that these are counted data the distribution seems to be negative binomial. A good idea would be to create a negative binomial regression model using different demographics as predictors. Since a regression model is sensitive to different values being correlated with each other the demographics were picked and bundled in a way such the amount of correlated predictors was reduced in the model. The table below summarizes the results:

Variable	Description	Coefficient	P-values	Standard er
Non_Native_pop_pp	Non-native population	-0.8003	0.391	0.933
Average_income	average income	-7.9490	0.00	1.891
65_above_yo_pp	residents over 65 years old	-4.5833	0.047	2.303
Complaints_scaled	amount of complaints about trash	6.6811	0.001	2.029

Table 4.7: Regression results

The results suggest that income age and complaints affect misplaced trash and the Non native population is not really a factor due to the high P-value and a relatively close to zero coefficient. The issue here is that a regression model does not work well when the predictors are correlated with each other.

	Non_Native_pop_pp	Native_pop_pp	Average_income_pp	65_above_yo_pp	Complaints_scaled	Unmarried_pop_pp
Non_Native_pop_pp	1.000000	-0.700750	-0.889160	-0.748968	0.302814	0.516886
Native_pop_pp	-0.700750	1.000000	0.615601	0.632458	-0.490619	-0.626079
Average_income_pp	-0.889160	0.615601	1.000000	0.705943	-0.268024	-0.584643
65_above_yo_pp	-0.748968	0.632458	0.705943	1.000000	-0.450281	-0.801689
Complaints_scaled	0.302814	-0.490619	-0.268024	-0.450281	1.000000	0.590994
Unmarried_pop_pp	0.516886	-0.626079	-0.584643	-0.801689	0.590994	1.000000

Table 4.8: Correlation of the predictors for regression model

It can be seen that there are large correlations on absolute values between the Non native populations and the other predictors. This does affect the validity of the model so it is a good idea to combine the results from all the types of analysis done in order to decide on the demographics to be targeted.

4.4.6. IDENTIFICATION OF HOT-SPOTS FOR EXPERIMENT

After this analysis one thing that seems to affect misplaced trash and can be used as information to micro-targeting is language. The hypothesis here is that some districts in the Hague have high amounts of misplaced litter and high amounts of non-native population because:

- They do not understand the language that municipality uses to inform about proper trash disposal.
- There was a different method of trash disposal in their country of origin.
- If every piece of information about proper trash disposal is in Dutch even though expats might know the language there is less interest in getting informed.

It's most likely a combination of these factors but informing people in their original language will help with all the above. Using the heat-map provided by the municipality, three hot-spots which had a lot of misplaced trash were picked shown below (this a rough presentation the locations will be made concrete in the next section):

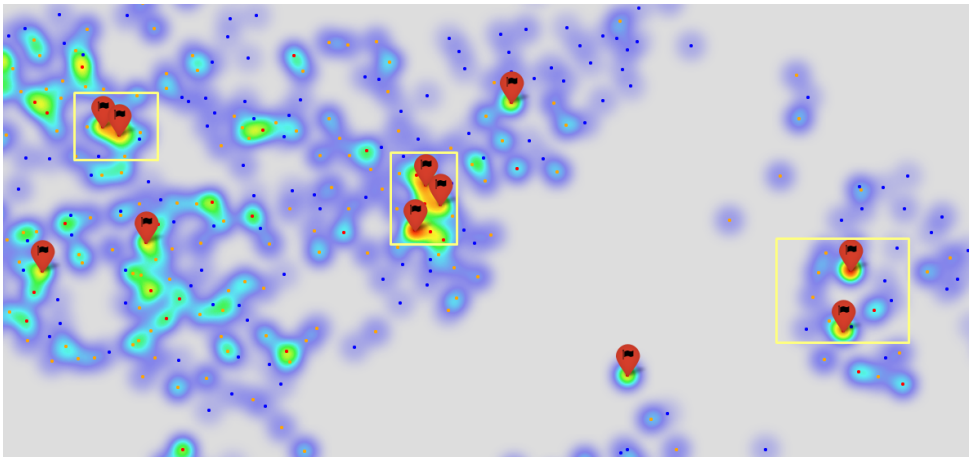


Fig 4.5: The three hot-spots selected for the experiment

4.4.7. EXPERIMENT METHODOLOGY

The methodology followed is the classic treatment and control group methodology (Hinkelmann and Kempthorne, 2007). To test the effectiveness of micro-targeted ads three misplaced trash hot-spots have been identified. One will be treated by micro-targeted ads that aim to reduce the misplaced garbage bags, the other one will be a control group and the third will get a generalized advertisement with the same aim as the micro-targeted one. Data collection about the misplaced trash in the area was done before and after the intervention in order to compare, each location with itself.

Since the locations are similar to the demographics of interest, have comparable amounts of misplaced trash, randomness was introduced , self bias was accounted for at data collection and counting , care was taken ton to have overlapping interventions as much as possible and a lot of different data-points are used the results of the experiment should be fairly reliable.

4.4.8. EXPERIMENT LOCATION DESCRIPTION

The locations where misplaced trash data collection was done and the locations the Facebook ads were run differ. The ads were run in a larger area around the location as there are limitations of of how small the areas that can be targeted by ads are. A detailed description of the areas the data misplaced trash data collection happened follows.

The first one (figure 4.6) in the neighborhood of Noordpolderbuurt, which in this work is called N-spot. It is comprised of eight different streets or parts of streets, namely Ingenhouszstraat, Drebbelstraat, Deimanstraat, Rijswijkseweg, Spilstraat, Draaistraat,

Asstraat, Laakade. Its size is roughly 0.0562 km^2.

The second one (figure 4.7) in the neighborhood of Schildersbuurt-Oost, which in this work is called S-spot. It is comprised of eight different streets or parts of streets, namely Vaillantlaan, Frans Halsstraat, Van der Heistraat, David Blesstraat, Hoefkade, Berckheydestraat, Van Ostaderstraat, Jacob Marisstraat. Its size is roughly 0.051 km^2.

The third one (figure 4.8) in the neighborhood of Transvaalkwartier-Midden, which in this work is called T-spot. It is comprised of eight different streets or parts of streets, namely Brandtstraat, Kritzingerstraat, Hertzogstraat, Schalk Burgerstraat, Delftselaan, Engelenburgestraat, Retiefstraat, Herman Costerstraat. Its size is roughly 0.0509 km^2.

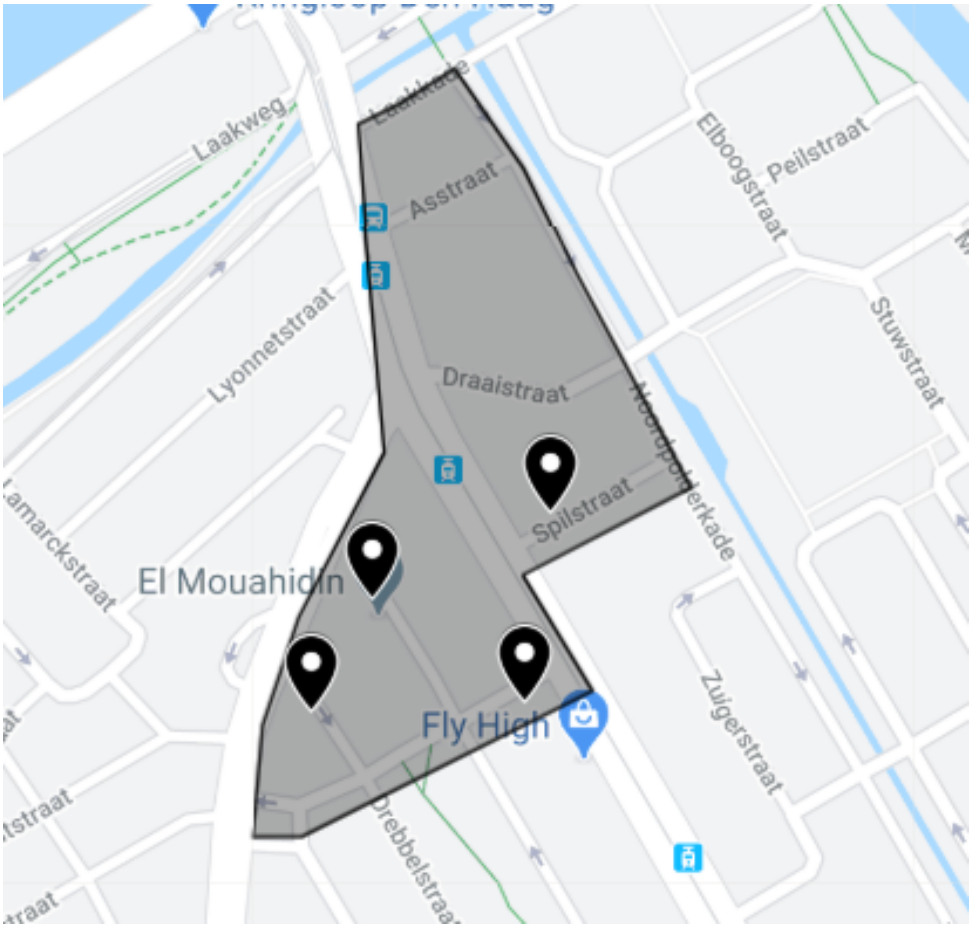


Fig 4.6: N-spot

The pins refer to some of the underground bins that have a high concentration of

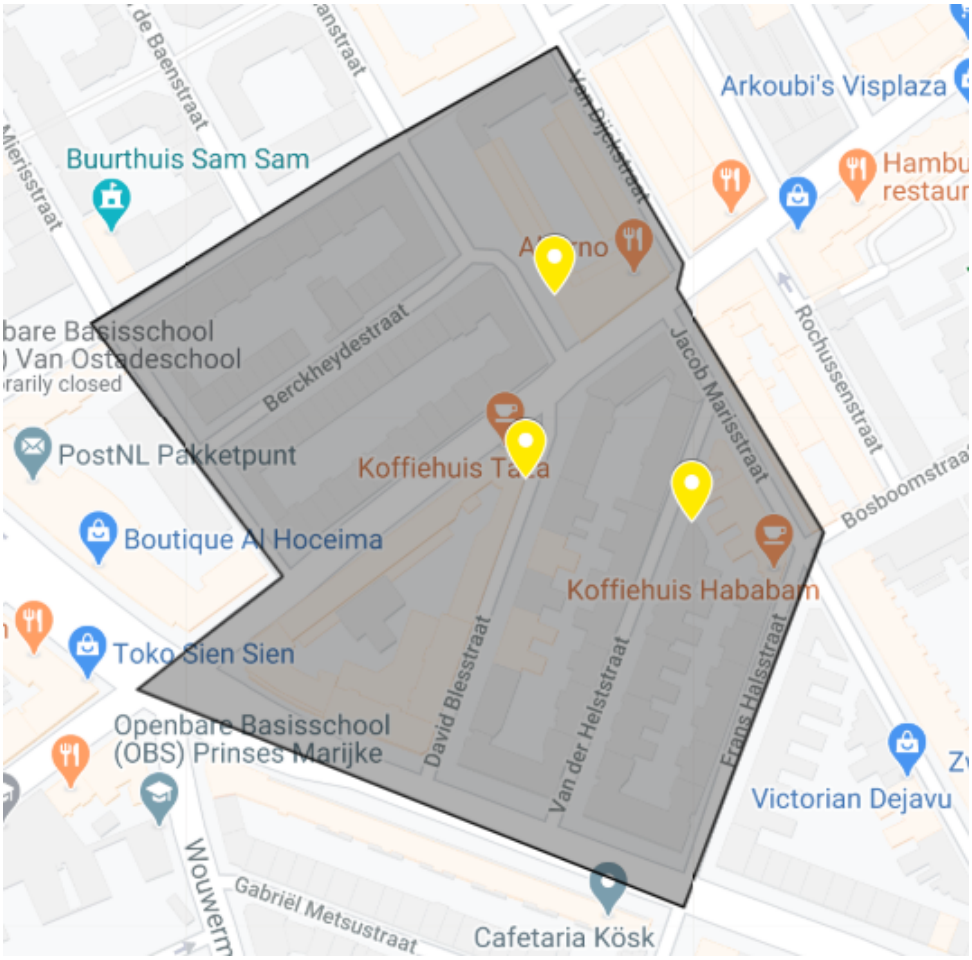


Fig 4.7: S-spot

misplaced trash according to the data provided by the municipality but there are a lot more bins inside each spot. The N-spot belongs in the district of Laakkwartier and Spoorwijk, the S-spot in the district of Schildersbuurt and the T-spot in the district of Transvaalkwartier. This means that they all belong in cluster 1 and are similar over the demographics used for clustering.

4.4.9. DATA COLLECTION METHODOLOGY

The principal investigator visits two of the three spots every day of the week except Sundays. On working days the workers from the Haagse Milieu Services (HMS), will start picking up the trash around 8 to 8.30 am so the data collection is always finished by that time. On Saturdays, the trash cleaning starts at about 10 am so the data collection is finished before that time.

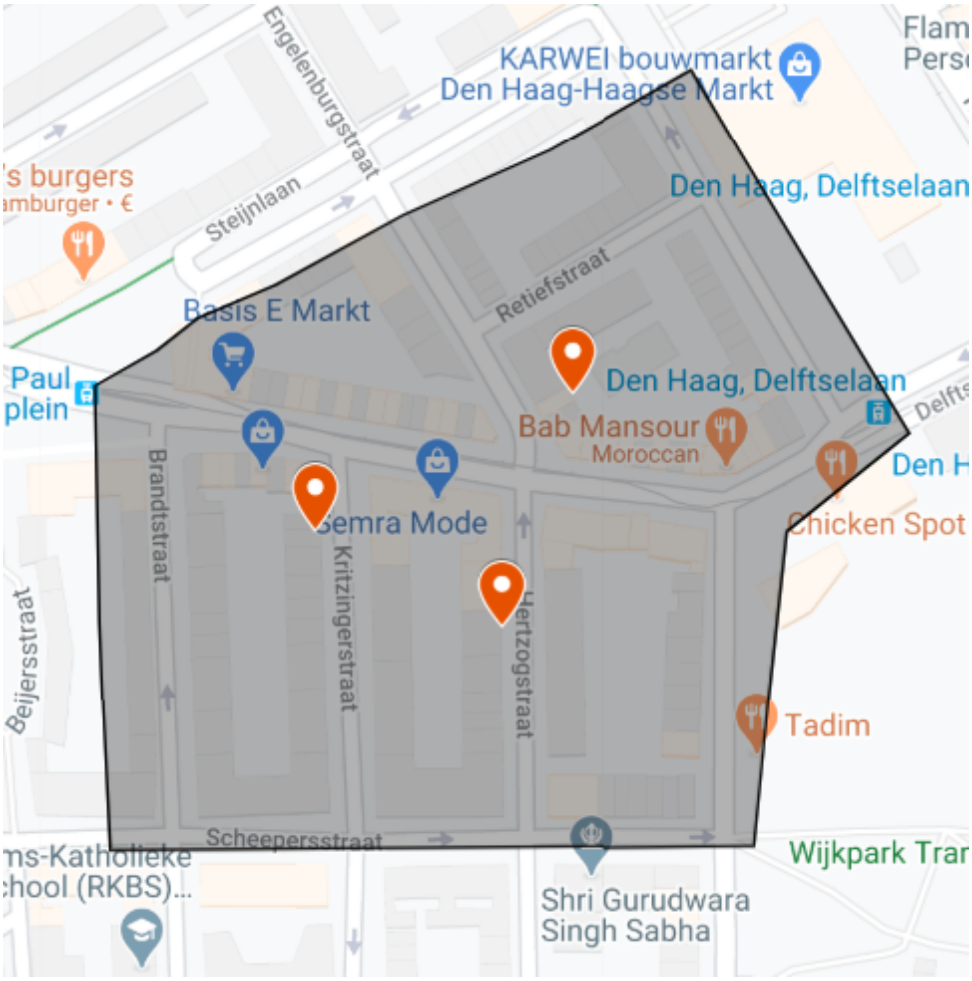


Fig 4.8: T-spot

The data collection is done by taking photos of the trash on the street as well as of big clusters of litter. The photos are timestamped, and location stamped. Since the trash collection by the HMS happens quite early it is not feasible for one person to visit all three locations in one day. Thus each day of the week except Sundays a pair of locations is visited. These pairs are randomized per week and it is made sure that each location is visited three times per week. The data collection before the start of the intervention lasted four weeks from 20/5 to 16/6 and resulted in twelve observations for each location. The data collection after the intervention lasted for another four weeks, the first three ones were done while the ads were running and the last one without the ads running. This part of the data collection started on 22/7 and finished in 18/8 and netted twelve observations for each location. The exact schedule of the collection is in the appendix.

DATA COLLECTION BIAS

Since all the misplaced trash data was collected by the same person and the hypothesis for the experiment was known beforehand, some measures needed to be taken in order for the primary investigator to not implicitly bias the study:

- Development of a data counting methodology and consistently use it.
- The places where the different interventions happened were picked at random and before the pre-intervention data was counted.
- The post-intervention data was not counted until the ads stopped running. The order the locations were visited is the same pre and post intervention and were randomised as well.

5

RUNNING THE EXPERIMENT

In this chapter a description on how the experiment was run will be given.What features were created to accommodate more robust data collection will be highlighted. The process of how the message was created will be outlined and how Facebook ad manager was used to deliver that message.

5.1. MICRO-TARGETED FEATURES

After the initial analysis, by looking at the literature and by taking into account the strengths and the limitations of the experimental methods that was used two characteristics of the population that would be subjected to the ad will be used for the micro-targeted ads, their native language and their location.

5.1.1. LANGUAGE

Since open data on the ethnicities that reside in the Hague was available high concentration of minorities in the area showed positive correlation with misplaced trash language was the first micro-targeted characteristic used. To live comfortably in the Netherlands one must be able to speak either English or Dutch. So most of the audience of the ads are at least bilingual. In low income areas (which was a characteristic of areas used for this experiment) live immigrants who recently arrived or short term workers who come for a few months. Those groups have a high chance of not knowing either English or Dutch. Ads in the native language of the consumer have been experimentally found to be much more effective (Noriega and Blair, 2008) and of course the ad is not really effective if the language cannot be understood. This notion of informing people on different languages have been supported by the municipality of the Hague as well. Thus there are strong arguments for using language as a parameter.

5.1.2. LOCATION

The second parameter used for micro-targeting is more implicit. Since there was knowledge about in which areas the ads were sent and the principal investigator would

visit part of these areas of data collection the videos that went to the micro-targeted locations used pictures taken by the primary investigator when visiting the areas. Subliminal advertising has been shown to be effective (Moore, 1982) especially when visual material is used. The idea is that subconsciously people will recognise parts of the areas they live in and they will be more likely to take action by seeing the ads.

5.2. WEBSITE

To supplement and support the experiment a website has been created. The "clicks" on the Facebook ads will redirect to this website as well. It was created using the paid version of a platform called Wix. The website used the domain https://www.fight-the-trash.nl/ which matched the name of the Facebook page supporting the experiment. In this website links to the surveys of this research can be found as well as practical advice about how to deal with different types of trash in the Hague. The videos that are used for the Facebook ads are uploaded to this website as the privacy statement for this work and more information about the research including ways of contacting the researchers and a form to share opinions about the research.

5.2.1. SURVEYS

Based on the fact that one of the targeted characteristics was language surveys matching these languages were created. The purpose of the surveys is as follows:

- See if the ads got sent outside their respective zones.
- Since Facebook posts the ads on other media as well (Instagram, twitter etc.) it was a check where people saw the ad.
- Get people's feedback about trash related issues and policy.

They were kept short in order to encourage people filling them in and were hosted on a website owned by the researchers. The full survey can be found in the appendix.

5.2.2. PRIVACY & CONTACT

Both the survey and the website have an opening statement and a privacy statement respectively. This informs people about the research and how their data is used. On top of that there is a separate page that explains more about the research and includes ways to contact the researchers as well as a research feedback from.

5.3. PHASE II: MESSAGE CREATION FACEBOOK AD MANAGER

In phase II the results from Phase one were used along with literature and audio visual content creation and the Facebook ad manager to create and run the ad campaigns.

5.3.1. SCRIPT CREATION

The first thing that needed to be created was the script for the video advertisement. The message itself in any form is essentially a "nudge", because it tries to alter the user's behavior in a predictable way without forbidding any options or significantly changing

their economic incentives and it is easy to avoid since users can just "scroll down" and stop seeing the ad(Thaler and Sunstein, 2008).More specifically the creation of the script was based on the ideas from (Vries, 2020) as it is more focused on "nudging" people towards more sustainable practices. The following guidelines were used:

- Simple message (avoiding complexity)
- Clearly defined actions.
- Local attachment
- Descriptive social norms
- Tailored message to relevant values

The message used was simple without any jargon the action was one and clear which was to put the trash in the bin, the Hague was referred to as our city, the video described what other cities in the Netherlands were doing well and the message was tailored to the values of cleanliness and public health as well as ecological values. The full script follows:

Unattended trash is a big issue for the Hague. Other cities in the Netherlands use their underground bins 30% more than we do.The biggest reason for rodent infestations in our homes is trash in the streets. The solution? Simple. Put your trash in the bin! If the bin is full, just walk to the next street instead of leaving it next to it; a bit of exercise these days is welcome after all. Let us give our city the love it deserves!

This was then translated by native speakers and used for the ad videos.

5.3.2. AUDIO VISUAL MATERIAL CREATION

The procedure of how each video was created will be outlined in this section. A draft storyboard was created for the video. After the raw videos were acquired, the videos that will be used were shorted out.(either parts or whole videos).Adobe premier was used to process the video after they had been converted to the appropriate format Afterward the main project was create as a template. The video material was imported for the first ad and work was done to make the subtitles.. The Arabic subtitles were first in Adobe Photoshop because they presented better than in Premiere. The PNG files in were created in Photoshop and then imported in Premiere. Using the main project as a template, each ad was worked in in a different save file.

Next step was to select the photos of the trash. Photos which were more clear and the objects were better centered the bins which were not working were picked on purpose in order to show that sometimes someone had to walk to the next bin. They were imported in the software and inserted in the timeline. Adjustments were made to their size and some color correction. Some photos were color corrected in Adobe Photoshop first, then imported in the Premiere project.

Afterwards the transitions between the photos was tackled. The transitions were created with small animations and added a color matte with opacity, serving as a background at the bottom of the video for the subtitles. It was made sure to create transitions

and cuts for that, as well with size readjustments depending on the number of lines the subtitle card had. This was the time the title cards in the beginning and their animation were also created.

The soundtrack was picked from work that did not have copyrights to use as background music for the ad and adjusted a bit its length, adding some slow gain and fading in its start and ending. A card was created at the end with the project info in Adobe Photoshop as well. For the generalized Dutch video with the google photos, a small animation with a png file of a red heart was created. The photos of this video were download from Google.

Reaching the final stages of the project, some small tweaking was done, a few changes here and there, some improvement in the animation or using the EQ to perfect the video sound alongside the soundtrack. The final step was the rendering and exporting of the videos with the appropriate settings.

5.3.3. TARGETED LOCATIONS

One challenge that Facebook creates is that the targeting of relatively “small” locations is difficult. As the misplaced trash data collection is limited to the locations mentioned before and Facebook, at least for the Netherlands, does not allow targeting using postal codes, the only way to do the advertisement campaign and focus on specific locations is by using the “pin” system of Facebook. This effectively means that we are using one-mile radius “pins” (the smallest ones that Facebook allows) one the map to say where we want our ad to me shown or not. See the pictures below for reference:

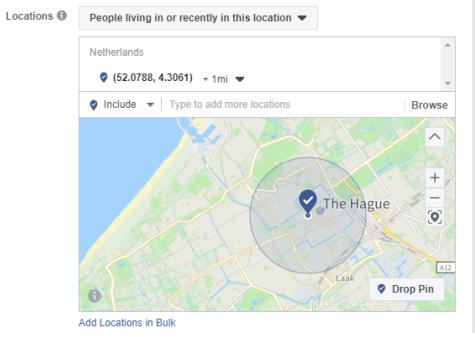


Fig 6.1: Facebook "include" pin

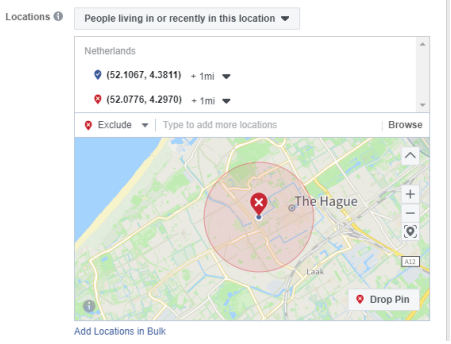


Fig 6.2: Facebook "exclude" pin

Through a combination of inclusion and exclusion pins an area for the advertisements to run is created, below all the data collection spots mentioned before can be seen as well as the bigger are around them is roughly the area that Facebook claims the ads will reach.

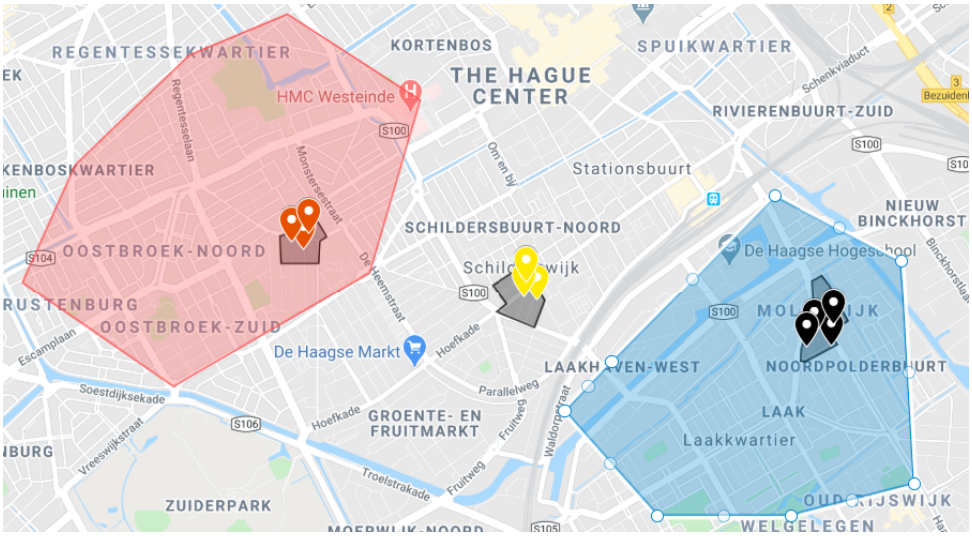


Fig 6.3: Areas where the ads were run

The red area is the micro-targeted area and the blue area is the area getting the general advertisements. is no perceived overlap between the regions but there is no assurance of that as Facebook ad managers does not offer this kind of transparency, a small questionnaire is used to fact check this and more can be found in the questionnaire section, the control group will be used as well to see if the ads "leak" on other neighborhoods. It can be seen that the area the ads affect is a lot larger than the area where the data collection happens. The reason for this is that Facebook ad manager is not made to deliver ads to very few people, specifically having less than a thousand prospective viewers does not allow a preview on how the viewers will respond to the ad.

5.3.4. FACEBOOK AD MANAGER

To manage the ad campaigns and monitor them Facebook ad manager was used. This is a tool provided by Facebook to create, manage campaigns and also gather and present required data. Two ad campaigns were created. One generalized campaign focusing in the area around the N-spot and one micro-targeted campaign focusing on the T-spot.

5.3.5. GENERALIZED CAMPAIGN

The Generalized campaign was done by using the script mentioned before, but only in Dutch and the video showed relevant pictures downloaded from the web. There was just one ad and its parameters are shown in the table below:

DUTCH GENERALIZED AD

The generalized Dutch ad was shown around the N-spot and the language used was Dutch with dutch subtitles. The video can be seen below:

5.3.6. MICRO-TARGETED CAMPAIGN

The micro-targeted campaign is composed of four different ads. All these ads use the same script but the person who takes part in is different and the language is different. The ads were in Dutch, English, Turkish and Arabic (Moroccan dialect). Pictures from the micro-targeted location was used in the ads.

DUTCH MICRO-TARGETED AD

The same person who was in the generalized ad also takes part in the Dutch micro-targeted ad.

TURKISH MICRO-TARGETED AD

The Turkish video followed a similar pattern with Turkish subtitles.

ENGLISH MICRO-TARGETED AD

Similarly the English video follows, it is worth noting that the person staring in the video is male compared to the other four videos where the protagonist was female.

ARABIC MICRO-TARGETED AD

The audio of the Arabic video was in the Arabic-Moroccan dialect since a lot of the Arabic speakers in the Hague are from Morocco the subtitles though were in standard Arabic.

6

RESULTS

In this chapter the analysis of the results after the experiment was completed will be described. The results themselves are of both quantitative and qualitative nature. Qualitative results come from the answers to the survey, the comments of the Facebook ads and the Facebook page messages received. The quantitative results come from the KPIs of the Facebook ad manager and the analysis on the collected data about misplaced trash in the Hague.

6.1. PHASE III:RESULT ANALYSIS, QUANTITATIVE RESULTS

In this section the qualitative results of the work will be described. A discussion of the key results will follow at the end.

6.1.1. FACEBOOK AD MANAGER

Facebook ad manager uses many KPIs to to showcase the effectiveness of the ads. A description of each KPI used follows:

- **Link clicks:** The number of clicks on links within the ad that led to advertiser-specified destinations, on or off Facebook.
- **Reach:** The number of people who saw the ad at least once. Reach is different from impressions, which may include multiple views of your ads by the same people.
- **Impressions:**Impressions: The number of times the ad was on screen.
- **Cost per Result:** The average cost per result from the ad.
- **Quality Ranking:**A ranking of the ad's perceived quality. Quality is measured using feedback on the ads and the post-click experience. The ad is ranked against the other ads that competed for the same audience.

- **Engagement Rate Ranking:** A ranking of the ad's expected engagement rate. Engagement includes all clicks, likes, comments and shares. The ad is ranked against other ads that competed for the same audience.

- **Conversion Rate Ranking:** A ranking of the ad's expected conversion rate. Essentially an indicator of how much action was taken by the viewers of the ad. The ad is ranked against ads with the same optimization goal that competed for the same audience.

- **Frequency :** The average number of times each person saw your ad.

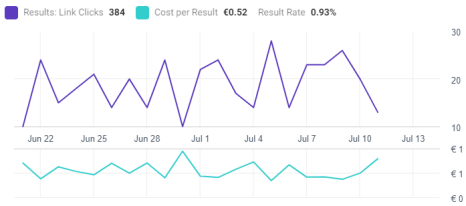


Fig 7.1: Generalized Campaign Link clicks, Cost per result & Result Rate

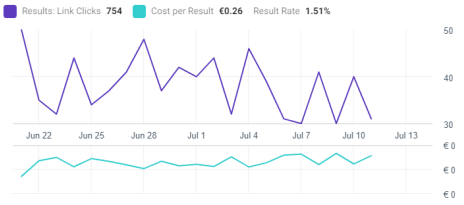


Fig 7.2: Micro-targeted Campaign Link clicks, Cost per result & Result Rate

6

From the two figures above it can be seen that overall, the micro-targeted campaign had more success than the generalized one on link clicks, users found the micro-targeted ads more interesting since the two populations that saw the ad were homogeneous. Specifically the micro-targeted campaign had 754 link clicks while the generalized campaign had 384 link clicks. A second important metric that can be seen here is the cost per result. Since Facebook ads are shown to people using an auction system, the idea is that the ads that are more relevant and are interacted with the most ,have a lower price per click in order to be shown. It can be seen that the cost is double in the generalized campaign compared to the micro-targeted one(0.52 euros for the generalized and 0.26 euros for the micro-targeted one). That means that users interacted more with the micro-targeted ads than the generalized one so with the same budget the micro-targeted campaign gave "more buck for its bang".

One thing that must be pointed out is that the multiple ads from the micro-targeted campaign "competed" with each other for views, while the generalized ad, since it was only one, did not. That means that the unique amount of people who saw the generalized ad were more than those who saw one of the micro-targeted ones. Figure 7.3 and Figure 7.4 illustrate this.

So, the generalized campaign reached more unique Facebook users, but the ad was shown more times to the same people in the micro-targeted campaign. The second reason this happened is that there was no targeting involved in the generalized campaign while the micro-targeted ads where only shown to people who spoke the aforementioned languages, so some people in the area were excluded and the audience was

smaller. Another interesting point to make is that, on average, someone saw the generalized ad 2.42 times while the micro-targeted ad was seen 4.01 times. Repetition in seeing the ad could mean an increased chance of taking action (Wakefield, Loken, Hornik, 2010).

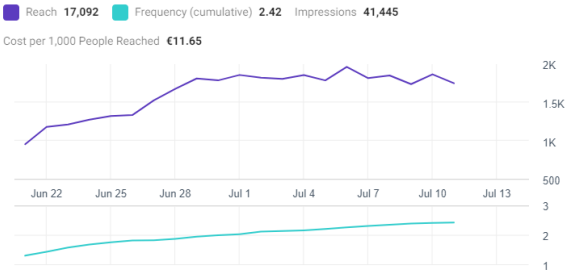


Fig 7.3: Generalized Campaign reach, frequency & impressions

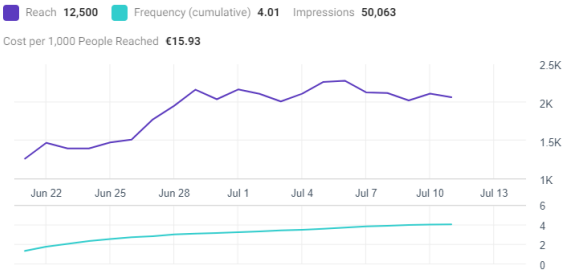


Fig 7.4: Micro-targeted Campaign reach, frequency & impressions

Specifically for the videos the table below summarizes the results:

Video	Total video plays	At Least Three second plays	At least 25% of video	100% of video	Video plays per person	Unique video plays
Generalized Dutch ad	28675	24% (6882)	9% (2581)	3% (860)	2.45	11704
Total Micro-targeted ads	34447	25% (8,612)	12.5% (4035)	7.5% (2584)	3.65	9437
Arabic ad	8509	22% (1872)	9% (766)	7% (596)	3.75	2269
Dutch micro-targeted ad	7798	34% (2651)	18% (1381)	10% (747)	2.42	3222
Turkish ad	10121	17% (1720)	11% (1113)	6% (607)	6	1686
English ad	8019	26% (2085)	12% (962)	7% (561)	2.43	3300

Table 7.1: Statistics on the video views for the ads

What can be seen in the table above is that even though around the same percentage of people saw just the first three seconds of the video, the micro-targeted ad was more successful in keeping people to continue watching. The Turkish video seems to not follow this pattern exactly, but the Turkish audience was the smallest one compared to the micro-targeted audiences so there were a lot of repeats of the video. This means that people who saw it once would probably skip it the next time, so the amount of video played went down.

The first three seconds of each video basically sum up that misplaced trash is a big problem for the Hague. This along with the Facebook caption for the ad is enough for people to understand what the video is about. To understand the message what to do

people need to at least see twenty-five percent of the video and in order to learn more about the other actions they could do to help change the trash situation, people have to click on the link and/or see the whole video.

Facebook ad manager uses some qualitative KPIs as well to check the effectiveness of ads. The table below shows these KPIs for each ad:

Ad	Quality Ranking	Engagement Rate Ranking	Conversion Rate Ranking
Generalized Dutch ad	Bottom 20%	Average	Below average
Arabic ad	Bottom 35%	Above average	Above average
Dutch micro-targeted ad	Bottom 35%	Above average	Average
Turkish ad	Bottom 35%	Above average	Above average
English ad	Bottom 35%	Above average	Above average

Table 7.2: Qualitative KPIs of videos

Overall it can be seen that the Ad quality is not high but this is normal because the ads were not a professionally created. In all the categories the micro-targeted ads, according to Facebook ad manager, performed better. It is interesting that the Dutch micro-targeted ad scored as average in the conversion rate. Since the conversion rate has to do with people clicking to go to the websites this seems to point out that clicking on the ad was more enticing for the minorities targeted since the ad was in their mother language.

SITE ANALYTICS

The results from the Wix site visits are summarized in the table below:

Site visits	Bounce rate	Unique visits	Facebook visits	Direct Visits	Twitter visits
750	92%	653	620	105	20

Table 7.3: Website analytics

- **Site Visits:** Total site visits to the site that lasted three seconds or more

- **Bounce rate:** Percentage of visits that only visited the main page of the site.
- **Unique visits:** Unique site visitors based on IP.
- **Facebook visits:** Visits that came directly from Facebook.
- **Direct visits:** Visits that came by directly typing the url in the browser.
- **Twitter visits:** Visits that came from twitter.

Only 620 compared to the 1138 clicks were registered as visits in the website. There are multiple reasons for this but the most prevalent ones are that either there were miss-clicks on the ad on Facebook or people were not interested enough to stay for enough time in order for Wix to register a visit. The later reason might have to do withe content of the website or it could be due to an unstable connection from the user. Another interesting observation is that only eight percent read the other pages of the website which included details about the research and the privacy statement for participating in the survey and the research.

AD DEMOGRAPHICS

Demographic wise in both campaigns we had a split of about 60-40 with more men seeing them and age wise, the scale tipped towards the 18-44 range. This is interesting as the locations that are getting the ads have a roughly 50-50 split between men and women so either Facebook believes that men are more “interested” in the content of the ad or women do not use Facebook as much as men in these neighborhoods.

Fig 7.5: Generalized Campaign demographics breakdown

Fig 7.6: Micro-targeted Campaign demographics breakdown

6.1.2. DISCUSSION ON FACEBOOK AD MANAGER RESULTS

Overall, there is evidence that the micro-targeted campaign was more effective than the generalized one. The micro-targeted campaign was more relevant to users and had almost double the number of clicks than the generalized. This is considering that the unique audience of the generalized campaign was bigger as there were no targeting criteria. That is also the reason that the generalized campaign had a higher reach along with the fact that the different ads in the micro-targeted campaign were “competing” for spots in the Facebook auction. No real conclusion can be drawn about the demographics of the participants other than the ones mentioned before. There is evidence that supports that the micro-targeted videos were more attractive to the audience and were watched for a longer period of time.

Facebook ad manager is mostly used to create ads to sell products and services. In this work it was used to "nudge" people to change their behaviour. Therefore the most important metrics from the ones presented here are Link clicks (which affect cost per result and conversion rate) because this means people read the website and got informed and Engagement rating as more interaction with the ad (commenting liking etc.) leads to the exchange of opinions and at least questioning if the current behavior of the user is correct. Since the micro-targeted ads did better in all of these KPIs it can be concluded that they were more effective in changing people’s behaviour according to the Facebook ad manager data.

6.1.3. ANALYSIS ON MISPLACED TRASH DATA

Misplaced trash photographed before and after the intervention was counted, as mentioned before, and plotted over time. After the counting the way the municipality counted the trash it was found out that this way underestimated the quantity of the misplaced trash, so there was a choice to focus on the trash counted by the method the principal investigator came up.

- **N-spot:** Generalized ad spot
- **S-spot:** Control spot
- **T-spot:** Micro-targeted ads spot

It should be pointed out that from all the types of misplaced types of trash only the misplaced trash bags will be considered for analysis.The reasoning behind this decision is that the intervention specifically tried to change peoples behavior towards putting their trash bags in the underground bin. The time-series depicting the rest of the types of trash can be found in the appendix.

TIME-SERIES

This is the spot that the generalized advertisement affected. The intervention started on the 21/6/2020 and stopped 11/7/2020 (red dashed lines) but some spots were not visited on there dates.

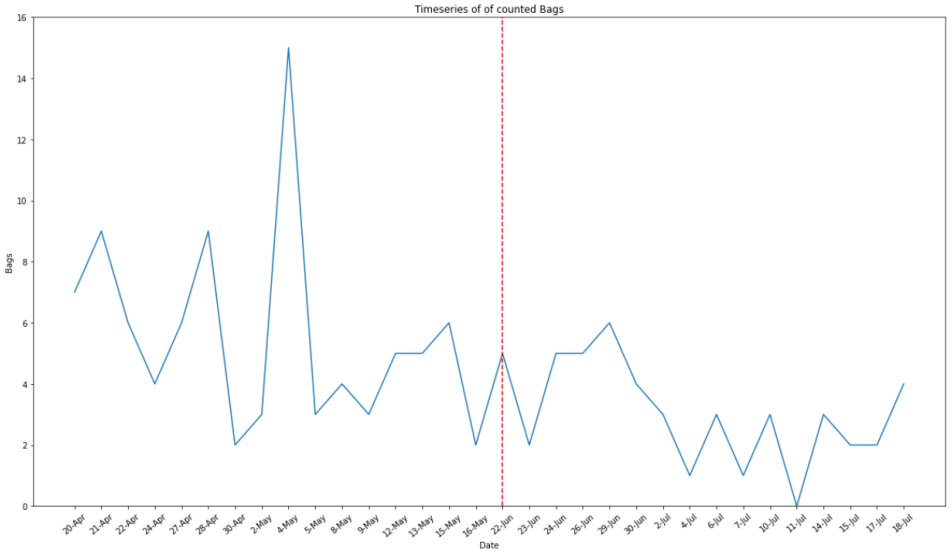


Fig 7.7: Time-series of Misplaced trash-bags in N-spot

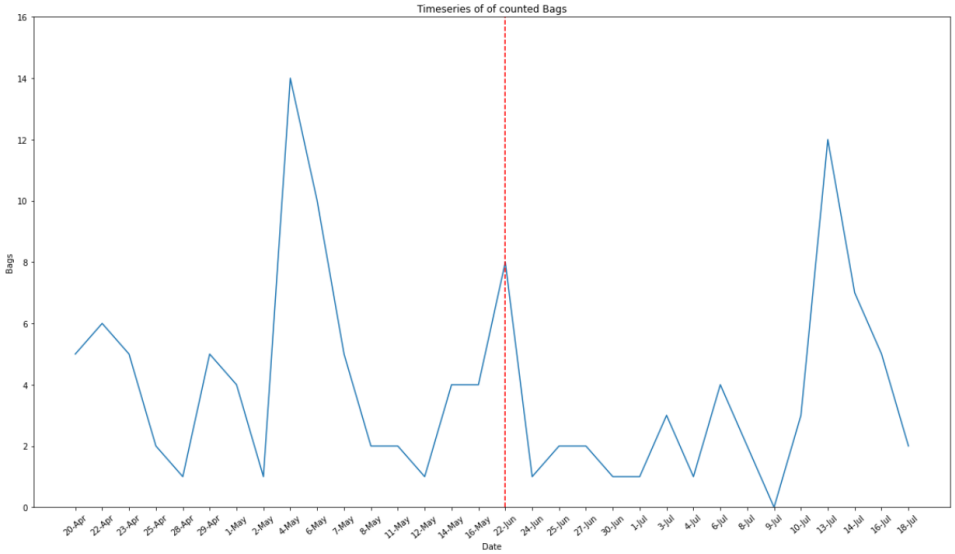


Fig 7.8: Time-series of Misplaced trash-bags in S-spot

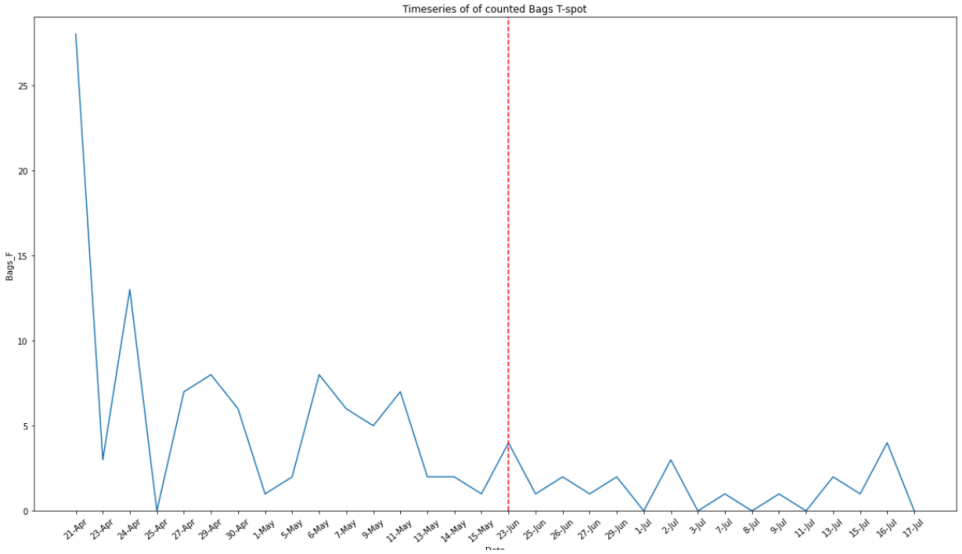


Fig 7.9: Time-series of Misplaced trash-bags in T-spot

Some kind of decrease can be seen by glancing at the figures but further analysis is required.

DISTRIBUTION ANALYSIS

The first step to understand the data is to plot them in a histogram and find their distributions. Looking at the figures below and with the knowledge that it the misplaced trash is a count type variable, a negative binomial distribution seems to be a good fit as a lot of data is closer to the left side of the graphs. It is important to assume the same underlying distribution in order to be able to compare the results of the rest of the analysis with each other.

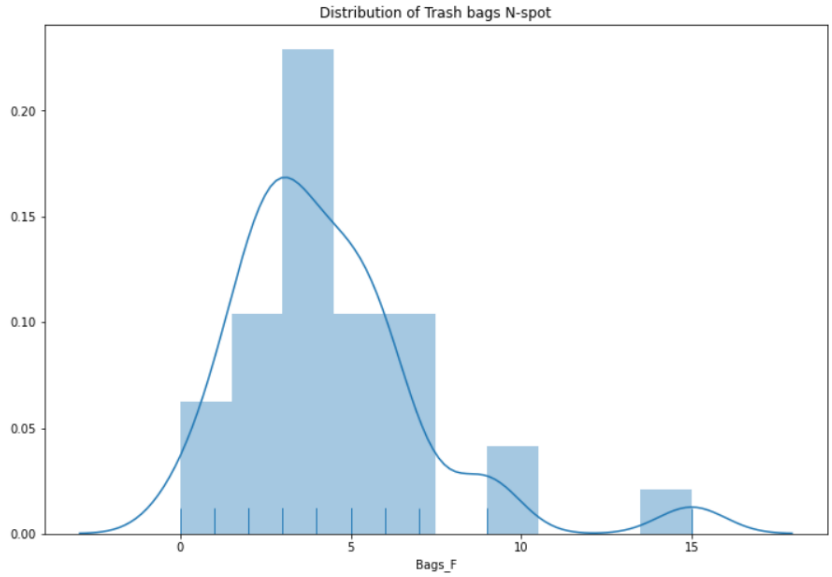


Fig 7.10: Distribution of Trash bags using collected data N-spot

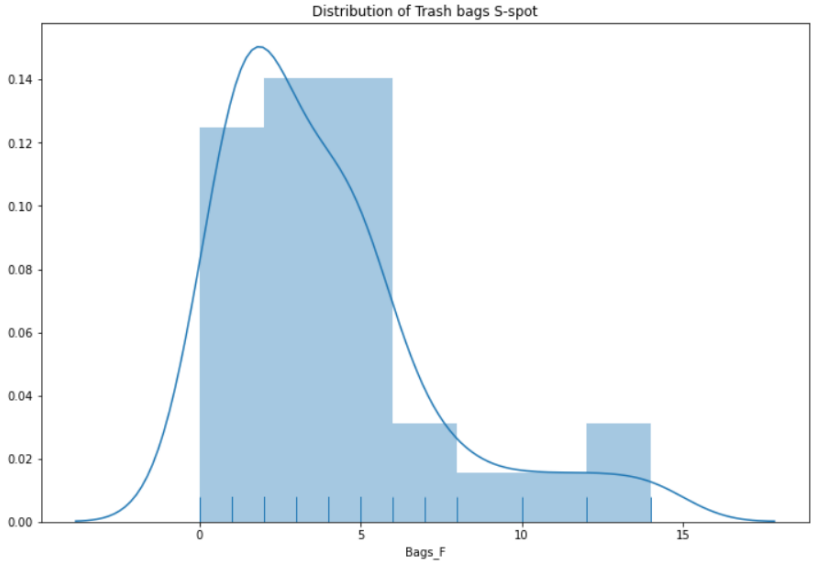


Fig 7.11: Distribution of Trash bags using collected data S-spot

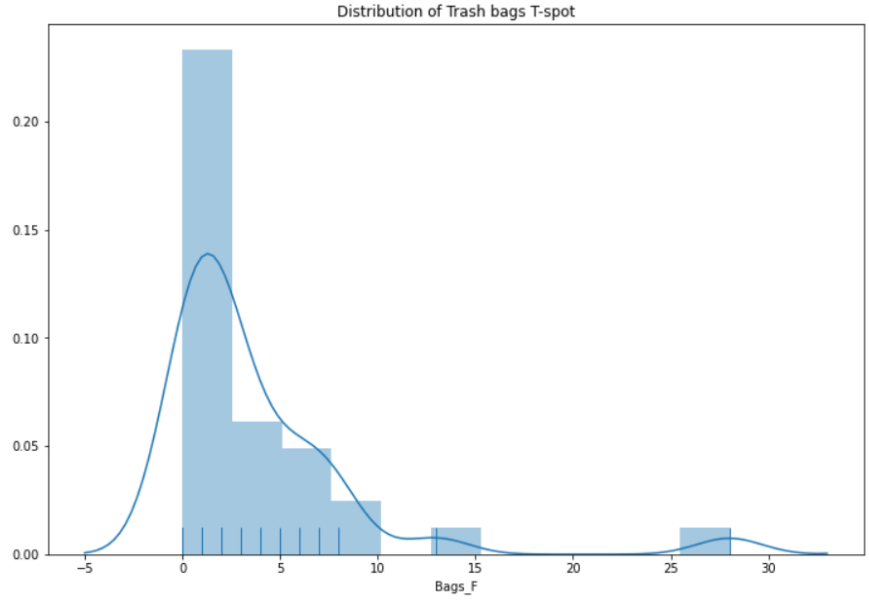


Fig 7.12: Distribution of Trash bags using collected data T-spot

WILCOXON SIGNED-RANK TEST

An important observation here is that none of the spots have a normal distribution.

In order to see if there was a distributional change before and after the intervention a statistical test needs to be used. The fact that the data i snot normally distributed prohibits the use of a parametric statistical test. So, the Wilcoxon signed-rank test(Wilcoxon, 1945) will be used to see if there was change in the distribution of the data and the results are summarized in the table below:

Spot	Null Hypothesis	P-value	Mean (Stdv) Before	Mean (Stdv) After
N-spot	Rejected	0.006	5.562(3.220)	4.312 (2.844)
S-spot	Not Rejected	0.334	4.438(3.354)	3.906 (3.273)
T-spot	Rejected	0.001	6.188(6.550)	3.781 (5.302)

Fig Table 7.4: Distribution of Trash bags using collected data T-spot

The idea behind this statistical test is that the starting null hypothesis is defined as "No distributional change in the data before and after the intervention". The test's target P-value was set to 0.05 so any spot with lower P-value than this had a change in distribution before and after the intervention. In this case we see that both the spots that had an intervention for the reduction of misplaced garbage bags had a change in distribution and the control group spot did not. This points out to some change in the two intervened spots.

By further looking at the mean and standard deviations in all of the spots a reduction in all three can perceived. The reduction is higher in T-spot then N-spot follows with S-spot having a small amount of reduction in misplaced trash bags. This aligns with the idea that the micro-targeted ads are more effective in reducing misplaced trash bags than generalized ones.

REGRESSION MODEL

To validate the previous results a regression model was fitted on all the misplaced trash bags for spots that had an intervention. Three useful variables were identified to create the model (Hyndman and Athanasopoulos, 2018).

- **Inter:** 0 if the intervention is not happening 1 if it is.
- **Time_past:** Amount of days that passed after the intervention started.
- **Time:** Overall days that have passed.

Using these variable five different regression models were identified. The Inter variable was kept in all of them.

$$\text{Bags} = \beta_0 + \beta_1 \times \text{Inter} + \beta_2 \times \text{Time\_past} + \beta_3 \times \text{Time} \tag{6.1}$$

$$\text{Bags} = \beta_0 + \beta_1 \times \text{Inter} + \beta_2 \times \text{Time\_past} \tag{6.2}$$

$$\text{Bags} = \beta_0 + \beta_1 \times \text{Inter} + \beta_2 \times \text{Time} \tag{6.3}$$

$$\text{Bags} = \beta_0 + \beta_1 \times \text{Inter} \tag{6.4}$$

All of the above equations could be used to see the effect of the interventions on trash but the best model was picked using the Akaike information criterion (AIC) (Bozdogan, 1987). The comparison of the results are shown below:

Spot	Model 7.1 AIC	Model 7.2 AIC	Model 7.3 AIC	Model 7.4 AIC
N-spot	182	223	198	223
S-spot	169	201	176	213
T-spot	181	215	198	213

Fig Table 7.5: Regression model comparison based on AIC

Since the AIC is lower on all spots in Model 7.1, this will be used for the regression.The results for the regression are summarized below:

Variables	Regression Coefficient (St.Error) N-spot	Regression Coefficient (St.Error) S-spot	Regression Coefficient (St.Error) T-spot	P-values N-spot	P-values S-spot	P-values T-spot
Inter	-1.2963 (0.488)	-0.8771 (0.489)	-1.6267 (0.544)	0.073	0.008	0.003
Time_past	-0.2858 (0.063)	-0.1956 (0.063)	-0.3189 (0.067)	0.000	0.000	0.000
Time	0.1691 (0.027)	0.1508 (0.027)	0.1672 (0.027)	0.000	0.000	0.000

Fig Table 7.6: Regression model (7.1) results

Overall the regression follows the results of the Wilcoxon test so the misplaced garbage bag reduction was more prevalent due to the intervention in the T-spot followed by the N-spot and then the S-spot. An interesting thing to point out here is the P-value of the Inter variable in the N-spot which is relative high. The reason for this is probably the fact that the N-spot did not follow exactly the negative binomial distribution but this concession had to be made in order to compare the results effectively.

TIME-SERIES ANALYSIS

Another idea was to analyse the existing time series in order to see any changes in trend or find out seasonality. This was done both for the time-series of misplaced trash bags nad the complaints about misplaced trash data. The python statsmodel library was used to break the time series into their trend component, their seasonal component and their residual component. The period of the time series was identified as four since each week there were four data-points for each spot.

Unfortunately there were no conclusive results possibly because there was a big gap between the pre-intervention data collection and the post intervention data collection. Another reason this method did not yield any results was there was not a lot of data available to compare. The time-series analysis is included in the appendix.

6.1.4. DISCUSSION ON THE RESULTS OF THE STATISTICAL ANALYSIS

The Wilcoxon test showed that the distribution in the intervened spots changed while in the control group did not. Furthermore the decrease in the mean and the standard deviation was larger in the micro-targeted spot, lower in the generalized ads spot and even lower in the control spot. The area where the generalized ads were run had 22% decrease(on average) after the intervention while the area in which the micro-targeted were run had a 38% decrease. The standard deviation reduction for the area that had generalized ads was 12% and the for the micro-targeted area was 13%. The regression showed similar results and these results align with the idea that micro-targeted ads are more effective in changing the behavior of the viewers than non micro-targeted ones.The binomial regression showed that the intervention was most effective in the micro-targeted are (regression coefficient equal to -1.62 with a standard deviation of 0.544) and less effective in the generalized ad area (-1.29 with a standard deviation of 0.488). Overall the statistical analysis points to the micro-targeted ads being more effective in reducing misplaced trash.

6.2. PHASE III:RESULT ANALYSIS,QUALITATIVE RESULTS

Qualitative results include the results from the surveys, the Facebook comments in each video, reacts and shares of the video viewers.

6.2.1. SURVEYS AND COMMENTS

In total fourteen people answered the Dutch survey, three the English one the Arabic and none answered the Turkish. The results of the video comments and reacts are summarized in the table below.

	Comments	Shares	Reacts
Dutch G. Video	30	3	27
Dutch M. Video	12	5	7
English Video	5	4	21
Turkish Video	3	7	28
Arabic Video	5	5	26

Table 7.7: Comments, shares and reacts

LOCATION CHECK

One reason a questionnaire was used was to see if the ads "spilled" outside of what the Facebook ad manager showed. Unfortunately, even though the question was phrased as "in which neighborhood (Buurt) do you live?" thirteen out of seventeen responses gave a district (Wijk) which is not enough pinpoint if the ads "spilled". Three pinpointed responses mentioned a park Cromvliet which is inside the area of the generalized ads, a street named Rijswijkseweg also belonging to the generalized ad area and Kootwijkstraat which belongs to the micro-targeted ad area. There was one wijk mentioned that had no chance of being in any of the advertisement areas and that was Bezeidenhout.

TRASH RELATED ISSUES

The questionnaire had a question regarding to which are the most important trash related issues. Out of eighteen survey answers and fifty-five comments there were fifty-four answers about trash related issues. These answers included one or more trash related issues that create problems for the Hague, identified by the citizens. A word cloud has been created from the surveys and comments and it highlights either problems that make the misplaced trash situation worse in the Hague or who/what is to blame for the situations:

Figure 7.13: Word cloud of trash related issues identified by citizens

- Government: Just blaming the government without a specific argument
- Municipality: Blaming the municipality without a specific argument

- People: saying that other people are the cause of the problem. Paired with name calling and no objective arguments only emotional ones.
- Animal: Mostly about seagulls and cats tearing bags spilling trash everywhere
- Full_bins: A lot of the bins are full and cannot be used.
- Few_bins: Too few bins in the neighborhood need to travel long distances
- Recycle_bins_full: The recycling bins are full so more stress is put on the underground bins
- Bag_quality: Retail bags are of poor quality so they rip easily
- Overpopulation: The Hague is overpopulated and densely populated in some areas so a lot of trash come up.
- not_have_afval_pass: A lot of the short term residents do not have access to the afval pass to dispose bulky litter.

POLICY ADVICE BY CITIZENS

Those who took the questionnaire along with a lot of the people who commented on Facebook gave their opinion about policy that should be implemented in order to reduce the amount of misplaced trash. There were a lot of ideas and each post or survey proposed on average three solutions. The results are presented in a word cloud:

Figure 7.14: Word cloud of policy advice given by citizens

- More_bins: Asking for the placement of more underground bins
- Split_bin_Usage: Businesses and residents should have separate bins
- Afvalpas: Remove the need for an afvalpas in order to dispose of trash
- Bin_emptying: Empty underground bins more frequently

- Fines: Stricter and larger fines
- Surveillance: Cameras, municipal officers patrolling etc.
- Street_cleaner: More public servants cleaning the streets
- Collaboration: The municipality should collaborate with other parties like NGOs and local initiatives
- Language: Communication and information should be available in different languages
- Education: School education should focus on imparting sustainable behavior
- Seagull_redux: Somehow reduce the seagull population in the Hague
- Awareness: Increase the amount of awareness initiatives about misplaced trash
- communication_mr: Make communication between the residents and the municipality easier and more effective
- Bulky_waste_dumps: More places to freely dump bulky waste
- bin_sensors: Have sensors on underground bins which show if they are full

RACISM AND POLITICS

It should be noted that out of the seventy-two comments and questionnaires three of the them had clear political content in them referencing politicians and political parties in the Netherlands. Seventeen of them had mild to heavy racist content criticizing different minorities and blaming them for the trash. Comments in the Turkish ad expressed concern about the targeting of Turkish people with the ad and the makers of ad believing that the cause of misplaced trash is the Turkish minority. After explaining to them that the ad was made in three more languages the users took back their complaint.

6.2.2. DISCUSSION ON THE QUALITATIVE RESULTS

Compared to how many people saw and interacted with the ads, few gave substantial comments or filled the survey (about 1.5% of those who saw at least 25% of one of the videos). Almost all comments and survey results were in Dutch or English which points out to the fact that most people in the ad radius do speak one of those languages. An interesting result from looking at the comments, with the municipality confirming it, is the existence of short-term workers from abroad. They come in the Hague for a relatively small amount of time to work mostly in manual labor related work. This means that they do not need to necessarily speak either Dutch or English so ads in different languages might be an effective way to inform them. Another interesting point is that the videos provoked more feedback and discussions through Facebook comments than through the surveys and people were prompted to fill in surveys after a discussion with the primary investigator over Facebook posts. This opportunity will be discussed more in the policy advice section.

The policy recommendations given by participants is quite thorough and some of the ideas seem applicable and interesting and will be further discussed in the policy advice section. Using language can spark racists and disruptive conversations and comments. Care should be taken to diffuse these as fast as possible and give people the correct information, it is generally true especially on the internet that people do not necessarily process information given to them thoroughly, this can sometimes be good as they will speak of their preferences truthfully but can be counterproductive and lead to offensive and inappropriate behavior.

7

CONCLUSIONS & POLICY ADVICE

7.1. SUMMARY OF RESULTS

The data from Facebook ad manager and the statistical analysis of the misplaced trash bags both suggest that the micro-targeted ads performed better than the generalized in both ad interaction and discussion participation. The link clicks from users were 2.2 times higher in the micro-targeted ads compared to the generalized one and the engagement rating was above average in the micro-targeted ads compared to being average in the generalized ad. The conversion rate of the micro-targeted ads was above average compared to the below average conversion rate of the generalized ads, showing that .

Both the Wilcoxon test and the negative binomial regression showed that there was a decrease of misplaced trash bags in all three spots but this decrease was significant enough to cause distributional changes only in the micro-targeted spot and the generalized ad spot. The area where the generalized ads were run had 22% decrease(on average) after the intervention while the area in which the micro-targeted were run had a 38% decrease. The standard deviation reduction for the area that had generalized ads was 12% and the for the micro-targeted area was 13%. The binomial regression showed that the intervention was most effective in the micro-targeted are (regression coefficient equal to -1.62 with a standard deviation of 0.544) and less effective in the generalized ad area (-1.29 with a standard deviation of 0.488). Furthermore the decrease was larger in the micro-targeted spot than the generalized one. It is important to highlight that the control group did not have significant change so even without sending ads directly to postal codes Facebook ad manager is precise enough.

The qualitative data show that people are not indifferent about the issue, have opinions and want to be heard. It hints that most people who voice opinions have knowledge of either Dutch or English. However judging from people sharing the video and the reactions on it, it seems that people who did not know the previous language watched the video. Location seemed to play subtle role as some survey results and comments hinted that they recognized the places shown in the video.

Overall the results point to micro-targeted ads being more effective in both having people watch them and changing their behavior to increase public welfare with the

caveat that this was a pilot work and more data would be required to get a definitive answer.

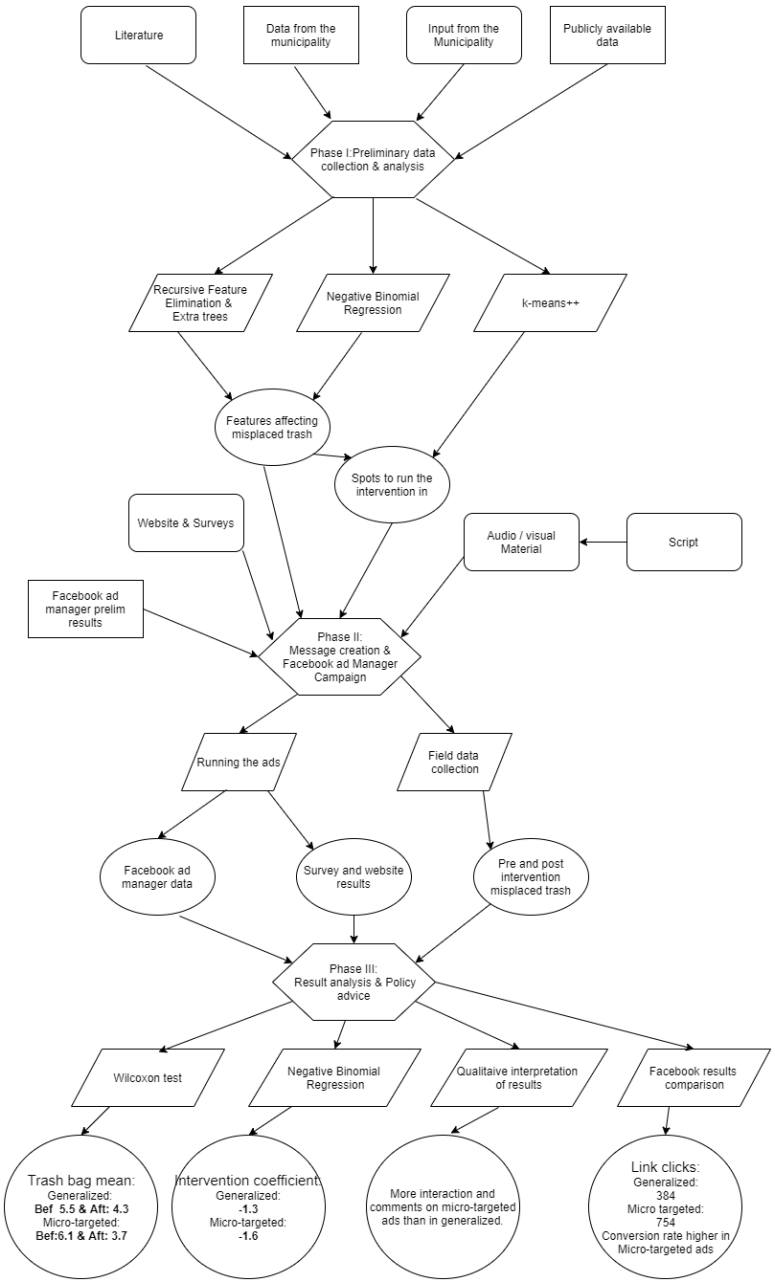


Fig 8.1: Research Diagram

7.2. LESSONS LEARNED

This work, like any pilot work, is of course not perfect. After reflecting on the results there are a number of things that, on hindsight, could have been implemented in a better way.

7.2.1. VIDEO QUALITY

Video quality played a bigger role than it was anticipated for the research. If the videos were of better quality, more qualitative data from both the surveys and the comments could have been gathered. The easiest thing to change would have been to reduce the video length to the recommended video length of fifteen seconds. This way the ads could be shown as part of other videos. Another way to improve the videos would be to hire professional editors and actors, but for this a bigger budget would have been needed.

7.2.2. DATA COLLECTION SCALE

Unfortunately data could not have been collected every day from each spot, so fewer data points were used. Only three relatively small spots were used for observation and they were close together. More data could have been collected more frequently over larger areas if more manpower existed. One idea could be to involve other organizations, which had similar goals to help with the project.

7.3. IMPLICATIONS OF THE WORK

The results that were produced from this research have a number of implications for both the city of the Hague and for the future use of social media platforms applying micro-targeted ads.

7.3.1. FOR THE CITY OF THE HAGUE

For the city itself, a reduction in misplaced trash bags was seen. A very easy method was offered to the citizens in order to share their concerns about the trash situation in the Hague, either through comments, through personal messages in the Facebook page or with filling the surveys. An interesting note here is that the videos sparked spontaneous answers to questions which in most cases are closer to the actual behavior a person exhibits (Veer *et al.*, 2017). The comments created threads as well, where citizens exchanged opinions which sparked conversations. As long as these conversations were kept civil, they promoted the exchange the information and opinions.

The results of this pilot work show promise for scaling it up and applying it in a larger scale in the Hague. A byproduct of this work was finding out that the method the city uses to count the misplaced trash underestimates the amount of said trash that exist in neighborhoods. This could misdirect the focus of other trash reducing actions and policies by the municipality.

Another not so obvious result is that when using micro-targeted for any characteristic that different groups identify with (in this case it was language) extreme care should be taken both when creating the ad content and when answering peoples questions and

comments. This especially true if the implementation was done by the municipality, be-cause there could be political costs.

7.3.2. FOR THE FUTURE OF SOCIAL MEDIA PLATFORMS

One of the goals of this work was to see if micro-targeted ads could be used in an ethical way to improve social welfare. It turns out that, if similar precautions to this work are taken, micro-targeted ads show promise, at least in misplaced trash reduction. Similar pilot projects could be done by either governmental or non-governmental organisations in order to improve social welfare.

Most of the behavior changing ads on Facebook are either product ads or political ads. Social welfare improving ads which do not translate directly to marketing (and profit) or swaying people' political opinions are treated the same as ads that do. Facebook has had a lot of ethical and legal issues, especially with privacy in the past (Balakrishnan, 2018). Maybe by checking if an ad is social welfare improving without "strings attached" to it would make it possible to give discounts so the ad is seen by more people. This is both good public relations for Facebook and helps society. Of course, other social media platforms could adopt this strategy as well.

This pilot work showed that in the case of the reduction of the misplaced trash in the Hague, micro-targeted ads were more effective while the privacy of the users was safe-guarded and ethical concerns were taken into account. Based on this result, considerations by both advertisers and social media platforms could be made in order to change the way micro-targeting is done so that it is both effective and protect the privacy of users, at least in the case when the ads themselves are used to improve social welfare.

7.4. PUBLIC POLICY ADVICE

The policy advice that can be elicited from this work, will focus on what The Hague could in order to combat the misplaced trash problem of the city. Of course the advice could be extrapolated for other cities in the Netherlands of for other functions of the municipality that could benefit from interventions through social media.

7.4.1. ADVICE ON MISPLACED TRASH COUNTING

The way that the misplaced trash counting is done underestimates the amount of misplaced trash in different parts of the city. This means that some areas that is believed to have a lot of misplaced trash might actually have less. The issue created here is that, without knowing in which neighborhoods actually have the most misplaced trash, the interventions that aim to reduce them are not done in the correct place. This means that for example increasing the amount of underground bins, having more frequent trash pickups or awareness campaigns about misplaced trash might be targeted in the wrong places.

A more elaborate misplaced trash counting methodology as the one used for this work might help with this issue. Of course implementing such a trash counting policy might be difficult. One idea is to use computer vision to detect different types of trash and then they can automatically be counted. The municipality has used cameras for

similar work so using the same to check the license plates of cars to it is not a far-fetched solution. Since most of the misplaced trash are near underground trash bins a camera that takes automatic photos when it detects misplaced trash could be fitted in the trucks that the HMS uses to empty underground bins.

A similar approach can be used and instead of fitting cameras in the truck the drivers of said trucks could be given special tablets in order to take said photos. It takes time to empty an underground bin and the process is semi-automated meaning that the driver needs to wait until the bin is emptied so it will not cost extra time from his rounds to snap a picture. Obviously this would require training, but since most people are comfortable using a smart phone these days it should not be too hard.

Of course if cameras are used they should only be used to take pictures of the trash and not any other reasons; all irrelevant data should be deleted in order not to infringe on people's privacy.

7.4.2. ADVICE ON THE USE OF SOCIAL MEDIA & AWARENESS

The municipality uses social media to inform and communicate with the public. There also a lot of awareness videos and signs that explain how misplaced trash is handled. One issue is that communication is done primarily in Dutch. About 40% of the population of the Hague is not native. The comments on the videos and the survey answers that were in Dutch also showed a limited command of the language from some people. This could mean that complicated messages might not be easily understood by the public. Another previously mentioned issue is that some workers come to work short term in The Hague and might not have any knowledge of the Dutch language.

In general it seems that it would be a good idea for the municipality to find what languages are spoken in different neighborhoods and change their awareness messages accordingly. The same could be done with targeted awareness ads as it was done in this research. This could be done with surveys or through the use of registration data that new expats provide to the City Hall.

From this work it is obvious that specific districts in The Hague have a misplaced trash issues, so micro-targeting can be used to focus only on these areas. The interventions should be specific like in this work and be on one trash related topic since this seemed to be effective.

7.4.3. COLLABORATING WITH OTHER ORGANIZATIONS

There are a lot of NGOs in The Hague that are trying to combat the misplaced trash issue, like waste.nl or oceancleanup and others. Facebook comments and surveys from residents pointed out that there should be more collaboration between these institutions and the municipality. These organizations could help the municipality find out about trash related issues faster and also co-organise interventions. Residents might be inclined to participate more in relevant interventions and surveys if they are not done directly by the municipality. This collaboration could also help with data collection as mentioned before.

7.5. ANSWERS TO RESEARCH QUESTIONS

In this section brief answers will be given in the research sub-questions defined in chapter one in order to see if the this work fulfilled its purpose.

Can the impacts of micro-targeted advertisements be identified from both a theoretical and experimental standpoint?

Indeed, micro-targeted ads have been used by both political parties and marketers to change voting behavior and sell products. There have been a lot of cases of unethical and manipulative use of micro-targeted ads. Societal, political and ethical impacts have been identified in Chapter 2.

Through the experiment it could be seen firsthand that the micro-targeted ads had a bigger impact in reducing misplaced trash bags and at provoking more interaction with the ad and the users. Unexpected reactions like residents believing that they were specifically targeted because of their ethnicity were identified as well.

Is micro-targeting able to positively influence public behaviour in an ethical manner?

The results of the experiment point out that it is possible to change the behavior in a positive way, namely by nudging residents to do actions that reduce misplaced trash bags near bins. Of course the data is limited, but even with few data points there are statistically significant results that the micro-targeted ads reduced the amount of misplaced trash bags more effectively than the generalized ads.

The research was done with an ethics impact assessment both before the start of the work and a separate one while the experiment was ongoing. Very few ethical issues arose, which could all be easily mitigated

Can the results from such a study be used to formulate policy advice?

The whole experiment gave some interesting insight on ideas about policy advice. The three main recommendations that are given to the municipality are about changing the way misplaced trash counting is done, how to use social media and awareness campaigns more effectively and for the municipality to collaborate more with external organizations with similar goals.

7.6. SCIENTIFIC CONTRIBUTION

The part of the novelty of this research comes from the fact that it is one of the few works that uses an experiment to evaluate the impacts of micro-targeted ads. Even when comparing to other experimental works of similar nature this work is novel. The experiment from Tovo labs was conducted in the US by a private company as such the methodology and the work done is not public and is not reproducible (Tovo Labs, n.d.). On the other hand a controlled environment study measuring the participants' stated preferences on micro-targeted ads ads(Kruikemeier *et al.*, 2016). Both of the aforementioned work had to do with political micro-targeted ads.

In contrast this work was done in a non controlled setting and it measured both stated and actual preferences (comments and surveys for stated amount of misplaced

trash for actual). Furthermore, this work explored the possibility of using micro-targeted ads in an ethical and privacy respecting way in order to increase social welfare (in this case it reduced the amount of misplaced trash in The Hague).

To conclude, this work combined experiment design, intervention (or "nudge") creation and delivery through Facebook in order to measure the impact of social welfare improving micro-targeted interventions. The results were used to measure the effectiveness of micro-targeted ads and to formulate public policy ideas on the misplaced trash problem of The Hague.

7.7. LIMITATIONS

Like in every research work there are limitations in this study. The limitations have do to with Facebook ad manager, the nature of the field experiment and the audio visual material created for this work.

7.7.1. LIMITATIONS OF THE RESEARCH DUE TO DUE TO FACEBOOK AD MANAGER

Facebook ad manager claims that postal code ad targeting is possible in the Netherlands. In reality, at least for the city of the Hague, this is not the case so a more imprecise method was used and that means that there might have been ad "spillage" to other spots.

The Moroccan Arabic was not supported through Facebook and most people of Moroccan or Algerian descent do not understand or use the Arabic language that Facebook supports. To get around this problem the when targeting Arabic speakers the interests tab was used instead of the language tab, targeting people who had interest in Morocco or Algeria.

In general the ad manager is made to mainly sell products or services and to target larger audiences, this could have an impact on both ad efficiency and in the validity of the analytics that Facebook ad manager provides.

7.7.2. LIMITATIONS OF THE RESEARCH DUE DOING A FIELD EXPERIMENT

Since only one researcher was in the field and collecting misplaced trash data, the following limitations apply:

- A few areas could be visited everyday (namely two of the three)
- Areas had to be relatively close to each other and to the researcher's base of operations, in order to be visited on the short time window that existed.
- Exogenous events that could have affected the amount of misplaced trash in each spot (construction works etc.)
- Other interventions that had to do with keeping the city clean could have taken place that the researchers did not have knowledge about.

7.7.3. LIMITATIONS OF THE RESEARCH ON AUDIO / VISUAL CONTENT

Due to the limited budget of this work the videos did not have professional actors or professional editing impacting the quality of the ads. The video length was higher than

the recommended length in order to get all the points and information needed to give a complete picture of the message.

7.8. FUTURE WORK

Since this was a pilot project affecting relatively few neighborhoods in the Hague, the logical next step would be to extend it to cover more areas in the Hague (or other cities). This way the results would be more definitive as more data would be available. Another idea for extension is to include more languages than the ones used. Anecdotal evidence point out to Greek, Polish and Russian minorities in The Hague but more data is required to find the spread of these minorities.

Since there is evidence that micro-targeted interventions are effective, similar interventions with different objectives would be of interest. For example increasing awareness about the COVID-19 virus or making people aware about (municipal) election participation.

This work presented both quantitative and qualitative results. One idea would be some similar work that focus in analysing the qualitative results from such an intervention. If there are enough comments a natural language processing approach (NLP) could be used to elicit more accurate results about how people respond in micro-targeted ads vs generalized ones.

8

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APPENDIX

8.1. HREC ETHICS APPLICATION

The results from the human research and ethics committee are presented here :

R.2. What will the research conducted be a part of?

- Master's thesis
  Bachelor's thesis
  PhD thesis
  Research shills training

R.3. What type of research is involved?

- Experiment
  Observation
  Questionnaire

R.4. Where will the research be conducted?

- Online
- At the university
- Off-campus / non-university setting: City hall in The Hague, Deloitte Headquarters in Amsterdam

R.5. On what type of variable is the research based?
Give a general indication, such a questionnaire scores, performance on tasks, etc.

The change of the amount complaints about misplaced litter and the change of the amount misplaced litter in each neighbourhood, the engagement of people with the advertisements ("clicks" through Facebook ad manager), the messaging that will be used to in the advertisements.

R.6. If the research is experimental, what is the nature of the experimental manipulation?

Users clicking or seeing an advertisement about an awareness campaign through Facebook. We will have personal information on the users, as the targeting will be done in similar demographically neighbourhoods. We will want to see the (aggregate) engagement with the ads and the impact towards the level of trash and complaints about trash.

R.7. Why is the research socially important? What benefits may result from the study?

Understanding the implications of advertisement micro-targeting in a non-controlled environment and helping the municipality of the Hague to find a way to decrease the amount of misplaced litter in the streets. Understanding the implication of micro-targeting is important because it is a social phenomenon that has huge real world impact (US elections, Brexit etc.)

R.8. Are any external partners involved in the experiment? If so, please name them and describe the way they are involved in the experiment.

The municipality of The Hague as data providers and helping design the advertisement campaign, Deloitte as facilitators of the researcher's thesis internship.

Pa.1. What is the number of participants needed? Please specify a minimum and maximum. Minimum: 5000 Maximum: 20000

Rough number gotten through the Facebook ad Manager it's an estimate as we do not know exactly how many people will see the ad campaign until we actually run it.

Pa.2.a. Does the study involve participants who are particularly vulnerable or unable to give informed consent? (e.g., children, people with learning difficulties, patients, people receiving counselling, people living in care or nursing homes, people recruited through self-help groups)

We will not target vulnerable people explicitly through the campaign.

Pa.2.b. If yes and unable to give informed consent, has permission been received from caretakers/parents?

N/A

Pa.3. Will the participants (or legal guardian) give written permission for the research with an 'Informed Consent' form that states the nature of the research, its duration, the risk, and any difficulties involved? If no, please explain.

No as we will not process or collect any of their personal data and they already have consented through Facebook that the aggregation of their responses ("clicks on the ad") can be used for research. Seeing advertisements in general does not need consent as long as there no sensitive content which our ads will not have. If the ad is clicked, then the user will be taken to the Facebook page that the ad supports. There more information about what can be done about misplaced litter will be contained as well as a link to our research page where the user will be able to visit and see what our research is about and how the data is used as well as contact both the researcher and the first supervisor.

Pa.4. Are the participants, outside the context of the research, in a dependent or subordinate position to the investigator (such as own children or students)? If yes, please explain.

No.

Pa.5. How much time in total (maximum) will a participant have to spend on the activities of the study?

As much time as time as they need to read a text of about 10-50 words (0-2 minutes). If they click on the ad they will be taken to the Facebook page this campaign represents,

that is their choice though. There we will have more information about what can be done about misplaced litter as well as a link to our research page. If they choose to read this information it will take about 2-5 minutes.

Pa.6. Will the participants have to take part in multiple sessions? Please specify how many and how long each session will take.

N/A

Pa.7. What will the participants be asked to do?

If the participants and up seeing they ad on Facebook and click on it they will see a short text that informs them about how trash collection in handled in the Hague and inform them not to leave their litter in the street. If they choose to click on it, they will be taken to the Facebook page that the ad supports. There more information about what can be done about misplaced litter will be contained there also might be a link to the city website where they can read more information.

Pa.8. Will participants be instructed to act differently than normal or be subject to certain actions which are not normal? (e.g. subject to stress inducing methods)

No, we will not instruct participants to do anything at all. If they read the ad and go to the page, they will become more litter aware and hopefully do not leave their litter on the streets.

Pa.9. What are the possible (reasonably foreseeable) risks for the participants? Please list the possible harms if any.

We are not aware of any risks that a simple litter awareness campaign can cause. (barring the risks of using social media) Pa.10. Will extra precautions be taken to protect the participants? If yes, please explain.

No personal identifiable information will be collected even if it offered from Facebook. Only aggregates on neighbourhood level will be used and demographics from the city of the Hague.

Pa.11. Are there any positive consequences for a participant by taking part in the research? If yes, please explain.

They will be informed about how the litter collection system works in the Hague and this might lead to them not leaving garbage on the street. This might also lead them to recycle more. If they end up visiting our research website which will be available on the Facebook page that the ad is tied to and read about our research, they might become more privacy aware in respect to micro-targeting advertisements. Pa.12. Will the participants (or their parents/primary caretakers) be fully informed about the nature of the study? If no, please explain why and state if they will receive all information after participating.

The study will be used for a Master thesis so it will be available publicly in the TU Delft repository. As mentioned before if they click on the Facebook ad the participants will be taken to the corresponding page managed by the researcher. There we will have a link that takes them to our research web page where there will be more information

about the experiment the data used and ways to contact the researcher and the first supervisor.

Pa.13. Will it be made clear to the participants that they can withdraw their cooperation at any time?

N/A

Pa.14. Where can participants go with their questions about the research and how are they notified of this?

As mentioned above if the participants click on the Facebook ad they will be taken to the corresponding page managed by the researcher. There we will have a link that takes them to our research web page where there will be more information about the experiment the data used and ways to contact the researcher and the first supervisor.

Pa.16. How will participants be recruited?

There will not be an explicit recruitment, participants in our case are people who click the awareness campaign ad on Facebook.

Pr.1. Are the research data made anonymous? If no, please explain.

The is no personal data is explicitly collected or stored if anything is collected by mistake it will be deleted immediately. Only neighbourhood level data will be used broken by existing demographic data.

Pr.2. Will directly identifiable data (such as name, address, telephone number, and so on) be kept longer than 6 months? If yes, will the participants give written permission to store their information for longer than 6 months?

Any directly identifiable data will not be kept or used there will be knowledge about their Facebook profiles but will not be used or stored.

Pr.3. Who will have access to the data which will be collected?

The researcher, the first and the second supervisor. If the municipality of the Hague is interested in using the data we will give them access as well. Pr.4. Will the participants have access to their own data? If no, please explain.

We do not collect personal data. Participants have the option, through Facebook, by clicking the “why am I seeing this?” button to get information about why they are seeing this ad

Pr.5. Will covert methods be used? (e.g. participants are filmed without them knowing)

Not intentionally (this is the nature of advertising) and the ads we will use do not have any deceiving content. Through the “why I am I seeing this” button it is made transparent. If they decide to click the ad and follow the link to our research page, they will get the full picture of the research.

8.2. ETHICS IMPACT ASSESSMENT

This is the whole ethics impact assessment which was used in order to find the ethical impacts of this work.

8.2.1. AUTONOMY

Autonomy refers to the existence of Self-rule that is free from both controlling interference by others and from limitations. It relies on liberty (independence from controlling influences) and agency (capacity for intentional action).

1. Does the technology or project curtail a person's right to liberty and security in any way? If so, what measures could be taken to avoid such curtailment?

No, the actions suggested by the intervention done the project are completely optional, those who see the message can choose to do anything they please.

2. Does the project recognize and respect the rights of persons with disabilities to benefit from measures designed to ensure their independence, social and occupational integration and participation in the life of the community?

The project does respect their rights and furthers them, excessive trash in the street can create problems for people who have physical disabilities because there is less space for them to move.

3. Will the project use a technology to constrain a person to curtail their freedom of movement or associations? If so, what is the justification?

No it will not.

4. Does the person have a meaningful choice, i.e., are some alternatives so costly that they ate not really viable alternatives? If not, what could be done to provide real choice?

Not applicable.

8.2.2. DIGNITY

Dignity means that people should be enabled to live in dignity and security and be free of exploitation and physical or mental abuse. They should be treated fairly regardless of age, gender, racial or ethnic background, disability or other status, and be valued independently of their economic contribution.

1. Will the technology or project be developed and implemented in a way that recognizes and respects the rights of citizens to lead a life of dignity and independence and to participate in social and cultural life? If not, what changes can be made?

The intervention is of informative nature and a call of action, so it respects the dignity and independence of the citizens.

2. Is such recognition explicitly articulated in statements to those involved in or affected by the project?

If the affected individuals follow the link to the proposed website they can find such a statement.

3. Does the technology compromise or violate human dignity? If so, what measures can be put in place to minimize or avoid compromising their dignity?

No it does not.

4. Does the project require citizens to use a technology that makes them in some way as cognitively or physically disabled? If so, can the technology be designed in a way that does not make them stand out from the crowd?

No it does not.

8.2.3. INFORMED CONSENT

Informed consent means that Decisions should be: freely given after the person is informed of the nature, significance, implications and risks and is evidenced in writing, dated and signed, or otherwise marked by that person so as to indicate consent.

1. Will the project obtain the free and informed consent of those persons to be involved in or affected by the project? If not, why not?

There is no explicit consent form, as this will might create unwanted effects in the interaction with the ad. Consent is given through the use of Facebook and agreeing to their terms and services.

2. Will the person be informed of the nature, significance, implications and risks of the project or technology?

If they choose to follow to the website that the ad is suggesting them then yes there is information about the project. A similar thing can be done by the municipality if they implement this.

3. Will such consent be evidenced in writing, dated and signed, or otherwise marked, by that person so as to indicate consent?

No explicitly but implicitly by agreeing on Facebook's terms and services.

4. Does the consent outline the use for which data are to be collected, how the data are to be collected, instructions on how to obtain a copy of the data, a description of the mechanism to correct any erroneous data, and details of who will have access to the data?

No, but there is no personally identifiable data collected and this is stated. There is also contact details in the website so users can get in contact with the researchers if they have questions. If this methodology is used by the municipality they should provide contact persons as well. The best idea would be that results are made public as well.

5. If the individual is not able to give informed consent, will consent be obtained from a guardian with legal powers over the person's welfare?

Not applicable. 6. Will the person be informed of their right to withdraw at any time, without being subject to any resulting detriment or the foreseeable consequences of declining to participate in withdrawing?

They care always choose to ignore the ad and scroll down.

7. Is information collected from children? How are their rights protected?

We do not target people under 18 years old. If the municipality used the methodology extra care for children should be taken, like creating a video especially for them.

8. Does the person need to give consent in order to get a service to which there is no alternative?

No they do not.

9. Does the person have to deliberately and consciously opt out in order to not receive the 'service'? No they do not.

8.2.4. SAFETY

Safety is defined as the intentional avoidance of and protection from harm inflicted upon others.

1. Is there any risk that the technology or project may cause any physical or psychological harm to consumers? If so, what measures can be adopted to avoid or mitigate the risk?

Not to our knowledge. The material that people will be exposed are either pictures of their own neighborhood or locations from the web without any material that can cause harm. The action that they are nudged towards does not cause harm as well. Similar steps should be taken by the municipality as well.

2. Have any independent studies already been carried out or, if not, are any planned which will address the safety of the technology or service? If so, will they be made public?

Not applicable. If the municipality applies the project to a larger scale it might be a possibility although there is no risk to the participants what so ever.

3. To what extent is scientific or other objective evidence used in making decisions about specific products, processes or trials?

The whole study is scientific everything has been carefully scrutinized through the lens of both social sciences and hard sciences. The municipality can build on these blocks as well and not require much extra work.

4. Does the technology or project affect consumer protection?

No it does not, as the project just provides information service free of charge.

5. Will the project take any measures to ensure the persons involved in or affected by the project will be protected from harm in the sense that they will not be exposed to any risks other than those they might meet in normal everyday life?

To our knowledge there is no foreseeable harm that could be done to the people by either seeing the video or clicking and getting informed by the corresponding website.

6. Can the information generated by the project be used in such a way as to cause unwarranted harm or disadvantage to a person or group?

Not in any foreseeable way. If done large scale by the municipality since language is one of the main methods used to pass the message then it could be that some racial friction is created between groups.

8.2.5. SOLIDARITY

Solidarity follows the notion of e-inclusion which refers to the actions to realize an inclusive information society that is, an information society for all.

1. Has the project taken any steps to reach out to the e-excluded (i.e., those excluded from the use of the internet)? If not, what steps (if any) could be taken?

No it has not, as this is a study that is done over social media and that requires access to the internet. If the project is implemented by the municipality then a good idea would be to maybe send physical mail over in the appropriate language (more on this in section 3)

2. Does the project or policy have any effects on the inclusion or exclusion of any groups?

It will not have if it stays small scale as the special case dictates. It might have if it is used by the municipality.

3. Are there offline alternatives to online services?

Physical mail is a cheap alternative but not effective as the message is a video. If it is implemented by the municipality television would be a viable (but expensive) alternative.

4. Is there a wide range of perspectives and expertise involved in decision-making for the project?

Indeed there is, the decision making process involves data scientists, privacy experts, social scientists and experiment experts as well as ethics experts. Implementation by the Hague would probably involve less experts as the decision would rest ultimately in the hands of the city's Aldermen.

5. How many and what kinds of opportunities do stakeholders and citizens have to bring up value concerns? Quite a lot. We offer surveys in different languages, where people can share their opinion, emails of the principal investigator is given and there is a research feedback form as well.

8.2.6. ISOLATION

Isolation is defined as having too few and too poor social ties/ of not being in any relevant social networks.

1. Will the project use a technology which could replace or substitute human contact? What will be the impact on those affected?

It will not replace human contact.

2. Is there a risk that a technology or service may lead to greater social isolation of individuals? If so, what measures could be adopted to avoid that?

No it will not.

3. Is there a risk that the use of technology will be seen as stigmatizing, e.g. in distinguishing the user from other people?

On the small scale it will not. If the Hague adopts the use of targeted ads this could be the case.

8.2.7. DISCRIMINATION

The project should not discriminate based on any ground such as sex, race, color, ethnic or social origin, genetic features, language, religion or belief, political or any other opinion, membership of a national minority, property, birth, disability, age or sexual orientation.

1. Does the product or service use profiling technologies?

Yes it does use information about the language spoken by the users and their general location (neighborhood).If implemented by the municipality then more profiling might be used.

2. Does the project or service facilitate social sorting?

In our case the social sorting is done by location and language. Implementation by the municipality would use language as well but maybe other ways too.

3. Could the project be perceived as discriminating against any groups? If so, what measures could be taken to ensure this does not happen?

On the contrary we try to include as many language groups possible. If more data existed on other language groups more would be included. Some locations of the Hague are excluded due to data collection limitations. If the municipality implements the idea all the Hague could be easily included and more less spoken languages can be included as well.

4. Will some groups have to pay more for certain services than other groups? No payments are involved.

8.2.8. BENEFICENCE

Beneficence is the requirement to provide benefit, or to balance benefits and drawbacks to produce the best overall results. 1. Will the project provide a benefit to individuals? If so, how will individuals benefit from the project (or use of the technology or service)?

On the long run it will. With less trash in the streets less rodents will be attracted to homes, the neighborhood will nicer and this will create an action the trash or even the litter will reduce even more (broken window theory). The city of the Hague will get policy advice based on the project as well and might benefit on an economic, political l and social level.

2. Who benefits from the project and in what way? The principal investigator as it is a requirement for him to get a Master's degree. The people of the locations participating in the experiment as discussed above and the municipality of the Hague.

3. Will the project improve personal safety, increase dignity, independence or sense of freedom?

If it is effective it could help with public health as rodent infestation could be decreased. It could help with dignity as well since citizens will live in cleaner neighborhoods.

4. Does the project serve broad community goals and/or values or only the goals of the data collector? What are these, and how are they served?

It serves both detailed in question one.

5. Are there alternative, less privacy intrusive or less costly means of achieving the objectives of the project?

As this is an experimental work we do not know unless the results come out.

6. What are the consequences of not proceeding with development of the project?

The principal investigator will not get a Master's degree. No change will be seen in the misplaced trash of the locations that the message would have gotten to. No policy advice for the Hague in order to reduce unattended trash and reach non Dutch speaking communities.

7. Does the project or technology facilitate the self-expression of users?

It's up to them to do anything they want with information provided, so yes.

8.2.9. UNIVERSAL SERVICE

Universal service is the obligation imposed to provide a minimum set of services to all users, regardless of their geographical location within the national territory.

1. Will the project or service be made available to all citizens? When and how will this be done?

Technically anyone will be able to visit the website that has relevant information. The ads will only be shown only on select locations so the service is available to all but a few will be directly inform. Implementation by the municipality can change this and show ads on all the Hague.

2. Will training be provided to those who do not (yet) have computer skills or knowledge of the internet? Who should provide the training and under what conditions?

Only people who know how use the internet will be able to participate.

3. Will the service cost the same for users who live in remote or rural area as for users who live in urban areas? How should a cost differential be paid?

No costs for the users of the service

8.2.10. ACCESSIBILITY

Accessibility assesses the user-friendliness of devices and services for the e-inclusion of citizens in the information society. 1. Does the new technology or service or application expect a certain level of knowledge of computers and the Internet that some people may not have?

No specialized knowledge required.

2. Could the technology or service be designed in a way that makes it accessible and easy to use for more people, e.g., senior citizens and/or citizens with disabilities?

No it cannot, as long as the intervention is done through social media and this one of the key points of the project.

3. Are some services being transferred to the Internet only, so that a service is effectively no longer available to people who do not (know how to) use computers or the Internet? What alternatives exist for such people?

Everything is done through the Internet. For the special case no alternatives exists as this is part of what is studied. Alternatives for the municipality might include mail and television.

8.2.11. VALUE SENSITIVE DESIGN

Value sensitive design is about the design of technologies bears directly and systematically on the realization, or suppression, of particular configurations of social, ethical and political values

1. Is the project or technology or service being designed taking into account values such as human wellbeing, dignity, justice, welfare, human rights, trust, autonomy and privacy?

To the best of the designer's ability yes. 2. Have the technologists and engineers discussed their project with ethicists and other experts from the social sciences to ensure value sensitive design?

Yes they have, this assessment is part of it.

3. Does the new technology, service or application empower users? It empowers

them with information that they might not have had before about optimal ways to dispose their trash.

8.2.12. SUSTAINABILITY

Sustainability is defined as a condition whereby a project or service can be sustained, can continue into the future, either because it can generate the financial return necessary for doing so or that it has the external support which is not likely to go away in the foreseeable future. In addition to economic and social sustainability, more conventional understandings of sustainability should also be considered, i.e., decisions made today should be defensible in relation to coming generations and the depletion of natural resources.

1. Is the project, technology or service economically or socially sustainable? If not, and if the technology or service or project appears to offer benefits, what could be done to make it sustainable?

Yes, it is. Careful steps must be taken if the project is implemented by the municipality.

2. Should a service provided by means of a research project continue once the research funding comes to an end? Does the technology have obsolescence built in? If so, can it be justified?

If micro-targeted ads are more effective than normal ones then yes it should continue.

3. Has the project manager or technology developer discussed their products with environmentalists with a view to determining how their products can be recycled or how their products can be designed to minimize impact on the environment? The impact to the environment can be only positive based on discussing with experts.

8.2.13. JUSTICE

Justice refers to Fair, equitable, and appropriate treatment in light of what is due or owed to persons. Distributive justice refers to fair, equitable, and appropriate distributions determined by justified norms that structure the terms of social cooperation.

1. Has the project identified all vulnerable groups that may be affected by its undertaking?

There is no vulnerable groups that would have negative consequences by the intervention

2. Is the project equitable in its treatment of all groups in society? If not, how could it be made more equitable?

Since the special case is experimental it is not possible to give fair treatment to all groups involved. No side effects exist for different treatment. If the idea is implemented it is easy for the municipality to do so.

3. Does the project confer benefits on some groups but not on others? If so, how is it justified in doing so?

It might depending which kind of intervention is effective. It is justified because it is an experiment in order to find the most beneficial solution in order

4. Do some groups have to pay more than other groups for the same service?

No payments are involved.

8.2.14. EQUALITY AND FAIRNESS

The principles of justice and fairness can be thought of as rules of "fair play" for issues of social justice. The principles of equity, equality, and need are most relevant in the context of distributive justice, but might play a role in a variety of social justice issues. These principles all appeal to the notion of desert, the idea that fair treatment is a matter of giving people what they deserve.

1. Will the service or technology be made widely available or will it be restricted to only the wealthy, powerful or technologically sophisticated?

See universal service 1.

2. Does the project or policy apply to all people or only to those less powerful or unable to resist?

No applicable.

3. If there are means of resisting the provision of personal information, are these means equally available or are they restricted to the most privileged?

Not applicable.

4. Are there negative effects on those beyond the person involved in the project or trials and, if so, can they be adequately mediated?

No foreseen negative effects.

5. If persons are treated differently, is there a rationale for differential applications, which is clear and justifiable? Will any information gained be used in a way that could cause harm or disadvantage to the person to whom it pertains?

See Justice 2. No harm or disadvantages are foreseen.

8.3. TRASH COLLECTION SCHEDULE

Date	Places
20-Apr	12
21-Apr	13
22-Apr	21
23-Apr	23
24-Apr	31
25-Apr	32
27-Apr	13
28-Apr	21
29-Apr	23
30-Apr	31
1-May	32
2-May	12
4-May	21
5-May	31
6-May	23
7-May	32
8-May	12
9-May	13
11-May	23
12-May	21
13-May	13
14-May	23
15-May	31
16-May	12

Fig 9.1: Trash collection schedule before intervention

Date	Places
22-Jun	12
23-Jun	13
24-Jun	21
25-Jun	23
26-Jun	31
27-Jun	32
29-Jun	13
30-Jun	21
1-Jul	23
2-Jul	31
3-Jul	32
4-Jul	12
6-Jul	21
7-Jul	31
8-Jul	23
9-Jul	32
10-Jul	12
11-Jul	13
13-Jul	23
14-Jul	21
15-Jul	13
16-Jul	23
17-Jul	31
18-Jul	12

Fig 3.7: rash collection schedule after intervention

1 means N-spot, 2 means S-Spot, 3 means T-spot

8.4. OTHER TRASH TIME SERIES

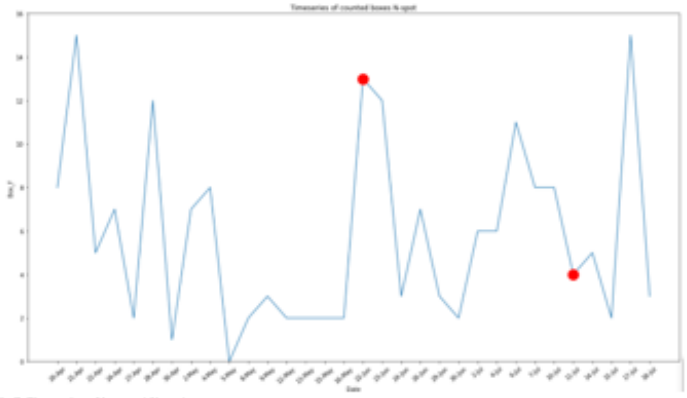

Fig 7: Timeseries of boxes at N-spot

In the figure above we can see a time series of the boxes counted pre and after intervention. No clear pattern can be distinguished as there is a decrease but then again, an increase and the main topic of the intervention was not cardboard boxes.

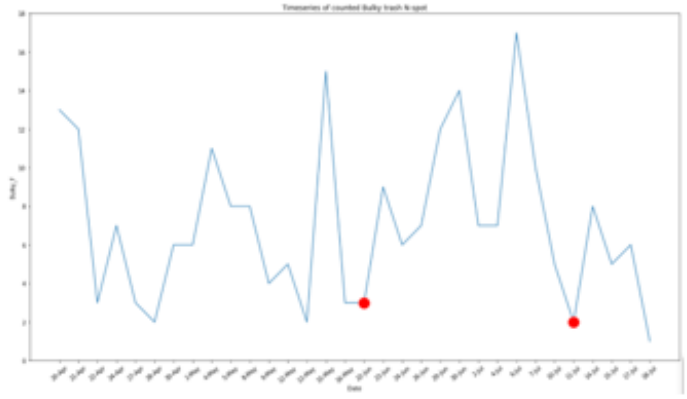

Fig 8: Timeseries of Bulky trash at N-spot

In the figure above we can see a time series of the bulky trash counted pre and after intervention. There was an increase at the time o the intervention.

Fig 9: Timeseries of the litter condition at N-spot

The litter condition followed a similar pattern before and after.

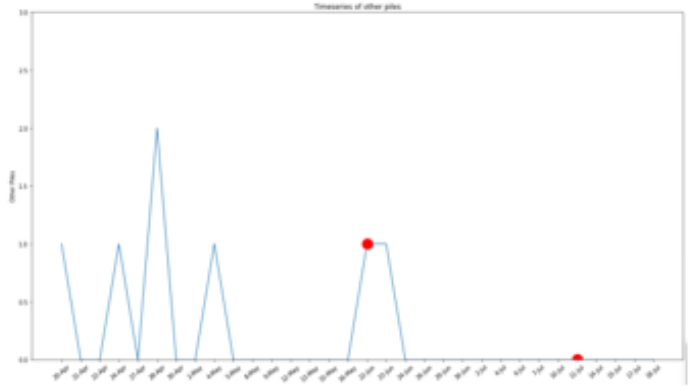

Fig 10: Timeseries of the non-organic trash piles in N-spot

There was a decrease in the amount of non-organic trash piles.

The quantity of interest and the one that the intervention through Facebook targeted are the misplaced trash bags seen below:

Fig 11: Timeseries of the trash bags in N-spot

It can be seen that there was a decrease close to the end of the intervention more analysis is required to see what exactly happened.

This is the control group spot. The timeseries for the misplaced trash are shown below.

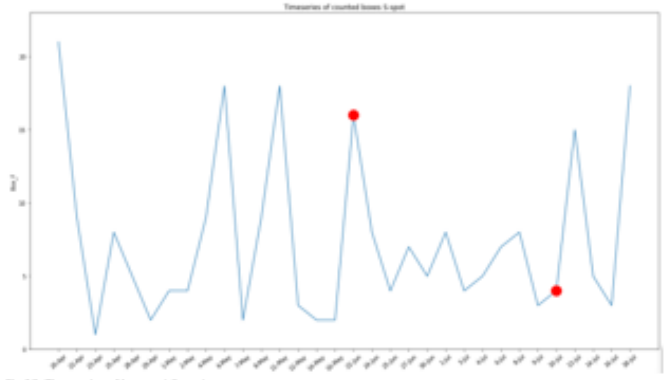

Fig 12: Timeseries of boxes at S-spot

There appears to be a reduction on the misplaced boxes during the intervention but is not related to the intervention itself.

Fig 13: Timeseries of Bulky trash at S-spot

Inconclusive results show in the bulky trash timeseries.

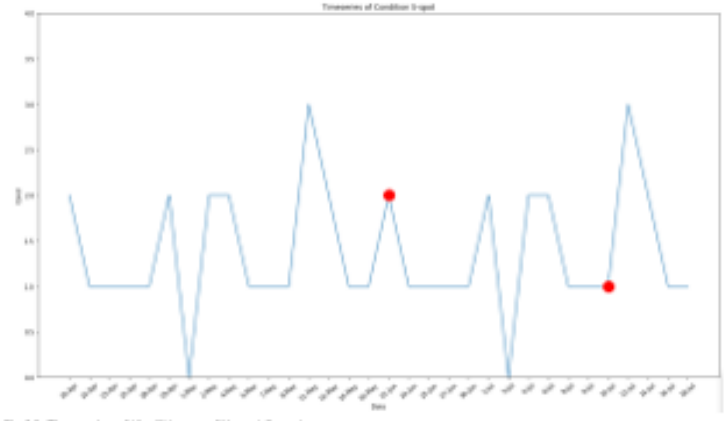

Fig 14: Timeseries of the litter condition at S-spot

The condition of the spot seems to be very seasonal with it repeating before and after the intervention.

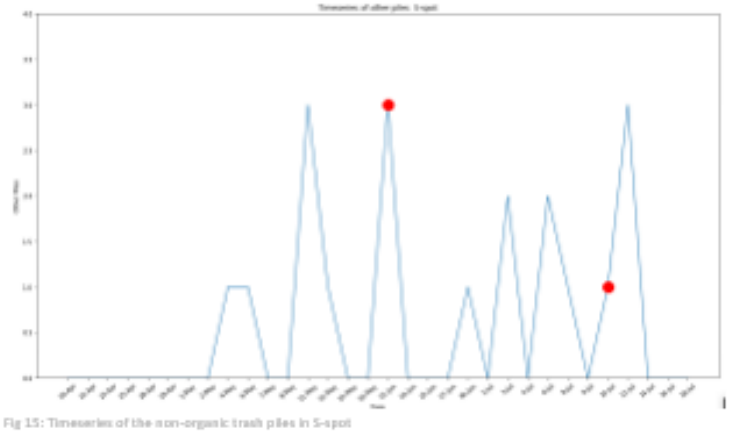

Fig 15: Timeseries of the non-organic trash piles in S-spot

Similar seasonality seems to follow the non-organic trash piles.

Fig 16: Timeseries of the trash bags in S-spot

Fig 17: Timeseries of boxes at T-spot

A small degree of decrease and then a big increase in misplaced boxes is evident here.

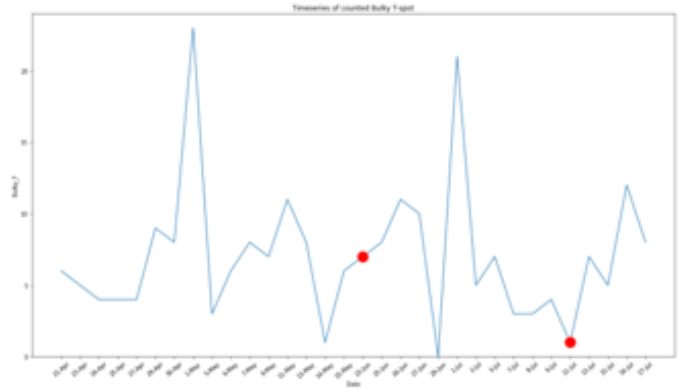

Fig 18: Timeseries of Bulky trash at T-spot

A seasonal change of the bulky trash seems to have happened here.

Fig 19: Timeseries of the litter condition at S-spot

A similar seasonal change seems to happen in the litter situation of T-spot.

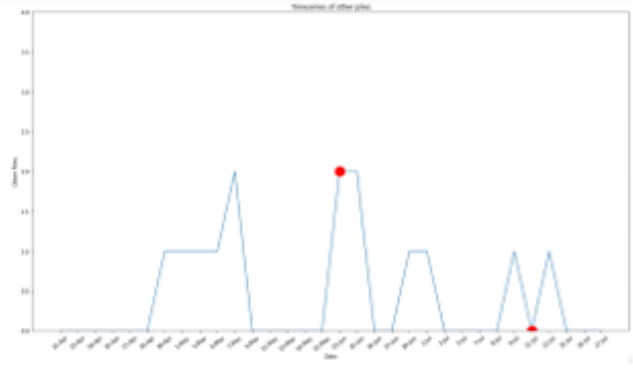

Fig 20: Timeseries of the non-organic trash piles in T-spot

It can be seen that there is a similar quantity of non-organic trash piles before and after the intervention.

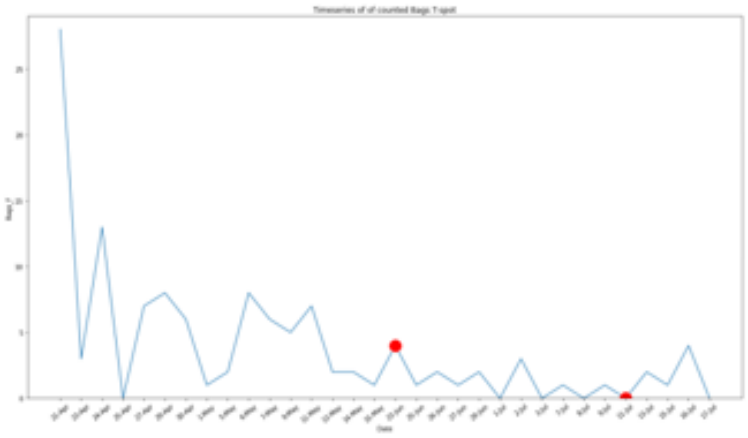

Fig 21: Timeseries of the trash bags in T-spot

We can see a decrease of trash bags compared to before the intervention.