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# Consumers and the Circular Economy

*A study of consumer behavior about recycling and reuse of mobile phones.*


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**Abstract**

The aim of the study was to research consumer behavior concerning past-use and end-of-life WEEE in Sweden, with a particular focus on consumer attitudes towards recycling and reuse of used mobile phones in the context of a Circular Economy. Our study focused on Swedish student and obtained data via a survey conducted by the authors. The data was analyzed through the use of descriptive analysis and logit regression models. The results show that respondents display a storing behavior in keeping their old and unused mobile phones and that respondents are generally unaware of how to recycle a phone. Convenience of recycling was the strongest predictor of recycling behavior, whilst reuse behavior was strongly linked to the quality and price of the already used mobile phone.

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# 1. Background

In this chapter we will first introduce the topic of this study under the subheading Introduction, which will be followed by a definition of the purpose of the study and our research questions. We will then provide a background for the Waste management system and mobile phone market in Sweden and finally we will present the theoretical frameworks which will support this study.

## 1.1 Introduction

At the beginning of the new millennia, commodity prices rose sharply for the first time in a hundred years. They have since become increasingly volatile. The price volatility on resources stem from an increased demand from an emerging global middle class. It is also associated with resource scarcities, through decreasing material accessibility and ore concentration, coupled with the decline of natural capital such as in fisheries, soil losses and forestry (Webster, 2015). UNEP (2016) estimates that the amount of primary materials extracted from the Earth rose from 22 billion tons in 1970 to 70 billion tons in 2010.

In addition to resource scarcity, many environmental issues are associated with resource extraction and production, as much of the resources used to manufacture a product end up as waste and emissions which can cause further environmental pollution. This is particularly true for Waste from Electrical and Electronic Equipment (WEEEs) which contain both hazardous, scarce and valuable materials, and pose considerable health and environmental risks if treated inadequately. For example, the materials contained within WEEE can contaminate both water streams and soil, or give rise to toxic smoke when burned (UNEP, 2016). WEEEs, sometimes referred to as E-waste, is one of the fastest growing global waste streams, with about 30-50 million tons disposed per year and an estimated annual growth rate of 3-5% (Cucchiella et. al. 2015). In the EU alone, 9.2 million tons of Electrical and Electronic Equipment (EEE) were put on the market in 2014, with a total WEEE of 3.6 million tons collected during the same year (Environmental Data Centre / Eurostat). A large proportion of small EEE that is not in active use does not enter waste management systems. This mainly occurs when consumers store old EEE in their

homes (Ongondo et. al. 2011), or when EEE is disposed incorrectly - either by citizens misplacing waste fractions in incorrect recycling bins or with mixed waste (Bernstad et al., 2011 & 2012).

To lessen environmental and health issues caused by WEEEs, EU implemented the WEEE Directive (2002/96/EC) in 2003 which introduced WEEE collection schemes. This was later replaced by Directive 2012/19/EU in 2014, which increased collection targets of EU WEEE. EU considers the collection, treatment and recycling of electronics at the end of their life as essential to enhancing resource efficiency and contributing to the development of a Circular Economy, which is a major ambition of EU through its 2015 program 'Action plan for the Circular Economy'.

In Sweden, 144 858 tons of WEEE was collected during 2014, of which 24 006 tons was Information Technology (IT) and telecommunications equipment. The collection rate for WEEE from Swedish households amounted to 13.63 kg per capita in 2014 and recycling and reuse amounted to 12.5 kg per capita. This placed Sweden at the top collection rate EU wide, with about 60 % collection rate of WEEE weighted with the total EEE of 21.103 kg per capita introduced to the market. Generally, private households are the main source of WEEE in Sweden, as other sources of WEEE accounted only for 1.3 kg per household in 2014 (Eurostat).

Mobile phones are one of the fastest growing and most common electronical products in the world. As mobile phones contain several rare and toxic materials, discarded mobile phones are a growing and significant contributor to e-waste (Ongondo et. al. 2011). Cucchiella et al. (2015) estimates that by 2020, the annual amount of smartphone waste generated on the European market will have increased by 105 %, to a total amount of 39 kilotons, with a further 5.5 kilotons of waste from Cell phones.

Cucchiella et al (2015) states that mobile phones are one of the most promising products to recover materials from, due to the valuable metals and materials contained in the

product. Their study estimates that 746 Million Euros could be obtained from recovering mobile phone materials in the EU countries, of which about 56 % of the revenues came from the recovery of the gold, whereas the other contributions came from palladium, platinum, cobalt and silver (Cucchiella 2015). However, Sugiyama and colleagues (2016) state that many mobile phones does not enter the waste flow in Japan, because consumers are not recycling their mobile phones, with an estimated 200 million used mobile phones hibernating in people's homes and a collection rate of about 20% which has gradually been decreasing. Such findings indicate that consumer behaviour could impact the effectiveness of policy measures intending to enhance recovery of materials and lessen environmental effects, but also that there are also untapped opportunities within waste collection systems.

### 1.2 Purpose of study and research questions

The aim of our study is to research consumer behavior and decision-making concerning past-use and end-of-life mobile phones in Sweden. In particular, this paper will focus on consumer attitudes towards recycling and reuse of used mobile phones. Mobile phones were selected as a case study, since it represents a common product which is a growing contributor to WEEE, but with indications that many mobile phones does not enter the waste management system.

Earlier research has provided material concerning consumer preferences towards purchasing new phones and possible behavioral economic policy measures to transition to a Circular Economy, by way of increasing collection and reuse rates. Although other studies have focused on past-use mobile phones, no study has specifically targeted the Swedish consumer market. This study seeks to shed light on Swedish consumer behavior, in order to provide material for future policy decision making.

To realize the aim of our study, we seek to answer the following research questions:

1. Why does not consumers recycle their old and unused phones?
2. What consumer behavior and attitudes can be seen as barriers or possible opportunities to implement circular economy principles?

### 1.3 Waste management and mobile phones in Sweden

Sweden's system for WEEE can be described as an Extended Producer Responsibility (EPR) system, where the end-of-life (post-consumer stage) management of a product is the producer's primary responsibility. The management of e-waste used to be the municipal government's primary responsibility but it has extended to a patchwork of programs involving national, state and local governments, manufacturers, private actors that profit from e-waste recycle and non-profit organizations (Wagner 2013).

Swedish law defines waste as a subject or a device that the owner disposes, intends to dispose of or are beholden to dispose. Swedish municipalities have the responsibility to collect most household waste and transport it to recycling facilities. In turn, consumers are beholden to separate waste and recycling. However, for certain products such as EEE, producers and suppliers are responsible for collection and treatment (Krook & Eklund, 2010).

In practice, the Swedish non-profit organization El-kretsen (co-owned by 21 industry association bodies) manages the collection of EEE by collaborating with 290 municipalities by way of hosting dedicated WEEE stations at local recycling centers. (The Swedish Waste Association, 2016). Swedish El-kretsen (2015) collected 132 450 tons of e-waste in 2016 with 13.32 kg per inhabitant, of which 8 % of the total number of products collected were telecommunications products. In 2015, 18 696 tons of IT, Telecommunications and office equipment was collected (El-kretsen, 2015). In addition, mobile phones can also be directly returned to the supplier of the phone.

There is a lack of reliable and precise statistics about the mobile phone market and directly associated waste streams. According to Statistics Sweden, the import of mobile phones to Sweden in 2016 amounted to 2 328 tons, with a value of 26 444 million SEK. The export of mobile phones from Sweden in 2016 amounted to 1 690 tons, to a value of 15 567 million SEK (SCB, 2016). Estimates for how many phones are sold in Sweden per annum vary between various media outlets from 2-3 million (Blocket, 2017) to 4 million

mobile phones (Crona, 2016). According to a survey made by ISS or 'Swedes and the Internet', 77 % of Swedes owned a smartphone (ISS, 2015), whereas 97 % of the population owns one mobile phone or more (Crona, 2016). Further, there are no accurate figures for how many phones are returned to retailers in Sweden, although a large portion of the used phones are supposedly sold to other suppliers and sold to be re-used, predominately in different markets than Sweden (Crona, 2016).

In terms of the direct sale of phones for reuse, through the most popular e-commerce website in Sweden Blocket.se, electronics were sold on its site for a value of 977 million SEK, with mobile phones being the most popular category with an average resale price of 2 927 SEK. Further, Blocket.se say that the average usage time of mobile phones in Sweden is 18 months and that about 5 000-10 000 mobile phones are discarded or stored in the cupboard every day, or about 1 825 000-3 650 000 mobile phones annually (Blocket, 2017).

In 2014, the Swedish mobile phone retailer Tele2 tasked Sifo/TNS to produce a report about the mobile phone market and behaviors of Swedish consumers, but the study remains unpublished. From newspaper articles referring to the study, a third of consumers had three or more phones in their possession and 15.5 million mobile phones were estimated to be stored in Swedish households. One person out of ten had more than 5 mobile phones in their cupboards. The main motivation for respondents to not return their mobile phones was that they were unaware of how to correctly dispose a phone to have it recycled (Wilhelmsson, 2013).

A report published by The IVL Swedish Environmental Research Institute calculated the carbon footprint of a mobile phone during its whole life-cycle to 110 kg Carbon Dioxide and a climate cost of 140 SEK per mobile phone, with the total of waste from production to end-of-line amounting to 85 kg (Laurenti & Stenmarck, 2015).

A study published by the Nordic Council of Ministers' analyses the consumption behavior

of mobile phones for young adults in Sweden and Denmark and assesses through experiments how nudge theory can be applied in order to identify unintentional behaviors or obstacles to sustainable consumption, such as repairing and reusing their phones. Their study shows that nudging can have a substantial effect on sustainable consumption patterns of mobile phones amongst young adults. Twenty percent more of the participants were more willing to repair their phones for the nudge incentive scenario of the experiment. Further, compared to the base scenario 28.9 % were more willing to buy a used mobile phone, which is approximately seven times more than the base scenario. In the experiment, 62 % choose to lease mobile phone compared to 38 % without nudging. The study concludes that lack of information and low awareness about recycling and reuse of mobile phones can produce an unsustainable consumption culture (Stefansdotter et al., 2016).

## 1.4 Theory

Our theory chapter explores both the Circular Economy concept as presented by various authors and the underlying causes of why consumers decide to reuse and recycle mobile phones. These theoretical ideas will support the analysis and conclusions reached in this study.

### 1.4.1 Circular Economy

Circular Economy has become an increasingly popular concept amongst academia, industry and government, as a way to promote industry resource-efficiency and competitiveness meanwhile fostering sustainable development. China has gone to lengths to include and implement a circular economy in its economic system through the Chinese Circular Economy Promotion Law (Lieder and Rashid 2016) and in 2015 the European Commission announced the 'EU action plan for the circular, economy' (2015), with a main focus on waste-management and recycling guidelines. (Winans 2017)

The development of the concept of a Circular Economy is generally attributed to Pearce and Turner (1990), although the Circular Economy concept is interwoven and influenced from several different theories and ideas about the interaction between the

environment and economic systems (Winans et al. 2017). For example, it has been shaped by ideas such as cradle-to-cradle production, laws of ecology, looped and performance economy, industrial ecology, biomimicry and the blue economy. Geissdorfer et al. (2017) argues that the concept has remained vaguely defined as a result of the multitude of influences. (Geissdorfer et al. 2017) (Webster 2015)

Andersen (2007) argues that a Circular Economy addresses the interlinkages of the four economic functions of the environment: “The environment not only provides amenity values, in addition to being a resource base and a sink for economic activities, it is also a fundamental life-support system.”. Andersen (2006) further states that taking the above four functions as an analytical starting point, unpriced or underpriced services should be internalized in the economy.

There is some common ground amongst the different interpretations of the concept. Primarily, there is the shared view that Earth is a closed biological system and that non-renewable resources within that system are finite. Further, Circular Economy is commonly juxtaposed as a holistic industrial model to the conventional linear and open-ended economic system, by way of feeding materials used in the linear economic system back into further production through material recycling and reuse and thereby creating a closed-looped system. Thereby, the emphasis is on minimizing the input of primary resources and waste, but also to increase recovery, recycling and reuse of used waste materials. Central to this idea is the perception of waste as a resource. (Geissdoerfer et al., 2017; Pearce and Turner, 1990)

Geissdorfer et al. (2017) defines the circular economy concepts as; 'a regenerative system in which resource input and waste, emission, and energy leakage are minimized by slowing, closing, and narrowing material and energy loops. [A Circular Economy] can be achieved through long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling.’

Ferdousi et al. (2016) argues that a widespread implementation of Circular Economy requires a paradigm shift in the way products are made, circulated and consumed, and would profoundly change consumption patterns of economic activities. Furthermore, through individual decisions and behavioral patterns, consumers are central actors to facilitate implementation of a Circular Economy (Kates, 2000).

Winans et al. (2017) states that most definitions of the Circular Economy concept include the three 'R' principles (reduce, reuse, and recycle), while some concept definitions also include the six 'R' principles (reuse, recycle, redesign, remanufacture, reduce, and recover). For this paper, we will focus on two of the three principles of Circular Economy, namely recycling and reuse, as consumers are an integral actor to achieve these two principles, whereas reducing waste through design and efficiency measures relies mainly on producers and regulators.

### 1.4.2 Recycling and Reuse consumer behavior

Several studies show that consumers are the essential actor and the main driving factor for the collection rate and the quality of the waste collection (Krook & Eklund, 2010; Ylä-Mella, 2015; Wagner, 2013). Thomas and Sharpe (2013) argues that recycling has become norm in many communities and is now seen as a common activity in which individuals and household engage in, particularly for dry recyclables (i.e. paper, glass plastics and cans). However, there is an ongoing debate of why certain people recycle and reuse, whereas others do not, from which a complex and often contradictory body of literature has emerged including a range of disciplinary perspectives, such as economics, sociology, psychology and marketing.

Ajzen and Fishbein's reasoned-action approach has successfully been used to explain the relationship between attitudes and behavior within human decision-making, particularly in earlier studies aiming to explain pro-environmental behavior (Cordano et al. 2011). The reasoned-action approach defines individuals' behavioral intention as the willingness to act a specific way, which in turn affects their actual behavior. Moreover, the behavioral intention is affected by pre-existing attitudes towards the specific behavior, perceived norms and perceived behavior control (Cordano et al. 2011). In relation to this study and according to the reasoned-action theory, pro-environmental attitudes and perceived norms about recycling could translate into an intention to recycle and consequently the actual recycling behavior. Wu and Chen (2014) shows that behavioral

intention and behavior control have positive influence on actual behavior and that the perceived benefit of green consumption has a positive impact on consumer attitude.

However, high concern for environmental issues amongst individuals does not necessarily translate into guiding the decision-making of consumers. According to Bonini and Oppenheim, a 2007 McKinsey & Company survey report of 7 751 consumers showed that 87 % of respondents were concerned about the environmental and social impacts of their purchases, but that only 33 % of the respondents were willing to buy or had already bought green products. (Bonini and Oppenheim, 2008)

Fredricks et al (2015) argues that consumer behavior is a complex topic, which rarely follows traditional economic theories of decision-making, such as the rational choice model. Instead, there is an attitude-behavior discrepancy in what people say they do, what they know and what people actually do – or what their intended behavior is in contrast to their actual behavior – to the extent that consumers are predictably irrational in their decision making. This is particularly applicable to individual choices around pro-environmental behavior (Fredricks et al. 2015). This attitude-behavior discrepancy is commonly referred to as the value-action gap and/or knowledge-action gap. Barr & Gilg (2005) analyses the attitude-behavior discrepancy in relation to recycling behavior and concludes that while there was analytical support that the intention reflected the behavior, a considerable amount of the value-action gap was explained by other variables which were mostly associated with societal norms about recycling (Barr & Gilg, 2005).

Thomas and Sharpe (2013) states that the knowledge of how to recycle as well as the access to and provision of services (e.g. recycling centers) play an important role in whether people recycle. Similarly, public education programs about recycling for younger adults and convenient recycling for older adults have a positive impact on the willingness to recycle electronic waste (Saphores et al., 2012).

Wagner (2013) states that the convenience of recycling is integral to maximize consumer participation in order to increase waste collection amounts, who also argues that the

term convenience is a subjective construct and therefore individuals have different recognitions of a convenient collection system. Wagner concludes that a collection system with high consumer convenience is easily obtainable with accessible centrally located collection points available, and that minimal effort is required to obtain and/or provide information about returning procedures (Wagner 2013).

Ylä-Mella et al. (2015) examines consumers' awareness and perceptions towards mobile phone recycling and reuse through a survey in Finland. The study's findings indicate that consumers' awareness of the importance and existence of waste recovery system was high, but that the awareness had not translated to recycling behavior. Respondents of the study displayed a storing behavior, which indicated that proximity and the convenience of current waste management systems were inadequate. (Ylä-Mella et al., 2015)

Barr et al. (2001) highlights that waste minimization and reuse behavior is different from recycling behavior: where reuse behavior is fundamentally based on environmental values, experience in environmental behavior and general knowledge, recycling behavior is based around acceptance of normative behavior, perceived benefits of recycling and the knowledge of recycling services. The conclusion made by Barr et al (2001) is that recycling is not a value-based behavior and that waste minimization and reuse behaviors is undertaken by a minority of citizens (Barr et al., 2001, p 2042).

According to Tucker and Douglas (2007) waste prevention behavior, which include reuse behavior, has multiple causes and divide the causes into four classifications: attitudinal factors, contextual factors, personal capabilities, and habits and routines. They conclude that there is a strong link between waste prevention behavior and the acceptance of personal responsibility. If there are emotional aspects involved (such as embarrassment and guilt) rather than an individual's sense of duty, there is a higher chance for a waste prevention behavior. Awareness and necessity were also important predictors for waste prevention behavior, whereas a strong moral code was a relatively poor predictor.

## 2. Methodology

In order to achieve the purpose of our study we collated data via a survey form. The data will then be analyzed through the use of descriptive statistics and two logit regression models to answer our two research questions. We will use the results from our analysis to draw conclusions whether any value-action gaps exists within the sample in between recycling and reuse behavior as well as to identify any opportunities and barriers in consumer behavior in the context of a Circular Economy.

### 2.1 Survey Methodology

We have decided to utilize quantitative method in order to answer the research questions posed above. The purpose of this survey is to obtain data, which will be used to analyze consumer behavior relating to reuse and recycling of mobile phones and the circular economy concept.

It was suitable for us to gather and collate a dataset via the survey method, as there is a lack of data about Swedish consumer behavior regarding the reuse and recycling of mobile phones. The survey method is also appropriate since we are interested in individuals' characteristics, attitudes, experiences and behaviors. We decided to use Swedish students as a homogenous focus group, as students were an accessible and available group for us to study, given the time limits imposed. Thus, we used a simple random sampling method, the students were randomly sampled as the survey was conducted at different faculties of Gothenburg University by way of the authors asking willing students to complete the survey (Lantz 2014). Due to the small number of the observations and homogenous group, the results may not reflect the general population. This may also affect the reliability of the data analyzed from the sample. For our study, this could translate into the young age of respondents being more environmentally conscious and more educated, which may affect the answers provided (Olsen, 2014).

A good questionnaire design seeks to maximize the relationship between the answers noted and what the researcher is trying to measure (Burton, 2011). One criticism of survey research is that the responses are obtained in an artificial situation that is

constructed by the researcher (Burton, 2011). Moreover, it is important try to ensure that the questions are reliable and consistent. When questions are reliable, a participant would provide the same answer on the survey in a similar situation if asked to complete the survey at another point in time (Burton, 2011). Another challenge in survey design is the symmetry between the answers and the true values, which has an impact on the validity of the research (Burton, 2011). While conducting the study, the aim was to be consistent in our approach and ask participants the same questions and obtain the answers in systematic fashion to ensure a good validity and reliability.

As we created our survey we chose a questionnaire form design that consists mainly of closed-ended questions, and to a lesser degree open-ended questions. This approach allowed us to design a survey which was easy and quick to complete through the close-ended questions, while also providing us with a larger range of information by using the open-ended questions. The aim was to keep the questions short and simple, in order to facilitate for respondents to answer in a straightforward way (Olsen, 2014). Further, multiple choice answers were used to simplify closed and pre-coded answers and the language was kept simple to make the questionnaire easy to understand. The design of the questionnaire is inspired from previous questionnaires from Ylä-Mella (2015) and Stefansdotter et al. (2016) which may allow for the results to be compared between the studies.

In order to design the survey in alignment with the theories and research questions used for the study, we asked questions about; recycling, reuse and attitudes to pro-environmental behavior. Further, to provide further background information we asked questions about the number of mobile phones owned, if respondents had previously owned a mobile phone and if respondents had a current mobile phone subscription with a retailer. In addition, we also asked questions which we could use as control variables, such as age, gender and education level.

### 2.2 Use of descriptive statistics

The data from our survey will be presented and discussed in chapter 3. This will make the

study more transparent and easy to replicate by other researchers, at the same time as it will allow readers to form their own opinion of the data obtained from the survey.

In order to address the first research question posed above, we will use descriptive statistics to analyze the results from our survey and subsequently answer the question, in the format of histograms bar charts and summarized statistics. We have selected this method, as we expect the results to be readily interpreted by presenting the answers of question directly relating to recycling behavior and will also provide an overview of some key behaviors of our sample.

Specifically, the following questions were selected to answer the study's first research question: question 7 (What do you do with old and unused mobile phones?), question 8 (If you keep one or more unused mobile phones at home, what is the reason that you still have it?) and finally question 10 (In your opinion, is it simple or troublesome to recycle a mobile phone?).

A drawback in using descriptive statistics is that we will not be able to understand the relationship between the variables and particularly between dependent and independent variables. However, these relationships will be analyzed through the use of a logit regression analysis model to answer our other research questions.

### 2.3 Use of regression analysis

By using a regression model it is possible to describe the relationship between the dependent variable and the explanatory or independent variables (or predictors). In this study, we will utilize a logistic regression analysis since the dependent variables we have selected are categorical and dichotomous. Specifically, our dependent variables are binary, that is, where the dependent variables can only take two values, '0' and '1', which represents the outcomes of an event.

Whereas in a multiple regression the variation in the dependent variable can be analyzed by several independent variables, the logistic regression analyzes the probability for a specific event to occur within a range between 0 and 1, based on the values of the

independent variables (the predictors). While probability represents the ratio of successes to successes plus failures, odds represent the ratio of successes to failures. The odds is defined as the probability for the event to occur divided by the probability for the event not to occur (p/(1-p)), which range from 0 to infinity. (Barmark & Djurfeldt, 2009, s.125-129).

The natural logarithm of the odds provided by the logistic regression equals the logit, that is the dependent variable in the logit model and it can assume values from minus infinity to plus infinity. In this model, we assume that the distribution of the sampling is binominal, which models the probability for a determined outcome in a series of events (Barmark & Djurfeldt, 2009, s.125-129).

In order to meaningfully interpret the results from a logistic regression, we first need to ensure that the model itself fits the data, or in other words, that the model's explanatory variables explain the changes in the dependent variable significantly better than the model would if the explanatory variables had no effect. For a logit regression model, commonly the likelihood ratio statistic is used, which approximatively follows a chi-squared distribution, which is also the statistic used for this study. (Liao 2011)

The interpretation of the coefficients in a logit regression differ from a OLS model since a logit model are estimated by the maximum likelihood method. An increase or decrease in a dependent variable increases or decreases the likelihood that the dependent variable will equal 1. We want to test the marginal effect of different variables because it reflect the change in the probability of Y=1 given a one unit change in an independent variable (Liao, 1994).

Our model will be tested for multicollinearity to ensure that the predictor variables are independent of each other. We assume that the limit for high correlation among the dependent variables is a correlation statistic of 0.9, at which point issues will occur with the model estimates and we will be unable to separate the results from one dependent variable to another (Mills et al, 2010).

The logistic regression model is suitable for our research because we want use the data

from the survey to find models for predicting consumer behavior and attitudes towards recycling and reuse of already used mobile phones. We aim to create two regression models to analyze the probability that a person recycle their already used mobile phone or buy an already used mobile phone. Thus, our predictor variables may increase the probability for a respondent to recycle or reuse while some may decrease the probability of recycling or reuse.

We will adapt a matrix to highlight and categorize the different predictors which can answer our research question about the possible opportunities solutions and barriers to recycle and reuse in light of an implementation of a Circular Economy. The coefficients of the independent variables which increased the probability of the event (i.e. positive) will then be categorized within the possible opportunities, whereas the coefficients which decreases the probability of the event will be categorized in the Barriers section, for the respective model.

The variables we have used for our regression models are based on the questions from the survey form. To facilitate the logistic models, we have created several dummy variables, due to issues with respondents selecting multiple answers for certain questions and respondents answering questions they were not supposed to answer given their earlier responses.

### 2.3.1. Recycle regression model

$$Y = \alpha + \hat{\beta}_1 X_1 + \hat{\beta}_2 X_2 + \hat{\beta}_3 X_3 \ldots + \hat{\beta}_{11} X_{11} + \hat{\beta}_{12} X_{12} + \mu$$

The dependent variable in our logit regression model for recycling is binary and represents the outcomes of recycling. It take two values, ‘1’ if the person have recycled and ‘0’ if not recycled. We seek to shed light on the relationship between recycle and the different explanatory variables we think have a statistically significant effect on individuals recycling behavior. The dependent variables we used in our regression models are presented fully in Appendix B, however below we discuss why we have included certain variables.

As discussed in the theory section above, the perceived convenience of recycling is likely to be a predictor of recycling behavior. If people find it troublesome to recycle we expect that respondents will be less likely to recycle mobile phones. We also chose to include an independent variable that describe the effect of environmental consciousness on recycling behavior, as Ajzen and Fishbein's theory suggests it would increase the probability of recycling behavior.

The variable 'Mobile phone will not work well enough' is included to examine whether old mobile phone that functions well decrease the likelihood for recycle unused mobile phone. We assume that if an old mobile phone works well, it is likely that a consumer will keep it as a spare instead of recycling the mobile phone. Also related to consumer storing behavior, the dummy variable "Number of unused Mobile phone at home" is anticipated to have a decreased likelihood for recycling behavior, since the respondents who store at least one unused phone at home have not engaged in recycling behavior.

Further, the respondents that do not know what to do with their old phone or how to properly get rid of it, are expected to be not as likely to recycle due to lack of will, knowledge or attitude. In the model we included a variable "Previous Mobile Phone", in order to test if there was a difference between the reference group and the respondents which had prior experience of owning a phone. We also included control variables as gender, age and educational level in the regression model.

### 2.3.2. Reuse regression model

$$Y = \alpha + \hat{\beta}_1 X_1 + \hat{\beta}_2 X_2 + \hat{\beta}_3 X_3 \ldots + \hat{\beta}_{10} X_{10} + \hat{\beta}_{11} X_{11} + \mu$$

The dependent variable in our logit regression model for reuse is binary and represents the outcomes of willingness to buy an already used mobile phone. It take two values, '1' if the person are willing to buy an already used mobile phone and '0' if the person is not willing to buy an already unused phone. We want to describe the relationship between the willingness to buy a used mobile phone and explanatory variables we think have a statistically significant effect on individuals' attitude towards reuse old mobile phones.

Two explanatory variables we assume can have an effect on the probability of buying an already used mobile phone are respondents' willingness to pay for an already used phone and whether it is important that it is cheaper than a new phone. Since there is no guarantee or warranty provided when buying a used mobile phone, we have added a variable for this purpose, which is expected to decrease the likelihood for reuse behavior as it adds uncertainty to the purchase.

Reliability and quality of already used mobile phones are other predictors that could affect the probability of reuse behavior and our assumption is that higher expected quality and reliability in used phones will generate higher likelihood of reuse. Further we want to test whether there is a relationship between environmentally consciousness and willingness to buy a used mobile phone, as Barr et al (2001) suggests is a deciding factor for reuse behavior. Lastly, we have added a dummy variable for respondent which have an ongoing mobile phone subscription service, as we expect that these respondents will receive attractive offers from their current retailer and therefore decrease the probability that the respondents will buy an already used phone.

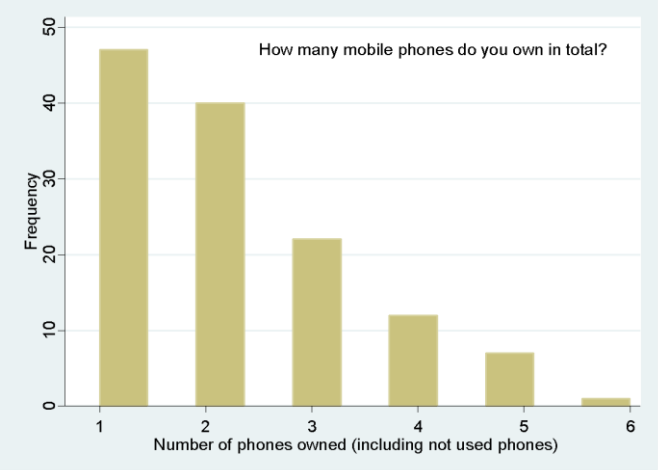
## 3. Data Presentation

As discussed in the method chapter above, our survey was conducted to obtain data about the recycling and reuse behavior of Swedish students. The sample we have obtained is relatively small to infer findings about the general populous with full confidence, but is assumed to be sufficiently reliable for statistical analysis.

The respondents of our sample display a low variance in their Education levels and Age, which may affect the variables usefulness for statistical analysis. This was foreseeable and due to our decision to sample university students, which are generally young and of a similar age, meanwhile they normally study at a bachelor or master degree level. Further, the majority of respondents to our survey are female, which may provide some skewed results, but is not unsurprising given the higher amount of women completing university studies in Sweden than men (SCB, 2015/16).

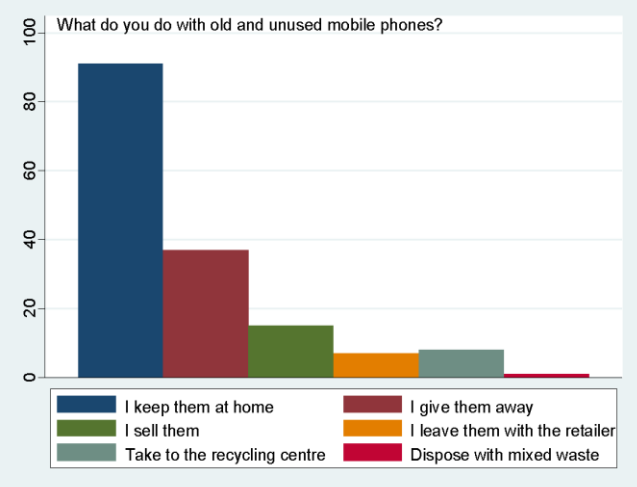
The data collated from the survey consisted of a sample of 129 respondents, of which 84

respondents (65 %) of our sample were women and 45 (35 %) were men. The average age of the respondents were 24.4 years and the general level of education of the sample were bachelor level studies (65 % of respondents).



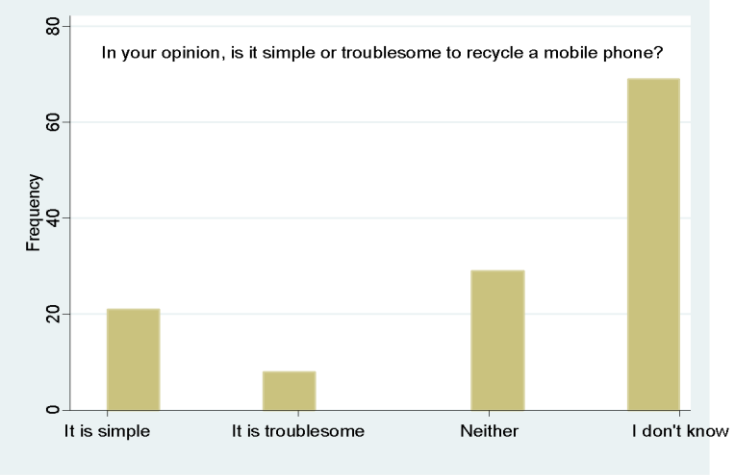

When asked how many mobile phones a respondent currently owned in total, 36.5 % owned one mobile phone, 31 % owned 2 mobile phones and 32.3 % owned three mobile phones or more. The average respondent owned 2.18 mobile phones with a standard deviation of 1.22. 98.5 % of the respondents had owned a mobile phone prior to their current one and 109 (85 %) respondents had a current mobile phone subscription plan with a retailer.

When respondents answered the question of what they do with their old and unused mobile phones, 57.2 % of respondents answered that they keep them at home, whereas 23.2 % give away their phones and 9.5 % sell them. However, some respondents have selected more than one answer to the question (159 observations for 129 respondents), which makes the data harder to interpret. Only a small number (8 or 5 %) of respondents said they take their old and unused phone(s) to the recycling center.

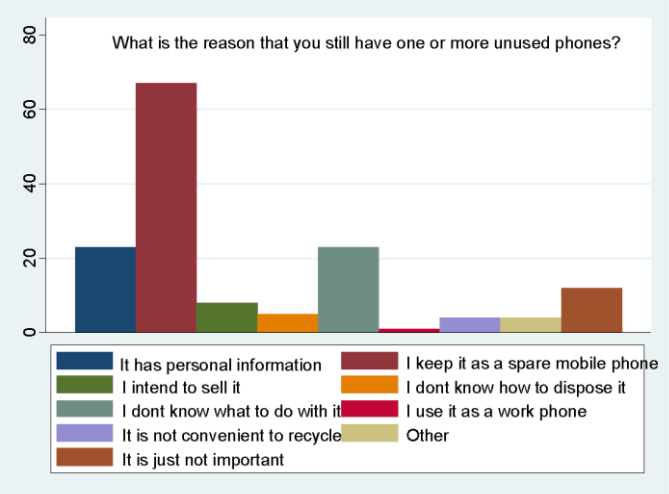



This low rate of recycling behavior is reiterated when respondents are asked what the reason was to recycle their phone, provided they had recycled their old phones. Interestingly, for this question we obtained a higher amount of observations (22) which said they had recycled their phones.

When asked if it was simple or troublesome to recycle a mobile phone, 69 respondents out of 127 (54,3 %) answered that they did not know how to recycle a mobile phone, whereas 22 respondents thought it simple to recycle a mobile phone and 29 respondents thought it was neither simple or troublesome.



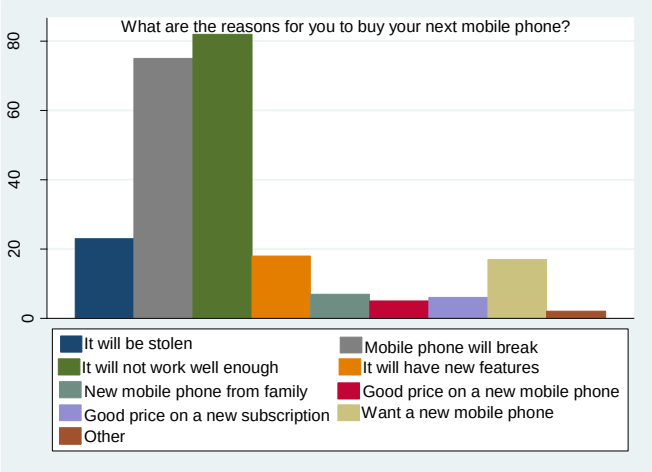

When asked about the reasons for why respondents keep their old and unused phones, a majority (61 out of 147 observations) answered that they keep a spare mobile phone in case their current mobile phone will break. Other reasons provided by respondents were that the old mobile phone has personal information stored on it (23 out of 147 observations), that they did not know what to do with the phone (23 out of 147 observations) or that it was simply not important to them (12 out of 147 observations).



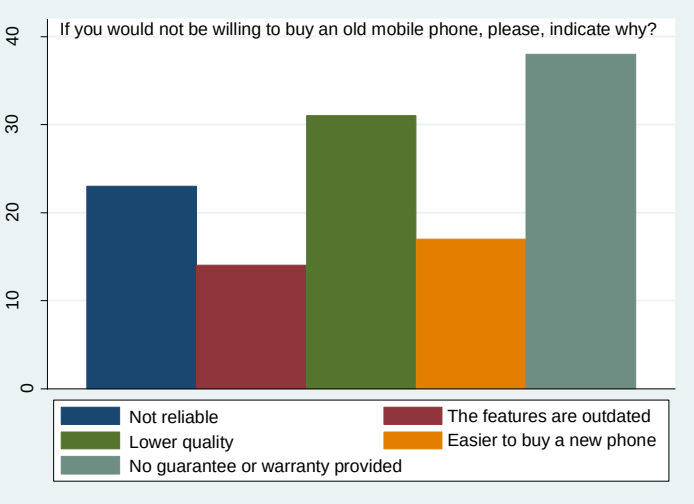
| Variable | Obs. | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| Number of Mobile phones owned | 129 | 2.186 | 1.223 | 1 | 6 |
| Age (years) | 129 | 24.426 | 3.747 | 19 | 40 |
| How frequently do you change phone? (years) | 129 | 2.86 | 0.62 | 1 | 4 |
| Usage time for next phone? (years) | 129 | 2.92 | 0.713 | 1 | 5 |
| Willingness to pay for a used mobile phone? | 97 | 2239.69 | 1221.33 | 500 | 6000 |

Table 1. Key statistics from answers obtained from our Survey questionnaire.

Respondents appear to buy new mobiles phone for different reasons, the data from our survey shows that the main reason for buying a new mobile phone is that respondents believe that their current mobile does not work well enough with 83 out of 237 observations and that the current mobile phone will break with 75 out of 237 observations. Less frequent reasons were that respondents believed their mobile phone would be stolen (23 out of 237 observations), that a new mobile phone has new features which the current one does not (19 out of 237 observations) or that they just wanted a new mobile phone (17 out of 237 observations).



On average, respondents answered that they change mobile phone every 2.8 years with a standard deviation of 0.6 years. In comparison, respondents believed their next mobile phone would last an average 2.9 years with a standard deviation of 0.7 years. 46.1 % (59 out of 128 observations) of the respondents stated that they were willing to buy an already used mobile phone. When asked about the main prerequisites to buy an already used mobile phone, 36 % (42 out of 116 observations) of the respondents said that it had to be in good condition and 32.7 % (38 out of 116 observations) answered that it had to be cheaper than buying a new phone and 14.6 % (17 out of 116 observations) said the mobile phone is no more than one year old. The mean price respondents were willing to pay for an already used mobile phone was 2 239 SEK, with a standard deviation of 1 221 SEK.




The 53.9 % which were not willing to buy an already used phone were asked about their reasons for the decision, 38 out of 125 observations answered that old mobile phones did not have a warranty or guarantee, 32 out of 125 stated that the old mobile phone were of lower quality than new ones and 23 out of 125 stated that they did not consider old mobile phones to be reliable.

When asked to consider how environmentally conscious the individual respondents were, 7 % considered themselves as very environmentally conscious, 37 % stated that they are environmentally conscious, 50 % considered themselves as somewhat environmentally conscious and 5.5 % stated that they did not consider themselves to be particularly environmentally conscious. When asked about the importance of recycling mobile phones, 112 out of 125 respondents or 89.6% of the respondents stated that recycling mobile phones is important.

## 4. Analysis & Results

Under this section, we will first analyze the descriptive statistics to answer our first research question. This will be followed by a presentation and analysis of the results from our two regression models used to answer the second research question.

### 4.1 Research Question 1

As mentioned above in the methods chapter, question 7, 8 and 10 from the survey were selected to answer the study's first research question: *Why do some consumers not recycle their old and unused phones?*

In terms of the findings provided by the descriptive data, a large amount of respondents keep their phones at home. 129 respondents owned a total of 275 mobile phones which would indicate that 146 or 53.1% of the mobile phones are likely not in current use, as most people commonly use one at a time. Although not reliably inferred, if we extrapolate this number to the numbers of students currently enrolled in Sweden as according to SCB (2015/16), 402808 Swedish students would own about 878 121 mobile phones, of which 53.1% would not be in current use.

Although these numbers not yet further statistically analyzed, it does appear that a large contingent of the sample show a value-action gap in their behavioral intent *vis a vis* their actual behavior, given the vast majority of respondents believe recycling mobile phones are important, meanwhile the attitudes have not translated into actual recycling behavior as a small amount of respondents appear to have recycled their phones.

From the histograms and bar graphs we can draw three conclusions; firstly, that only a small percentage of respondents actually recycle the phones. Instead, most people tend to store their phones at home, or respondents sell or give away their already used phones. This finding strengthens Sugiyama et al. (2016) claim that a large portion of mobile phones does not enter waste management processes due to consumers' storing behavior.

Secondly, most respondents keep their old phone as a spare mobile phone in case their currently used mobile phone breaks, or that they keep an already used mobile phone since it contains personal information or simply do not know what to do with it. These

results are similar to the findings of the Nordic Council of Minister's report where most people kept their old mobile phone as a spare in case the current one would break (Stefansdotter et al., 2016).

Thirdly, the knowledge of how to recycle a mobile phone is low, as a majority of respondents does not know how to recycle a mobile phone. According to Thomas and Sharpe (2013) this is one of the main predictors of recycling behavior and would thereby result in less recycling behavior.

### 4.2 Research Question 2

As discussed in the method chapter, we have decided to use two different logit regressions models to answer Research question 2: *What consumer behavior and attitudes can be seen as barriers or possible opportunities to implement circular economy principles?* Below in Table 2, we present the summary statistics for the variables used in the regression models.

| Summary Statistics | Observations | Mean | Std. Dev. | Min | Max | Sum |
|---|---|---|---|---|---|---|
| **Recycle Regression Model:** | | | | | | |
| Simple to Recycle | 127 | 0.386 | 0.489 | 0 | 1 | 49 |
| I don't know | 127 | 0.213 | .411 | 0 | 1 | 27 |
| Previous Mobile phone | 127 | 0.984 | 0.125 | 0 | 1 | 125 |
| Keep it as a spare phone | 127 | 0.520 | 0.501 | 0 | 1 | 66 |
| Environmentally concsious | 127 | 0.417 | 0.495 | 0 | 1 | 53 |
| Mobile phone do not work well enough | 127 | 0.646 | 0.480 | 0 | 1 | 82 |
| Mobile phone will break | 127 | 0.590 | 0.494 | 0 | 1 | 75 |
| Keep mobile phone at home | 127 | 0.700 | 0.451 | 0 | 1 | 89 |
| True Recycle | 127 | 0.157 | 0.365 | 0 | 1 | 20 |
| | | | | | | |
| **Reuse regression model:** | | | | | | |
| Willingness to buy used mobile phone | 127 | 0.465 | 0.500 | 0 | 1 | 59 |
| No guarantee | 127 | 0.299 | 0.460 | 0 | 1 | 38 |
| Not reliable | 127 | 0.181 | 0.387 | 0 | 1 | 23 |
| Lower quality | 127 | 0.244 | 0.431 | 0 | 1 | 31 |
| Old Mobile phone cheaper | 127 | 0.299 | 0.460 | 0 | 1 | 38 |
| Subscription | 127 | 0.842 | 0.366 | 0 | 1 | 107 |
| Good condition | 127 | 0.331 | 0.472 | 0 | 1 | 42 |
| Willingess to pay for used mobile phone | 97 | 2239.691 | 1221.337 | 500 | 6000 | 217250 |
| | | | | | | |
| Gender | 127 | 0.661 | 0.475 | 0 | 1 | 84 |
| Age | 127 | 24.441 | 3.762 | 19 | 40 | 3104 |
| Education level | 125 | 4.088 | 0.783 | 1 | 5 | 511 |

Table 2. Summary statistics of all variables used in the two regression models.

### 4.2.1. Recycle regression

The variables used for our Recycle regression model were tested for multicollinearity through a correlation test. The table 5 (Appendix C) shows that the estimated recycle regression model have small collinearity which indicates that the predictors are independent from each other.

| Variables | Coefficient | Marginal Effect |
|---|---|---|
| Simple to Recycle | 2.983 (0.942)*** | 0.257 (0.072)*** |
| Environmentally Conscious | 0.741 (0.727) | 0.065 (0.061) |
| Mobile phones at home | -0.312 (0.749) | -0.027 (0.064) |
| Willingness to buy used mobile phone | 0.166 (0.665) | 0.014 (0.057) |
| I do not know | -0.650 (1.367) | -0.056 (0.117) |
| Mobile phone will break | -0.5 (0.731) | -0.043 (0.063) |
| Mobile phone not work well enough | -1.392 (0.736)* | -0.111 (0.059)** |
| Previous mobile phone | -0.407 (0.736)** | -0.350 (0.141)** |
| Keep Mobile phone as a spare phone | -1.392 (0.736)* | 0.075 (0.058) |
| Gender | 0.618 (0.717) | 0.053 (0.061) |
| Age | 0.119 (0.092) | 0.010 (0.015) |
| Education level | -0.351 (0.444) | -0.03 (0.038) |
| Observations | 125 | 125 |
| Likelihood ratio Chi 2 | 36.95 | |
| Prob > Chi2 | 0.0002 | |
| Mcfadden's Pseudo R-squared | 0.3469 | |

Table 3. Results from the Logit Recycle Regression models. Dependent variable (Y): The probability to Recycle (1), not recycle (0). Standard deviation is presented in parenthesis under the coefficient of each independent variable. Significance levels are displayed as; *= 0.1, **= 0.05, ***=0.01.

As seen above in Table 3, our model has a likelihood ratio chi-square (LR Chi2) test statistic of 37.03 for our 125 observations. The probability that we would obtain a likelihood ratio test statistic as extreme as the observed LR Chi2 statistic under the null hypothesis is 0.0002. In other words, the probability that we would obtain our LR Chi2 test statistic of 37.03 if there is in fact no effect of the predictors on the dependent variable. The pseudo R2, or McFadden's pseudo R-squared, is 0.3469.

Only a few of the results from our model are statistically significant. The largest positive effect which is statistically significant at a 99 % confidence level is the dummy variable for the convenience of recycling. Respondents who find it simple, or neither simple or troublesome, to recycle a mobile phone are more likely to recycle. The marginal effect

on actual recycling behavior is 27 % and statistically significant. It appears that in order to encourage people to recycle mobile phones, it should be convenient to recycle the phone.

Although not statistically significant, if you are environmentally conscious, you are more likely to recycle the mobile phones you own by a marginal effect of 6.4 %, which implies that it is not a strong predictor of recycling behavior. Moreover, Respondents who were not sure of how to recycle their phones or did not know what to do with their past-use mobile phones, did not affect the outcome of the recycling behavior at a statistical significance level, although the coefficient and marginal effect was negative.

The results also show that if the participants expect to buy their next mobile phone due to their current mobile phone not working well enough (e.g. slow, cannot run programs, poor battery time), people will be less likely to recycle their phone, by a marginal effect of -11%. Both the coefficient and marginal effects of this variable were statistically significant within a 90 % and 95 % confidence interval respectively. Perhaps mobile phones which are still functional are more valuable to retain for respondents, as they are able to keep their phones as a spare phone. This argument is strengthened by the variable where respondents keep a spare phone at home which has a positive coefficient, as well as the negative coefficient for the variable of mobile phone breaking, although neither of these variables are statistically significant within a 90 % confidence interval.

The most negative effect on recycling behavior stems from our binary variable where respondents had previously owned a mobile phone prior to their current phone, which was an overwhelming majority of respondents. The effect was statistically significant with a 95 % confidence and the marginal effect was -35%. This is surprising as arguably you need to have owned a phone prior in order to later recycle a phone and a positive coefficient was expected. The result could be explained by the low variance of the dummy variable, but the result also highlights how few of the respondents who participates in actual recycling behavior.

Lastly, the control variables of Age, Education level and Gender were not statistically significant, which may be a result of homogeneity of the sample group.

### 4.2.2. Reuse regression

The explanatory variables used for our Reuse regression model were tested for collinearity through a correlation test and can be viewed in the appendix section below. Table 6 (Appendix C) shows that the model have small multicollinearity and that the estimated variables are independent from each other.

| Variables | Coefficient | Marginal Effect |
|---|---|---|
| Environmentally Conscious | 3.294 (2.180)* | 0.143 (0.086)* |
| No guarantee | -7.507 (3.361)** | -0.327 (0.114)*** |
| Not reliable | -8.768 (5.210)* | -0.382 (0.203)* |
| Lower quality | -4.487 (2.810) | -0.196 (0.115)* |
| Old mobile phone is cheaper | 6.370 (2.651)** | 0.277 (0.083)*** |
| Subscription | 1.081 (4.760) | 0.047 (0.207) |
| Good condition | 4.816 (2.135)** | 0.201 (0.071)*** |
| Willingness to pay for a used phone | -0.001 (0.001) | -0.000037 (0.0000202)*** |
| Gender | 0.400 (1.357) | 0.017 (0.059) |
| Age | 0.033 (0.154) | 0.001 (0.007) |
| Education level | -0.204 (7.202) | -0.001 (0.067) |
| Observations | 96 | 96 |
| Likelihood ratio Chi 2 | 105.11 | |
| Prob > Chi2 | 0.0000 | |
| Mcfadden's Pseudo R-squared | 0.8021 | |

Table 4. Results from the Logit Reuse Regression models. Dependent variable (Y): The probability to Reuse a mobile phone (1), not to reuse a mobile phone(0). Standard deviation is presented in parenthesis under the coefficient of each independent variable. Significance levels are displayed as; *= 0.1, **= 0.05, ***=0.01.

As displayed in table 4 above, our Reuse logit model has a likelihood ratio chi-square (LR Chi2) test statistic of 105.11. The probability that we would obtain a likelihood ratio test statistic as extreme as the observed LR Chi2 statistic under the null hypothesis is 0.00. In other words, the probability that we would obtain our LR Chi2 test statistic of 105.11 if there is in fact no effect of the dependent variables is close to non-existent. Our model has a McFadden R2 value of 0.802 which indicates the goodness of fit for our model.

The results show that environmentally conscious respondents are 14.3 % more prone to

buy an already used mobile phone than someone who is not, albeit only statistically significant with a 90 % confidence level. Further, the willingness to buy an already used mobile phone will increase by 20.9 % if the buyer considers the mobile phone to be in good condition with a 95 % confidence level. On the other hand, respondents are less likely to buy already used mobile phones since they perceive them to be of lower quality (19.5 % with a 90 % confidence level of only the marginal effect), not functioning reliably (38.2 % with a 90 % confidence level) and lack a guarantee or a warranty (32.7 % with a 95 % confidence level).

Price appears to be important to predict the willingness to buy an already used phone. The willingness to pay for a mobile phone decreases by 0.00365% per increase in X although the coefficient is not statistically significant whereas the marginal effect is within a 99 % significance level. The mean value which respondents have said they are willing to pay for a mobile phone is 2 239.69 SEK, multiply the mean by the marginal effect provides an estimate of respondents being -8.1% less likely to buy an already used phone at the mean price. This number can be compared to the average selling price on Blocket.se (2017) - 2927 SEK - which gives a negative marginal effect of 10.6%. In line with this finding is the dummy variable for respondents who were more willing to buy an already used phone given that phone's price was lower than the price for a new mobile phone. The marginal effect of this dummy variable was 27.7% and statistically significant with a 95 % confidence level.

Our control variables Age, Gender and Education level are not affecting the results at a statistically significant level.

## 5. Conclusion & Discussion

Below we will present the conclusions drawn from our descriptive statistics and regression models in the context of the Circular Economy concept. Further, we will discuss both some future policy-options based on our conclusions as well as future

research within the field of study. The findings are summarized in figure 1.

| Matrix | **Recycle** | **Reuse** |
|---|---|---|
| **Possibilities** | ● Convenience of recycling | ● Price Sensitivity<br>● Environmentally conscious |
| **Barriers** | ● Knowledge about recycling<br>● Change phone due to quality of phone | ● No guarantee or warranty<br>● Quality of the product |

Figure 1. Matrix to summarize key findings of the study in relation to the Circular Economy concept..

### 5.1 Conclusions

Our findings indicates that consumers have a storing behavior and that a large share of mobile phone and the valuable resources they contain does not enter the Swedish waste management system. This behavior has also been reported by both Sugiyama et al. (2016) and Ongondo et al. (2011) in their respective studies. It has implications for the recycling industry in terms of withholding potential revenue, but it is also problematic for the effectiveness of potential policy measures to implement a Circular Economy.

For mobile phones that are stored at home, our result imply that whilst a working mobile phone is not currently used, its functions are still valued by respondents and regarded as a utility product. From a Circular Economy policy perspective, this raises interesting questions of suitable approaches which could address this issue. For example, Stefansdotter et al. (2016) examines the option of retailers withholding a deposit at the time of purchase to increase return rates of mobile phones. One finding from our survey is that nearly all respondents have a subscription service with a retailer, which could yield such a policy measure effective.

Furthermore, our results show that there is a lack of knowledge of how to recycle a

mobile phone. Also, a vast majority of respondents have answered that recycling is important and the majority see themselves as somewhat or more environmentally conscious. This finding indicates that there is a gap between the attitude towards pro-environmental behavior and the actual behavior, such as the value-action gap where people have environmentally friendly values but still they do not engage in the actual pro-environmental behavior.

The strongest statistically significant predictor for increasing the probability of recycling behavior is how convenient respondents perceive it to be to recycle. This conclusion is similar to the reasoning of Wagner (2013) who argues that the convenience of recycling is integral to maximize consumer participation and increase waste collection rates, a crucial component for the realization of a Circular Economy. Wagner states that the term convenience is a subjective construct, but that the main predictor of subjective convenience is knowledge of how to recycle. This conclusion is similar to Thomas and Sharpe's (2013) view that knowledge of how to recycle and access to and provision of services play an important role in whether people recycle. Unfortunately, in our model the variable coefficient and marginal effect for lack of knowledge was not statistically significant but still displayed a negative coefficient, or a decrease in the likelihood to recycle, which is similar to the above conclusions and could be viewed as a barrier to a Circular Economy (or opportunity if there's room for improvement).

It appears that when respondents still value the functions of unused mobile phones, the probability to recycle will decrease. This could possibly indicate that there are possibilities for people to use their mobile phones for a longer time if the phone was repairable - repair being one of the six 'R' principles of Circular Economy albeit consumer behavior of repair of mobile phones remains outside the scope of this study.

In terms of the reuse of mobile phones, our findings are more statistically significant than for the recycle regression model. About half the respondents were open to the idea of buying an already used phone, the main findings from our logit regression analysis shows

that price and quality of the mobile phone matters most when predicting whether respondents will buy an already used phone. When considering the quality of an already used mobile phone, our findings indicate that consumers feel uncertain about purchasing an already used mobile phone which may relate to risk-averse behavior. In relation to the Circular Economy this consumer uncertainty likely leads to a lower reuse rate of old mobile phones and could be seen as a barrier for Circular Economy.

As price is set by market mechanisms, it is hard to ascribe price sensitivity as either a possibility or a barrier to the implementation of a Circular Economy, although it does give an indication for policymakers of the price levels consumers anticipate to buy a phone for. When comparing the mean price for the resale of phones on the internet commerce site Blocket.se - 2927 SEK - to the mean of the willingness to pay for an already used phone amongst our respondents - 2239.69 - our survey results are significantly lower. This may very well be due to the lower income levels of students than the general populous.

Another interesting finding is that environmentally conscious respondents are 14.3 % more prone to buy an already used mobile phone than someone who is not. This indicates that environmental values plays a decisive role for reuse behavior, as suggested by Barr et al. (2011) and that a value-action gap does not exist.

### 5.2 Discussion

The Swedish waste management system is reliant on consumers taking their WEEE to recycling stations which are not always located centrally in urban areas and therefore not necessarily convenient for consumers which the results from this study indicate. A topic of future research could focus on how geographical distances to these recycling stations predict the recycling behavior of consumers. A possible policy measure to increase collection rates of WEEE and mobile phones in particular could be to locate small WEEE collections at minor household waste recycling stations which are often more centrally located.

A policy measure intending to decrease storing behavior could possibly be to ask retailers to provide a service where consumers could opt to secure the information from their old mobile phones to a cloud service and then delete the information on the phone when purchasing a new one. Another retailer service could be to provide loan phones for consumer that have a current subscription service, which consumer could use in place of spare phones stored at home. Alternatively, such a service could also be provided by libraries or other public institutions.

In terms of reuse behavior of mobile phones, it was strongly linked to the quality and price of the product. A possible policy measure to provide a quality control of already used mobile phones could possibly reduce the uncertainty about purchasing the product for consumers and lead to an increased rate of reuse of mobile phones.

As our study focused on Swedish students and obtained a relatively small and homogenous sample, any future research about this topic would do well in obtaining a larger sample across the general population in order to more reliably infer results about the general Swedish consumer market. Another topic of interest would be to include further principles of Circular Economy, as per wider definitions of the concepts, for instance studies about consumer attitudes and behavior about repairing mobile phones. It could also be interesting to approach reuse behavior from the supply side of the production and sales of mobile phones, reviewing measures to reduce waste and design to increase life time and make phones more easily repairable.

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# 7. Appendix

## 7.1 Appendix A – Survey

Thank you for taking this survey, please circle your answers if there are multiple choices.

1. How old are you?

_____ Years

2. What is your gender?

- Female
- Male
- Other

3. What is your highest level of education? (Include any not yet completed level of education)

- Primary school
- High school.
- Vocational education.
- Short- or medium course higher education (e.g. Bachelor level).
- Long course higher education e.g. (master level and more).

4. How many mobile phones do you own in total? (Include phones you are not currently using)

- 0.
- 1
- 2
- 3
- 4
- 5
- More than 5. Please specify how many: _____ mobile phones

5. Have you had any other mobile phones before your current one?

- Yes.
- No.

6. Do you currently have a mobile phone subscription with a retailer?

- Yes
- No

7. What do you do with old and unused mobile phones?

- I keep them at home
- I give them away, for example to my children, friends or relatives
- I sell them
- I leave them at the store when buying a new one
- I take them to the recycling centre
- I dispose of them with mixed waste

8. If you keep one or more unused mobile phones at home, what is the reason that you still have it?

- It has personal information (e.g. pictures, messages) on it, which I would like to store or transfer one day.
- I keep it as a spare mobile phone in case my current mobile phone breaks.
- I intend to sell it but have not done it yet.
- I don't know what to do with it
- I don't know how to adequately dispose of it.
- I use it as a work phone.
- It is not convenient to recycle the mobile phone
- It is just not important, I have not gotten around to do it yet
- Other? Please comment

9. If you have recycled your old mobile phone(s), what was your reason to recycle the phone(s)? (Only answer if you have recycled your old phones)

- I try to make environmentally conscious decisions

- I felt it was the only adequate way to dispose it
- It was easy and accessible
- Other? Please comment

10. In your opinion, is it simple or troublesome to recycle a mobile phone?

- It is simple to recycle a mobile phone
- It is troublesome to recycle a mobile phone
- Neither simple nor troublesome to recycle a mobile phone
- I do not know how or where to recycle a mobile phone

11. How frequently do you change mobile phone?

- More often than one year
- 1–2 years
- 2–3 years
- Less frequently than above; please specify how long: _____ years

12. When you get your next mobile phone, how long do you believe that you will be able use that phone for?

- Less than a year
- 1–2 years
- 2–3 years
- 3-4 years
- Longer than 4 years; please specify how long: ____ years

13. What are the reasons for you to buy your next mobile phone? Please feel free to fill in several fields.

- My current mobile phone will be stolen.
- My current mobile phone will break.
- My current mobile phone is not working well enough (slow, cannot run programs, poor battery life, etc.).

- A new mobile phone has new features that my current mobile phone does not have
- I can get a new mobile phone from my parents, family, friends or job.
- There is a good price on a new mobile phone.
- There is a good price on a new subscription or my current subscription is too expensive.
- I just want a new mobile phone.
- Other? Please comment.

14. Would you be willing to buy an already used mobile phone?

- Yes
- No

15. If yes, what would be your prerequisites for buying an already used mobile phone? If you choose more than one, please, underline the most important option.

- The mobile phone is no more than one year old
- It has features that my current mobile phone does not have
- It is cheaper to buy a used mobile phone than a new one
- I know the last owner/ buy it at first hand
- It is in good condition
- I prefer the brand of the mobile phone
- Other, what?

16. What is the maximum price you would be willing to pay for a used mobile phone (max. SEK)?

_____ SEK

17. If you would not be willing to buy an old mobile phone, please, indicate why?

- Old mobile phones are not reliable
- Lower quality than purchasing a new mobile phone
- The features for old mobile phones are outdated
- It is easier to buy a new mobile phone
- No guarantee or warranty provided with the purchase

18. Do you consider yourself to be environmentally conscious?

- I am very environmentally conscious
- I am environmentally conscious
- I am somewhat environmentally conscious
- I am not particularly environmentally conscious
- I do not care at all

19. In your opinion, is recycling mobile phones important?

- Yes
- No

## 7.2 Appendix B – Variable view

**Recycle logit regression model**

$$Y = +\alpha + \hat{\beta}_1 X_1 + \hat{\beta}_2 X_2 + \hat{\beta}_3 X_3 \ldots + \hat{\beta}_{11} X_{11} + \hat{\beta}_{12} X_{12} + \mu$$

$Y$ = Willingness to Recycle (Coded: True Recycling)

$\hat{\beta}_1$ = Simple to Recycle (Coded: Simple2Rec)

$\hat{\beta}_2$ = Environmentally Conscious (Coded: Envcon)

$\hat{\beta}_3$ = Keeping old and unused mobile phones at home (Coded: MPathome)

$\hat{\beta}_4$ = Willingness to buy an already used mobile phone (Coded:WTBusedMP)

$\hat{\beta}_5$ = I don't know (Coded: I don't know)

$\hat{\beta}_6$ = Mobile phone will break (Coded: MPwillbreak)

$\hat{\beta}_7$ = Mobile phone will not work well enough (Coded: MPnotenough)

$\hat{\beta}_8$ = Previous Mobile Phone (Coded: PrevMP)

$\hat{\beta}_9$ = Keep my old mobile phone as spare mobile phone (Coded: MPasspare)

$\hat{\beta}_{10}$ = Gender (Coded Gender)

$\hat{\beta}_{11}$ = Age (Coded: Age)

$\hat{\beta}_{12}$ = Education level (Coded: EducLvl)

Willingness to Recycle: A dummy variable for the participants that found reasons for recycling their old mobile phones (question 9) and do not keep old mobile phones at home (question 7) are stated with `=1`. The reference group are the respondents that have not recycled their old mobile phones and are assigned with `=0'. This is the dependent variable for our recycling logit regression model.

Simple to Recycle: Dummy variable where respondents who have answered that 'It is simple to recycle a mobile phone' or 'Neither simple nor troublesome to recycle a mobile phone' are coded '=1', while other answers are coded '=0'. Values obtained from question 10.

Environmentally conscious: Dummy variable where respondents who has answered 'I am very environmentally conscious' or 'I am environmentally conscious' have been coded as '=1' and other answers are coded '=0'. The data is obtained from question 18 in the questionnaire.

Keeping old and unused mobile phones at home (dummy): Dummy variable for respondents who keep their old mobile phones at home (=1) and those that do not keep their old mobile phones at home (=0). This variable was created from the answers of question 7 in the survey.

Willingness to buy an already used mobile phone: A dummy variable for respondents that are willing to buy an already used mobile phone (=1) and those that are not willing to buy an already used phone (=0). The values were obtained from question 14 in the survey. This is the dependent variable for our reuse logit regression model.

I don't know: Participants that keep unused mobile phones at home because they do not know what to do with or how to adequately dispose of it (=1), while other answers are assigned with '0'. Values obtained from question 8.

Mobile Phone will Break: Dummy variable for respondents who expect that the reason to buy their next phone is since it will break are coded '=1' and respondents who has selected other answers are coded '=0'. Values obtained from question 13.

Mobile phone will not work well enough: Dummy variable for respondents who expect that the reason to buy their next phone is since it will not work well enough are coded '=1' and respondents who has selected other answers are coded '=0'. Values obtained from question 13.

Previous Mobile phone: Dummy variable for respondents who have owned a phone

prior to their current form. Data obtained from question 5 in the survey form.

Keep my old mobile phone as spare mobile phone: Dummy variable for respondents who answered that they kept their old and unused mobile phones as a spare mobile phone are coded '=1' and respondents who has selected other answers are coded '=0'. Values obtained from question 8.

Gender: Dummy variable for the reported gender of respondents. Female respondents have been assigned the value '=1', whereas men have been assigned the value '=0'. Values obtained from question 2 in the questionnaire.

Age: A continuous variable and the data is obtained from question 1 in the survey form.

Education level: Ordinal variable which ranges from 1-5 depending on the respondent's education level. The values are obtained from question 3 in the questionnaire.

**Reuse** (only variables not explained above are presented below):

$$Y = \alpha + \hat{\beta}_1 X_1 + \hat{\beta}_2 X_2 + \hat{\beta}_3 X_3 \ldots + \hat{\beta}_{10} X_{10} + \hat{\beta}_{11} X_{11} + \mu$$

$Y$ = Willingness to buy an already used mobile phone

$\hat{\beta}_1$ = Environmentally Conscious (Coded: Envcon)

$\hat{\beta}_2$ = No guarantee or Warranty (Coded: No guarantee)

$\hat{\beta}_3$ = Not reliable (Coded: Not reliable)

$\hat{\beta}_4$ = Lower Quality (Coded: Lower Quality)

$\hat{\beta}_5$ = Old Mobile Phone cheaper (Coded: OldMPcheaper)

$\hat{\beta}_6$ = Subscription (Coded: Subscription)

$\hat{\beta}_7$ = Used mobile phone in Good Condition (Coded: Good Condition)

$\hat{\beta}_8 =$ Willingness to pay for already used mobile phone (Coded: WTP of uses phone)

$\hat{\beta}_9 =$ Gender (Coded Gender)

$\hat{\beta}_{10} =$ Age (Coded: Age)

$\hat{\beta}_{11} =$ Education level (Coded: EducLvl)

Willingness to buy an already used mobile phone: A dummy variable for respondents that are willing to buy an already used mobile phone (=1) and those that are not willing to buy an already used phone (=0). The values were obtained from question 14 in the survey. This is the dependent variable for our reuse logit regression model.

No guarantee or Warranty: Dummy variable for the respondents that are not willing to buy an old mobile phone due to no guarantee (=1) and other answers reported equals with '0'. Values obtained from question 17.

Not reliable: Dummy variable for the respondents that are not willing to buy an old mobile phone because it is not reliable (=1) while other answers reported equals with '=0'. Values obtained from question 17.

Lower quality: Dummy variable for the participants which are not willing to buy an old mobile phone because it is of lower quality than purchasing a new phone are coded '=1' while other answers are represented with '=0'. Values obtained from question 17.

Old Mobile Phone cheaper: Dummy variable for participants which have answered that they are willing to buy a used mobile phone since it is cheaper than purchasing a new one have been coded '=1', while other answers equals with '=0'. Values obtained from question 15.

Subscription: The respondents that have a current subscription with a retailer are coded '=1' and those that do not have a subscription (=0). Values obtained from question 6.

Used mobile phone in Good Condition: Dummy variable for the respondents which have answered that a good condition of the mobile phone is a prerequisite for buying a used mobile phone are assigned '=1' and other answers are stated with '=0'. Values obtained from question 15.

Willingness to pay for already used mobile phone: Continuous variable where respondent state their willingness to pay for an old mobile phone in SEK. Two outliers at 10 000 SEK were removed from the dataset and values were obtained from question 16.

## 7.3 Appendix C – Collinearity tests

Table 5: Collinearity matrix for the recycling model

| Variable | $\hat{\beta}_1$ | $\hat{\beta}_2$ | $\hat{\beta}_3$ | $\hat{\beta}_4$ | $\hat{\beta}_5$ | $\hat{\beta}_6$ | $\hat{\beta}_7$ | $\hat{\beta}_8$ | $\hat{\beta}_9$ | $\hat{\beta}_{10}$ | $\hat{\beta}_{11}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $\hat{\beta}_1$ | 1.000 | | | | | | | | | | |
| $\hat{\beta}_2$ | 0.1096 | 1.000 | | | | | | | | | |
| $\hat{\beta}_3$ | 0.0167 | 0.3178 | 1.000 | | | | | | | | |
| $\hat{\beta}_4$ | −0.1464 | 0.3092 | 0.3040 | 1.0000 | | | | | | | |
| $\hat{\beta}_5$ | 0.2490 | −.1641 | -.2626 | −.2512 | 1.000 | | | | | | |
| $\hat{\beta}_6$ | −.0725 | −.0007 | -.0773 | −.0563 | -.0480 | 1.000 | | | | | |
| $\hat{\beta}_7$ | 0.1179 | −.2400 | -.2436 | −.2826 | .3448 | .0282 | 1.000 | | | | |
| $\hat{\beta}_8$ | 0.0759 | −.2152 | -.1802 | −.0258 | -.0067 | .0396 | 0.1610 | 1.0000 | | | |
| $\hat{\beta}_9$ | 0.0994 | −.0775 | -.2252 | . 0192 | .0678 | -.1266 | 0.2200 | -0.0159 | 1.0000 | | |
| $\hat{\beta}_{10}$ | 0.1390 | −.0998 | -.1208 | −.2136 | -.0126 | .0278 | -.0738 | -0.2026 | .1552 | 1.0000 | |
| $\hat{\beta}_{11}$ | −0.0120 | −.1638 | 0.153 | 0.1047 | .1038 | .1052 | 0.0066 | -0.1658 | -.0047 | 0.1907 | 1.000 |

Table 6: Collinearity matrix for the Reuse regression model

| Variable | $\hat{\beta}_1$ | $\hat{\beta}_2$ | $\hat{\beta}_3$ | $\hat{\beta}_4$ | $\hat{\beta}_5$ | $\hat{\beta}_6$ | $\hat{\beta}_7$ | $\hat{\beta}_8$ | $\hat{\beta}_9$ | $\hat{\beta}_{10}$ | $\hat{\beta}_{11}$ | $\hat{\beta}_{12}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $\hat{\beta}_1$ | 1.000 | | | | | | | | | | | |
| $\hat{\beta}_2$ | 0.0837 | 1.000 | | | | | | | | | | |
| $\hat{\beta}_3$ | 0.0587 | −0.0398 | 1.000 | | | | | | | | | |
| $\hat{\beta}_4$ | −0.0248 | 0.3002 | -0.019 | 1.0000 | | | | | | | | |
| $\hat{\beta}_5$ | -0.2932 | 0.1847 | 0.298 | 0.0948 | 1.000 | | | | | | | |
| $\hat{\beta}_6$ | −.0.0308 | 0.0228 | -0.055 | 0.0372 | -0.0761 | 1.000 | | | | | | |
| $\hat{\beta}_7$ | 0.0122 | −0.1075 | -0.017 | −0.0691 | -0.0174 | -0.2151 | 1.000 | | | | | |
| $\hat{\beta}_8$ | 0.1003 | −0.0212 | -0.083 | −0.1358 | -0.0889 | -0.1053 | 0.0385 | 1.0000 | | | | |
| $\hat{\beta}_9$ | 0.1792 | −0.1452 | 0.129 | 0.0739 | -0.2323 | 0.0328 | 0.2434 | 0.0050 | 1.0000 | | | |
| $\hat{\beta}_{10}$ | −0.0824 | 0.0994 | 0.005 | 0.1327 | 0.2091 | 0.2840 | -0.147 | -0.0905 | 0.055 | 1.0000 | | |
| $\hat{\beta}_{11}$ | −0.0026 | 0.1390 | 0.013 | 0.0631 | 0.1032 | 0.0125 | -0.014 | -0.0020 | 0.021 | 0.1552 | 1.000 | |
| $\hat{\beta}_{12}$ | -0.1088 | -0.0120 | 0.028 | 0.0577 | 0.1696 | -0.1359 | 0.040 | -0.0674 | 0.138 | -0.005 | 0.1907 | 1.0000 |