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Can you be Nudged? Exploring the Impact of Behavioural Techniques on Pro-environmental Actions

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List of Acronyms

CDF	Cumulative Distribution Function
EEE	Electrical and Electronic Equipment
E-waste	Electronic Waste
UNEP	United Nations Environment Programme
WTP	Willingness to Pay

Abstract

This research aims to explore the effectiveness of information nudges and visual priming on the willingness of consumers to purchase a sustainable smartphone. This study is relevant because large amounts of electronic waste are generated in the world, including the disposal of smartphones, and these are causing serious environmental issues such as contamination of soil and water and increases in greenhouse gas emissions. In the Netherlands, electronic waste is of special interest as the Dutch government wishes to transform the economy into a circular economy, for which recycling of electronic devices is vital.

The main question this paper aims to explore is the impact of visual priming and information nudges on consumer's willingness to purchase a sustainable smartphone. Additionally, it will assess the impact of nudges on the importance given to environmental characteristics and the willingness to pay a higher premium for sustainable smartphones. This question is addressed through a web-based questionnaire which presents these nudges in the form of videos. Probit and ordered probit models are used to estimate the relationship between nudges and pro-environmental behaviour.

The findings suggest that the information nudge had no effect on the willingness to purchase a sustainable smartphone when individuals receive information on the benefits of recycling their products. However, those who received information on the negative impact of disposing smartphones showed a decrease in the likelihood of purchasing a sustainable smartphone. Finally, the nudges had no effect on the importance given to environmental characteristics when purchasing a new smartphone and on the willingness to pay higher premiums.

Relevance to Development Studies

This research is relevant to development studies since it argues the need for sustainable development. This term is defined as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (Brundtland, 1987). The contamination of soil and water, and the release of carbon emissions during the collection, production, consumption, and disposal of electronic waste threatens economies in achieving sustainable development. Understanding consumption behaviours of individuals is crucial to identifying the barriers in the transition to a circular economy, which is seen as a possible solution towards reaching sustainable development. Moreover, this study contributes to the growing body of behavioural insights that are being used to promote sustainability goals and understand the preferences of consumers.

Keywords

Pro-environmental behaviour, nudges, priming, sustainable consumption, e-waste

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Chapter 1 Introduction

1.1 Research Context and Justification

The world is facing unprecedented climate issues, which may be due to human activities such as littering, wasteful consumption, combustion of fossil fuels, or consuming unsustainable products. There is a need for individuals to have a sustainable lifestyle, such that everyday choices result in minimal environmental damage and simultaneously supporting equitable socio-economic development, thus making pro-environmental decisions. Steg and Vlek (2009) define pro-environmental behaviour as “behaviour that harms the environment as little as possible, or even benefits [it]” (p. 309). The current paper follows this definition and is synonymously used as pro-environment actions, pro-environment choices, pro-environment attitudes, or pro-environment decisions. While there are many policies that change consumer behaviour through modifications in economic incentives (such as fines, taxes, subsidies), there are few non-technical policies that aim to change preferences through rules or guidelines. An example of such non-technical policies are nudges. Introduced by Thaler and Sunstein (2008), nudges are defined as “aspects of the choice architecture that alter people’s behaviour in a predictable way without forbidding any options or significantly changing their economic incentives” (p. 6). The idea that the choices made by individuals are guided by their System 1 and System 2 thinking was introduced by Kahneman (2011). The former system relates to fast, intuitive, and emotional thinking whereas the latter corresponds to a slower, conscious, and controlled form of thinking. These non-technical policies, like nudges, can affect human behaviour since many of the choices we make are influenced by System 1, which can be changed or adapted due to its automatic characteristic. At the same time, nudges can affect choices made by System 2 thinking as it allows people to reflect on their behaviours and adjust accordingly.

This dual influence is particularly relevant in addressing urgent environmental challenges, such as electronic waste (e-waste). The United Nations Environment Programme (UNEP) suggests that e-waste is one of the fastest growing waste sectors globally (*Sustainable future of e-waste*, 2023). E-waste is defined as electrical and electronic equipment (EEE) and its parts that no longer satisfy the consumer and has been discarded by the owner as waste (Widmer *et al.*, 2005). This type of waste mainly covers three categories: large equipment like washing machines or dishwashers, small equipment (for example vacuum cleaners or microwaves), and information technology and telecommunication systems like mobile phones or laptops (Perkins *et al.*, 2014). In this time, when technology and electronics have become prevalent, the rapid pace of innovation and consumption of digital devices pose a threat not only to the environment but also our health. The hazardous substances¹ used to produce electronic devices are inadequately disposed of, resulting in contamination of soil and water, increase in greenhouse gas emissions, and exposure to toxic environments (*Sustainable future of e-waste*, 2023). To this extent, sustainable e-waste management is necessary for consumers who are heavily dependent on these electronic devices. E-waste can be addressed by either recycling these devices, disposing them responsibly, or by incorporating sustainable products in the manufacturing process.

Recognising this urgency, some technology companies are changing their manufacturing processes to produce more eco-friendly and sustainable designs. For eco-friendly

¹ Hazardous substances include lead, chromium, cadmium, mercury, zinc, nickel, lithium, barium, and beryllium (Perkins *et al.*, 2014). These are exposed into the air, dust, water, and soil and exposes individuals to these substances through inhalation or ingestion.

smartphones, sustainable practices mean sourcing recycled materials such as plastics and metals, and responsibly sourcing the minerals used in production (Karishma, 2024). Since the extraction and shipping of raw materials accounts for almost 95% carbon emissions, reusing and recycling materials is necessary to decrease reliance on mining activities (Lee and Bucaille, 2022). Another vital component of sustainable smartphones is their design, which is made to be adaptable. This facilitates repairing specific parts of a phone, without needing to dispose of the entire device, thus combating e-waste generation significantly. Finally, a smartphone's software support plays an important role towards its longevity. Regular security and software updates which keep the operating system working efficiently need to increase from the current three to five years to possibly seven to eight years to accommodate longer use of smartphones (Lee and Bucaille, 2022). Sustainable smartphones are also characterized by their energy efficiency and optimized battery life, thus reducing charging time.

One instance of the shift towards sustainable technological products are the new battery regulations implemented by the European Parliament. The regulations, which apply to manufacturers of all types of batteries, state that users should be able to easily replace their own batteries, without requiring specialised tools, for at least five years until a product is discontinued. The aim of these regulations is to create a stronger recycling industry that transforms towards a circular economy (Popp, 2023). Similarly, the Dutch electronics manufacturer, Fairphone is a leading company that produces smartphones designed to maximise sustainability and repairability. Fairphone aims to raise awareness about all the minerals and components included in the production of a smartphone, information that is currently unclear to most consumers and even some producers (Wernink and Strahl, 2015). Their design reflects the entire production process from the sourcing of minerals and components to the distribution and recycling, with the motivation to share their practices with the entire technology industry. What sets Fairphone apart is that they address the lack of repairability by manufacturing phone batteries that are easily removable and replaceable with normal screws (Wernink and Strahl, 2015). In order to make repairing products easier, Fairphone also provides spare parts directly to their consumers while also distributing detailed, but easy to follow repair instructions.

Additionally, and interestingly, Fairphone distinguishes itself from other smartphone manufacturers by prompting consumers to confirm whether they already own a USB cable for charging before making the final purchase. This encourages awareness of existing resources and potentially reducing e-waste generation. Additionally, Fairphone offers dual-sim functionality, enabling users to manage two numbers on a single device, further decreasing the need for multiple phones (Wernink and Strahl, 2015). Nonetheless, Fairphone cannot compete with the giants of the smartphone market like Apple or Samsung. Although some features, such as display quality, in a Fairphone are better than those of its competitors, the company lacks the resources and market scale to achieve top-tier specifications across all features like its larger competitors do (Gibbs, 2023). Given these limitations and the unique sustainability initiatives implemented by Fairphone, this study defines a sustainable smartphone as one that is designed for ease of repair, offers readily available spare parts, encourages mindful consumption through reusing compatible accessories, and provides dual-sim functionality to reduce the need for multiple devices. These features also define the environmental characteristics that could be considered when purchasing a new smartphone. The features not only contribute to a more sustainable device but also highlight the role of consumer awareness in sustainable practices, a concept closely related to priming.

Priming can be defined as an activator where the exposure to a stimulus influences, or activates, a person's behaviour and makes them more sensitive to it. It is operated through implicit memory, where it affects one's cognition without their awareness, thereby subtly influencing their decisions or behaviours (Schacter and Buckner, 1998). Visual priming is a

tool used to make certain behaviours more salient using images, patterns, colours, or videos (Bimonte, Bosco and Stabile, 2019). Bimonte, Bosco and Stabile (2019) were interested in understanding the effect of priming on making environmentally friendly preferences. They examined the effect of priming on the willingness to pay (WTP) for a recyclable smartphone in Italy. According to these authors, the main perspective we have of our environment is aesthetic and visually appealing. Due to this, visual priming can present different environmental backgrounds and assess the impact of positive or negative settings. They apply this opinion to their research by hypothesizing that on the one hand, a clean and conserved environment signals to individuals what they would lose without sustainable policies. On the other hand, a degraded environment indicates the need for sustainable policies as it signals what could be gained through conservation of the environment. Similarly, this current research aims to understand whether young individuals (mainly university students) can be primed towards sustainable choices in The Netherlands. Taking a step further, in addition to understanding the effect of priming, this research aims to investigate whether individuals can be nudged to make pro-environmental choices after receiving information about the benefits of recycling a smartphone or disadvantages of disposing of a smartphone.

This research is especially interesting in the Netherlands since the Dutch government seeks to transform their economy into a circular one, that is, producing no waste or pollution by the year 2050 (Ministerie van Infrastructuur en Waterstraat, 2023). To achieve this, they suggest four methods: reduce the usage of raw materials, substitute raw materials for more sustainable products, reuse and repair products to extend their life, and recycle materials with high-grade processing (Ministerie van Infrastructuur en Waterstraat, 2023). Recycling these products can be helpful in reducing resource consumption and recovering scarce and expensive resources that are used during the manufacturing of electronic devices. Given their importance, organizations collect and recycle this waste in addition to removing and safely destroying the hazardous chemicals (Golsteijn and Martinez, 2017). Between the years 2009 and 2016, large amounts of e-waste were collected per year in The Netherlands (increase from 83,000 tonnes to 110,000 tonnes) wherein 80% of this waste was recycled into useful materials, 17% energy was recovered, and 155,000 tonnes of CO₂ equivalents emissions were avoided (Golsteijn and Martinez, 2017). These figures infer the environmental benefits of appropriate e-waste disposal and its contributions towards achieving a circular economy. However, Golsteijn and Martinez (2017) suggest that there is scope for further reductions in the loop towards a circular economy. One reason is that the disposal of e-waste generates environmental pollution and health damage through contamination of soil, water, and air. Furthermore, in recent years, there have been instances of e-waste occurring in municipal waste. Improvements in the efficiency of collecting e-waste can help reduce carbon emissions beyond current levels (Golsteijn and Martinez, 2017).

Research on the acceptability and usage of sustainable electronic products in the Netherlands thus seems relevant. It is important to understand the factors that may influence the acceptance of these devices such that more effective policies that directly target consumption may be implemented. Moreover, existing literature on the effects of nudges and priming on consumer behaviour is insufficiently researched in the Netherlands. Hence, understanding the preferences and stance of young individuals who are living and studying in the Netherlands will be interesting to study, especially since the government aims to be a leader in the sustainability forefront. Finally, this research can provide insights into consumers' preferences towards sustainable devices, allowing us to analyse production patterns in the future.

1.2 Research Questions

Given the relevance of the research, the paper seeks to answer:

Research Question: What is the impact of visual priming and information nudges on consumer's willingness to purchase a sustainable smartphone?

Sub-research question 1: Do visual priming and information nudges lead to increased importance given to environmental characteristics when purchasing a new smartphone?

Sub-research question 2: Do visual priming and information nudges affect an individual's WTP a higher premium for a sustainable smartphone?

In order to answer the research questions, primary data on individual's attitudes towards smartphones, their willingness to purchase a sustainable smartphone, the maximum premium they would pay for it, and their pro-social traits were collected. To analyse the data, probit and ordered probit regression models were used. The results indicated that watching the clean environment video had no effect on the likelihood of purchasing a sustainable smartphone. Contrary to expectations, watching the degraded environment video suggested a decrease in this likelihood. The videos had no effect on the importance given to environmental characteristics and on the WTP a higher premium for a sustainable smartphone.

The remainder of the paper is structured as follows. Section 2 discusses the theoretical and empirical literature on pro-environmental behaviour and nudges. This is followed by an elaboration of the data and methodological approach in Section 3. Section 4 presents and discusses the results. Finally, a conclusion is reached in Section 5.

Chapter 2 Literature Review

This chapter provides an overview of the existing literature on the effectiveness of nudges in promoting pro-environmental behaviour. Section 2.1 firstly delves into the theoretical concepts that underpin behavioural interventions, focusing on the mechanisms by which nudges influence decision-making processes. Following this, Section 2.2 presents the empirical evidence on the application of nudges, specifically in promoting sustainable diets and recycling behaviours. Finally, section 2.3 examines relevant studies conducted in the Netherlands.

2.1 Theoretical Framework

The term nudge was first popularised by Thaler and Sunstein (2008) and it refers to “aspects of the choice architecture that alter people’s behaviour in a predictable way without forbidding any options or significantly changing their economic incentives” (Thaler and Sunstein, 2008, p. 6). This term evolved from behavioural economics through the realisation that traditional economic theories failed to account for the complex human behaviour, which is influenced by psychological factors and cognitive biases. This leads to understanding that there is a difference between homo economicus, who is a rational person, and homo sapiens, who makes mistakes in their everyday life (Thaler and Sunstein, 2021). On the one hand, homo economicus are hypothetical beings used in traditional economic theory. They are perfectly rational and self-interested individuals who maximise their utility and do not make errors. However, research into cognitive biases and heuristics by Tversky and Kahneman (1974) showed that in the real world, decisions are not made based on rational models. Instead, it relies on mental shortcuts, or heuristics, that allow quick decisions but could lead to error. This led to the shift from assuming only homo economicus to also including homo sapiens, or humans, who may make apparently irrational decisions, influenced by cognitive biases or social norms. Rather than maximising utility, humans are influenced based on the framing of choices, their emotions, or habits. This shift in understanding of human beings has been vital in the development of nudges and to understand the design of choice environments such that people are not required to overcome their cognitive limitations (Thaler and Sunstein, 2021).

There are several cognitive biases and heuristics that influence human decision-making. Firstly, there is the concept of loss aversion, introduced in Kahneman and Tversky’s (1974) prospect theory. They theorise that individuals perceive losses more intensely than equivalent gains. For example, an individual is loss averse when they value losing €100 more than gaining €100. This explains that the presentation of an option as a potential loss or gain can affect choices significantly and can guide people towards a beneficial choice. Framing effects utilise this theory and manipulate the presentation of information to aid in decision-making. This tool is vital in designing nudges that encourage positive behaviour without restricting choices. In this study, the use of a clean or a degraded environment exploits this concept of loss aversion and framing effects. The idea is that presenting a clean environment signals to individuals what they could lose if the environment is not conserved. On the other hand, the degraded environment signals what could be gained if individuals make pro-environmental choices.

Secondly, Thaler (2018) addresses individual’s tendencies to be present biased wherein immediate rewards are prioritized over future benefits. This leads to individuals making choices that may have poor consequences in the long-term. Nudges that aim to present

future gains that feel more immediate may help counter these biases. Examples include reminders or commitment devices. The status quo bias links with the present bias since it leads to the development of default nudges. It is argued that individuals tend to accept default settings, such that the default option implies the “best” choice. Moreover, the additional cognitive effort required in understanding and evaluating a different choice incentivizes people towards the default option. The most common example is that of a retirement savings plan, especially for present biased employees, where they are enrolled in this plan by default. This leads to a significant increase in savings rates without withholding choices of the employees. Similarly, default options could be applied in online grocery shopping, for instance, where the eco-friendly choice is set as the default, encouraging consumers to purchase these products.

Finally, social norms are a powerful tool that presents desired actions as the norm (Thaler, 2018). It is argued that people often follow social norms, looking to others to understand what behaviours are socially acceptable. When individuals see a certain behaviour is common, they are more likely to adopt the same behaviour. These nudges do not restrict choices but influence behaviour by making individuals aware of common practices in society. Social norms are most commonly used to target behavioural intention (extent to presenting expected behaviours) and behaviour (self-reported behaviour) (Shulman *et al.*, 2017). These tools are mainly used in the health category, focusing on alcohol use or dietary behaviours, or with topics related to recycling or littering (Shulman *et al.*, 2017). Van Doesum *et al.* (2021) also show evidence of pro-social behaviours linked to pro-environmental behaviours. They argue that greater levels of social mindfulness, which is the ability to recognise the needs of other individuals, contributes positively towards environmental protection due to the sense of cooperation individuals feel towards each other. Subjective well-being also plays an important role in behaving via social influences as indicated by Zawadzki, Steg and Bouman (2020). Individuals who recognize a personal significance in their pro-environmental actions tend to experience higher levels of subjective well-being. This sense of meaningful action may suggest an increased likelihood of sustainable choices, suggesting a relationship between intrinsic motivation and pro-environmental behaviours. These theories recognise that individual behaviour is not always driven by rationality but rather by biases, heuristics, or social influences. Through these insights, nudges were developed as subtle, cost-effective tools that promote “good” behaviours while keeping the individuals’ autonomy intact, highlighting the need to work with our cognitive patterns rather than against it.

Another theory that has led to the development of nudges is the Dual Process Theory popularised by Kahneman (2011) which theorises that human cognition works through two processes: System 1 and System 2 thinking. System 1 thinking is fast, automatic and often unconscious. While it relies on heuristics to make quick judgements, it is also prone to biases and errors. System 2 thinking is slower, and more conscious. It involves logical reasoning and analysis, thus being less prone to errors. Primarily, nudges work with System 1 to guide decisions, however, nudges can influence System 2 thinking through a more deliberate reflection. By setting beneficial defaults, nudges use System 1 thinking to guide individuals towards positive behaviours without requiring any rational calculation by the individual. It brings about an immediate and emotional aversion to losses, motivating action towards loss frames compared to gain frames. Present bias manipulates the impulsive tendencies presented by System 1 to choose options that bring about more gratification in the present than the future. Overall, nudges leverage System 1 by creating environments that feel easy or socially expected, guiding people toward beneficial choices with minimum cognitive effort.

While many nudges are designed to work with System 1 thinking, some nudges can be utilized to work with System 2 thinking as well. Firstly, System 2 thinking can be nudged by providing information that prompt individuals to evaluate options. For example, before an

individual buys a new smartphone, they read through all the available information and compare different models. Information that convey specific features about a phone can nudge consumers into purchasing that phone. Moreover, visual nudges, like timelines, can be used to depict the future implications of current choices, again engaging the conscious and slow thinking of System 2. For example, many information nudges on energy conservation present the amount of energy or money that can be saved over a month. However, if this were to be extended to a year, it encourages consumers to consider the bigger picture. Finally, System 2 thinking uses feedback nudges to compare one's behaviour to that of others to bring about self-reflection or deliberate efforts. This applicability of nudges to both forms of thinking explain their possible beneficial impact on human behaviour.

The shift from homo economicus to homo sapiens provides a more realistic depiction of real-world decision-making and presents opportunities for policymakers that can guide individuals toward better outcomes. The ideology that underlies nudges is the concept of libertarian paternalism, introduced by Thaler and Sunstein (2008). This concept explains that due to the biases and heuristics, individuals can make errors in their decisions. This allows institutions in the private sector and governments, the paternalists, to influence choices. These nudges are such that they are most likely to help and least likely to inflict harm (Thaler and Sunstein, 2008). The libertarian aspect of nudges lies in the fact that it is possible to influence people's choices to improve their well-being while still allowing them the freedom to make their own decisions (Thaler and Sunstein, 2008). Institutions or governments are choice architects who transform the presentation of choices and attempt to generate socially desirable decision-making. Choice architects understand that the environment needs to be structured in a way that the nudges work with the biases inherent in individuals rather than against it (Thaler and Sunstein, 2008). Due to the predictability of biases, choice architects create environments that can nudge individuals towards making better decisions, while respecting the individuals' freedom of choice.

With this, the current paper hypothesizes that the loss frame, presented as the clean video, has a larger effect on the likelihood of purchasing a sustainable smartphone, having enhanced environmental considerations, and WTP a higher premium compared to the gain frame, depicted through the degraded video. Grounded in prospect theory, this hypothesis aims to assess whether loss-framed nudges are more effective than gain-framed ones in motivating sustainable consumption behaviour. Moreover, the hypothesis is in accordance with the ideologies that underly nudges because the structure of the choice architecture, presented as a loss or gain frame, works with the biases already present in individuals. It makes their pro-environmental behaviour salient, guiding them in making decisions that improve well-being, while still retaining individual freedom.

2.2 Empirical Framework

This sub-section will focus on the extensive literature of the effect of nudges to influence consumer behaviour, exploring both the effectiveness and ineffectiveness of this tool. This review first examines the common areas where nudges have been introduced, followed by a review of papers directly relevant to the current context. As such, the use of nudges in influencing diets is discussed first before engaging with literature on recycling habits and e-waste.

2.2.1 Nudges to influence diet

Firstly, Nørnberg et al. (2015) conduct a systematic review of 12 papers to understand if nudges are a useful tool in increasing vegetable intake in school settings. Out of the 12 studies, nine studies were conducted in the United States, two were conducted in Canada, and

one in Europe. The reviewed studies exploited nudges through the provision of free fruits and vegetables, self-service, increased variety, and plate size to test the effectiveness of changing the choice architecture to promote healthy eating habits. In addition to only finding a few studies that research the effect of nudges on diet consumption in schools, the researchers also found inconclusive evidence of the effectiveness of nudges in promoting vegetable intake, that is, no significant differences were found between control and treatment groups. The inconsistent results and lack of cultural representation in vegetable consumption studies indicate the need of further research within this context. Similarly, Broers et al. (2017) systematically reviewed 20 papers that discuss nudging as a tool to increase fruit and vegetable consumption. The 20 papers were split into three types of nudges: altering properties (labelling, sizing), altering placement (availability, proximity), and altering both properties and placement (priming, combined nudges). The selected papers investigated the effect of nudges on either food choice, sale of fruits and vegetables, or portion sizes. Out of the 23 experiments applied in the 20 articles, three were conducted in a laboratory and 20 were field studies where different settings were involved. Most of the field studies (11 experiments) were conducted in middle school cafeterias, and the remaining were cafeterias in universities, hospitals, or train stations. These experiments were conducted mainly in the United States. A random effects model estimated that overall, nudging interventions have a moderate effect on consumption, with those that alter the placement of fruits and vegetables being the most effective. However, the individual effects are quite varied. Altering properties, that is nudges that changed the labelling and sizing, showed only small effect sizes and altering placement showed an overall moderate effect. The combination of the three nudges suggested a medium effect size on fruit and vegetable choice. The 20 papers reviewed by Broers et al. (2017) which use nudges to increase the consumption or sales of fruits or vegetables, indicate that altering the choice architecture of healthier dietary options (such as fruits and vegetables) can be effective. While they acknowledge that the current empirical evidence on the effectiveness of nudges is contradictory, they argue that altering environmental cues seems to be a promising tool in promoting the intake and portion sizes of healthier food options. They also explain that the cause of the inconsistent results does not lie in the lack of evidence on the topic of nudges, but rather a lack of clarity in the application of choice architectures, such that issues arise in the application and definition of nudges, leading to mixed or inconclusive results.

Thirdly, Pandey et al. (2023) reviewed nine articles that discussed sustainable food consumption in university canteens through the use of randomised controlled trials and interventional studies. The sample size included more than 100 participants for all the selected articles and majority of the studies were conducted in Europe (7 articles) and the rest in the United States (2 articles). The five types of nudges identified in the articles are position and portion size of food items, availability, presentation, and information about sustainable consumption, wherein the total sales of items is used as the main variable of outcome. A random effect model was used to compute the estimates. While most articles that used one of position, size, availability, or presentation nudges provided evidence of small to moderate size effects, mixed results were found for the information nudges. One article presented information on the effect of unsustainable food choices on climate change through conducting lectures and it brought about a 28% decrease in meat consumption while also increasing sales of plant-based meals. However, a second article reviewed by Pandey et al. (2023) exploited information posters on consumer behaviours by presenting information on the issue of food waste which showed a negative effect in students choosing plant-based meals. This shows that the current literature on information nudges provides contrasting conclusions, thus requiring more research with different, larger samples and application of the nudge. Furthermore, a commonality seen in these studies is that nudges are applied in contexts of schools and universities, which only include individuals from a certain socio-economic demographic.

As Kusters and Van der Hijden (2015) also note, nudges seem to be extremely context dependent. The application of a nudge and its supporting evidence collected from one context cannot be assumed to be effective in a different context. As such, to develop nudges that bring about positive change not just for a specific demographic, the equity dimension in applying nudges also needs to be studied since there is a severe lack of it in the current literature.

Additionally, Weimer, Ahlström, and Esteves (2022) researched the effect of nudges on promoting consumption of organic fruits and vegetables in Sweden. In eight weeks (four intervention weeks, four non-intervention weeks), the researchers presented two nudges for organic fruits and vegetables in a grocery store: social norm message or emotional message. The social norm included the following message “Increasingly more people buy organic [vegetables] in recent years” for three products (Weimer, Ahlström, and Esteves, 2022, p.4). As for the emotional message, a happy face was presented under the remaining three organic products. The main variable of outcome was the quantity of sold product per week for six products, one fruit and five vegetables. Through the implementation of logistic regressions, the authors found no effect of the nudge on four out of the six options. The two products that did show an effect were nudged with the emotion message, and it was found that the quantity of the organic products decreased during the nudging period. They argue that price was a determinant factor for these purchase decisions since the organic products generally had a higher price compared to the non-organic alternatives. Their research infers that nudges that aim to change consumption patterns towards a more positive behaviour require an inquiry into the price of the product and understanding at what price levels consumers would purchase the environmentally friendly goods.

High levels of meat consumption are also linked to negative environmental impact. Thus, research focusses on implementing policies to reduce its consumption, and nudges have shown to be useful. As Weimer, Ahlström, and Esteves (2022) note, price is one of the determining factors in purchasing sustainable products. Thus, Vellinga et al. (2022) conducted a parallel designed randomised controlled trial to examine the effect of information nudges, price increases, and a combination of both on household meat purchases. Participants, over the age of 18 years, were randomly assigned to one of four conditions (information nudge, price increase, combination of the two, no nudge) in a virtual grocery shopping experience. The information nudge explained the environmental impact of meat consumption, the price condition saw a 30% increase in meat products, and the combination was both, information about meat consumption and the price increase. Their findings show that there was no difference in the quantity of meat purchased between the information nudge group and control group. Those in the price condition purchased 145 grams of meat less, and the combination group purchased 390 grams less meat. This study by Vellinga et al. (2022) clearly presents that information nudges need to be complemented with other nudges to be effective. However, this study also provides evidence for the argument by Weimer, Ahlström, and Esteves (2022) that price is an important factor that consumers consider.

Finally, Coucke et al. (2019) investigated the effect of visibility on choosing sustainable meat options, such as poultry instead of meat since poultry is less harmful to the environment than meat. The field experiment was conducted over a total of 12 weeks where sale of different meat options was recorded. The 12 weeks were split into three periods of four weeks, the pre-intervention period, intervention period, and post-intervention period. The authors nudged two aspects, firstly, they increased the visibility of poultry by enlarging the display size and quantities for those products. At the same time, they reduced the display size and quantity of meat products. Their results indicate an increase in the quantity and revenue of poultry products compared to meat products during the intervention period, providing evidence towards the effectiveness of visual cues on consumption behaviour. However, in the

post-intervention period, when the nudge was removed, the researchers found an 18% decrease in the sale of poultry. Coucke et al. (2019) thus argue that to achieve long-term change in consumption behaviour, the nudges and changes in choice architecture also need to be incorporated for a longer time.

2.2.2 Nudges to influence recycling

Nudges have also been applied to positively influence recycling behaviour of individuals. For instance, a study conducted by Chakravarty and Mishra (2019) in India shows the use of a poster with an image of a crying tree and sentence reading “reduce reuse recycle. Use less paper” in an effort to reduce paper usage and paper disposal. They apply the nudge in two firms and use a third firm as a control during an intervention period of 45 days. Using an ANOVA test, the authors find that the two nudged offices report decreased per capita paper wastage during the nudge period compared to the control office. When compared to the pre-intervention periods, the two offices report lower paper wastage as well. To understand the long-term impact of the nudge, the authors continued to collect data on the paper wastage in the three offices after the nudge period and found that while paper wastage had increased in the treatment offices, it still did not reach the pre-intervention levels. This provides some evidence towards the long-term changes in consumer behaviour when the nudge is applied for a longer period, however, more research into this is required.

Bimonte, Bosco and Stabile (2019) conducted a web experiment to investigate the effect of priming on consumers’ decision to recycle smartphones. Additionally, in their experiment, they included if consumers would pay a higher premium for smartphones made from recycled materials. The authors used social media platforms like Facebook, Instagram, and Twitter to recruit participants to answer their web-based survey on the platform Google Forms. With this method, they collected 181 responses and Google Forms randomly assigned each participant to one of three treatment groups. The questionnaire used by the authors consisted of four sections. The first section included questions regarding multimedia cartoon which had no relevance to the research goal. The next section aimed to understand attitudes towards smartphones where participants were required to rate the factors that influence their decisions when buying a new smartphone. Additionally, they were asked if they would be willing to pay a higher price for an eco-friendly smartphone and the highest premium they are willing to pay. The third section was devoted to sociodemographic characteristics. Finally, participants were inquired if they noticed the stimulus from the videos and whether that influenced their responses.

The videos were 50-seconds long and explained the lifecycle of a smartphone with either a neutral, clean, or dirty background. The neutral video did not present any specific images, only explaining the lifecycle of a smartphone from its manufacturing to it being replaced by a new device with the use of a black and white cartoon. The clean background depicted the same lifecycle but with smiling factory workers, pretty landscape views of mountains and waterfalls, and use of bright colours such as blue and green. At the end of the video, a person is shown to be sending the phone back to the manufacturer to recycle it. The video ends with a consumer purchasing a recycled smartphone. Contrastingly, in addition to the same black and white cartoon, the degraded video depicts frowning factory workers with images of factory smoke. Moreover, a polluted background with cars and more factories are presented with the use of dull colours like grey and black. Towards the end of the video, the smartphone is disposed of, and it ends up in a mountain of e-waste.

These videos were used as priming methods since clean backgrounds indicate what individuals would lose if they do not take care of the environment, and the dirty background indicates what they could gain from keeping it clean. The results by Bimonte, Bosco and Stabile (2019) show that priming makes the individuals’ pro-environment attitudes more

salient. Individuals are not only willing to purchase a sustainable smartphone, but they are also willing to pay higher prices for it. Out of the three treatment groups, 90.2% of participants in the clean environment group were willing to pay a higher price for an eco-friendly smartphone, compared to 76.7% in the degraded group and 66.7% in the control group. Moreover, 16.4% participants in the clean environment group were willing to pay a premium of 20% for a sustainable smartphone compared to 8.7% and 7.5% in the degraded and control groups respectively. Conversely, 40% of participants in the control group were willing to pay a premium of 5% compared to only 18.2% of participants in the clean group. These results provide evidence that the priming technique influenced consumer decisions and that individuals respond more to loss frames compared to gain frames. However, their results suggest that consumers are more likely to purchase a sustainable smartphone only if they are stimulated to do so. Therefore, different nudging techniques, such as information about recycled smartphones in mobile stores or information about the environmental impact of discarding phones, would need to be constantly applied to ensure that individuals choose sustainable smartphones over its mainstream alternatives.

Nudges have also been used to monitor and address digital footprints caused by our internet search methods as shown by Henkel et al. (2019). They use default nudges to prime individuals into making pro-environmental choices by using Blackle, an environmentally friendly search engine which uses less energy due to its black background, as a default. They conducted a randomized laboratory experiment on three groups: the priming group (received neutral information about the energy consumption of Google and Blackle), status quo group (opened Blackle by default, had the option of switching to Google), and the control group (received no information and could choose between Google and Blackle). The results by Henkel et al. (2019) provide evidence for pro-environmental behaviour through default nudges. The participants in the priming group showed no more pro-environmental behaviour than the control group. Also, the differences between the two treatment groups showed higher levels of pro-environmental behaviour in the status quo group as compared to the priming group. This study thus suggests the possible ineffectiveness of priming techniques in causing positive behavioural change. The multiple studies that have been analysed indicates that the application and effectiveness of nudges is highly context dependent. Where one type of nudge can change one behaviour, it may be ineffective in doing so for another behaviour.

2.3 Research in the Netherlands

As has been mentioned, research on the effect of nudges on consumption behaviour is limited within the Netherlands. As such, there is a need for more study within this context. Nonetheless, the few papers that have been situated here have shown ambiguous results. Firstly, de Wijk et al. (2016) conduct an in-store experiment on the effect of accessibility on sales of wholegrain and white bread in supermarkets by measuring the total units of bread sold. Wholegrain bread is seen to be a healthier alternative to white bread, and they argue that the product which is encountered by consumers first has a higher likelihood of being purchased than a product that is seen last. In a total of a 12-week experiment period, the researchers changed the position of wholegrain and white bread across two supermarkets. For the first six weeks, supermarket A presented the wholegrain bread first and supermarket B placed the wholegrain bread last. In the last six weeks, this arrangement was reversed. The authors found that the change in accessibility did not affect sales as statistically insignificant estimates were derived. de Wijk et al. (2016) suggest that the nudge may not have been effective due to multiple reasons. One explanation is that bread purchase is a habitual and planned action that is implemented frequently, thus consumers already know what they are

looking for and proceed to buy that. Similarly, consumers have their preferred choices and regardless of changes in accessibility, they would purchase their favoured choice. Moreover, this study highlights the importance of “nudgeable” goods. They argue that it is important to understand the difference between goods and products that can be nudged compared to those that cannot. If nudges are applied to non-nudgeable products, the intervention will be ineffective in producing a change in consumption patterns.

Another study that targets healthy food choices in the Netherlands is conducted by Gillebaart et al. (2023) who explore the role of attention and health goals in nudging healthy food choices. In their field study, they present images of healthy snacks (banana, peanuts, tomato) on a selection of shopping carts, forming their treatment group, while other carts feature pictures of neutral snacks (lemon juice, baking powder, tomato paste), forming the control group. The aim of the study was to investigate the effect of the nudge on the healthiness of snack choice. In order to implement this, a mobile eye tracker was utilised to measure the implicit attention given to the pictures. Data on healthiness of snack choice, explicit and implicit attention, and healthy eating goals were collected over the span of two weeks. A Nutri-Score was calculated for the chosen snacks to measure the healthiness of the snack choice. Explicit attention was measured through answering a question related to the snack options presented in their shopping basket, and whether they extensively looked at the pictures or not (answered on a Likert scale between 1 (not extensively at all) and 7 (very extensively)). Implicit attention was measured using the mobile eye tracker and counting the total number of fixations on the pictures. Finally, participants were required to answer whether they thought it was important to eat healthy on a seven-point Likert scale (1 is totally disagree, 7 is totally agree) which measured the healthy eating goal.

Their results firstly demonstrated that 75% participants in the nudge condition looked at the pictures compared to 43.1% in the control group. Moreover, those in the nudge condition looked at the pictures more extensively than the control group (Gillebaart *et al.*, 2023). Secondly, their findings indicate that neither explicit attention nor healthy eating goal affected the participants’ snack choice. The same results were found for the effect of implicit attention and healthy eating goal on the snack choice. Nonetheless, focusing solely on the effect of healthy eating goals, the results show that having strong goals affected the snack choice as compared to those with weak to non-existent eating goals. Thus, their findings emphasize that pre-existing preferences for certain products (or goals) play a relevant and significant role in nudge effectiveness, not the level of attention given to it.

While these papers have not shown a significant impact of nudges on consumption behaviour, Van Den Berge, Magnier and Mugge (2022) examine the role of the design of electronic products to nudge its repair, thus contributing to sustainable behaviours. They argue that designing electronic products that can be easy to repair by the consumers themselves will reduce e-waste due to the replaceability of the products. The authors conducted two experiments to test the effects of a fault indication on consumers’ willingness to repair either washing machines or vacuum cleaners measured through a questionnaire. Their results found that the willingness to repair increased significantly when a fault indication was present, particularly for products less likely to be repaired by professionals. They also noted that this effect was consistent across different types of product failures. The belief in one’s ability to repair was seen as a mediating factor in this relationship where higher self-efficacy was correlated with a greater willingness to repair products. This study provides evidence for reductions in e-waste by designing electronic products that clearly indicate the failure and enhances the consumers’ own ability to repair products. Therefore, Van Den Berge, Magnier and Mugge (2022) highlight the important role of easy repairability of products in their lifetime extension to lower electronic goods consumption and disposal. This indicates that increasing the repairability of electronic products, such that it can retain its initial value more, is also a

solution that the Dutch government can use to achieve a circular economy and is seen as the preferred route towards it.

Aligning with the research conducted by Bimonte, Bosco and Stabile (2019), this paper offers a second hypothesis that there is a significant effect of the clean and degraded videos on the likelihood of purchasing a sustainable smartphone, importance given to environmental characteristics, and the WTP a higher premium for sustainable smartphones. Moreover, the research on the effect of nudges in influencing recycling behaviour, in addition to the research by Van Den Berge, Magnier and Mugge (2022) in the Netherlands, highlights the potential of nudges to influence pro-environment decisions.

Chapter 3 Data and Methodology

3.1 Data

The data was collected anonymously through a web-based questionnaire shared through the Qualtrics platform. This questionnaire can be found in Appendix I. A total of 170 responses were collected out of which 34 were excluded either due to incomplete responses (30 responses), failing to obtain consent (two responses) or having very few observations with which analysis would be difficult (two responses). The Qualtrics questionnaire randomly assigned participants to one of three treatment groups: control, clean, or degraded. Participants were first required to answer some demographic questions (age, gender, income and education levels), and were then required to watch a video based on their treatment assignment. Following this, participants had to answer questions regarding their attitudes to smartphone characteristics (price, advertising, advice from friends, and environmental characteristics). Finally, to understand the participants' pro-social qualities, 16 questions on pro-social tendencies as developed by Caprara et al. (2005) were asked.

The choice of the survey population is considered based on the objectives of the study. Since the research focusses on the attitudes of young people and their consumption behaviour, the survey was distributed to Dutch and international students studying at Dutch universities, specifically, Erasmus University Rotterdam and Leiden University. This also allows us to present a multinational sample that is well-educated and aware of the current environmental crisis, however, there is little variation in the income levels of the respondents. To understand population characteristics, the first part of the survey was devoted to demographic questions. Participants' age, gender, nationality, current income level, and highest level of education achieved were asked. The questions were a mix of open (age, nationality) and multiple-choice type (gender, income and education level).

From the 136 responses, the average sample age was 25 years with the highest educational attainment of a bachelor's degree. 61.6% of the respondents were female and the average income earned by the sample was less than €2,000 per month, explaining the university student's population which generally tends to earn little to no income. Dutch and Indian students were the largest represented nationalities with 26.81% and 17.39% respectively. Indonesians were the third most represented nationality with 5.80% respondents. Overall, 48 nationalities were represented from North America, South America, Europe, Africa, Asia, and Oceania regions. A list of all nationalities and the number of responses per nationality can be found in Appendix II.

In the second section of the survey, participants were required to watch a video. Three different videos were created by the author that explained the lifecycle of a smartphone. The links to these videos can be found in Appendix III. The control video was a short 30 second video that explained the process of manufacturing a smartphone, from the extraction of raw materials until the end of its life. The clean video depicted the same lifecycle as the control video but also depicted a clean environment background and explained the environmental benefits of recycling the smartphone through a one minute 20-second-long video. Pictures like a woman standing in a field of tulips with a windmill in the background, a store selling recycled electronic gadgets, and an image of a happy planet were used. Finally, the degraded video, which was also one minute and 20 seconds long, presented the same lifecycle as the control video in addition to a polluted background. The video also explained the environmental degradation that would take place if smartphones were disposed of irresponsibly. Factories polluting the environment, deforestation, mountain of e-waste, and a polluted ocean were some images used in this video. The use of clean and degraded pictures of the

environment exploits the concept of loss aversion and framing effects. The presentation of a clean environment signals what could be lost if the environment is not conserved, while the degraded environment invokes what could be gained if the environment is taken care of. Thus, according to prospect theory, individuals put more value on protecting the environment that could be lost through conserving it by making pro-environmental choices than the environment that could be gained through making these decisions. The videos also incorporate the System 2 thinking through the information nudges, allowing individuals to reflect and consider the environmental consequences of smartphone disposal. The informational content of the videos is designed to activate conscious processing of information, which is expected to further increase the likelihood of sustainable purchasing behaviour among participants who view either the clean or degraded videos.

Research shows that unconscious priming works when individuals are shown pictures, words, or a combination of the two (Bruno *et al.*, 2020; Sperber *et al.*, 1979). The pictures used in the videos quickly convey messages about the environmental benefits and harms of recycling and disposing of smartphones. According to Bruno *et al.* (2020), this can help respondents unconsciously process the positive or negative aspects of the message through priming. Sperber *et al.* (1979) argue that depicting multiple related images makes this priming effect stronger due to shared visual features of the pictures. Thus, pictures related to environmental benefits or harm creates strong associations which aid in understanding the impact of recycling or not recycling smartphones. Therefore, it is anticipated that the clean and degraded videos will prime participants differently, with the clean environment enhancing environmental considerations more strongly than the degraded one. The Qualtrics platform randomised these videos such that 43 participants were in the control group, 44 in the clean group, and 49 in the degraded group.

Following the videos, questions regarding smartphones and individual attitudes were asked. Participants were required to rate the importance of certain characteristics (price, advertising, advice from friends, and environmental characteristics) on a five-point Likert scale ranging from 1 (not at all important) to 5 (extremely important). Categories with very few observations were combined to prevent unstable estimates. Few observations in certain categories would lead to biased estimates for the corresponding coefficients as well as high standard errors and wide confidence intervals. Finally, they were asked whether they would be willing to pay a higher premium for sustainably produced smartphones and how much this premium would be (ranging from 5% to above 20%). The last section of the survey included questions regarding individual's pro-social attitudes as developed by Caprara *et al.* (2005). This scale was designed to measure the inclination of adults to consider others in their own decisions. They argue that while pro-social actions (helping, sharing, or caring) and empathic feelings (feeling compassion for others) are distinct, they work together to reflect a desire to be considerate of others. Thus, these questions were asked to understand an individual's pro-social tendencies and relate that to their pro-environmental actions.

There were two ethical issues expected during the data collection process. These are firstly the collection of personal data such as the respondents' age, gender, income, and education level, and secondly, seeking voluntary informed consent to participate in the survey. The collection of personal data is seen as low sensitivity and is addressed by informing participants of how their data will be used and stored before the start of the survey. Furthermore, the research objectives are clearly explained, and participants are informed about their right to withdraw consent and stop the questionnaire at any time. In order to confirm their participation and receive consent, a question asking for consent is posed before the start of the survey. If the participant provides consent, they are able to continue the survey, otherwise, the survey ends, and no questions are presented.

3.1.1 Descriptive Statistics

Table 3.1 below presents the descriptive statistics of the collected data and the differences between the three treatment groups. Column (1) presents the statistics for the entire sample and columns (2) to (4) depict the statistics for each treatment group. A Kruskal-Wallis and chi-squared test are implemented to explore the baseline differences between the treatment groups, as shown in column (5). Column (5) presents the p-value for the differences between all three treatment groups. The Kruskal-Wallis test is used for all variables except gender and whether the respondents are willing to pay a higher price for a sustainable smartphone or not. Due to the categorical nature of the question (yes/no outcome), a chi-squared test was used instead.

Table 3.1: descriptive statistics of the data

Variable	All (1)	Control (2)	Clean (3)	Degraded (4)	p-value (5)
Demographic characteristics (mean)					
Age	25.36 (7.98)	24.20 (7.35)	26.27 (9.80)	25.56 (6.66)	0.339
Income (€)					0.427
Below 2,000	87.50%	93.02%	86.36%	83.67%	0.388
2,000-3,500	6.62%	2.33%	4.55%	12.24%	0.131
3,500-5,000	5.88%	4.65%	9.09%	4.08%	0.750
Education					0.032**
Primary education					
Secondary education	34.78%	27.27%	45.45%	32%	0.143
Bachelor's degree	44.2%	43.18%	45.45%	44%	0.969
Master's degree or higher	21.01%	29.55%	9.09%	24%	0.045**
Gender					0.103
Female	62.50%	72.09%	65.91%	51.02%	
Male	37.50%	27.91%	34.09%	48.98%	
Smartphone characteristics (median)					
Price	4	4	4	4	0.719
Advice from friends	3	2.5	3	3	0.966
Advertising	2	2.5	2	2	0.342
Environmental characteristics	3	3	2.5	3	0.443
Willing to purchase a sustainable smartphone (mean)					
Yes	61.59%	65.91%	63.64%	56%	0.581
No	38.41%	34.09%	36.36%	44%	
WTP (median)	10%	10%	15%	10%	0.760
Pro-sociality (median)	4	4	4	4	0.330
Observations	136	43	44	49	

As Table 3.1 infers, 61.59% of the sample included females of which the mean age was 25.36 years and majority of the respondents earned less than €2,000 per month and had achieved a bachelor's degree. The Kruskal-Wallis test shows no difference between the three groups in terms of the demographic characteristics. With regards to the importance given to smartphone characteristics, price was the most important factor where "very important" was the median level and advertising was the least important (slightly important). Advice from friends and environmental characteristics were rated to be moderately important across all groups. The Kruskal-Wallis indicates no significant difference between the three groups in terms of the importance given to smartphone characteristics. Interestingly, the control group had the highest willingness to purchase a sustainable smartphone, with 65.91% participants indicating they would pay a higher price, compared to 63.64% in the clean group and 56% in the degraded group. Conversely, the degraded group was the least willing, with 44% respondents indicating they would not pay a higher price. The chi-squared test infers that there is no difference between the groups suggesting that there might not be any effect of the nudge and priming technique in motivating consumers to purchases sustainable smartphones. This finding highlights that the nudge may not have been effective on its own and would need to be combined with other interventions to create a more significant impact. The information nudge and visual priming seem to be insufficient tools in altering consumer preferences, especially for decisions with higher costs. This clearly aligns with the literature which suggests that nudges need to be accompanied with other incentives to drive behavioural changes (Coucke *et al.*, 2019; Vellinga *et al.*, 2022).

In terms of WTP an additional premium for sustainable smartphones, the clean group showed the highest willingness, with the median premium being 15%, while the control and degraded groups both indicated a premium of 10%. This could suggest that exposure to the clean video may have had a stronger impact on the WTP a higher price compared to the control and degraded groups. Finally, there was no difference in the pro-social traits between the three groups, with the median being very pro-social across all groups.

As this research takes inspiration from the study conducted by Bimonte, Bosco and Stabile (2019), it should be noted that the observed descriptive statistics are similar across their study and the present study. However, Bimonte, Bosco and Stabile (2019) found statistically significant differences between the three treatment groups for the main variables of interest (willingness to purchase a sustainable smartphone, importance given to environmental characteristics, and the WTP a higher premium for sustainable smartphones), suggesting that the information nudge and priming technique had a notable impact on their sample. In contrast, this study does not observe these significant differences across the treatment groups, indicating that students in the Netherlands are perhaps less influenced by these nudges.

3.2 Methodology

To analyse the impact of the treatment videos on the willingness towards purchasing sustainable smartphones, probit and ordered probit models are employed in this study. The probit model is used to examine the willingness of respondents to purchase a sustainable smartphone (a binary outcome where 1=yes or 0=no), while the ordered probit model is applied to assess the importance given to environmental characteristics when choosing a smartphone and the respondents' WTP a higher premium for sustainable smartphones (ordinal outcomes). Control variables are included in both models to ensure that the effects of the treatment videos are not influenced by other factors.

3.2.1 Probit Model

The probit model is used to estimate the likelihood that a respondent would purchase a sustainable smartphone. This model can be derived from an underlying latent variable model where:

$$Y_i^* = \beta_1 \text{clean} + \beta_2 \text{degraded} + \gamma X_i + \varepsilon_i$$

Here, Y_i^* is the latent continuous variable for individual i . The main treatment effects are captured by β_1 and β_2 . X_i represents the control variables and is estimated by γ . The random error term, ε_i , follows a standard normal distribution with mean 0 and standard deviation 1 ($\varepsilon_i \sim N(0,1)$) (Wooldridge, 2018).

While the latent variable is continuous, the actual outcome variable Y_i is binary. Thus,

$$Y_i = \begin{cases} 1 & \text{if } Y_i^* > 0 \\ 0 & \text{if } Y_i^* \leq 0 \end{cases}$$

Since the error term ε_i follows a standard normal distribution, the response probability is given by the cumulative distribution function (CDF) of the standard normal distribution, denoted as ϕ (Wooldridge, 2018). With this, the response probability can be computed as:

$$P(Y = 1 | \text{treatment}) = \phi(\beta_0 + \beta_1 \text{clean} + \beta_2 \text{degraded} + \gamma X_i) \quad (1)$$

Here, $P(Y = 1 | \text{treatment})$ is the probability that the respondent will be willing to pay a higher price for a sustainable smartphone given the treatment condition. ϕ is the CDF of the standard normal distribution. β_0 , β_1 and β_2 are the intercept and coefficients for the treatment groups. The control variables are presented in the vector X_i and is quantified by the coefficient γ . The marginal effect estimates how a one-unit change in the independent variable affects the probability of the dependent variable being equal to 1.

The CDF of the standard normal distribution, denoted by ϕ , calculates the probability that a standard normally distributed variable with mean 0 and standard deviation 1 is less than or equal to a particular value (Wooldridge, 2018). In the context of the probit model, the CDF transforms the linear combination of the predictors (β_1 , β_2 and γ) into a probability ranging between 0 and 1. This ensures that the estimated probability of purchasing a sustainable smartphone is always a valid probability. Furthermore, to understand how each variable influences the probability of purchasing a sustainable smartphone, marginal effects are calculated. These measure how a one-unit change in each predictor variable affects the probability of the outcome. Since marginal effects are produced, standard errors are estimated using the delta method which accounts for the non-linear nature of the probit model.

3.2.2 Ordered Probit Model

The ordered probit model is used for outcomes that have an ordinal structure. In this case, it examines two different dependent variables: the importance given to environmental characteristics in choosing a sustainable smartphone, and the WTP a higher premium for sustainable smartphones. The ordered probit model also assumes a latent continuous variable Y_i^* which outlines the individual's inclination towards the outcome of interest (for example, their WTP a higher premium for a sustainable smartphone). The latent variable can be depicted as:

$$Y_i^* = \beta_1 \text{clean} + \beta_2 \text{degraded} + \gamma X_i + \varepsilon_i$$

Here, Y_i^* is the latent continuous variable for individual i . The main treatment effects are captured by β_1 and β_2 . X_i represents the control variables and is estimated by γ . The random error term, ε_i , follows a standard normal distribution with mean 0 and standard deviation 1 ($\varepsilon_i \sim N(0,1)$) (Wooldridge, 2010).

While the latent variable is continuous, the actual data that is collected is ordinal. Thus, an ordinal variable Y_i is observed, which takes one of J ordered categories. The relationship between the latent and ordinal variables is explained by thresholds $\alpha_1, \alpha_2, \dots, \alpha_{j-1}$. The observed outcome is now defined as:

$$\begin{aligned} Y_i &= 1 && \text{if } Y_i^* \leq \alpha_1 \\ Y_i &= 2 && \text{if } \alpha_1 < Y_i^* \leq \alpha_2 \\ &&& \vdots \\ Y_i &= J && \text{if } Y_i^* > \alpha_{j-1} \end{aligned}$$

Since the error term ε_i follows a standard normal distribution, the probability that an individual lies in a particular category is determined by the standard normal cumulative distribution function (CDF). This is denoted by ϕ . With this, the response probabilities can be computed as:

$$\begin{aligned} P(Y_i = 1) &= P(Y_i^* \leq \alpha_1) = \phi(\alpha_1 - (\beta_1 \text{clean} + \beta_2 \text{degraded} + \gamma X_i)) \\ P(Y_i = 2) &= P(\alpha_1 \leq Y_i^* \leq \alpha_2) \\ &= \phi(\alpha_2 - (\beta_1 \text{clean} + \beta_2 \text{degraded} + \gamma X_i)) \\ &\quad - \phi(\alpha_1 - (\beta_1 \text{clean} + \beta_2 \text{degraded} + \gamma X_i)) \\ &\quad \vdots \\ P(Y_i = J) &= P(Y_i^* > \alpha_{j-1}) = 1 - \phi(\alpha_{j-1} - (\beta_1 \text{clean} + \beta_2 \text{degraded} + \gamma X_i)) \end{aligned} \quad (2)$$

In the ordered probit model, marginal effects estimate the change in the probability of being in each category of the dependent variable for a one-unit change in the independent variable. They help to understand how each predictor influences the likelihood of falling into each specific category. Moreover, the marginal effects for each explanatory variable always sum to zero. This occurs because an increase in the probability of one outcome category necessarily means a corresponding decrease in one or more of the other categories, as the total probability across all categories must always sum to one (Wooldridge, 2010). The ordered probit model captures how a one-unit change in an independent variable influences the probability of falling into each ordinal category. Thus, any positive change in probability for one category will be offset by negative changes in other categories to maintain the overall sum of probabilities as one (Wooldridge, 2010).

In accordance with the prospect theory, β_1 and β_2 are hypothesized to have positive coefficients for both probit and ordered probit models because it is expected that the information nudge and priming technique would increase the likelihood of purchasing a sustainable smartphone, it would increase the importance given to environmental characteristics, and increase the WTP a higher premium for sustainable smartphones. Moreover, β_1 would be expected to have a larger coefficient compared to β_2 since the former is a variable that presents the clean environment, or the loss frame, while the latter presents the degraded environment, or the gain frame.

Chapter 4 Results and Discussion

Before implementing the probit and ordered probit models, some transformations were made to the data for clearer analysis and interpretations. These modifications are listed below:

1. Due to only one observation each for the gender categories of “Third gender/non-binary” and “Prefer not say”, these were removed from the dataset, leading to 136 total observations.
2. Income: combined three observations in category 4 (above €5,000) with category 3 (€3,000 - €5,000). Remaining categories are 1 (Below €2,000), 2 (€2,000 - €3,500), 3 (€3,000 - €5,000).
3. Importance given to price: combined two observations in category 2 (slightly important) with 1 (not at all important). Remaining categories are 1 (not at all important), 3 (moderately important), 4 (very important), 5 (extremely important).
4. Importance given to advice from friends: combined three observations in category 5 (extremely important) with 4 (very important). Remaining categories are 1 (not at all important), 2 (slightly important), 3 (moderately important), 4 (very important).
5. Importance given to advertising: combined two observations in category 5 (extremely important) to 4 (very important). Remaining categories are 1 (not at all important), 2 (slightly important), 3 (moderately important), 4 (very important).
6. Importance given to environmental characteristics: combined two observations in category 5 (extremely important) with 4 (very important). Remaining categories are 1 (not at all important), 2 (slightly important), 3 (moderately important), 4 (very important).
7. WTP a higher premium: combined six observations from category 15% to 10%. Combined five observations from category Above 20% to 20%. Remaining categories are 5%, 10%, and 20%.
8. Average pro-social behaviour: combined one observation from category 2 (slightly pro-social) with 3 (moderately pro-social). Remaining categories are 1 (not pro-social), 3 (moderately pro-social), 4 (very pro-social), 5 (extremely pro-social).

4.1 Results

Firstly, a probit regression was implemented to evaluate the effect of the videos on the willingness of individuals to purchase a sustainable smartphone. The main variables of interest are presented in Table 4.1. The complete table with all the control variables can be found in Appendix IV.

Table 4.1: effect of treatment on the willingness to purchase a sustainable smartphone

VARIABLES	(1) Sustainable phone
Clean	-0.049 (0.120)
Degraded	-0.199* (0.114)
Observations	136

Note: The marginal effect of the videos on the likelihood of purchasing a sustainable smartphone are presented here. These estimates control for age, gender, income level, education, nationality, importance given to price, advice from friends, advertising, and average pro-social behaviour. The complete table can be found in Appendix IV. Delta-method standard errors are in parentheses. Values are rounded to 3 d.p. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

The marginal effects of this probit regression suggest that watching the clean video as compared to the control video has no effect on the likelihood of purchasing a sustainable smartphone. Having watched the degraded video decreases this willingness to purchase by 19.9 percentage points compared to watching the control video. This result is significant at the 10% level. Although the effect of watching the degraded video is statistically significant, the observed direction that the estimate takes contradicts the hypothesis that the nudging techniques would increase the likelihood of purchasing a sustainable smartphone. This is because the pictures presented in the video are designed to convey the harms of disposing smartphones to the environment, allowing individuals to unconsciously process the negative aspects of the message through priming (Bruno *et al.*, 2020). Moreover, as Sperber *et al.* (1979) explain, the depiction of multiple pictures that show the danger to the environment should have made the priming effect stronger, leading to a positive association between watching the degraded video and the likelihood of purchasing a sustainable smartphone. Hence, both results fail to accept the hypothesis that the videos had an effect on the likelihood of purchasing a sustainable smartphone. While the clean video decreases the willingness to purchase a sustainable smartphone, watching the degraded video decreases this likelihood by a greater margin. Therefore, these results could support the hypothesis that the loss frame presented in the clean video has a greater impact on the likelihood of purchasing a sustainable smartphone compared to those in the degraded group since the clean video leads to fewer individuals who are less likely to purchase sustainable smartphones than the degraded video. However, due to statistically insignificant results, this cannot be concluded.

The results in Table A4.1 also suggest that individuals earning between €2,000 - €3,500 per month are 37 percentage points more likely to purchase a sustainable smartphone compared to those earning below €2,000. Therefore, it can be argued that middle-income individuals may perceive sustainable options as both desirable and feasible, compared to an individual that earns below €2,000. As prospect theory states, individuals value losses more than to equivalent gains, this result could suggest that those individuals that earn between €2,000 - €3,500 might perceive the financial cost of a sustainable smartphone as achievable and value the loss to the environment more. In contrast, individuals that earn less than €2,000 might prioritize the financial cost of buying a new smartphone over the perceived benefits to the environment.

Similarly, an ordered probit regression was implemented to understand the effect of the videos on the importance given to environmental characteristics when choosing a smartphone. Table 4.2 presents the main results. The complete table can be found in Appendix V.

Table 4.2: effect of treatment on the importance given to environmental characteristics

VARIABLES	(1) 1	(2) 2	(3) 3	(4) 4
Clean	0.013 (0.049)	0.009 (0.034)	-0.010 (0.035)	-0.013 (0.048)
Degraded	0.060 (0.048)	0.042 (0.034)	-0.044 (0.035)	-0.059 (0.047)
Observations	136	136	136	136

Note: Marginal effects of the videos on the importance given to environmental characteristics when buying a new smartphone are presented here. Age, gender, income level, education, nationality, importance given to price, advice from friends, advertising, and average pro-social behaviour are included as control variables. 1: not at all important, 2: slightly important, 3: moderately important, 4: very important. The complete table can be found in Appendix V. Delta-method standard errors in parentheses. Values are rounded to 3 d.p. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

The marginal effects of the ordered probit regression indicate that having watched either the clean or degraded video has no effect on the importance given to environmental characteristics when choosing a smartphone, thus providing insufficient evidence to accept the hypothesis that the nudging techniques would lead to increased importance given to environmental characteristics. These findings highlight once more the ineffectiveness of nudges in altering consumption behaviour. These results are unexpected as the information on the advantages and disadvantages of recycling or disposing of a smartphone are expected to give more importance to environmental characteristics, as is also shown by Bimonte, Bosco and Stabile (2019). At the same time, due to statistical insignificance, these results do not provide enough evidence to support the hypothesis that the clean video (loss frame) leads to increased importance given to environmental characteristics compared to the degraded video (gain frame).

The results in Table A4.2 further suggest that age has a statistically significant effect on the importance of environmental characteristics in decision-making. The results indicate that a one-year increase in age decreases the likelihood of being in lower importance categories and are more likely to be in the higher importance categories. This suggests that older people might be more likely to consider environmental factors of a smartphone before purchasing one. Similarly, these results show that individuals earning between €2,000 - €3,500 are more likely to give higher importance to environmental characteristics compared to those earning below €2,000. Contrastingly, those individuals that earn between €3,500 and €5,000 per month are likely to give lesser importance to environmental factors. This lower level of importance could indicate preferences towards established brands, emphasizing factors like performance or luxury, over sustainability. The results also highlight that males give lesser importance to environmental characteristics when choosing a smartphone as compared to females. As Creutzig et al. (2023) notes “[y]ounger, female, and more educated individuals perceive climate risks to be larger” (p. 547).

Finally, results in Table A4.2 suggest that to increase the importance of environmental characteristics in decision-making, individuals should be targeted through other mechanisms than advertising strategies. This is because individuals that consider advertising to be slightly important when choosing a new smartphone are less likely to give higher importance to environmental characteristics. Moreover, there is no effect on the importance given to environmental characteristics for those individuals who give higher importance to advertising.

An ordered probit regression was also applied to understand the effect of the videos on WTP a higher premium for a sustainable smartphone. The main results of this regression are presented in Table 4.3 below and the complete table can be found in Appendix VI.

Table 4.3: effect of the treatment on the maximum WTP

VARIABLES	(1)	(2)	(3)
	5%	10%	20%
Clean	-0.071 (0.093)	-0.001 (0.004)	0.073 (0.094)
Degraded	-0.047 (0.090)	-0.001 (0.003)	0.048 (0.092)
Observations	136	136	136

Note: Here, the marginal effects of the videos on the maximum premium a respondent is willing to pay for a sustainable smartphone are depicted. Age, gender, income level, education, nationality, importance given to price, advice from friends, advertising, and average pro-social behaviour are included as control variables. The complete table can be found in Appendix VI. Delta-method standard errors are in parentheses. Values are rounded to 3 d.p. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

The results here suggest that having watched either the clean or degraded videos compared to the control video does not influence the WTP a higher premium for sustainable smartphones. These results also fail to provide enough evidence to support the hypothesis that there is a significant effect of the clean and degraded videos on increasing WTP a higher premium. Since the results are statistically insignificant, there is also not enough evidence to support the hypothesis that the presentation of the loss frame through the clean video has a larger effect on the WTP compared to the gain frame shown by the degraded video.

Exploring the importance of advertising on the WTP higher premiums, the findings show that as more importance is given to advertising, individuals become more likely to pay a higher premium for a sustainable smartphone. This could be due to the fact that advertising raises awareness of sustainable products used in the manufacturing of phones and can make it appealing for customers to purchase it. While the previous results found in Table A4.2 suggest that advertising is insufficient in driving deeper environmental consciousness, it could still be effective in motivating individuals to pay a premium. Similarly, individuals that earn between €2,000 and €3,500 are less likely to pay higher premiums, possibly due to balancing sustainability preferences with budget constraints. The premium can be viewed as a significant financial loss, outweighing the gains from making a sustainable choice. The discrepancy between the results highlighted in Tables 4.1, 4.2, and 4.3 for those earning between €2,000 and €3,500 indicate that while these consumers value sustainability, their purchasing decisions may still be budget constrained. Thus, they aim to make environmentally responsible choices, but the financial aspect remains a significant barrier to translating these preferences into actions.

Among the results, the findings on the WTP a higher premium for a sustainable smartphone align most closely with the expectations from prior research, such as Bimonte, Bosco and Stabile's (2019), whose work this study draws on. While the results may not reach statistical significance, WTP stands out as a meaningful factor since it can reflect individuals' broader preferences for sustainability. For instance, if someone is willing to pay a 20% higher premium for a sustainable smartphone, it suggests a degree of importance placed on sustainability that may go beyond product itself. It may imply that nudges or interventions aimed at influencing WTP may have the potential to affect sustainable consumer behaviour.

Finally, a probit regression was implemented to understand whether individuals that exhibit more pro-social behaviours (average pro-social score higher than 3) choose pro-environmental actions. This was investigated because some research (Van Doesum *et al.*, 2021) suggests that pro-sociality is linked to making environmentally conscious decisions. The main results are depicted below in Table 4.4. The complete table of results can be found in Appendix VII.

Table 4.4: effect of the treatment on the likelihood of purchasing a sustainable smartphone for respondents with higher-than-average pro-social traits

VARIABLES	(1) Sustainable phone
Clean	-0.082 (0.136)
Degraded	-0.284** (0.131)
Observations	106

Note: The marginal effect of the videos on the likelihood of purchasing a sustainable smartphone for those individuals with an average pro-social score greater than 3 are presented. Age, gender, income level, education, nationality, importance given to price, advice from friends, advertising, and average pro-social behaviour are included as control variables. The complete table can be found in Appendix VII. Delta-method standard errors are in parentheses. Values are rounded to 3 d.p. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

These results show that having watched the clean video compared to the control has no effect on the likelihood of purchasing a sustainable smartphone for those individuals that exhibit higher than average pro-social behaviours. Similarly, those individuals who are more pro-social and watched the degraded video are 28.4 percentage points less likely to buy a sustainable smartphone compared to those who watched the control video. This result is statistically significant at the 5% level. These findings challenge the theoretical expectations posed by prospect theory and highlight a potential disconnect between theory and real-world consumer behaviour, especially for pro-social individuals. It could be that these individuals are already familiar with sustainable practices, making them less susceptible to the nudges. Or pro-social individuals might feel that they are already doing their part in protecting the environment (recycling, reducing waste) and may not be open to the idea that they need to do more. The presentation of a gain frame, showing an environment that could be gained by making pro-environmental choices, may perhaps affirm their belief that they are already taking enough action to protect the environment, reducing their motivation to take additional steps.

As Table A4.4 indicates, a one-year increase in age leads to a 2.4 percentage point increase in the likelihood of purchasing a sustainable smartphone for those with average pro-social score above 3, and those that earn between €2,000 and €3,500 have a significantly larger increase of 36.8 percentage points likely to purchase a sustainable smartphone. This result further emphasizes that factors like income and age may have a more significant impact on motivating consumers towards sustainable products compared to the nudge and priming techniques that have shown to be either ineffective or that they bring about undesired change in influencing consumer behaviour.

4.2 Discussion

Although the present study is similar to Bimonte, Bosco and Stabile (2019) who find that visual priming aided in influencing behaviour, the differences in sample and video content could likely explain the contrasting results. Another explanation for the zero effect of the videos, especially the clean videos, could be that there is no way to confirm if the respondents watched the entire video, thus diminishing the effectiveness of the information nudge. Moreover, these results align with the previous literature that nudges are not always the most effective tool for behavioural change, thus the lack of effect found in this study (Weimer, Ahlström, and Esteves, 2022; Vellinga *et al.*, 2022; de Wijk *et al.*, 2016).

Further, previous research has shown that information nudges need to be complemented with other types of nudges or policies to bring about behavioural change since they may be ineffective when used alone (Coucke *et al.*, 2019; Vellinga *et al.*, 2022). As the results indicated, middle-income earners are willing to take steps to reduce environmental damage, but their possible financial situation prevents them to do so. This suggests that combining information nudges with the price mechanism might be necessary to translate pro-environmental intentions to actual purchasing behaviour. In the Netherlands, an example of where nudges have been complemented with the price mechanism for example, and has been effective, is a deposit system which has shown promise in recycling plastic bottles (Buurman, 2022; Govers, 2022). The basic idea targeted by the Dutch government is to charge between 10 to 25 cents on every plastic bottle that is purchased, nudging the buyers to recycle them and get the refund. Individuals are then able to return these bottles and have the option of either getting a refund or donating it. The widespread access to these depositing machines has proven to be successful in recycling plastic bottles in the Netherlands by up to 41% fewer bottles in the litter, especially because it provides a financial reason to recycle (Buurman, 2022; Govers 2022). This approach could be extended to smartphones by implementing a similar deposit system. Since a smartphone is retained for a longer period, deposit at the time of purchase may not be appropriate. Instead, consumers could be eligible for a voucher or a small refund when they return the phone at the end of its lifecycle to a certified program. Alongside this deposit, information nudges can be utilized to raise awareness about these programs and encourage people to recycle their phones.

At the same time, the rise of numerous phone resellers has provided a market for second-hand phones and illustrates how financial incentives can encourage sustainable practices. Information nudges that explain the benefits of reselling the phones, or large smartphone sellers advertising the resale value of their phones can possibly nudge individuals to recycle their smartphones and thus decrease the environmental impact.

In order to better understand the low rates of smartphone recycling and sustainable smartphone purchases, a short follow-up interview was conducted with 15 respondents of the survey inquiring reasons for the lack of willingness to purchase sustainable smartphones. The primary reason for the low recyclability rates of smartphones amongst all interviewees was the lack of knowledge about available recycling methods and locations. While some disposed of their old phones irresponsibly, the others keep it with themselves without using it, making the materials of the smartphone lose its value. Therefore, information nudges can be used differently. Rather than explaining the benefits of recycling, nudges could focus on raising awareness about the points of access to recycle smartphones. Public collection points for disposing electronic items can also be made more widespread, just like the deposit machines for the collection of plastic bottles. Additionally, low rates of sustainable smartphone purchases were attributed to the features available in them. Factors such as camera quality, the processing speed, the size and weight of the phone, were features that could possibly discourage someone from purchasing a sustainable smartphone. These observations

highlight a significant barrier to sustainable smartphone adoption. Consumers prioritize performance features like camera quality, which are often thought to be lacking in sustainable models. Although individuals may express concern for the environment, this suggests that their actual decisions are driven by factors like functionality and performance of the device, making them hesitant to pay higher premiums. Thus, sustainable smartphone manufacturers need to understand and meet the expectations of consumers, while also improving their advertising strategies, without which sustainable smartphones will remain the limited choice, affecting the impact on e-waste generation.

Chapter 5 Conclusion

The objective of this paper was to explore whether information nudges and priming can influence young individuals into making pro-environmental decisions. It aimed to answer the question “What is the impact of visual priming and information nudges on consumer’s willingness to purchase a sustainable smartphone?” and sub-questions “Do visual priming and information nudges lead to increased importance given to environmental characteristics when purchasing a new smartphone?” and “Do visual priming and information nudges affect an individual’s WTP a higher premium for a sustainable smartphone?” A web-based questionnaire was created wherein participants were directed to watch a clean, degraded, or control video on the lifecycle of a smartphone and to present the benefits of recycling smartphones or the risks of disposing it off irresponsibly. To examine this effect, probit and ordered probit models were implemented.

The analysis from 136 observations demonstrated ambiguous results such that the information on recycling smartphones and using a clean environment (loss frame) as a visual prime was unable to influence consumers into potentially purchasing sustainable smartphones. These results were unable to accept the hypothesis that there is a significant effect of the clean video on the likelihood of purchasing a sustainable smartphone. Thus, the clean video did not have any impact on the likelihood of purchasing a sustainable smartphone. However, contrary to expectations, the degraded environment video, which explained the risks of disposal of smartphones, exhibited a decrease in the likelihood of purchasing a sustainable smartphone. While this result was statistically significant, the observed direction that the estimate takes contradicts the hypothesis that the loss frame, presented as the clean video, has a larger effect on the likelihood of purchasing a sustainable smartphone than the gain frame, depicted through the degraded video. Moreover, having watched either the clean or degraded video compared to the control video, it was found that the importance given to environmental characteristics when choosing a smartphone was not affected, therefore, the hypothesis that a significant effect of the clean and degraded videos on the importance given to environmental characteristics could not be accepted. The same results were derived for the WTP a higher premium for sustainable smartphones, wherein the videos had no effect on the premium paid.

Additional estimations were produced to understand whether pro-social traits are linked to pro-environmental choices. The results suggested that having watched the clean video compared to the control video has no effect on the likelihood of purchasing a sustainable smartphone for those individuals with an average pro-social score greater than 3. At the same time, contrary to the current literature, having watched the degraded video compared to the control video decreases the likelihood of purchasing a sustainable smartphone.

The ambiguity in the results indicates that more research into this topic is necessary. The effect of information nudges on changing the consumption patterns of electronic devices requires further investigation since it can be a cost-effective and beneficial tool to make behaviours more sustainable. A key concern highlighted in this research, as well as in the existing literature on nudging, is the importance of complementary policy measures alongside information nudges (Coucke *et al.*, 2019; Vellinga *et al.*, 2022). This represents a significant drawback of this research as it relies on information nudges without integrating other supportive measures. The information nudge presented in the videos seems to be ineffective in driving meaningful change. Future research could address this by combining information nudges with other policy measures, such as a deposit system for electronic devices similar to those used for plastic bottles in the Netherlands. Such measures could incentivize sustainable

purchasing directly by offering financial rewards for environmentally friendly actions, potentially increasing the effectiveness of nudges in promoting pro-environmental behaviour.

Moreover, a number of studies have highlighted the uncertainty surrounding the long-term effectiveness of nudges on consumer behaviour. While nudges can be effective in immediate or short-term impact on choices, there is still some debate about whether these changes will last over time once the nudge is removed. Therefore, further research is necessary into the long-term impacts of nudges on the consumer demand for environmentally friendly products. This can be implemented by examining whether reinforcing nudges over time, or integrating them within policy measures, like financial incentives or penalties for non-sustainable actions, can create a longer-term impact on consumer demand for environmentally friendly products.

The research could have also benefitted from a deeper exploration of the link between pro-environmental behaviour and subjective well-being. As indicated by Zawadzki, Steg and Bouman (2020) and Gillebaart et al. (2023), individuals who recognize a personal significance in their pro-environmental actions tend to experience higher levels of subjective well-being. This sense of meaningful action may suggest an increased likelihood of sustainable choices, suggesting a relationship between intrinsic motivation and pro-environmental behaviours. While this research did not examine the role of personal motivation, further research should explore this link possibly through a more detailed questionnaire that inquires the role of intrinsic motivation in making choices. Questions could target the desire to contribute positively to environmental outcomes, a sense of personal responsibility, or personal alignment with sustainable actions. In addition, questions related to sustainable practices that the respondent already engages in could allow for a deeper exploration into how these behaviours influence their likelihood of purchasing sustainable smartphones.

Furthermore, since this research relies on hypothetical scenarios, it may introduce a hypothetical bias wherein participants' willingness to pay a higher premium for sustainable smartphones or to choose environmentally friendly options may not reflect their real-world choices. This gap between the intention to act a certain way and exhibiting the same behaviour in real-life emphasizes the need for future research to incorporate longitudinal studies, for example, to capture more accurate insights into consumer behaviour and understanding what drives this behaviour such that more focused policies can be implemented.

Overall, changes in the demand-side patterns are more important now than ever. While significant improvements and changes in the supply-side have already been implemented, there is a limit to how much these adjustments alone can achieve sustainable development. Economic theory shows that for any shift in supply, a corresponding shift in demand is required to reach a new equilibrium state. In the context of sustainable consumption, it is essential to make these demand-side shifts for a lasting impact on the environment, which is needed more than ever today.

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Appendix I

Consent

Dear participant,

My name is Preksha Gupta, and I am conducting research for my Master thesis at the International Institute of Social Studies, Erasmus University Rotterdam. The research will be conducted on sustainable behaviour and factors influencing a smartphone choice. The survey is expected to take around 5-7 minutes to complete. In addition to questions, you will also be asked to watch a short video.

Participation in this survey is completely voluntary. You can stop at any time and would not need to provide any explanation. I do not anticipate any risks or discomforts while participating in this study. During the survey, I will ask you about your age, gender, and ethnic background. This data will be stored securely and only persons involved in this research will be able to see the data. The data will be retained for 10 years after the completion of the research. We do this to allow opportunities for other researchers to verify that this research was conducted correctly.

If you have any questions about the study or your privacy rights, such as accessing, changing, deleting, or updating your data, please contact me.

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If you have a complaint or concerns about your privacy, please email the Data Protection Officer (fg@eur.nl) or visit www.autoriteitpersoonsgegevens.nl. (T: 088-1805250).

Until you submit your response, you can still decide not to take part in the research. If you stop, your data will not be stored. After you click “Submit”, I cannot trace what data you have shared with me anymore.

By clicking “Yes”, you:

1. Consent to participate in this research;
2. Consent to the use of your personal data;
3. Confirm that you understand that participation in this research is completely voluntary and that you can stop at any time.

Demographic Questions

1. What is your age?
2. What is your gender?
 - a. Male
 - b. Female
 - c. Third gender/Non-binary
 - d. Prefer not say
3. What is your monthly income?
 - a. Below €2,000
 - b. €2,000 - €3,500
 - c. €3,500 - €5,000
 - d. Above €5,000
4. What is your nationality?
5. What is your highest level of education achieved?
 - a. Primary education
 - b. Secondary education

- c. Bachelor's degree (HBO)
- d. Master's degree (WO) or higher

Videos

Smartphone attitudes

6. Rate the importance of the following factors in influencing your decision to buying a new phone (1 – not at all important, 2 – slightly important, 3 – moderately important, 4 – very important, 5 – extremely important)
 - a. Price
 - b. Advice from friends
 - c. Advertising
 - d. Environmental characteristics
7. Would you be willing to purchase a smartphone that is manufactured in an eco-friendly and sustainable manner?
 - a. Yes
 - b. No
8. What is the maximum additional amount you would be willing to pay for a sustainably manufactured smartphone compared to a standard smartphone?
 - a. 5%
 - b. 10%
 - c. 15%
 - d. 20%
 - e. Above 20%

Pro-social attitudes

9. The following statements describe some common situations. Read each phrase and answer that reflects your first reaction. There is no right or wrong answer; the best answer is the immediate one (1 – never, 2 – rarely, 3 – occasionally, 4 – often, 5 – always)
 - a. I am pleased to help my friends in their activities
 - b. I share the things that I have with my friends
 - c. I try to help others
 - d. I am available for volunteer activities to help those in need
 - e. I am emphatic with those who are in need
 - f. I immediately help those who are in need
 - g. I do what I can to avoid others getting into trouble
 - h. I intensely feel what others feel
 - i. I am willing to make my knowledge and abilities available to others
 - j. I try to console those who are sad
 - k. I easily lend money or other things
 - l. I easily put myself in those who are in discomfort
 - m. I try to be close to and take care of those who are in need
 - n. I easily share with my friends any good opportunity that comes to me
 - o. I spend time with those friends who feel lonely
 - p. I immediately sense my friends' discomfort even when it is not directly communicated to me

Appendix II

Table A3.1: number of responses by nationality for each treatment group

Nationality	Total	Control	Clean	Degraded
British	2	-	-	2
Argentinian	1	-	1	-
Australian	1	-	1	-
Azerbaijani	2	1	1	-
Bangladeshi	1	1	-	-
Brazilian	1	-	1	-
Bulgarian	1	1	-	-
Chilean	2	1	-	1
Chinese	1	1	-	-
Colombian	2	1	1	-
Dutch	37	12	12	13
Ethiopian	3	-	1	2
Finnish	1	-	1	-
French	6	4	1	1
German	2	-	1	1
Ghanaian	6	2	1	3
Indian	24	6	11	7
Indonesian	8	3	2	3
Iranian	1	-	-	1
Italian	3	2	1	-
Japanese	3	-	3	-
Kenyan	2	1	-	1
Mexican	1	-	1	-
Moroccan	1	-	-	1
Nigerian	4	1	1	2
Peruvian	1	-	-	1
Polish	4	1	-	3
Romanian	2	2	-	-
Rwandan	1	-	-	1
Saudi Arabian	1	-	-	1
Senegalese	1	-	1	-
Spanish	1	-	-	1
Tanzanian	2	-	-	2
Thai	1	1	-	-
Turkish	1	-	-	1
Vietnamese	5	2	2	1

Appendix III

Below, the link to the videos used in the survey can be found.

Control video: <https://youtu.be/MdIyMahQQk0>

Clean video: <https://youtu.be/1gev5rWvZpA>

Degraded video: <https://youtu.be/7Y6zCvKLz2k>

Appendix IV

Table A4.1: effect of treatment on the likelihood of purchasing a sustainable smartphone

VARIABLES	(1) Sustainable phone
Clean	-0.049 (0.120)
Degraded	-0.199* (0.114)
Age	0.012 (0.008)
	Price
Moderately important	0.060 (0.205)
Very important	-0.047 (0.210)
Extremely important	-0.250 (0.235)
	Advice from friends
Slightly important	0.008 (0.158)
Moderately important	0.244 (0.143)
Very important	-0.043 (0.178)
	Advertising
Slightly important	0.033 (0.123)
Moderately important	0.055 (0.115)
Very important	0.067 (0.140)
	Average pro-social behaviour
Very pro-social	0.016 (0.110)
Extremely pro-social	0.003 (0.162)
Male	0.020 (0.099)
	Income level
€2,000-€3,500	0.370** (0.073)
€3,500-€5,000	-0.145 (0.276)
	Education
Bachelor	-0.107 (0.121)
Master or higher	0.041 (0.130)
Nationality	-0.000 (0.004)
Observations	136

Note. Table A4.1 presents the marginal effect of the videos on the probability of purchasing a smartphone manufactured through sustainable standards. Delta-method standard errors are in parentheses. Values are rounded to 3 d.p. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Appendix V

Table A4.2: effect of the videos on the importance given to environmental characteristics

VARIABLES	(1) 1	(2) 2	(3) 3	(4) 4
Clean	0.013 (0.049)	0.009 (0.034)	-0.010 (0.035)	-0.013 (0.048)
Degraded	0.063 (0.049)	0.042 (0.033)	-0.045 (0.036)	-0.060 (0.047)
Age	-0.013*** (0.004)	-0.009*** (0.003)	0.009*** (0.003)	0.012*** (0.004)
		Price		
Moderately important	-0.130 (0.092)	-0.091 (0.066)	0.094 (0.069)	0.127 (0.091)
Very important	-0.152 (0.091)	-0.106 (0.066)	0.110 (0.068)	0.148 (0.090)
Extremely important	-0.147 (0.098)	-0.103 (0.071)	0.107 (0.074)	0.143 (0.097)
		Advice		
Slightly important	-0.015 (0.069)	-0.010 (0.050)	0.011 (0.050)	0.014 (0.068)
Moderately important	-0.027 (0.071)	-0.019 (0.050)	0.020 (0.052)	0.026 (0.070)
Very important	0.003 (0.078)	0.002 (0.054)	-0.002 (0.057)	-0.003 (0.076)
		Advertising		
Slightly important	0.146** (0.054)	0.102** (0.041)	-0.106** (0.041)	-0.142** (0.056)
Moderately important	-0.069 (0.049)	-0.048 (0.033)	0.050 (0.036)	0.067 (0.047)
Very important	-0.066 (0.062)	-0.046 (0.044)	0.047 (0.045)	0.064 (0.061)
		Average pro-social behaviour		
Very pro-social	0.071 (0.047)	0.050 (0.033)	-0.051 (0.035)	-0.069 (0.045)
Extremely pro-social	0.048 (0.070)	0.034 (0.049)	-0.035 (0.052)	-0.047 (0.068)
Male	0.126*** (0.043)	0.088*** (0.032)	-0.091*** (0.033)	-0.123*** (0.043)
		Income level		
€2,000-€3,500	-0.181** (0.084)	-0.126** (0.060)	0.131** (0.066)	0.176** (0.080)
€3,500-€5,000	0.198* (0.113)	0.138* (0.082)	-0.143* (0.084)	-0.193* (0.113)
		Education		
Bachelor	0.054 (0.051)	0.038 (0.036)	-0.039 (0.038)	-0.053 (0.050)
Master or higher	-0.078 (0.056)	-0.055 (0.039)	0.057 (0.041)	0.076 (0.055)
Nationality	0.002 (0.002)	0.001 (0.001)	-0.001 (0.001)	-0.002 (0.002)
Observations	136	136	136	136

Note: The marginal effect of the videos on the importance given to environmental characteristics when buying a new smartphone are depicted here. 1: not at all important, 2: slightly important, 3: moderately important, 4: very important. Delta-method standard errors in parentheses. Values are rounded to 3 d.p. *** p<0.01, ** p<0.05, * p<0.1.

Appendix VI

Table A4.3: effect of the treatment on the maximum WTP

VARIABLES	(1) 5%	(2) 10%	(3) 20%
Clean	-0.071 (0.093)	-0.001 (0.004)	0.073 (0.094)
Degraded	-0.047 (0.090)	-0.001 (0.003)	0.048 (0.093)
Age	0.004 (0.006)	0.000 (0.000)	-0.004 (0.006)
	Price		
Moderately important	-0.147 (0.176)	-0.003 (0.008)	0.150 (0.179)
Very important	-0.168 (0.174)	-0.003 (0.009)	0.171 (0.177)
Extremely important	-0.057 (0.188)	-0.001 (0.005)	0.058 (0.192)
	Advice		
Slightly important	0.002 (0.134)	0.000 (0.003)	-0.002 (0.137)
Moderately important	0.082 (0.137)	0.002 (0.005)	-0.083 (0.140)
Very important	-0.047 (0.151)	-0.001 (0.004)	0.048 (0.154)
	Advertising		
Slightly important	-0.224** (0.101)	-0.004 (0.012)	0.229** (0.102)
Moderately important	0.083 (0.085)	0.003 (0.005)	-0.086 (0.088)
Very important	0.081 (0.119)	0.002 (0.005)	-0.082 (0.121)
	Average pro-social behaviour		
Very pro-social	-0.055 (0.090)	-0.001 (0.003)	0.056 (0.092)
Extremely pro-social	-0.183 (0.140)	-0.003 (0.010)	0.187 (0.143)
Male	-0.051 (0.080)	-0.001 (0.003)	0.052 (0.082)
	Income level		
€2,000-€3,500	0.288* (0.152)	0.005 (0.016)	-0.294** (0.156)
€3,500-€5,000	-0.143 (0.213)	-0.003 (0.009)	0.145 (0.217)
	Education		
Bachelor	-0.144 (0.097)	-0.003 (0.008)	0.147 (0.099)
Master or higher	0.036 (0.104)	0.001 (0.003)	-0.037 (0.107)
Nationality	-0.001 (0.004)	-0.000 (0.000)	0.001 (0.004)
Observations	136	136	136

Note: The marginal effect of the videos on the maximum premium a respondent is willing to pay for a sustainable smartphone are presented here. Delta-method standard errors are in parentheses. Values are rounded to 3 d.p. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Appendix VII

Table A4.4: effect of the treatment on the likelihood of purchasing a sustainable smartphone for respondents with higher-than-average pro-social traits

VARIABLES	(1) Sustainable phone
Clean	-0.081 (0.136)
Degraded	-0.284** (0.131)
Age	0.024* (0.013)
	Price
Moderately important	0.271 (0.183)
Very important	0.126 (0.239)
Extremely important	-0.021 (0.264)
	Advice
Slightly important	-0.148 (0.205)
Moderately important	0.065 (0.196)
Very important	-0.233 (0.225)
	Advertising
Slightly important	0.006 (0.141)
Moderately important	0.025 (0.133)
Very important	-0.007 (0.180)
Male	0.002 (0.119)
	Income level
€2,000-€3,500	0.368** (0.078)
€3,500-€5,000	-0.250 (0.291)
	Education
Bachelor	-0.121 (0.155)
Master or higher	0.110 (0.144)
Nationality	-0.000 (0.004)
Observations	106

Note: The marginal effects of the videos on the likelihood of purchasing a sustainable smartphone for those individuals with an average pro-social score greater than 3 are depicted here. Delta-method standard errors are in parentheses. Values are rounded to 3 d.p. *** p<0.01, ** p<0.05, * p<0.1.