An online self-assessment quiz as a tool to moderate the behaviour of correct bio-waste separation

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DESIGN CASE

Context

An average citizen of the Netherlands produces between 106.0 and 147.0 kilograms of food waste per year (Voedingscentrum, 2019). This is a twofold problem: not only is the food's value lost, the efforts and resources required to produce, manufacture, package and transport the food also go to waste. It is estimated that food waste in Dutch household contexts amounts to 1.5% of an individual's contribution to greenhouse gases (Milieucentraal, n.d.).

Fortunately, we have come a long way in repurposing waste. Properly sorted waste can be recycled into products that are of virtually the same quality (e.g. aluminium and glass (Glass Recycling Facts, 2013)) or of lesser quality, though still useful (e.g. plastics and paper). Organic waste, which includes food waste, has a multi-step recycling process, depicted in figure 1, where some of the waste is turned into useful materials such as biogases and compost. Nevertheless, not all organic waste can be repurposed. After food waste is picked up from the households, its pollution levels are measured in mass (Vang HHA, 2018). If more than 10% of the total waste's mass is contaminated with unsuited materials, the waste is burned (Afval Overleg Orgaan, 2002). While this process generates some energy, it also produces harmful gases (Griffin, Sobal & Lyson, 2009). Additionally, the compost extracted from recycled organic waste is purified in the post-processing phase, which further produces waste that is discarded and burned. Finally, not all organic waste is disposed of properly: a 2018 poll held by the Utrecht municipality revealed that just 19% of its inhabitants fully separate all of their organic waste (Gemeente Utrecht, 2018). Meanwhile, 43% of inhabitants stated that they do not separate organic waste at all.

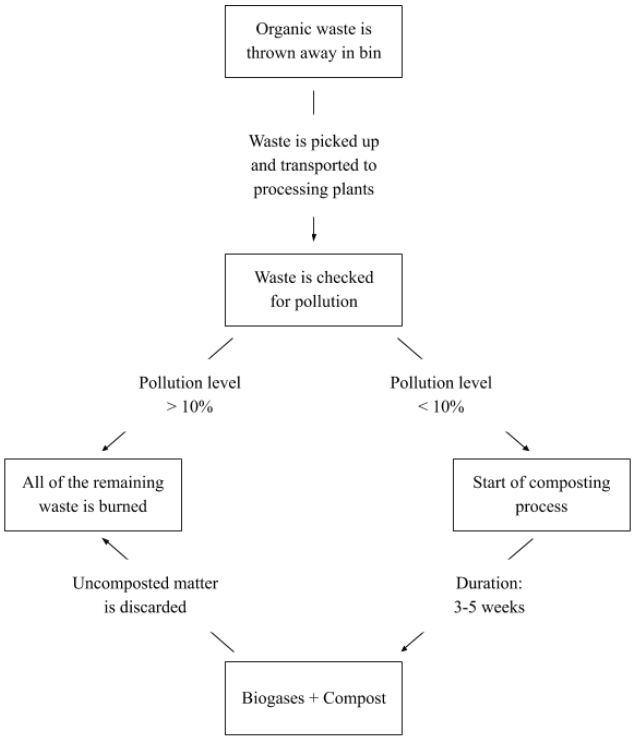

Figure 1: *An overview of the organic waste recycling process.*

Target Audience

The target group for this case consists of citizens living in the Netherlands, ranging in age from 18 to 30. The rationale for this audience is because this group is expected to have a large impact on the outlined problem. As they reach the end of adolescence, most leave the family household for their own place, which comes with new responsibilities with regards to disposing of food waste.

Stakeholders

The stakeholders involved in this case were identified by analyzing the value chain of waste recycling processes. On a national scale, this includes governmental organs such as the Ministry of Infrastructure and Water Management. On a more local scale, this includes waste recycling companies (i.e. Van Kesteren, Van Kaathoven, RD4, Cure Afvalbeheer) spanning multiple municipalities. These stakeholders are identified based on their contribution to waste recycling: both positive and negative contextual

developments as a result of this case can affect these parties.

Intended Behaviour Change

This design case focuses on a topic related to food waste disposal caused by behaviour of the highlighted target audience. This research focuses on the correct separation of the different categories of waste, such as organic, plastic, and residual waste. Organic waste is often misplaced and cannot be recycled as efficiently, resulting in economic and environmental losses. An in-depth analysis of how this behaviour can be changed is included in the section on Concept Description.

Spillover Behaviour

Changes in behaviour in one area often result in changes in behaviour in related areas, which is known as behaviour spillover. Nash et al. (2017) evaluated behavioural spillover in the context of environmental responsibility, where they concluded that spillover behaviour such as changes in resource conservation and consumption-related behaviour are common. Consequently, it could be reasoned
that the target audience adopts an eco-friendlier mindset as a result of the behaviour intervention: moderate reductions in their consumption rates of products and production of waste, and a moderate increase in efforts undertaken to recycle their waste are also possible.

CONCEPT DESCRIPTION

COM-B Analysis

The COM-B method is part of the behaviour change wheel. The behaviour change wheel has been developed as a way to combine existing frameworks on behaviour change, and attempt to characterize interventions and link them to the analysis of behaviour to target (Michie et al, 2011). The COM-B method focuses on the *Capabilities*, *Opportunities*, and *Motivations* behind people's behaviour. These can be further split up in the Physical and Psychological Capabilities, the Physical and Social Opportunity, and the Reflective and Automatic Motivation. A COM-B analysis was performed on the target behaviour in order to establish priorities in developing a behaviour change intervention. This is further explained below. An overview can be seen in appendix A.

From the capability side of view, albeit physical or psychological, there is a low need for change. In terms of the physical capability of successfully separating trash, there seem to be no barriers. The psychological capability, the knowledge to be able to successfully separate trash, could be improved. However, there are plenty of resources available that can be accessed although not readily used by the general public.

Looking at the physical and social opportunities, a clearer discrepancy is seen. The physical opportunity to enable waste separation requires no need to change as there is sufficient support (e.g. infrastructure) in the Netherlands. However, looking at the social opportunity, waste separation can be seen as a system of a black box. In general, one knows of their friends and family that they separate their waste. Yet there is no social opportunity to do it well as there is no penalty of some sort for incorrect trash separation.

Finally, the reflective and automatic motivation are reviewed. For the reflective motivation it is hypothesised there is little active reflection in terms of how well waste is separated. There seldom are cases of consequences for people who poorly separate their waste. Only in more severe cases people will get a letter in their mailbox, and only in some municipalities. Looking at the automatic motivation of people, it is assumed they already separate their waste. There is already a routine in the separation of waste, yet people too often misplace the waste in the incorrect bin. It is assumed there is no need for change in this type of motivation as it is likely based on misconceptions.

Behaviour Change Techniques

The diagnosis resulting from the COM-B analysis states that in order to change the target audience's waste disposal behaviour, improvements in the *Social Opportunity* and *Reflective Motivation* are needed.

Research conducted by Michie et al. (2014) states that social opportunity is best tackled through the intervention functions of restriction, enablement, environmental restructuring, and modelling. Furthermore, reflective motivation is best addressed through the intervention functions of education, persuasion, incentivisation, and coercion. The tables on identifying intervention functions and linking the functions to behaviours can be seen in appendix B.

Proposed concept

The concept that is derived from the aforementioned goals defined by the Com-B analysis focuses on (1) the social opportunity, and (2) the reflective motivation of people. This is done through an educational concept in the form of

an online quiz, in which a social element is included through social media. The quiz revolves around questions about frequently incorrectly recycled waste, in a humorous manner. The other ideated concepts can be seen in appendix C.

The intervention function to improve Reflective Motivation is served by *feedback on the outcome(s) of their behaviour through self-assessment*. Receiving feedback on internalized behaviour can serve as a prompt for reflection that shifts the attitude towards disposing organic waste, which is its intended change objective.
In order to improve Social Opportunity, the intervention function of *social comparison* is used. By providing a frame of reference as to how well peers take care of disposing of their waste, the recipients of the intervention are poised to see more value in taking care of their waste.

Mass media behaviour change

Social media is highly effective in reaching a large audience, yet lacks in engagement. This is a trade-off that can be seen often when dealing with the creation of communication strategies, yet mostly in physical environments (Clampitt, DeKoch, & Cashman, 2000). When looking at the effectiveness of behaviour change through social media, many positive effects can be seen. In a systematic literature review conducted by Wakefield et al. ((Wakefield, Loken, & Hornik, 2010), mass media campaigns have been analysed from a passive perspective. Passive indicates there is no interaction between the targeted person and the behaviour change intervention. These interventions are typically seen including risks of the behaviour, the benefits of quitting, and a support resource, and a reminder of social norms. Topics of behaviour change were primarily focused on health-related behaviour. Few of these topics had inconclusive findings (suicide prevention, child maltreatment), and few had weak or no evidence for behaviour change (bowel cancer screening, breastfeeding). All other mentioned topics had moderate evidence (11 topics) or strong evidence for beneficial behaviour change (2). Furthermore, the likelihood increases by using multiple interventions.

Digital interventions propose an additional type of information flow: interaction. Interventions through this medium have shown to be effective (e.g., Murray, Burns, See Tai, Lai, & Nazareth, 2004; Portnoy, Scott-Sheldon, Johnson, & Carey, 2008; Wantland, Portillo, Holzemer, Slaughter, & McGhee, 2004; Webb, Joseph, Yardley, & Michie, 2010).

Various studies indicate that tailoring the intervention to the audience creates a higher degree of engagement than generic interventions, both in online and offline interventions. (e.g., Kreuter, Oswald, Bull, & Clark, 2000; Spittaels, De Bourdeaudhuij, Brug, & Vandelanotte, 2007; Strecher et al., 2008). As a result, more positive affective responses and greater recall is present.

For social media, it is possible to react on certain types of information. Next to that, it is also possible to include the social factor in these types of behaviour change. Maher et al. ((Maher et al., 2014) have conducted a systematic literature review on the use of online social networks in the field of health behaviour change interventions. Nine of the ten studies they included were significant in outcomes. Yet the effect sizes of these studies vary largely from -0.05 (95% CI 0.45-0.35) to 0.84 (95% CI 0.49-1.19). The magnitudes were also small and non-significant. This indicates there is more research necessary in the field of social media as a medium for behaviour change interventions, yet does not strongly support nor deny the effects of social media in this role.

TPB Framework

The theory of Reasoned Action (TRA) and Theory of Planned Behaviour (TPB) (Montano & Kasprzyk, 2015) are two frameworks commonly seen for behaviour change research. According to the TRA, the immediate determinant of behaviour is the intention to perform a specific behaviour, or to not perform a specific behaviour. Intentions are modeled to be influenced by two variables, namely attitude and subjective norm. The attitude is defined as the attitude towards a behaviour with respect to that object. For example, the behaviour of getting a mammography takes into account the attitude of obtaining mammography, and not the attitude one has towards cancer. Next to that, the subjective norm is defined by the individual's normative beliefs and whether referents approve or disapprove a specific type of behaviour. Azjen later made an addition to the TRA model which is described in the TPB model. This model includes perceived control as a predictor variable for intention, yet also having a direct link to the behaviour itself. Perceived control is characterised by the presence or absence of facilitators or barriers to a certain behaviour. they are weighted by the perceived power or the impact of each factor. However, this addition is hypothesised and currently has little empirical support. Conditional to both the TRA and TPB framework is that the individual is under volitional control.

Aforementioned requirements make the model well suited for the field of behaviour in recycling as it systematically investigates factors that influence the choices of recycling. This framework has also been successfully applied in this field by Chan (1998).

EVALUATION PLAN

In evaluating interventions, two distinct levels of behaviour change are recognized (Blanson Henkemans et al., 2015). Firstly, the *interaction level* or *micro level persuasion* is directly related to the interface: it is used to determine whether the target audience is motivated to interact with the interface by looking at constructs such as usability and user experience. Secondly, the *intervention level* or *macro level persuasion* looks at the long-term effects of the intervention, where it determines whether the behaviour change objectives are met. While behaviour change interventions are designed to cause intervention level changes, functioning well on an interaction level is required as well for the former to occur.

In order to measure the effectiveness of the designed behaviour change intervention, an empirical approach for a summative evaluation is taken. By using the Theory of Planned Behaviour (TPB) as a guiding framework, a white box approach can be used to make sense of how the different components of the intervention work. As TPB connects one's beliefs and their behaviour, it can be applied to establish determinants that predict target behaviour. There are two target behaviours that the proposed intervention is expected to elicit:

1. The behaviour of *carefully separating organic waste*;
2. The behaviour of *actively seeking out information on correctly separating organic waste*.

Analysis of the two target behaviour yields three determinants that are hypothesised to cause increased intention towards performing those behaviours, as illustrated in figures 2 and 3, and Table 2. For clarity, these hypotheses have been marked as 'H1' through 'H3'.

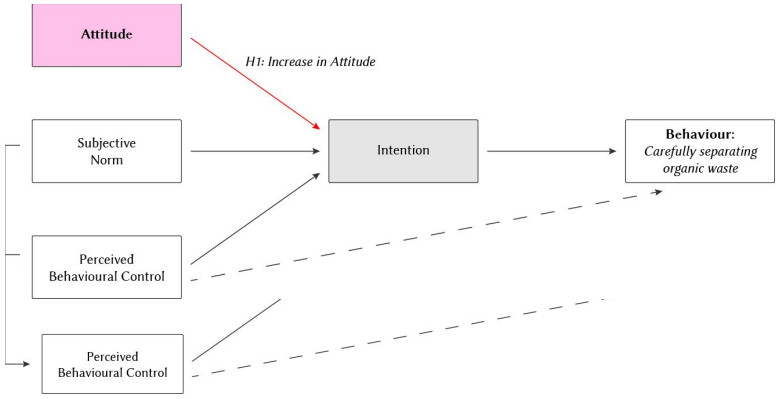

Figure 2: *Application of TPB to the target behavior*

Figure 3: *Application of TPB to the two target behaviours*

Table 2: *Mapping Techniques on Change Objectives and Description of Strategy of Intervention*

Behaviour Change Technique	**Possible Determinants**	**Change Objective**
Education: Self-assessment-based feedback on the outcome(s) of their behaviour	H1 — Attitudes towards the act of carefully separating organic waste	Higher intention of carefully separating organic waste
Persuasion: Social Comparison	H2 —Attitudes towards actively informing oneself about separating organic waste	Higher intention of informing oneself about separating organic waste
Persuasion: Social Comparison	H3 —Subjective Norm in being taking a proactive stance on learning about separating organic waste	Higher intention of informing oneself about separating organic waste

Since all determinants are identified through TPB, evaluation of their change objectives can also be measured using related constructs. A commonly used method to evaluate the determinants is to use questionnaires that focus on TPB-related constructs such as *Outcome Evaluations, Past Behaviour, Behavioural Beliefs, Control Beliefs, Power of Control* and *Normative Beliefs*, as previously demonstrated by (Ajzen, 2013). The

questionnaire was adapted to the domain of organic waste recycling using input from the literature evaluation (Appendix D) and interviews conducted with members of the target group, and is included in Appendix E.

In order to evaluate the potential behaviour change caused by the intervention, participants of this study would be asked to fill out the same questionnaire both *before* and *after* being introduced to the behaviour change intervention. This allows potential changes in behavioural intent to be measured, validating the idea that this BCT is effective.

After validating whether the determinants are good indicators for behaviour change, a follow-up study could take place where changes in behaviour are measured by reviewing their outcomes. A concrete way to measure the behaviour of carefully separating organic waste is to review the contents of the bins for contamination.

The level of contamination in the waste is crucial to the recycling process, and should ideally be as low as possible. In order to establish a base level, these contamination percentages can be measured for a number of weeks before introducing the intervention. By comparing this baseline to measurements taken after the intervention the actual behaviour rather than the intent for behaviour can be measured.

MOCK-UP AND EVALUATION

The COM-B analysis concluded social opportunity and reflective motivation as the main factors to address. While the concept contains elements of both, reflective motivation seems most easily measurable in this concept - on a small scale. If the social aspect of the concept would have to be measured, ideally some degree of virality would have to be achieved for participants to see and be confronted with other people's results. No formal measurement of this construct was included of the pilot test. However, it will be briefly touched upon in the "discussion" section.

Only hypothesis 1 of the evaluation plan will be addressed in the pilot study. Hypothesis 2 and 3 assume an intervention that successfully addresses the behaviour change, likely through the educational mechanism of the behaviour change wheel. During the pilot study, the main focus was on the *intervention* level of the concept: discovering whether the proposed intervention achieves the desired impact on participants' attitudes. Subsequently, this was also the topic of interest for the majority of questions in the questionnaire. The latter part of the questionnaire focused on the workings of the quiz itself, the *interaction* level.

The pilot study will be conducted with the created questionnaire as described in the evaluation plan, based on Azjen (2013). Furthermore, the self-assessment quiz is physicalized as a satirical "personality quiz" entitled *"Which Compost Heap Are You?"*, where users are meant to find out which type of compost heap they would be. The quiz questions and screen captures of the quiz are mentioned in Appendix G. As opposed to an online test, this pilot study is executed in the physical world. As a result, the social element (which would ideally work through social media) will be emulated through placing stickers on the backside of a person's notebook that shows the result of the self-assessment quiz they have taken. The sticker also displays a QR code that links to the quiz itself.

Results

After analyzing the questionnaire, which is described in appendix G, no real conclusions can be drawn. It seems that attitude is the main driver of the three constructs in order to predict the behaviour, but the results are too insignificant and its standard error is too large to draw any meaningful conclusions from this.

Furthermore, it was mentioned that *social opportunity* came forward as one of two constructs to focus on from the COM-B analysis. However, no formal measurements were done to test the impact of the intervention on this aspect. The stickers that were given out to users after partaking in the quiz invited new people to participate through a QR code. While 21 people formally participated in the quiz in relation to the pilot study, a total of 38 people played the quiz at the time of writing, indicating some degree of "spread" through the stickers. Further work could be focused on this social aspect.

ETHICAL ASPECTS AND CONSEQUENCES

Value & stakeholder analyses

This research was initiated to investigate the effects of an online personality quiz on participants' attitude towards proper waste separation - a relatively uncontroversial subject for most. Few will contest the importance of society-wide recycling and responsible waste disposal. However, this often stands in contrast with people's willingness to act. The stakeholder analysis is based on the principles established by Fogg (2002). The value chain of

waste disposal consist of many stakeholders. Among them are the municipality, waste collection and processing companies, and inhabitants. They stand to benefit from improved recycling in similar ways: when inhabitants take better care of disposing their waste, this leads a more efficient recycling process, reducing the companies' operational costs and ecological footprint. This consequently leads to decreased air pollution for all, both due to less waste being burned and more biogas being created. On the other hand, it is possible that the intervention is received poorly. This could start a counter-movement, where target users purposefully recycle their waste worse than before to make a statement. However, the odds of the concept backfiring are considered to be small by the researchers.

DISCUSSION

Intervention and concept

In hindsight, the design of the test that was carried out can be improved in several ways. Firstly, the impact of the educational aspect of the quiz was likely reduced due to the way the pilot study was set up. At the end of the quiz, a page was shown that linked to more information about correct waste separation. However, users were given insufficient time to to browse and explore this page as they were asked to fill out the questionnaire instead. This may have hampered their eagerness to seek out extra information and can be considered a flaw in the *interaction* level of the concept.

Questionnaire design

The questionnaire was based on constructs from the Theory of Planned Behavior, adapted to fit the topic of organic waste separation. Due to this fact, some participants indicated during the study that they found the wording of the questionnaire to be confusing at times. It is possible that some questions were misunderstood or filled in incorrectly. Furthermore, there was no saturation when it comes to response rates and the sample size is small.

Tailoring information

Tailoring information seems to suggest higher engagement rates for online applications. In the case of this research, only the outcome has been tailored to the participants. It could be explored whether the phrasing or topics of the questions in the questionnaire could have been tailored more to the participant in order for them to be taught better on the correct bio-waste separation.

CONCLUSION

The recycling of bio-waste is beneficial for the production of bio-gasses. When 10% or more of bio-waste is incorrectly separated, it gets burned instead. This paper explored the use of the theory of planned behaviour (TPB) as a way to guide participants to correctly separating their bio waste. Through the behaviour change wheel, developed by Michie, the capabilities, opportunities, and motivations of this incorrect bio-waste separation was explored. It appeared to be likely the result of insufficient knowledge on how to separate various items. Education is used to guide participants in learning the correct ways to separate this waste.

An online self-assessment quiz, disguised as a "Which compost heap are you?" test, is used to change the behaviour of the participants. Literature suggests that tailored information shared through social media programs can often lead in successful behaviour change - especially in the health domain.

An evaluation plan has been drafted in which the attitude of people's intention to correctly separate their bio-waste is expected to be a large role. Next to that, the subjective norm and perceived control is theorized to be drivers of finding out more information on the correct bio-waste separation.

A pilot has been conducted with 38 participants as a between-group study. The intervention seemed not to address the educational level that has been hoped for. As a result, all participants could be considered as one group. Through logistic regression, this lead to insignificant results. This likely has to do with either the developed questionnaire, or the limited amount of participants.

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Appendix A — COM-B analysis of disposal behaviour with respect to organic waste

COM-B Components	What needs to happen for the behaviour to occur?	Is there need for change?
Physical Capability	The target audience is able to successfully separate organic waste.	No, they are able to do so.
Psychological Capability	The target audience understands how to dispose of organic waste. Training and/or info could help avoid misplaced items.	Perhaps, although this is not necessarily a priority.
Physical Opportunity	Waste recycling methods are easily accessible to the target audience.	No, bio-waste containers are available, and are emptied of a bi-weekly basis.
Social Opportunity	Social translucence can be a motivating factor.	Yes, they do not see the way others handle their organic waste.
Reflective Motivation	Belief that proper recycling is important to the planet. Value of successful recycling could be emphasised.	Yes, there is no significant personal incentive for people to adjust their behaviour.
Automatic Motivation	Have established routines for recycling	Perhaps, although this is not necessarily a priority.
Diagnosis:	*Both Social Opportunity and Reflective Motivation need to be established.*	

Appendix B — Evaluation Matrices

Table B1. Using the Behaviour Change Wheel's APEASE criteria to identify appropriate intervention function for an intervention to promote organic waste separation behaviour

Candidate Intervention Functions	*Does the intervention function meet the APEASE criteria (affordability, practicability, effectiveness/cost-effectiveness, acceptability, side-effects/safety, equity) in the context of promoting organic waste separation behaviour?*
Education*	Yes.
Persuasion*	Yes.
Incentivisation	Not acceptable as this is likely to produce side-effects. Measures like these set a precedent for performing unacceptable behaviour that will be corrected with an incentive later on.
Coercion	Not acceptable to participants.
Training	Not cost-effective as the target audience is vast, and would require training every other few years.
Restriction	Not practicable to deliver in this context.
Environmental restructuring	Not cost-effective as the environment is large, and changes as the target audience changes.
Modelling	Not practicable to deliver in this context.
Enablement*	Perhaps, although it depends on the knowledge of the recipient.
Selected Intervention Functions	Education, Persuasion and potentially Enablement.

Table B2. Linking Intervention Functions to Behaviour Change Techniques

Intervention Functions	Individual BCTs
Education	*Most frequently used:* Information about social and environmental consequences, Information about health consequences, Feedback on behaviour, Feedback on outcome(s) of behaviour, Prompts/cues, Self-monitoring of behaviour
Persuasion	*Most frequently used:* Credible source, Information about social and environmental consequences, Information about health consequences, Feedback on behaviour, Feedback on outcome(s) of the behaviour *Less frequently used:* Social Comparison
Enablement	*Most frequently used:* Social support (unspecified / practical), Goal setting (behaviour / outcome), Adding objects to the environment, Problem solving, Action planning, Self-monitoring of the behaviour, Restructuring the physical environment, Review behaviour goal(s), Review outcome goal(s)
Selected BCTs	'Education > Feedback on outcome(s) behaviour' and 'Persuasion > Social Comparison'

Appendix C — Concept Ideation

Concept:	ComPROst
Scenario:	The participant is given a dedicated waste bin where they can deposit their organic waste. Just like regular organic waste bin, these get emptied weekly. When the waste is collected, the participant is gifted ComPROst™ which can be used to fertilize gardens and allotments. The compost quality and quantity are dependent on how much waste they produce, as well as how well sorted their waste is.
Framing:	*Reflective Motivation* → *Incentivisation* → *Feedback on Outcome of Behaviour*

Concept:	ComPile
Scenario:	The participant is given a dedicated waste bin where they can deposit their organic waste. Just like regular organic waste bin, these get emptied weekly. However, the way they dispose of organic waste is evaluated, and is represented by the state of their waste bin. The exterior can be neat and well-managed, or be trashed.
Framing:	*Reflective Motivation* → *Coercion* → *Feedback on Outcome of Behaviour*

Concept:	GIT Trashed
Scenario:	Through geotargeting, we select neighbourhoods that are notoriously bad at recycling organic waste. Through online platforms *(Google AdWords, Facebook Ads)* we reach this impactful group, educating them on the importance of recycling, thus persuading them to change their behaviour. *See also: The Great Hack (2019) — https://www.imdb.com/title/tt9358204/*
Framing:	*Reflective Motivation* → *Persuasion* → *Information about social and environmental consequences*

Concept:	BioEducate
Scenario:	Once the organic waste bin has been emptied, a biodegradable flyer is attached to the lid. This flyer contains interesting facts or riddles about organic waste, aimed at increasing the understanding of importance of recycling. After reading the flyer, it can be discarded in the same bin.
Framing:	*Reflective Motivation* → *Education* → *Prompts/cues*

Concept:	TrashTreaty
Scenario:	The participant forges an alliance with peers in their neighbourhood: the TrashTreaty™. We document the performance of the participant, and provide perspective by comparing it to their neighbours and other areas. Through this intervention, our participant receives a social opportunity to adjust their behaviour. .
Framing:	*Social Opportunity* → *Enablement* → *Review outcome goal(s)*

Concept:	TrashTown — #6
Scenario:	We establish a community (vegetable) garden in a neighborhood, with a fee to participate. However, the fee is reduced when participants bring in waste to make compost from. If they bring X amount per week/month, the fee is reduced to zero and they can garden for free.
Framing:	*Social Opportunity* → *Enablement* → *Review outcome goal(s)*

Concept:	AllotmentFissa
Scenario:	People visiting and working on an allotment get the opportunity to contribute to the allotment's compost pile. When people put in bad trash, they ruin it for everyone.

Framing:	Social opportunity -> Enablement -> Review outcome goals

Concept:	Turfy's Law
Scenario:	An informational campaign on the dos and don'ts of bio waste separation.
Framing:	Reflective motivation -> Education

Concept:	Pear Alliance
Scenario:	The participant forges an alliance with peers in their neighbourhood: the TrashTreaty™. We document the performance of the participant, and provide perspective by comparing it to their neighbours and other areas. Through this intervention, our participant receives a social opportunity to adjust their behaviour. .
Framing:	*Social Opportunity* → *Enablement* → *Review outcome goal(s)*

Concept:	The bin with the face
Scenario:	A bin displays a random object that is or is not allowed to be thrown into the bio waste bin
Framing:	

Concept:	I've bin shopping
Scenario:	The material or look of the bio waste bin defines the eco-self-sufficient level of the owner

	Digital avatar of progression on how well you separate your biowaste
Framing:	

Concept:	Compost Companion
Scenario:	Feedback on progress in terms of - Temperature of the compost bin - Amount of waste -
Framing:	

Concept:	Which compost pile are you?
Scenario:	Buzzfeed-style quiz of which compost pile you are. Dank illustrations and viral performance expected. Performance indicator: Evaluate users' performance, perhaps also over time
Framing:	*Reflective Motivation* → *Education* → *Prompts/cues*

Appendix D — Bio-waste Separation Factors

This dataset regarding the collection of organic waste (GFT) is courtesy of a poll of the citizen's panel Utrecht (Bewonerspanel Utrecht). It was used to better understand the reasons behind why the behaviour of correctly separating organic waste is not as frequent as we had hoped. These insights were used in the creation of the evaluation questionnaire (Appendix E).

Please note that the answers given to this question are multiple-choice: participants of this research were free to give multiple answers to the questions, making the percentages non-cumulative.

The dataset is licensed as CC-0, and can be retrieved from https://data.overheid.nl/dataset/afvalinzameling-gft

Kunt u aangeven waarc het niet (altijd) lukt om GFT te scheiden?
Te weinig ruimte
Wist niet van scheiden
Wist niet waar aanbiedei
Afval op één hoop
Te veel moeite
Ruikt vies
Geen nut
Weet niet wat
Geen afval
Middel niet handig
Geen van bovenstaande

Kunt u aangeven wat d gemeente kan doen zo u GFT vaker gescheider aanbiedt?
Informatie over gevolger milieu
Informatie over aanwezigheid containers
Huis-aan-huis ophalen
Meer containers
Geven van boetes
Geen van bovenstaande

Appendix E — Evaluation Questionnaire

Hello, and thank you for your willingness to participate in our user study!

We are a team of aspiring researchers that have delved into the realm of waste separation. More specifically, we focus on waste separation of biodegradable waste. This survey is part of the investigation on the reasons why some people either successfully or unsuccessfully separate their waste.

Thanks again, and good luck!

We would like to ask you to:

- ☐ first complete the self-assessment test
- ☐ continue below!

Consent form

For the project 'Design for Behavior Change' of the Eindhoven University of Technology, we are conducting research on your opinion about separating your biological waste (bio-waste). As part of this research we ask you to fill out this questionnaire.

You have been invited to take part in this study, to give insight about the experience of separating your bio-waste. In order to investigate this, we have developed this questionnaire.

You are not obligated to participate in this research or to answer the questions of the students. In case you want to withdraw from the study you can mention this to the researcher at any time. Collected information will be treated confidentially, unless you indicate that it can be made publicly.

- ☐ I **do** give permission to processing my data anonymously for the purpose of this research.
- ☐ I **do not** give permission to processing my data anonymously for the purpose of this research.

I understood this 'consent form', and voluntarily take part in this interview. I understand that my permission does not damage my legal rights in case of negligence or other legal fault of anyone involved in this study.

Date:	Date:
Name participant:	Name researcher:
Signature participant:	Signature researcher:

Demographics

What is your age?

17 or younger | 18 - 21 | 22 - 25 | 26 - 29 | 30 or older

What is the highest level of education you have finished?

MBO | HBO | University | PhD / PdEng | Postdoc

What is your living situation?

By myself | With my partner | With housemates | With my parents

What type of house do you live in?

Studio / Apartment | Terraced house (rijtjeshuis) | Semi-detached house | Other, namely:

What kind of trash do you separate?

Plastics | Cardboard | Textiles | Glass | Residual waste

On a scale of 1 (very uninformed) to 7 (very informed), how well informed are you in separating your waste?

Very Uninformed 1 2 3 4 5 6 7 Very Informed

Please explain why.

Please answer each of the following questions by circling the number that best describes your opinion. Some of the questions may appear to be similar, but they do address somewhat different issues. Please read each question carefully.

Outcome evaluations

1. For me to gain a better understanding of my ecological footprint is

Extremely Good 1 2 3 4 5 6 7 Extremely Bad

2. For me to decrease my ecological footprint is

Extremely Good 1 2 3 4 5 6 7 Extremely Bad

3. For me to play a role in ecological footprint of my household is

Extremely Good 1 2 3 4 5 6 7 Extremely Bad

4. For me to own separate bins for recycling my bio-waste is

Extremely Good 1 2 3 4 5 6 7 Extremely Bad

5. For me to contribute to the production of bio-gasses is

Extremely Good 1 2 3 4 5 6 7 Extremely Bad

6. For me the smell of recycling my bio-waste is

Extremely Good 1 2 3 4 5 6 7 Extremely Bad

7. For me the opportunity (i.e. bins, retrieval routes by my municipality) to recycle my bio-waste is

Extremely Good 1 2 3 4 5 6 7 Extremely Bad

Past behavior

8. During the past 4 weeks, what percentage of trash have you incorrectly separated?

During the past 4 weeks, I have incorrectly separated about ____% of my biological waste

Direct measures of perceived behavioral control, subjective norm, attitude, and intention

9. For me to separate trash successfully on a regular basis is

Extremely Difficult 1 2 3 4 5 6 7 Extremely easy

10. Most people who are important to me think that...

I should 1 2 3 4 5 6 7 I should not

... separate bio-waste successfully on a regular basis

11. For me to successfully separate bio-waste is

Extremely Good 1 2 3 4 5 6 7 Extremely bad

12. I plan to successfully separate my bio-waste on a regular basis

Extremely Likely 1 2 3 4 5 6 7 Extremely Unlikely

13. Whether I successfully separate my bio-waste on a regular basis is completely up to me

Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree

14. Most of the people with whom I am acquainted separate their bio-waste on a regular basis successfully

Definitely True 1 2 3 4 5 6 7 definitely false

15. For me to separate my biological trash on a regular basis is

Extremely valuable 1 2 3 4 5 6 7 Extremely worthless

16. I am confident that if I wanted to successfully separate my trash on a regular basis I could

Definitely True 1 2 3 4 5 6 7 definitely false

17. It is expected of me that I separate my bio-waste successfully on a regular basis

Definitely True 1 2 3 4 5 6 7 definitely false

18. For me to separate my bio-waste successfully on a regular basis is

Extremely Pleasant 1 2 3 4 5 6 7 Extremely unpleasant

19. I will make an effort to successfully separate my bio-waste on a regular basis

I definitely will 1 2 3 4 5 6 7 I definitely will not

20. For me to separate my bio-waste successfully on a regular basis is

Impossible 1 2 3 4 5 6 7 Possible

21. Most people whose opinions I value would approve of me separating my bio-waste successfully on a regular basis

Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree

22. For me to successfully separate my bio-waste is

Interesting 1 2 3 4 5 6 7 Boring

23. I intend to successfully separate my bio-waste on a regular basis

Strongly Agree 1 2 3 4 5 6 7 Strongly Disagree

Motivation to comply

24. Generally speaking, how much do you care what your municipality think you should do?

Not at all 1 2 3 4 5 6 7 Very much

25. Generally speaking, how much do you care what your parents think you should do?

Not at all 1 2 3 4 5 6 7 Very much

26. Generally speaking, how much do you care what your close friends think you should do?

Not at all 1 2 3 4 5 6 7 Very much

27. Generally speaking, how much do you care what your neighbours think you should do?

Not at all 1 2 3 4 5 6 7 Very much

Behavioral beliefs

28. Successfully separating my bio-waste on a regular basis will help me gain a better understanding of my ecological footprint

Extremely Unlikely 1 2 3 4 5 6 7 Extremely Likely

29. Successfully separating my bio-waste on a regular basis will decrease my ecological footprint

Extremely Unlikely 1 2 3 4 5 6 7 Extremely Likely

30. Successfully separating my bio-waste on a regular basis will enable me to play a role in the ecological footprint of my household

Extremely Unlikely 1 2 3 4 5 6 7 Extremely Likely

31. Successfully separating my bio-waste on a regular basis will require me to own separate bins for recycling my waste

Extremely Unlikely 1 2 3 4 5 6 7 Extremely Likely

32. Successfully separating my bio-waste on a regular basis will let me contribute to the production of bio-gasses

Extremely Unlikely 1 2 3 4 5 6 7 Extremely Likely

33. Successfully separating my bio-waste on a regular basis will cause me to experience unpleasant smells of trash

Extremely Unlikely 1 2 3 4 5 6 7 Extremely Likely

34. Successfully separating my bio-waste on a regular basis will be supported by my municipality, for example through bins or close retrieval routes

Extremely Unlikely 1 2 3 4 5 6 7 Extremely Likely

Control beliefs

35. How often do you encounter unanticipated events that impact your bio-waste separation?

Very rarely 1 2 3 4 5 6 7 Very frequently

36. How often do house mates impact your ability to separate your bio-waste successfully?

Very rarely 1 2 3 4 5 6 7 Very frequently

37. How often does your knowledge on bio-waste separation impact your ability to successfully separate your bio-waste?

Very rarely 1 2 3 4 5 6 7 Very frequently

38. How often do other activities aimed at improving your ecological footprint place heavy demands on your time?

Very rarely 1 2 3 4 5 6 7 Very frequently

Power of control factors

39. If I encountered unanticipated events that impact my bio-waste separation, it would make it more difficult for me to separate your bio-waste successfully on a regular basis

Strongly Agree 1 2 3 4 5 6 7 Strongly Disagree

40. If housemates (e.g. parents, other students) impact my ability to successfully separate my bio-waste, it would make it more difficult for me to separate your bio-waste successfully on a regular basis

Strongly Agree 1 2 3 4 5 6 7 Strongly Disagree

41. If knowledge impacts my ability to separate my bio-waste successfully, I am unable to find the information that I need in order to improve the act of separating bio-waste

Strongly Agree 1 2 3 4 5 6 7 Strongly Disagree

42. If other activities aimed at improving my ecological footprint place heavy demands on my time, it would make it difficult for me to separate the bio-waste

Strongly Agree 1 2 3 4 5 6 7 Strongly Disagree

Normative beliefs

43. My municipality thinks I should successfully separate my bio-waste

Extremely Likely 1 2 3 4 5 6 7 Extremely Unlikely

44. My parents think I should successfully separate my bio-waste on a regular basis

Extremely Likely 1 2 3 4 5 6 7 Extremely Unlikely

45. My close friends think that I should separate my bio-waste successfully on a regular basis

Extremely Likely 1 2 3 4 5 6 7 Extremely Unlikely

46. My neighbours think that I should successfully separate my bio-waste on a regular basis

Extremely Likely 1 2 3 4 5 6 7 Extremely Unlikely

If you have completed the “Which compost heap are you?” personality quiz, we would also kindly ask you to fill in the following four questions. If you haven’t, congratulations! You’re now done!

Behavior

47. Because of the personality quiz I found I have misconceptions about separating bio-waste

Strongly Agree 1 2 3 4 5 6 7 Strongly Disagree

48. The personality quiz did not teach me any new things regarding separating bio-waste

Strongly Agree 1 2 3 4 5 6 7 Strongly Disagree

49. I found the satirist tone-of-voice of the personality quiz enjoyable

Strongly Agree 1 2 3 4 5 6 7 Strongly Disagree

50. I did not recognize my level of knowledge on bio-waste separation in the result I was presented with

Strongly Agree 1 2 3 4 5 6 7 Strongly Disagree

Appendix F - Quiz questions and screen captures

Waarin bewaar je je verse groenafval? [4 options]
Where do you keep your green waste?

[...] Je hebt net een gekookt eitje gegeten. Mogen de eierschalen op de composthoop? [4 options]
[...] You have just eaten a boiled egg. Can the shells go onto your compost heap?

[...] Je tuin ligt bezaaid met visgraten. Wat doe je ermee? [4 options]
[...] Your garden is filled with fishing grates. What do you do with them?

Hoeveel kaaskorsten heb jij deze maand bij het GFT gemieterd? [open question]
How many cheese crusts have you thrown into your green waste this month?

Maak het gezegde af: liever een koffiefilter op m'n composthoop… [4 options]
Finish the saying: rather a coffee filter on my compost heap…

Wat is jouw weloverwogen standpunt over gescheiden afvalinzameling? [4 options]
What is your informed viewpoint on waste separation?

Figure F1: *Welcome screen*

Figure F2: *Question example*

Figure F3: *Final screen with redirect to more information*

Figure F4: *One of the result stickers*

Appendix G - Data analysis

As the concept can be seen as a personal reflection on waste behaviour, the aim became to measure the impact of partaking in the quiz on participants' attitudes towards waste separation. A pilot study was conducted (N=38) to gain insights in the aforementioned questions. Two groups were recruited, one of which had experienced the intervention (N=21) and the second group had not (N=17). Both groups had a similar division in age of the participants (all 18-25 years old, one 26 years old), and all participants were in university. Some in their bachelor education, some in their master education.

The first step in measuring the intervention level, four questions were formulated in regards to the extent of which they recognize their results and agree with them, and whether or not they learned something new. These questions all reported a wide range of responses, indicating the intervention did not work as planned. As a result, it was decided to combine the answers to the questionnaire of both groups in order to increase the reliability of the test, as there appeared to be little differences in the answers given to other questions.

Prior to running data analysis tools, the constructs of the theory of planned behaviour (TPB) framework were calculated through transforming scales to bipolar scales from -3 to 3, and transforming all questions from "least favourable" as the lowest point and "most favourable" as the highest points possible. The construct *attitude* is defined by *outcome evaluations* multiplied by *behavioural beliefs*, *perceived control* is defined by the *power control factors* multiplied by the *control belief factors*, and the *subjective norm* is calculated by multiplying the *normative beliefs* with the *motivation to comply*.

As variables of the model are measured through different questions, its internal validity needs to be measured in order to see whether the construct is actually measured. These Cronbach's alphas can be seen in table F1.

	Attitude	***Perceived Control***	***Subjective Norm***
Cronbach's alpha	0,66	0,69	0,79
Standard deviation	2,2	1,8	5,7

Table G1*: Cronbach's alpha results*

Although Cronbach's alpha is acceptable for attitude and acceptable for perceived control and subjective norm, the standard deviation is high (on a 7 point scale) - especially for the subjective norm.

For the regression analysis, the threshold for good versus bad behaviour of waste separation will be placed at 10%. incorrect waste separation in the past as a determinant. As the outcome is binary (either good or bad behaviour), a logistic regression model will be used. The results of this model can be seen in table F2.

	Estimate	**Standard deviation**	**p-value**
Intercept	0,17053	0,23579	0,486
Attitude	0,08588	0,08187	0,319
Perceived Control	-0,12105	0,09403	0,227
Subjective norm	0,03898	0,02712	0,181

Table G2*: Logistic regression output*

The regression results are very unreliable. The standard deviation is approximately the same as the estimate, and the p-values are nowhere near significance. This is likely to blame due to the small sample size, or the development of the questionnaire. This will be further discussed in the discussion section.