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The Circular Economy – Evaluating value propositions by investigating consumer preferences

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Abstract

This master's thesis investigates the Circular Economy (CE), thus the transformation from a linear model of resource consumption to a circular one from a consumer and market perspective. It contributes to the current state of art by providing a literature review on consumer acceptance of the CE. Furthermore, this master's thesis uses Choice-based Conjoint (CBC) analysis for consumer preference elicitation in the context of the CE. More particularly, using smartphones as product of investigation, this master's thesis examines the market acceptance of two types of circular smartphones (remanufactured/refurbished smartphones and smartphones made of recycled materials) in comparison to conventional ones. It further investigates different product features to derive consumers' willingness-to-pay (WTP). Results show that overall, circular smartphones are highly accepted by the market and that specific product characteristics like warranty and environmental benefits affect the decision-makers' WTP. Deriving from the research's results, new value propositions for a CE and managerial implications are outlined, paving the way for a practical transformation towards a CE and for further research in this regard.

Abstrakt

Diese Masterarbeit erforscht die Akzeptanz der ‚Kreislaufwirtschaft' – im genaueren, die Transformation von linearem hin zu nachhaltigem, zirkulären Ressourcenkonsum aus der Sicht von Konsumenten. Die folgende Masterarbeit leistet einen Beitrag zur aktuellen Forschung, indem eine Literaturübersicht zur Konsumentenakzeptanz der Kreislaufwirtschaft zur Verfügung gestellt wird. Außerdem wurde eine Choice-based Conjoint (CBC) Analyse durchgeführt, welche die Präferenzen der Entscheidungsträger am Beispiel von Smartphones erforscht. Insbesondere wird die Akzeptanz zweier zirkulärer Smartphones (remanufactured/refurbished und recycled) im Vergleich zu herkömmlichen Smartphones untersucht. Verschiedene Produktcharackteristiken und deren Kombination wurden in der CBC Analyse erforscht, um dann Aussagen über die WTP (Zahlungsbereitschaft) für diese Smartphones treffen zu können. Die Ergebnisse zeigen, dass zirkuläre Smartphones generell auf dem Markt akzeptiert sind und dass Eigenschaften wie Garantie und Nachhaltigkeit die WTP der Konsumenten beeinflussen. Diese Ergebnisse lassen auf neue Wertbeiträge für eine Kreislaufwirtschaft schließen und Manager Implikationen erörtern, welche den Weg für eine praktische Transformation hin zur Kreislaufwirtschaft, sowie für weitere Forschung in diesem Bereich, ebnen.

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Abbreviations

CE	Circular Economy
WTP	Willingness-to-pay
GHG	Green-house-gas
OECD	Organization for Economic Cooperation and Development
CBC	Choice-based Conjoint
HB	Hierarchical Bayes

1. Introduction

"Should the global population reach 9.6 billion by 2050, the equivalent of almost three planets could be required to provide the natural resources needed to sustain current lifestyles."

(United Nations, 2020)

1.1 Rethinking Human Behavior Patterns

The above UN statement reveals different relevant future societal challenges and calls for overall structural change. According to the United Nations, population developments, finite resource availabilities and human behavior patterns will eventually result in excessive demands on the earth's ecosystem capacities. Therefore, in order to keep our planet a place to live for humankind, behavioral change and a transformation of lifestyles is required (United Nations, 2020). But how can society tackle such far-reaching changes?

As a matter of fact, change is already happening right now, has always accompanied humankind and will in the future. One of the biggest examples for current change is the technological revolution, which is the transformation from an industrial society to a technological, data-driven production and workforce. This change is continuously affecting us in all our day-to-day activities (Harteis, 2018; National Research Council, 1988).

Experts further show that crisis and external influences enable change towards the way people think and behave and recommend e.g. for managers to use crisis to sustainably foster it (Kraaijenbrink, 2020). The most recent example, triggering societal as well as consumer change, is the global Covid-19 pandemic hitting the international community in 2020. It is quite likely that this pandemic will shape our society in the long-run and will have a sustainable impact on peoples' way of thinking and consuming. Governmental restrictions on for instance travelling have already impacted everyday behaviors, enabling worldwide daily CO2 emissions to decrease by 17% by April 2020 relatively to developments in the previous year (Le Quéré et al., 2020). These examples are very ground-breaking in showing that change is taking place right now and that often crisis is a good starting point to change behavioral patterns and habitudes. Hence, tackling the above-mentioned global crisis – excessive resource consumption - researchers have rethought behavioral patterns and business operations of the modern western society, evaluating the consequences and coming up with alternatives to recent best practices. In this master's thesis the transformation from the original linear way of resource consumption and economic activity towards a new approach will be investigated: The Circular Economy (CE). Being defined as an economy that is "restorative by intention and design" (Ellen

MacArthur Foundation, 2013, p. 14), the CE could be a way to decrease resource consumption in the future. For example, according to the International Research Panel, improved recycling, as one crucial approach of the CE, would be able to reduce green-house-gas (GHG) emissions by almost one fifth by the year 2050 in the G7 states (IRP, 2020). This transformation would need to involve a variety of stakeholders to work together in order to be successful. As research has up until now mostly focused on the business and political perspective, this master's thesis contributes to the current state of art by posing the focus on the consumer side of a CE. Market demand and trends might play a pivotal role in pushing the change forward to a more sustainable economy.

1.2 Aim and Structure of the Thesis

The aim of this thesis is to investigate the CE concept from a consumer perspective. More particularly, the objective is to provide a valuable contribution to current literature, answering the question of whether a CE would be accepted by the market. In other words, in this thesis the focus will be set on researching value propositions for a new CE by investigating under what circumstances consumers prefer products and services that are of circular nature over conventional ones. By choosing one relevant product – smartphones – and contrasting traditional with new circular approaches, consumer preferences can explicitly be evaluated. More particularly, by using conjoint analysis, relevant circular product features will be distilled in order to draw conclusions on product design and systematic approaches towards a CE transformation and to derive valuable managerial implications.

The thesis is structured as follows. The first part of the theoretical background is going to describe the CE concept from a theoretical perspective, starting with the depiction of reasons for the obsolescence of the linear economic system of resource consumption and continuing with the definitions for a new CE concept. The second part of Chapter 2 offers a CE perspective from the business angle, outlining relevant business models and transformation opportunities. The thesis continues by reviewing and classifying relevant consumer literature and by developing hypotheses for investigation. In the following chapter, the methodology used to conduct the study is described by a stepwise explanation of the set-up of the survey, finishing with data collection. Next, results of the study are presented and analyzed in chapter 4. After summarizing and discussing outcomes in the first part of chapter 5, the second part is dedicated to the application of research results to theory as well as to derivation of managerial implications. Last, limitations of this thesis' research as well as recommendations for future investigations are outlined.

2. Theoretical Background

The Theoretical Background of this thesis is divided into three parts. The first subchapter outlines the CE concept from a theoretical perspective. The second one identifies concrete business models and suitable products in order to provide guidance for a practical implementation of the CE, hence provides a business perspective towards the CE. The third and last subchapter of the theoretical background concludes with the consumer perspective on the CE, providing a literature review on consumer acceptance towards circular products and services and paves the way for hypothesis development for the thesis.

2.1 The Circular Economy Concept – Theoretical Approach

Chapter 2.1 focuses on theory behind the CE by providing relevant argumentation on the obsolescence of the linear model of research consumption and by additionally defining the CE concept and its opportunities in terms of new value creation relatively to the 'old' economic concept.

2.1.1 Original Resource Consumption Patterns have come to an end - Phasing out the Linear Economy

The Ellen MacArthur Foundation posits that until today the industrial economy is dominated by a linear model of resource consumption, which is also called 'take-make-dispose' model. It is very helpful in order to understand the way economic actors have been consuming resources within the last century. Linear resource consumption begins with the companies' extraction of materials. After extraction, companies apply energy and/or labor to the resource in order to manufacture products. Finally, consumers buy the products, use them and throw them away after they are of no longer service to them. Pursuing this way of consumption as a predominant global best practice, the reusage of materials and resources has not been a major target in the recent century and rather, the cheap and wasteful turnover of resources has been a driving force in order to achieve economic growth (Ellen MacArthur Foundation, 2013).

In other words, in the last hundred years, companies and consumers have been dealing with resources in a very wasteful manner, extracting new resources rather than considering the reuse of 'old' materials. And this, in spite of the fact that the further pursuit of this consumption model has implied tremendous downsides for the world population. This becomes especially important

when considering that global population will be anticipated to increase to approx. 9.7 billion by 2050 (United Nations, 2019b). Hence, this model is obsolete for a variety of reasons:

Loss of resources and resulting waste creation. The linear consumption of resources creates a massive amount of lost resources. First, materials are lost during the manufacturing process, when they are not incorporated in the manufactured product itself but are being tossed since they only serve the process and not the product per se.
Second, resources are lost when products are discarded at the end of their lifecycle. Only less than half of all virgin materials incurred in 2010, have reentered the economic system through recycling, reusing or composting. That is, around 60% of all resources extracted have been lost, thus have been transferred into waste (Ellen MacArthur Foundation, 2013). For specific resource groups like rare earth materials (e.g. Lithium) numbers are even more alarming: only 1% is currently recycled of these types of resources (UNEP, 2011). And, even the materials that have promising recycling rates, such as paper or PET loose 30-75% of the material value in the first recycling circle (McKinsey & Company, 2015). Third, energy resources are extremely relevant in a linear economic system and these are similarly lost when products for whose production the energy has been used, are being discarded (Ellen MacArthur Foundation, 2013). When talking about resource losses it implicates that at the same time waste is being created. According to a World Bank report, global waste is going to increase by 70% by 2050 if no measures against conventional resource consumption are taken. Interestingly, of all solid global waste, plastic will account for 12% (Kaza, Yao, Bhada-Tata & van Woerden, 2018).

Impact on Climate Change /Environmental damage. The linear economic model of resource consumption has led to an extensive increase in material and resource use over the last decades which is impacting and will further affect the environment in the future. According to the International Resource Panel of the United Nations Environment Program (UNEP) material production contributes extensively to climate change. More particularly, material manufacturing in 2015 has generated one fourth of the global GHG emissions. Whereas in 1995 material production emitted only 5 Gigatons of GHG emissions, in 2015 this number has already more than doubled with 11.5 Gigatons (IRP, 2020).
These numbers, provided by the International Resource Panel only include resources such as biomass, cement, fossil fuels, metals, non-metallic minerals, plastics and wood. In the 'OECD Global Material Resources Outlook to 2060', the OECD additionally considers water, energy and land when calculating the total impact on GHG emissions. Hence, adding the impact of

these resources shows that material management activities account for around two-thirds of all GHG emissions. The OECD projected these numbers to future developments. Consequently, they anticipate global GHG emissions of 75 Gigatons CO2-eq.[1] by 2060 which will mean 50 Gigatons CO2-eq. GHG emissions, resulting from resource manufacturing and use only. These forecasts would mean for the global community not to be able to reach the goals of the Paris agreement of keeping global warming below two degrees Celsius (OECD, 2019).

Risks for companies. The linear economic model of resource consumption has been a successful way for companies to boost their growth over the last century. This is especially due to the fact that resource prices have been relatively low in comparison to sustainable resources such as for instance labor. Hence, the growth and success of businesses has been majorly depending on cheap non-sustainable commodities. That can also be seen when analyzing the relationship between GDP and commodity prices *(*see *Figure 1).* According to an analysis of Accenture, using data of the World Bank, in fact until the 2000s, GDP and commodity prices were inversely related. However, at the turn of the century, this relation changed, showing that economic growth does no longer depend on cheap commodity prices and hence, that it becomes rather unattractive to be dependent on them (Accenture strategy, 2014).

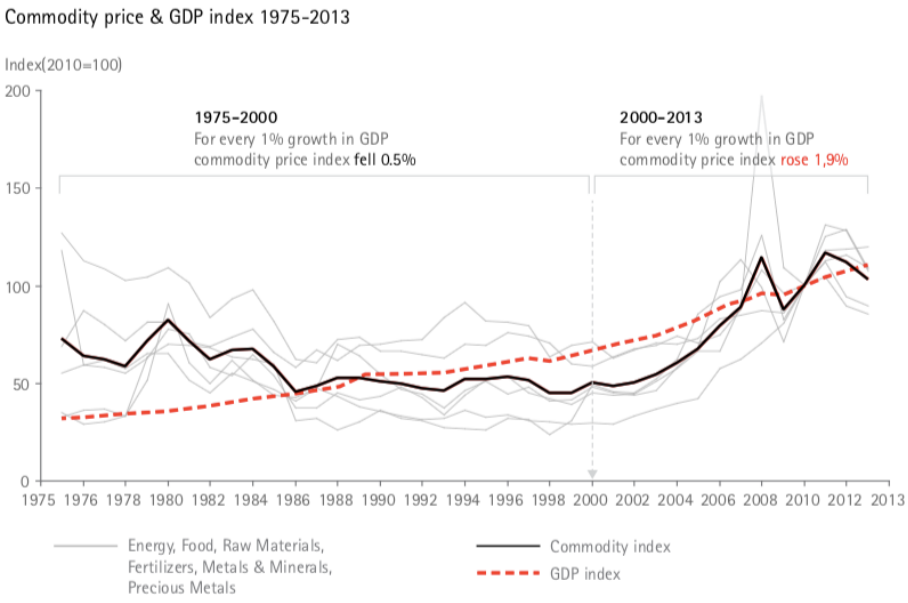

Figure 1 Commodity Price and GDP (Accenture Strategy, 2014)

[1] „A […] CO2-eq is a metric measure used to compare the emissions from various greenhouse gases on the basis of their global-warming potential (GWP), by converting amounts of other gases to the equivalent amount of carbon dioxide with the same global warming potential" *(Glossary: Carbon Dioxide Equivalent – Statistics Explained, n.d.)*

Also, the UN Sustainable Development Goals Report 2019 confirms that in many countries the target of decoupling growth from resource use has had success. Still this needs to be looked at with caution. A decrease in material intensity can definitely be seen in some developed countries, however, the fact that these countries often depend on resources available in developing countries implies a rather stagnating worldwide material intensity (United Nations, 2019a).

Apart from the opportunity for companies to achieve growth without depending on non-renewable resources, in addition, sticking to the linear model exposes them to diverse risks. Extensive consumption, especially due to population explosion will eventually lead to a scarcity of resources and to a point at that world demand cannot be serviced (United Nations, 2019a). Consequently, deteriorating supply is going to increase resource prices in the long run which will be a major cost risk for companies depending on them (Accenture strategy, 2014).

Other than cost increases and supply shortages, also price volatility will become a substantial threat for companies. *Figure 1* shows that commodity prices have been subject to extensive volatility in the last century. Firms, depending on resource prices are confronted with uncertainties if prices are highly volatile and cannot be predicted easily. As a result, companies are not able to forecast costs and profits accurately, which exposes them to further tremendous risks (Ellen MacArthur Foundation, 2013).

Furthermore, consumer demand for more sustainable economic action is going to push businesses into the direction of acting sustainably in order to avoid consumer shunning (Euromonitor Research, 2017). According to the 'Zukunftsinstitut's' future analysis, neo-ecology - the awareness of environmental matters as a global culture - is one of the most important megatrends of our time and will impact society values, consumer purchase decisions and business strategies towards a more sustainable behavior (Gatterer, n.d.). A study of the consulting firm McKinsey & Company has revealed that sustainability strategy implementation among businesses has increased extensively within the last years. For example, whereas in 2014 only half of the respondents said they would have some form of governance in this context, in 2017 this number increased to 70% (Bové, D'Herde & Swartz, 2017). Hence, out of common sense and in order to meet consumer expectations, companies will have to cope more and more with sustainability issues. If not, the risk of intangible assets being negatively evaluated, increases for businesses (Accenture strategy, 2014).

2.1.2 The Circular Economy as a new concept of Value Creation

So how can we achieve a slowdown of global warming, a decrease in resource losses i.e. waste creation and a reduction of risks for companies? A concept that has been evaluated by different researchers and experts may be able to supersede the linear economic model of resource consumption. This model is the so-called Circular Economy (CE).

Definitions by different schools of thought. The modern CE concept is rooted in a number of different branches of research like the Cradle to Cradle movement (McDonough & Braungart, 2002 as cited by McDonough, 2020), Looped and Performance Economy (W. Stahel, 2010), Regenerative Design (Lyle, 1996) and Industrial Ecology (Graedel & Allenby, 2003). These schools of thought have set milestones that guide to approach a regenerative economic system and ecologically sustainable production processes.

Based on these research branches, the Ellen Mac Arthur Foundation has primarily defined the modern concept of a CE and is since pioneering its current understanding.

Per definition of the Ellen MacArthur Foundation the CE "denotes an industrial economy that is restorative by intention and design" (Ellen MacArthur Foundation, 2013, p. 14). That means, in a CE, growth is no longer dependent on the extraction and use of scarce resources. Instead, in a CE, the attention is directed towards resources, that are infinitely available - like for instance labor. Naturally limited resources, on the contrary, are of minor importance in this type of economic system (Ellen MacArthur Foundation, 2013).

The decoupling of dependencies can be achieved through the implementation of new technology as well as newly developed business models. The general objective of the CE is no longer to boost efficiency and scale in order to reduce cost, but instead create products and services that last, are highly qualitative and always available. Therefore, firms are supposed to rethink and redesign their creation and offering of products and services, basing it on reuse, dematerialization, product to service transformation, remanufacturing and sharing. Especially manufacturing firms that have material costs averaging around 40%, are able to save extensively when adapting their business value creation and hence are more profitable in a CE (Accenture strategy, 2014).

Stahel (2019) emphasizes the counter verse objectives of the linear and the CE in his book "The Circular Economy: A user's guide". He states that in a CE the maintenance of value is important, whereas in a linear economy, the focus lies in the creation of new value. Furthermore, the author emphasizes that it is the efficient usage of a product, that is relevant in a CE whereas in a linear one it is the efficient production that creates the value (Stahel, 2019).

EU as a driver of the CE concept. The concept of the CE has already successfully entered supranational political implementation. The European Union as a worldwide pioneer in terms of environmental policies, has adopted its first Environmental Action Program (EAP) in 1973 followed by six further Action Plans covering measures up to the year 2020 (Benson, Gravey & Jordan, 2016). In 2014, the EU made its first steps towards a CE, issuing a European Commission Communication, called "Towards a Circular Economy – a zero waste programme for Europe" (COM (2014) 398 final, 2014). In 2015 a CE Package followed, incorporating directives as well as legislative proposals, that should lead the EU to a more sustainable, closed-loop, CE (COM (2015) 614 final, 2015). Most recently, on March 11, 2020, the European Commission again published a communication, called "A new CE Action Plan - For a cleaner and more competitive Europe" (COM (2020) 98 final, 2020). This final Action plan was incorporated into the European Green deal which is targeting a CO2 neutral European Union by 2050 (COM (2019) 640 final, 2019).

Principles of a Circular Economy. A number of researchers rely on the very generic 3 Rs 'Reduce, Reuse, Recycle' as main principles of the CE and as the three golden rules for its implementation (e.g. Lieder, Asif, Rashid, Mihelič & Kotnik, 2018; Wang, Che, Fan & Gu 2014; Wu, Shi, Xia & Zu, 2014). A second group of researchers rather makes use of sustainable design strategies as official CE principles (Accenture strategy, 2014; Bocken, de Pauw, Bakker & van de Grinten, 2016; Ellen MacArthur Foundation, 2013; McDonough & Braungart as cited in 2002; Prieto-Sandoval, Jaca & Ormazabal, 2018; Stahel, 2010). These strategies or principles are describing in a detailed manner how products and services need to be designed to contribute to a CE. Overall consensus on the naming of these strategies is not yet reached (Prieto-Sandoval et al., 2018).

This thesis will provide an overview of the sustainable design strategies or CE principles, relying on the naming of Accenture Strategy and incorporating other researchers' perspectives. Hence, in this thesis, the four principles of a CE are named: 'linked value chains', 'long life cycles', 'lasting resources' and 'liquid markets' (Accenture strategy, 2014). The Ellen MacArthur foundation is also offering an overview on CE principles, visualized in *Figure 2* (Ellen MacArthur Foundation, 2013).

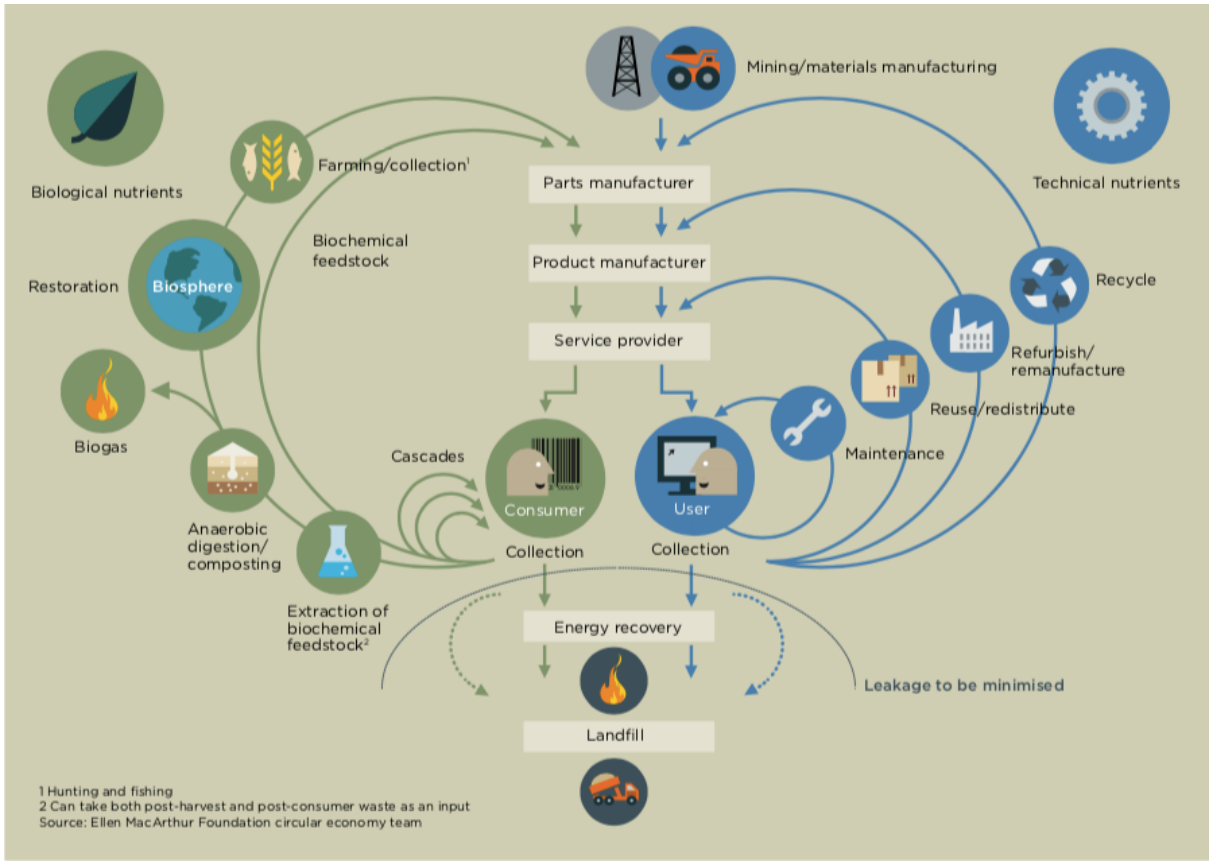

Figure 2 The CE Visualization (Ellen MacArthur Foundation, 2013)

Principle 1: Linked value chains. "Design out waste" is the guiding principle or design strategy of a CE. That means, products need to be manufactured and designed such that there is no waste created throughout the supply chain. For durables (i.e. technical nutrients), reuse and disassembly have to be boosted in order to avoid waste. When it comes to biological products, these need to be natural, hence not harmful for the environment when composted, so that they are part of the economic cycle without presenting materials that contaminate the environment (Ellen MacArthur Foundation, 2013). Designing out waste can be achieved by the linkage of different supply chains, thus by closing loops. The residual resources of one supply chain can be used as input for another, so that no waste is created (Bocken et al., 2016; Ellen MacArthur Foundation, 2013).According to Accenture, these linked value chains make up to 20% of the total value a CE could create (Accenture strategy, 2014).

Principle 2: Long life cycles. A second principle of the CE is the concept of long product life cycles. That means, product life cycles need to be extended, such that a bigger amount of demand can be satisfied and the maximum utility is captured (Accenture strategy, 2014; Bocken et al., 2016; Stahel, 2019). Again, consumable and durable products need to be looked at

separately *(see Figure 2).* Consumables in a CE need to be made of biological components that can be repatriated into the biosphere after consumption. Durable goods need to be designed in a way that disassembly, reuse, refurbishment as well as longevity through service is possible and achievable. Hence, these products need to be designed for reuse from the beginning on (Accenture strategy, 2014; Bocken et al., 2016; Ellen MacArthur Foundation, 2013). The realization of long life cycles will be contributing to the total value of the CE by approx. 30% (Accenture strategy, 2014).

Also, the 'new CE Action Plan', issued by the European Commission, includes the long-life cycle principle in its communication. This action plan implies that products should be improved with regard to their resource efficiency, their recycled material components and their environmental footprints. The Action plan suggests prohibitions to be made on destroying unsold durable goods and rewards to incentivize producers to create more sustainably performing products. In this package, also digitalization and transformation of products into services is targeted. Products as services shift the responsibility from the consumer to the producer. If the producer is the owner of the product, hence only offers a service, it is automatically in the company's interest to enhance longevity (COM (2020) 98 final, 2020). In regards of consumable goods, the Commission did not make very detailed statements on how they can be repatriated into the biosphere after consumption, hence what exact measures are taken to ensure circularity. The problems of food waste as well as the water waste problem are however mentioned (COM (2020) 98 final, 2020).

Principle 3: Lasting resources. In a CE energy should be of a renewable nature (Ellen MacArthur Foundation, 2013). It is necessary to create an economy, which is independent of scarce resources in order to minimize risks for companies. According to Accenture, the transition towards renewable energy and biochemicals would account for 40% of the total value created by a CE (Accenture strategy, 2014).

Principle 4: Liquid markets. A fourth principle of the CE are liquid markets which are necessary to enable the dynamic utilization of products. These are given by a high amount of accessibility and transferability between users and account for 10% of the total value created by a CE (Accenture strategy, 2014).

Value creation in a CE. In comparison to the linear economic model, value creation in a CE is sourced in a new manner. The previously mentioned principles enable four sources of value creation according to the Ellen MacArthur Foundation, namely 'the power of the inner cycle', 'the power of circling longer', 'the power of cascaded use' and the 'power of pure cycles' (Ellen MacArthur Foundation, 2013).

First, the power of the inner cycle (Ellen MacArthur Foundation, 2013) *(Figure 3)* or otherwise named 'narrowing resource loops' (Bocken et al., 2016) means, the tighter the cycles in a CE, the more costs and resources like energy, labor or materials can be saved. For example, looking at the technical cycle in *Figure 2,* recycling (depicted as a larger cycle) would incur much higher costs and resource intensity than maintenance (depicted as a smaller cycle). Energy and labor costs are typically extensively lower for maintenance or repair of a product relatively to the costs incurred when recycling the same product (Ellen MacArthur Foundation, 2013).

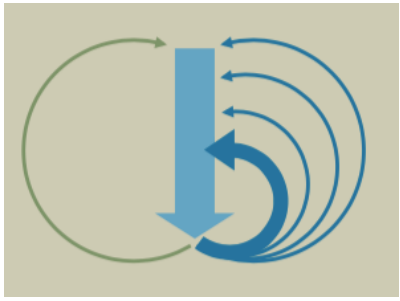

Figure 3 Power of the Inner Cycle (Ellen MacArthur Foundation, 2013)

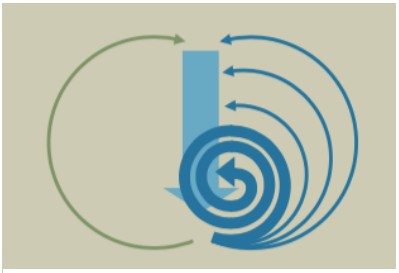

Figure 4 Power of Circling Longer (Ellen MacArthur Foundation, 2013)

Second, value creation is addressed by 'prolonging cycles' (Ellen MacArthur Foundation, 2013) or in other words by 'slowing resource loops' (Bocken et al., 2016). That is, the longer a product is used, the more value will be created in a CE. Further, it can be achieved by ensuring a number of consecutive cycles. For example, instead of refurbishing a smartphone once, it could be refurbished multiple times.

Third, cascaded use is a source of value creation in the CE. Instead of using the same materials or products longer or refurbish them multiple times, cascaded use implies crossing value chains. The value of the 'waste-resources' of a product are used to produce another product. Value is created due to the lower marginal material, labor and energy cost of the 'used material' relatively to the virgin material (Ellen MacArthur Foundation, 2013).

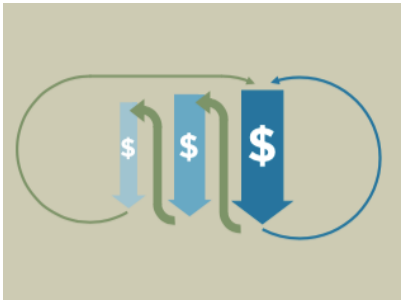

Figure 5 Power of Cascaded Use (Ellen MacArthur Foundation, 2013)

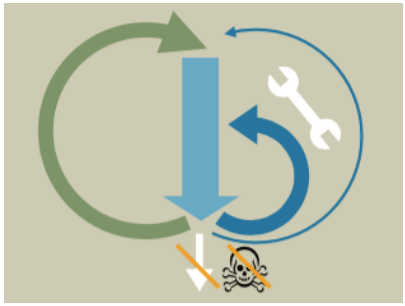

Figure 6 Power of Pure non-toxic Materials (Ellen MacArthur Foundation, 2013)

Power of pure, non-toxic materials is a last way of creating value in a CE, however a very important one. Quality and purity of products and materials should be ensured in order to avoid that after consumption, cycles cannot be guaranteed due to mixtures of materials which might be inseparable. Further, the absence of toxic materials in a CE is creating value since materials can be reused safely (Ellen MacArthur Foundation, 2013).

Promising effects of a CE. Deriving from the single sources of value creation, the following part will outline predictions on the positive impact a transformation from the linear to the CE could have, overall.

Different organization have tried to monetize the CE, using specific scenarios and scopes. For example, estimations of the International Resource Panel predict that improved recycling alone would be able to reduce GHG emissions by almost one fifth by the year 2050 in the G7 states (IRP, 2020).

According to a study of McKinsey & Company, by moving to a CE, Europe would be able to reduce food, mobility and built-environment costs by €1.8 trillion (-25%) by 2030. Approximately half of the cost savings would attribute to the usage of disruptive technologies and business models which increase resource productivity (McKinsey & Company, 2015).

Further, the Ellen MacArthur foundation calculated the monetary and systematical benefit of a transformation from the linear to the CE, outlining the benefit for economies, companies and consumers. Their very optimistic transformation scenario is based on a situation where reverse technologies are entirely developed, customer acceptance for a circular setting is given, legal frameworks are established and collaboration among actors is ensured. Further, take-back programs are incorporated into supply-chains and 5-to-10 percent point tighter loops (power of the inner cycle, *Figure 3*) are hypothesized (Ellen MacArthur Foundation, 2013).

For this scenario economies are expected to benefit in a number of ways. First, the approximate magnitude of material costs saving in the European Union is estimated to amount to around USD 600 billion. Furthermore, economies would benefit as a consequence of reduction in volatility and supply shortages risk. Even though future demand for resources would increase, due to population growth, the Circular Economic System would be able to diminish the need for resource extraction (due to business model transformation) which in turn, would reduce price volatility and supply shortages. Additionally, the creation of a user-focused economic

system would push forward innovation, employment and capital productivity. Another advantage of the circular system are reduced externalities such as for example GHG emissions or water. Since resource extraction would be minimized, due to reuse of materials, also externalities would decline (Ellen MacArthur Foundation, 2013).

Apart from the fact that economies as a whole can benefit from a transformation to a circular system, also companies are able to do so. Cost savings for materials would boost profits and a higher focus on quality would diminish warranty risks in a circular setting. Additionally, consumers would be users instead of owners, having more influence on product design and therefore, being more loyal. Further, in a CE, companies are able to manage shorter product lifecycles more easily, by reducing the complexity of their products and at the same time by adding on extras such as software or extension devices as customized parts (Ellen MacArthur Foundation, 2013).

Last, consumers are benefitting from a CE in different ways. Due to longer product lifecycles, quality improvements and shifts of ownership to the producer, overall ownership costs decrease for customers. Further, leasing contracts would be customized, which offers consumers a greater choice and convenience and other than that, products having more than one function will be the new normal. Of course, all economic actors would benefit from overcoming the environmental damage as well as the costs that are connected with it (Ellen MacArthur Foundation, 2013).

While up until now, the opportunities of the CE have been majorly investigated by politicians, businesses and consultants, the scientific perspective is less explored. However, it is highly necessary to expand the perspective towards the CE to all angles. Also, it is necessary to disperse the concept from bottom-up in order to reach acceptance (Korhonen, Honkasalo & Seppälä, 2018; Stahel, 2016). Additionally, according to Stahel (2016) the rather slow implementation of CE practices today is owed to the fear of change and innovation which in this regard means complete structural reorientation. More particularly, all actors in the economy would have to shift their view from the belief that resources need to be consumed in order to increase GDP towards a view where resources need to be preserved in order to achieve human flourishing and prosperity.

2.2 The Circular Economy Concept – A business perspective

Having explained the theoretical concept of the Circular Economy, this chapter focuses on the practical implementation and hence, summarizes how businesses can incorporate the CE into their strategy. Further, some examples for business transformation opportunities in terms of products and services are given.

2.2.1 Innovative Business models enabling the Establishment of a Circular Economy

How can companies practically implement the CE into their business strategy? Based on the CE concept, businesses might incorporate the CE in different ways. First of all, it is necessary to mention that researchers classify circular business models differently (e.g. Accenture strategy, 2014; Ellen MacArthur Foundation, 2013; Lewandowski, 2016; Stahel, 2019). In order to be really clear in terms of terminology distinction, this master's thesis is based entirely on the classification of Accenture strategy (2014), who distinguish five circular business models and subcategorize them again according to distinct business approaches (see *Figure 7*). By founding or transforming businesses according to the suggested models, a practical implementation of the CE can be achieved. *Figure 7* shows the five circular business models in a graphical manner.

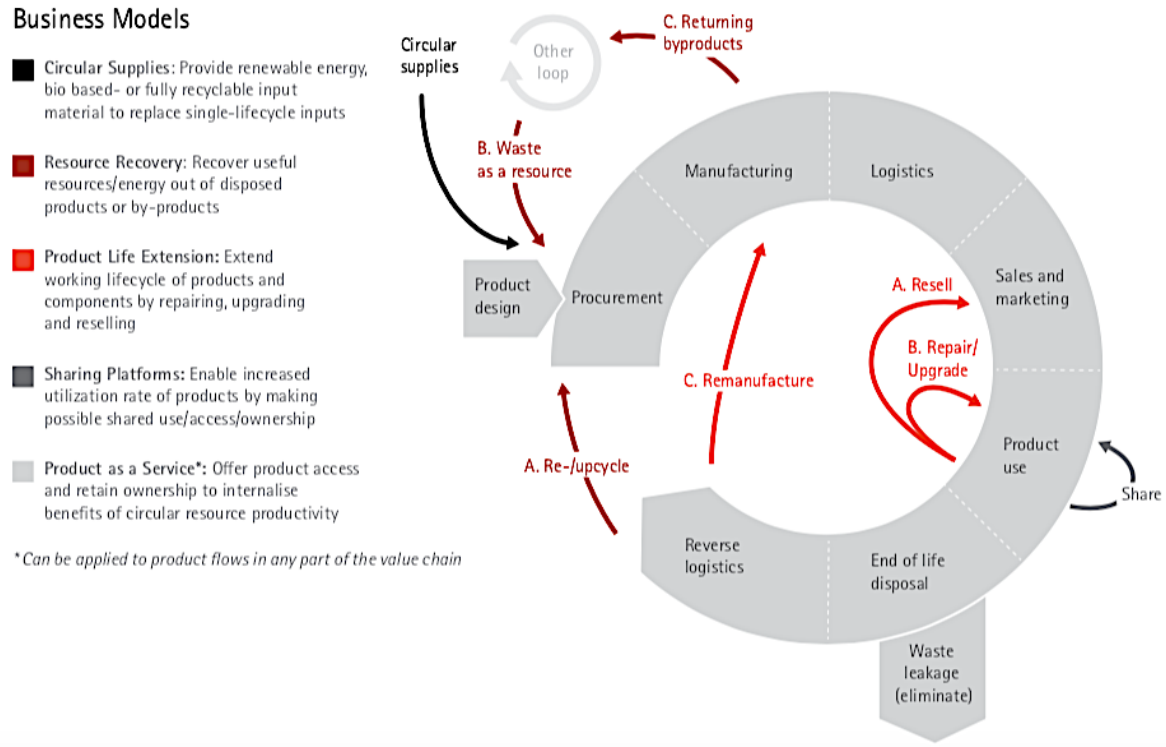

Figure 7 The five Circular Business Models (Accenture Strategy, 2014)

First, there is the **Circular Supplies** Business model. Its approach towards a CE is the supply of renewable resources instead of limited ones. That means, businesses who are nowadays the supplier of virgin resources or of materials whose production processes are subject to high CO2 emissions, should transform towards the supply of reusable resources, by substituting the old, wasteful ones (Accenture strategy, 2014). One example is the business transformation of DSM. Being coal-mining company at its origin, it has managed to restructure their business strategy towards a fully sustainable one, producing bio-fuel as one of their core business lines (Royal DSM, 2018).

Second, the **Resource Recovery** business model indicates that firms should recover resources and materials after utilizing them. More particularly, this is directed towards firms, who create a high number of waste or byproducts while manufacturing. These firms are urged to sustain the value, by either using waste and byproducts for the creation of other production processes (loops) (*Figure 7*, Resource Recovery B&C.) or by up- or recycle materials to use them for the original production process (*Figure 7*, Resource Recovery A). For example, a retailer could generate energy out of the food-waste, incurred each month resulting from unsold products. Also, manufacturers of products that contain highly valuable resources could take back their products, re-/ upcycle them and hence, maintain the valuable resources, instead of disposing them (Accenture strategy, 2014). An approach in this direction has for example been made by Adidas' Parley collection. A cooperation with Parley (a thinktank on ocean recovery) allows Adidas to produce sportswear from recycled plastics in order to avoid it being discarded or burned but reused in a new way (adidas America Inc., n.d.).

For the scope of this master's thesis, recycling is of high importance since research focuses on consumer acceptance of smartphones made of recycled materials. Therefore, recycling will be defined as follows: A process of recovering materials for the original purpose or for other purposes (Accenture strategy, 2014; Ellen MacArthur Foundation, 2013).

Third, the **Product Life Extension** business model is of high importance for capital-intensive manufacturing businesses. These can contribute towards a CE and at the same time generate additional revenue by extending the lifecycle of their products. That is, by either reselling, repairing/upgrading/refurbishing or remanufacturing, companies save resources and costs because they do not manufacture a new product. Instead, they sustain the valuable resources by extending the user cycle of the products (Accenture strategy, 2014). For example, instead of reassembling a laptop from bottom up, hence melting virgin materials to manufacture a new one, extending the products life refers to exchanging for instance the battery and the screen of it and resell it. *Refurbed* and *Backmarket* are two companies that extend life of technical

products by remanufacturing/refurbishing and reselling used products to new clients (*Backmarket*, 2020; *Refurbed.at*, 2020).

In this master's thesis, refurbishing/repairing/upgrading and remanufacturing – concepts, which are very similar in their meaning - are regarded jointly and hence, are defined as follows: A process of returning a used product into a good working condition, by disassembly, cleaning, replacing and/or repairing major components that are faulty, damaged or close to failure and making cosmetic changes to update the appearance of a product (Ellen MacArthur Foundation, 2013; Mugge, Jockin & Bocken (2017)). The intensity of refurbishing and remanufacturing varies depending on the condition of the product after its first cycle of use.

Fourth, **Sharing Platforms** constitute another circular business model (Accenture strategy, 2014; Lewandowski, 2016; W. R. Stahel, 2019). Offering sharing platforms enables maximizing utilization of products that are normally rarely used but that have a high ownership rate at the same time. One example for a potential sharing product are cars - a product that is majorly owned by people, that is however parked most of its lifetime instead of being used. Uber has successfully transferred the product 'car' into a sharing business model. The company created a sharing platform, where private car owners can offer rides to users of the app who need to go somewhere (How Uber Works for Drivers and Riders | Overview, 2020). In summary, this circular business model ensures the maintenance of the values of specific products because they are utilized to their full potential.

Fifth, the last business model is called **Product as a Service**. Product as a Service means for companies to offer services instead of selling haptic products. Hence, only the access to the product is sold to customers (Accenture strategy, 2014; Lewandowski, 2016; Stahel, 2019). For example, Hilti, a tool manufacturer is offering their tools for rent. Instead of selling the very expensive tool, which in a private household is probably only used very rarely, the customer, just orders it for the time needed (Hire Hilti Tools, 2020). This is beneficial in terms of sustainability and circularity, since ownership is transferred from the consumer to the producer and hence enables a shift of responsibility. If manufacturers own the product, they are subsequently interested in its high quality and longevity and therefore produce accordingly. This counteracts waste creation and contributes to the CE (Accenture strategy, 2014).

2.2.2 Products, promising Opportunities for a more Circular World

Having summarized several circular business possibilities, it is also important to understand, which products offer the potential to be transformed into circular activities. In their report, the Ellen MacArthur Foundation (2013) presents the results of their analysis graphically regarding potential products - see the above matrix (Figure 8). Products have been categorized according to, on the one hand, suitability for the CE, and on the other, according to their ease of implementation. Suitable products are those that are easy to disassemble in order to remanufacture or repair them, but also those, that have high ownership rates but are utilized rarely. Hence, products in the upper left quarter do have high potentials for circular business practices, however, implementation lacks until today. Products like furniture, washing machines, smartphones and nursery beds belong to this category. The matrix also shows suitable products for circular business, that have already been implemented, such as machinery or drinking bottles (upper right) (Ellen MacArthur Foundation, 2013).

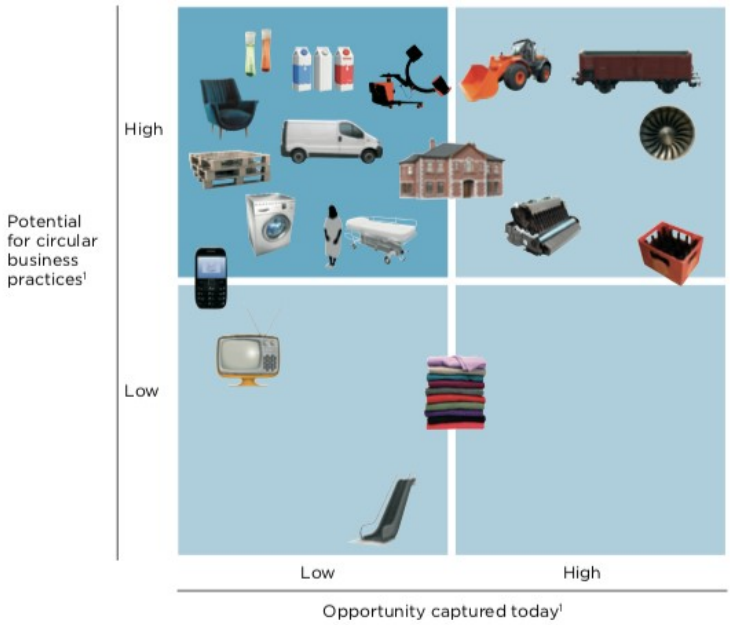

Figure 8 Products offering potential for CE activities (Ellen MacArthur Foundation, 2013)

Especially when taking a closer look at products, which opportunities are already captured today, it appears that mainly B2B products are referred to. End-consumer products have rarely been transferred into circular products or services successfully up until today according to this source. There is a significant gap in research, identifying the transformation from a consumer driven perspective.

2.3 The Circular Economy Concept – A Consumer perspective

Businesses and consultants have dominated research in relation to the CE and hence, have focused majorly on the business perspective of a transformation from a linear economic system towards a circular one (Korhonen et al., 2018; Stahel, 2016). That means, in the past the CE was rather viewed as a business-driven concept.

On the contrary, the consumer perspective was rather unexplored up until today (Borrello, Caracciolo, Lombardi, Pascucci & Cembalo, 2017; Catulli, Cook & Potter, 2017). In the very recent years, certain researchers have made clear that consumers are crucial actors in order to successfully achieve transformation and hence more and more academic researchers are now exploring the consumer view towards this social and economic transformation (e.g. Elzinga, Reike, Negro & Boon, 2020). Also, the political landscape is interested in consumer acceptance of a CE. For example, the European Union commissioned a research dedicated at investigating consumer engagement in the Circular Economy in order to derive implications for policy making in this regard (Cerulli-Harms et al., 2018). Therefore, one can conclude that even though, more and more researchers involve the consumer as a crucial part of the CE, there is still a research gap to be filled in the future. In order to meet the scope of this master's thesis to contribute to investigations of the consumer perspective in a CE, this chapter summarizes research regarding the consumer acceptance of circular products or services. This should serve to receive a deepened understanding of the role of the consumer, being crucial for a successful transformation towards a CE.

2.3.1 Literature Classification – Consumer Acceptance of Circular Business Approaches

Current research provides a number of studies, investigating consumer behavior with regard to circular products or services. In order to be able to match business and consumer perspective and hence conclude with valuable implications for managers, consumer research is classified according to the previously described business models of a CE. The classification scheme, presented in *Figure 9,* shows details on how this chapter classifies consumer literature. Basing the literature classification on the five business models, presented in the previous chapter, only four of them are appropriate for investigation of the consumer perspective. As the Circular Supplies Business Model is of a B2B nature, hence proposes for firms that are virgin material suppliers to completely transform their core business, the consumer perspective is of secondary importance. Hence, only Product as a Service, Product sharing, Resource Recovery and Product Life Extension can be investigated from a consumer perspective.

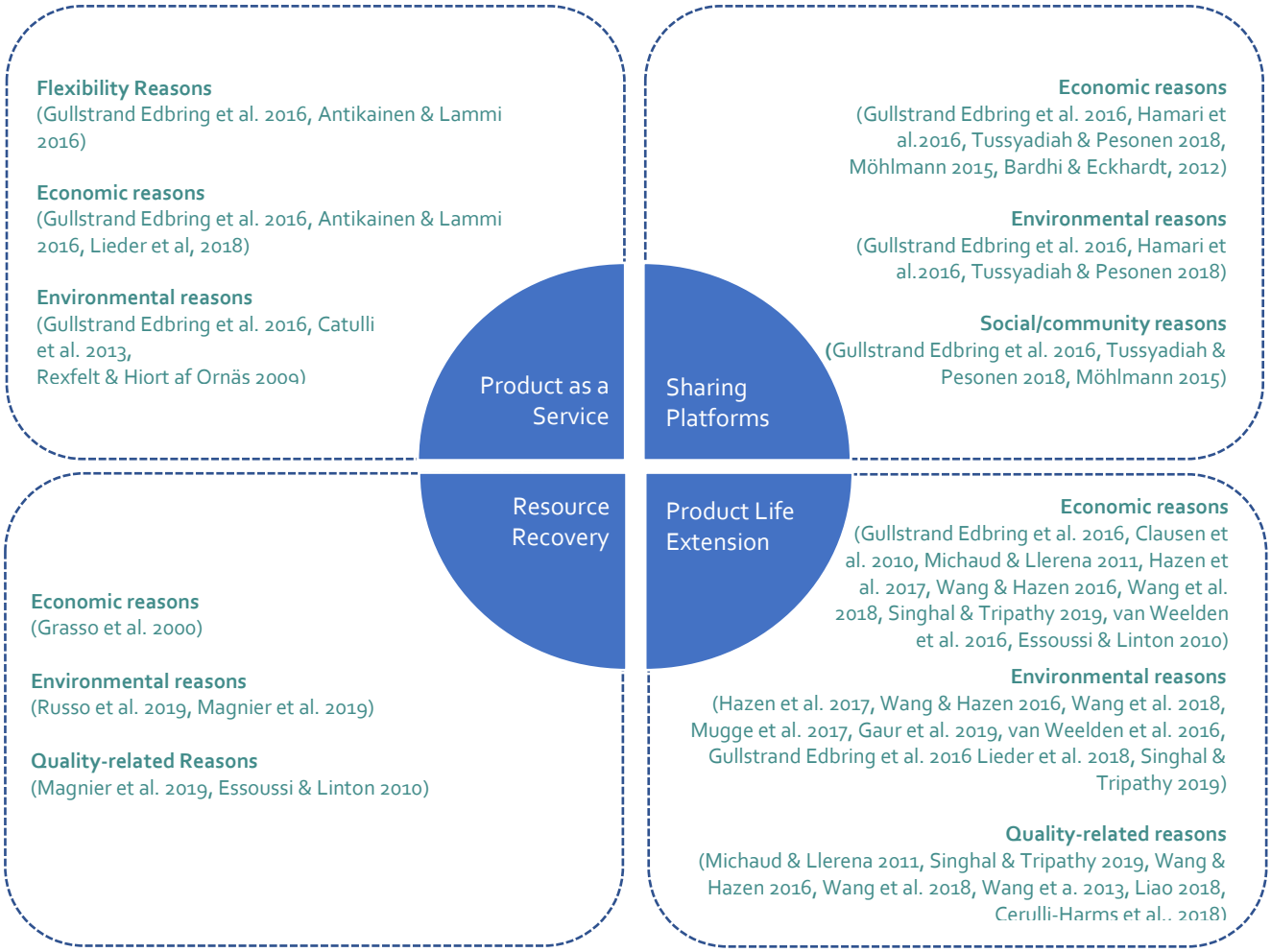

Figure 9 Literature Classification Scheme - Created by author

2.3.2 Product as a Service

Generally, there is some existing consumer research on Product as Service business models. However, investigators have only very rarely focused particularly on consumer engagement towards this business model of a CE. Gullstrand Edbring, Lehner & Mont (2016) and Antikainen & Lammi (2016) are the authors of two research papers, dealing with consumer behavior in relation to the business model 'Product as a service'. Using qualitative research methods, they interviewed consumers regarding their motivations and concerns towards leasing or renting different products. Summarizing their findings and including complimentary literature on the extended topic, one can conclude that the biggest drivers towards Product as a Service are flexibility, economic and environmental reasons.

Flexibility Reasons. According to Gullstrand Edbring et al. (2016), the strive for freedom and flexibility is the major motivator for consumers to utilize Product as a Service business models. The practicality, this business models offers is attractive to users. In referral to these authors' research, it seems that the majority of subjects named flexibility or practicality as main motivators to engage in this business model (Gullstrand Edbring et al., 2016). The finding is supported by Antikainen & Lammi (2016) who investigated the acceptance of different products transformed into services. When asking their subjects about renting a couch or a washing machine, respondents also firstly mentioned the high practicality and flexibility as a positive attribute of the business model. Hence, from a research perspective, flexibility seems to be the main driver for consumers to engage in Product as a Service business models.

Economic Reasons. A second important driver for respondents of their survey were the economic benefits, this business model offers. According to the results of their study, consumers perceive it as economically beneficial to rent or lease a product instead of buying it entirely (Gullstrand Edbring et al., 2016). Especially when it comes to products that are normally highly priced, consumers find the idea of leasing as economically interesting (Antikainen & Lammi, 2016). Investigating consumer preferences towards circular business practices in the context of washing machines, Lieder et al. (2018) found that consumers prefer flexible payment schemes, such as monthly rates or pay-per use, rather than the conventional buying price. Hence, there is a general interest of consumers to rather pay for access than for ownership.

Environmental reasons. According to Gullstrand Edbring et al. (2016) environmental reasons do indeed drive consumers to engage in leasing or renting. Interestingly, subjects were especially referring to children's furniture when they highlighted the importance of its environmental aspect. In support of this finding, also Catulli et al. (2013) who researched the interaction between access-based consumption and consumer culture in the context of baby and nursery products, found that consumers would prefer Product as a Service, if proven that it is more sustainable than other modes of consumption.
On the contrary, other researchers investigating a variety of service-based consumption modes did not find any sustainability-related influencing factor on Product as a Service business models (Rexfelt & Hiort af Ornäs, 2009).

2.3.3 Sharing Platforms

When it comes to sharing models or so-called access-based consumption models of providing products or services, researchers found that consumers are driven by different motivators.

Economic Reasons. Current research found that economic reasons are one main driver for consumers to engage in and make use of sharing services (Bardhi & Eckhardt, 2012; Gullstrand Edbring et al., 2016; Hamari, Sjöklint & Ukkonen, 2016; Möhlmann, 2015; Tussyadiah & Pesonen, 2018). Yet investigating different sharing services such as car-sharing (Bardhi & Eckhardt, 2012; Möhlmann, 2015), accommodation sharing (Möhlmann, 2015; Tussyadiah & Pesonen, 2018) and furniture sharing (Gullstrand Edbring et al., 2016), all of these researchers found that consumers would choose to utilize these services due to economic benefits. Consumers perceive sharing as more cheap, relative to buying new products and hence, comparing different determinants of engagement into sharing services, this fact is the most valuable for potential users (exceeding for example morale attitudes) (Bardhi & Eckhardt, 2012). Hamari et al. (2016) classified economic benefits as an extrinsic consumer motivation and found that perceived economic advantages - stemming from using a sharing service - do have a direct effect on the behavioral intention towards these types of business models. Whereas Hamari et al. (2016) researched the behavioral intention as a dependent variable, Möhlmann (2015) took 'satisfaction with a sharing service' as a target of investigation. She found that consumers' satisfaction with a car-sharing service as well as with an accommodation sharing service is determined by the fact that consumers save costs relative to when they would buy the product or use a similar service (e.g.hotels). Similar findings have been reached by Tussyadiah

& Pesonen (2018) who investigated peer-to-peer accommodation and identified economic appeal as one of two major reasons for consumers to engage in these sharing services.

Environmental Reasons. When it comes to environmental reasons as determinants of collaborative consumption/sharing services, researchers present different findings. According to the qualitative study of Gullstrand Edbring et al. (2016) consumers are willing to share furniture due to its sustainable nature. Hence, according to these researchers, the fact that less production reduces resource extraction and protects the environment, motivates consumers to engage in these business models. Tussyadiah & Pesonen (2018) support this finding, showing that especially older people would choose peer-to-peer accommodation sharing because it is a sustainable business model. Interestingly, Möhlmann (2015) contradicts these outcomes with her research paper. According to her, neither 'satisfaction with a sharing option' nor 'the likelihood of choosing a sharing option again' was influenced by environmental reasons. As a matter of fact, environmental impact was not in any case connected to the utilization of sharing services. Hamari et al. (2016) were able to distinguish the effect of sustainability as an intrinsic motivation for one thing on behavioral intention and for the other, on attitude towards sharing services. The results of this study reveal that consumers form positive attitudes towards sharing services, resulting from their intrinsic motivation to consume in a sustainable manner. However, sustainability did not directly affect the behavioral intention towards participating in sharing services.

Social and Community Reasons. Further determinants of consumer engagement in sharing services are social and community reasons. Regardless of the shared product, consumers were motivated to participate in sharing models due to their desire of being part of a community, as well as to achieve more interaction with people (Gullstrand Edbring et al., 2016; Möhlmann, 2015; Tussyadiah & Pesonen, 2018).

In their study, Gullstrand Edbring et al. (2016) show that a significant number of respondents mentioned access to community as a personal motivator to participate in furniture sharing models. Also, Möhlmann (2015) examined the effect of community belonging on the likelihood of choosing a sharing option for the second time. In the context of car-sharing, a positive relationship between the desire of consumers to belong to the community and the choice of sharing model for a second time, occurred. However, when investigating accommodation sharing, the community belonging factor did not determine the choice. This was different in the study of Tussyadiah & Pesonen (2018) who also chose accommodation as a product of

investigation and did reveal social appeal as a major determinant of utilization of sharing services. In summary it can be seen, that study results in this context are diverse and that here might be necessity of further research.

2.3.4 Product-life Extension

The consumer perspective towards Product Life Extension and Resource Recovery is especially important for this research (chapter 2.3.4 and chapter 2.3.5). From a consumer perspective, engaging into product life extended and resource recovered products means to move away from buying conventionally produced products and towards more sustainable ones. Hence, a purchase transformation towards greener products takes place. On the contrary, Product as a Service and Sharing Platform business models require consumers to tap into completely new spheres of products being transformed into services and of accessing instead of owning. In other words, Product Life Extension as well as Resource Recovery require from the consumer the shift to purchasing a new type of product, whereas the other two are more of a completely new experience and way of consuming. Hence, Product Life Extension and Resource Recovery are more of a conscious decision of the consumer to act sustainably and therefore of highest relevance in this thesis.

As described in chapter 2.2.1 on business models of a CE, product-life extension refers to reuse, repairing/upgrading/refurbishing or remanufacturing. Hence, in this chapter all literature on consumer behavior towards these types of products, thus the product-life extension business model, will be summarized. Results of diverse studies can be subsumed under the following categories: Economic Reasons, Environmental Reasons and Quality-related reasons. From the following findings, hypotheses for remanufactured/refurbished phones will be derived.

Economic Reasons. A number of different studies show that buying life-extended products is to a large part, financially motivated.
By conducting in-depth interviews, Gullstrand Edbring et al. (2016) and Clausen, Blättel-Mink, Erdmann & Henseling (2010) investigated the reasons, that influence consumers to engage in second-hand consumption. In both papers, results suggest that financial factors, e.g. price, play a major role for consumers. Hence, the lower price of second-hand products is one of the main determinants for consumers to engage in product-life extension business models. But not only

second-hand consumption is motivated extensively by price, also refurbished[2] products determined very much by this factor (van Weelden, Mugge & Bakker, 2016).

Other than that, Singhal & Tripathy (2019) examined purchase intention towards remanufactured products. They found that personal benefit, derived from low cost or discounts, has a major impact on the intention to buy these remanufactured products. Similarly, Wang, Hazen & Mollenkopf (2018) investigated purchase intention towards remanufactured automobile parts and came to the same conclusion: Price advantage had a positive direct effect on the perceived value of the product, which in turn elicited a positive effect on purchase intention towards it. These findings are also supported by Wang & Hazen who published their paper in 2016, showing that cost knowledge is related to the purchase intention towards remanufactured products. In particular, they state that if a consumer knows about the fact that a remanufactured product is usually priced lower than a conventional product, they are more likely to buy it (Wang & Hazen, 2016).

Other authors specifically aim at investigating the comparison between new and remanufactured products, that is the consumers' switching intention (Hazen, Mollenkopf & Wang, 2017; Michaud & Llerena, 2011).

Hazen et al. (2017) reveal that if the price of a conventional product increases relatively to the life-extended one, consumers are more willing to buy the remanufactured product. Hence, according to these researchers, the price of the new product is positively related to the consumers' switching intention towards the remanufactured product. Michaud & Llerena (2011) also found interesting results, similar to the ones of Hazen et al. (2017). They investigated the WTP of remanufactured cameras in an auction experiment. In terms of financial motivation, they found that when consumers receive positive information (e.g. about the environmentally friendly nature of the remanufactured product) the WTP remained the same for these products. However, consumers decreased their WTP for the conventional product. That means, like Hazen et al. (2017) also Michaud & Llerena (2011) found that consumers consider both, the price of the remanufactured as well as the price of the conventional product, when taking their purchase decision.

Further, Essoussi & Linton (2010) investigated a variety of products and their differences in consumers' WTP. For example, these authors compared products like recycled paper and refurbished cell phones. They found that the higher the functional risk of a circular product, the

[2] Refurbishing/repairing/upgrading and remanufacturing: A process of returning a used product into a good working condition, by disassembly, cleaning, replacing and/or repairing major components that are faulty, damaged or close to failure and making cosmetic changes to update the appearance of a product (Ellen MacArthur Foundation, 2013; Mugge et al., 2017)

lower the WTP for it. Furthermore, according to them, switching from a circular product to a non-circular product also happens within different price ranges depending on the type of product. That means, e.g. for refurbished smartphones, there is only a very small range of price that leads consumers to decide not to switch. For less functional products like paper, the price range is substantially higher in which consumers decide to switch towards not buying the recycled paper. This is due to the fact that paper is a product category with less functional risk than for instance technical products, so consumers are willing to relatively pay more for a recycled non-functional than for a functional product.

Environmental Reasons. Other than economic reasons, also environmental reasons have been examined as an influencing factor for consumer engagement towards product-life extended products and a vast majority of papers confirm the relation.

Conducted in-depth interviews by Gullstrand Edbring et al. (2016) and van Weelden et al. (2016) reveal a first tendency on what consumers subjectively perceive as a motivation to buy remanufactured (van Weelden et al., 2016) or second-hand products (Gullstrand Edbring et al., 2016). The results of their studies suggest that environmental reasons are a key factor influencing consumers' buying behavior towards these products.

Also in the context of environmental, the comparison between new and remanufactured products is a focus of research. For example, Hazen et al. (2017) investigated the effect of environmental benefits on switching intention from conventional to remanufactured products. The hypothesis that environmental benefits would motivate consumers to switch to remanufactured products was supported in their paper. Wang et al. (2018) go along with this finding by confirming that environmental benefits have an influence on the perceived value of a remanufactured product, which in turn positively influences the purchase intention towards it. Similarly, Mugge et al. (2017) gain the same result with regard to environmental benefits and the impact on the purchase intention of refurbished phones.

Using conjoint analysis in order to examine preferences towards new circular business practices, Lieder et al. (2018) contribute to research with a new type of investigation in this context. Interestingly, despite the different methodology, results are consistent with the previous researchers' findings. Also letting consumers compare circular to conventional products, they find that if remanufactured products are associated with a specific amount of CO2 reduction, they are more likely to be purchased. Hence, signaling the environmental impact, remanufactured products offer, results in shifted preferences towards it.

A similar finding is published by Wang & Hazen (2016) who measure the impact of green knowledge on purchase intention. Green knowledge suggests that consumers are conscious about the resource, waste and energy reduction, the purchase of remanufactured products entails. As a matter of fact, disposing over green knowledge does have a positive effect on the perceived value and therefore on the purchase intention of the remanufactured product.

Even though, all of these authors have found a positive relationship between product-life extended products and environmental influence, Singhal & Tripathy (2019) offer contradicting results. In their paper 'Acceptance of remanufactured products in the CE: an empirical study in India', they find that green awareness does not have any influence on the purchase intention towards remanufactured products.

However, Gaur, Mani, Banerjee, Amini & Gupta (2019) may be able to give some insights on a potential reason for this contradiction. According to Gaur et al. (2019) it is important to differentiate between countries and cultures and since Singhal & Tripathy (2019) only took India as a place of investigation, they could have come to different results than other researchers.

In particular, what Gaur et al. (2019) did was to compare socio-cultural differences between the US and India as a driver of buying behavior towards remanufactured (or in their words 'reconstructed') products. Socio-cultural differences are distinguished according to different environmental attitudes. The results of their research show that there is a substantial difference between consumer behavior towards remanufactured products in India and the US. Whereas, for example, US consumers show altruistic buying behavior, thus feel 'responsible for the environment' and would like to make a 'sacrifice for mother nature', Indian consumers are more likely to consume utilitarianly, thus they buy according to price, quality and warranty. Further, also attitude towards waste disposal, obligation to government conservation norms and environmental value orientation differs among the two cultures.

Generally, Gaur et al. (2019) claim that cultural attributes with regard to environmental issues associated with developed countries, lead to higher purchase intentions towards remanufactured goods than cultural attributes associated with emerging countries. This is due to their diverse environmental attitudes and behaviors.

In summary, the majority of researchers in this context come to the conclusion that consumer preference towards life-extended products is related to their environmental impact and the bigger this impact, the more they are willing to buy and pay for these products. Consequently, the third assumption is the following:

All parameters being equal, the higher the environmental benefit, the higher the consumers' WTP for a refurbished/remanufactured product.

Quality-related Reasons. According to several researchers, quality is one influencing factor for consumers to purchase and to switch from conventional to life-extended products.

According to Wang et al. (2018) the perceived quality of a remanufactured product is positively related to its perceived value. In turn, the higher perceived value directly influences the purchase decision of this product. In other words, if a consumer perceives the quality of a remanufactured product as high, its value is perceived as high, too and therefore the consumer is more likely to buy it. However, the same occurred to be true in the other direction: If a consumer perceives the product as of low quality, the product is devalued in his/her perception and less likely to be bought.

Michaud & Llerena (2011) found on the one hand, that generally, consumers perceive the quality of remanufactured products as lower relatively to conventional ones. On the other, this was reflected in their WTP, when comparing new and remanufactured products. Low-quality perception of remanufactured products, results in a lower WTP.

Extending this finding, Singhal & Tripathy (2019) reveal that knowledge about the quality and features of remanufactured products has a significant impact on the purchase intention towards them. Hence, if a consumer is aware of the high quality of a remanufactured good, he/she would have a higher intention to purchase it compared to when he/she did not have this information. This finding is confirmed by Wang & Hazen (2016) who show that quality knowledge exerts the highest influence on perceived value but also on perceived risk of a remanufactured product. That means, knowing about the quality of the product raises its perceived value and at the same time reduces its perceived risk, which in turn positively influences purchase intention.

Wang, Wiegerinck, Krikke & Zhang (2013) contradict previous revelations with their research. As well as Wang & Hazen (2016), they tested the effect of product knowledge on purchase intention towards remanufactured products. However, they received a negative correlation between the two variables. That means, according to their study, the more consumers understand what remanufactured products are, the less likely they are to purchase them.

Instead of investigating the effect of product knowledge, other researchers rather looked at other measures to promote the purchase of remanufactured products.

Lieder et al. (2018) include quality signaling attributes into their conjoint analysis seeking to investigate the acceptance of new business models. Their finding was that high service levels or warranty, which can be interpreted as signaling high quality, did contribute as the major

component to the consumers' utility. That means, perceiving a remanufactured product as highly qualitative is majorly contributing to the consumers' utility and therefore determines preferences for this type of product.

Liao (2018) focuses even more particularly on the effect of warranties in the context of remanufactured products and reveals very interesting findings. Especially in the eyes of loss-averse consumers, warranty is perceived as an insurance against quality deficits and hence, these customers are willing-to-pay for imposed warranties. Furthermore, according to this researcher, warranty raises the WTP for remanufactured products since it acts as a mitigator for risks or low product value perception.

Instead of investigating purchase intentions, attitudes or similar, Cerulli-Harms et al. (2018) examined the engagement of consumers towards the CE by investigating their behaviors in regards of product durability and reparability – which they defined as the main characteristics of products in a CE. Especially durability is often associated with quality. What they now find was that consumers are willing to compensate for these characteristics with price. That means, consumers are willing to pay more for products that last longer, thus that are perceived as being of higher quality. Additionally, they also confirm that consumers wish to receive more information on the quality/durability of products in order to be able to distinguish poor from good quality.

Deriving from the research, consumers' choice for remanufactured/refurbished products is influenced by quality concerns towards these types. Counteracting these quality concerns, researchers as well as companies have previously used warranty as an indicator for quality (Cerulli-Harms et al., 2018; Liao, 2018; Lieder et al., 2018; *Refurbed.at*, 2020). Consequently, in this master's thesis, warranty will be used as an indicator for quality in order to assess the influence on the WTP for a remanufactured/refurbished product. The following assumption will be made:

All parameters being equal, the higher the warranty, the higher the consumers' WTP for a remanufactured/refurbished product.

2.3.5 Resource Recovery

This chapter focuses on findings of consumer behavior patterns towards the business model Resource Recovery. Resource Recovery in the context of consumer acceptance refers to upcycled products or ones that are made of recycled materials. Therefore, literature investigating the purchasing behavior towards recycled and upcycled products has been summarized in this chapter and shows that economic, environmental and quality-related reasons are main determinants for the purchase of these products.

Economic Reasons. According to Grasso, McEnally, Widdows & Herr (2000) price has a major impact on the purchase of recycled products. The authors investigated recycled textile products and confronted the consumers with these as well as with conventional clothes. Their results show that price influenced their choice in a way that a lower price of the recycled product, relative to the new one, led to the consumer rather buying the recycled one. This shows also, however, that consumers were not willing to pay a price premium for the recycled product but rather the reduction in price was crucial for their behavior.

Environmental Reasons. Even though Magnier, Mugge and Schoormans (2019) did not find an effect of environmental benefits on the purchase intention or willingness to pay (in the following WTP) a price premium for recycled products, they did reveal a related finding. According to their study, anticipated conscience had a positive effect on both, purchase intention and WTP a price premium. The authors define anticipated conscience as an affective benefit, thus a positive emotion, the purchase of a recycled product is eliciting in a consumer. This positive emotion can be interpreted as coming from the fact that buying a recycled product is something altruistic. With the purchase, the consumer contributes to saving the environment and supporting society and feels a positive feeling. As a result, anticipated conscience, thus the emotional satisfaction from the purchase, can be related to an actual environmental reason, influencing the purchase of a recycled product. Also, Russo, Confente, Scarpi, & Hazen (2019) investigated consumer purchase intention, intention to switch and WTP regarding products made of bio-waste. Interestingly their result show that consumers' green self-identity mediates the effect of attitude towards bio-based products on the intention to buy these products, to switch from a conventional to a bio-based product and on the willingness to buy these products. Hence, intrinsic belief or conviction influences people to engage in the business model Resource Recovery. The finding of Grasso et al. (2000), however, offers opposite results. According to them, environmental labeling on recycled textile products did not motivate

consumers to choose recycled products over conventional products. However, more detailed investigations like the one of Russo et al. (2019) show that intrinsic motivation (e.g. having a green self-identity) mediates the effect of attitude towards these kinds of products on purchase intention. Hence, intrinsic conviction pushes consumers towards recycled products. The simple fact, that they are recycled does not influence the purchase probability.

In summary, the relationship between environmental benefits and recycled products is controversially discussed by researchers. However, the majority of the researchers see a positive effect of environmental features on the preference for these types of products. Using the level of WTP as an indicator for preference, the following relationship will be assumed (basis for this assumption is that identical products need to be compared, differing only in regards of their level of environmental benefit):

All parameters being equal, the higher the environmental benefit, the higher the consumers' WTP for a product made of recycled materials.

Quality-related Reasons. Essoussi & Linton (2010) researched the WTP for recycled versus new products. Considering different types of products, they found that when consumers compare new to recycled products, their values (expressed in an amount of money a consumer is willing to pay) differ substantially. More specifically, recycled products are perceived as having a lower value than new products. According to the researchers, one reason for consumers to value them less high, is the perception of functional risk of these products. That means, the more a product has the risk to not functioning properly, the less its recycled version is accepted by consumers in comparison to the corresponding new one. Hence, e.g. the difference of attributed values between a new and a recycled smartphone

Magnier et al. (2019) concentrated their research on consumer purchase intention and WTP for products made of ocean plastic. The authors found that consumers were more willing to purchase recycled products if perceived as providing a high value for money. Additionally, the results suggest that functionality expectations of the product have an influence on consumers' purchase intention. The more a consumer perceives a recycled product as functioning well, the more he/she is willing to buy it. Hence, if products made of recycled materials were attributed to high quality, they were more likely to be purchased. The authors extended their research by investigating the consumers' WTP a price premium for recycled products. In this regard, they found quality-related influencing factors as well. The researchers revealed that the safer in terms of contamination risk, a product is to the consumer, the higher the price premium he/she would

be willing to pay. Hence, quality features have been of major importance to consumers since these would lead people to pay more.

Deriving from the findings of Magnier et al. (2019) and Essoussi & Linton (2010) quality signaling is crucial for consumers to elicit preferences for recycled products. That means, in order to research consumer preferences of recycled products, quality characteristics need to be made comparable. Therefore, in this master's thesis, warranty will be used as a proxy for quality. The more warranty a manufacturer grants the consumer, the longer the manufacturer is liable for the quality of the product. In other words, the manufacturer indicates that he ensures a certain amount of quality standard to the consumer (Liao, 2018). In different CE research papers, investigators have used warranty to operationalize quality (Liao, 2018; Lieder et al., 2018, Lieder, Asif & Rashid, 2020). Consequently, in this thesis, it will be hypothesized that higher perceived quality, signaled as warranty, has a positive influence on consumer purchase decision for products, made of recycled materials. The second assumption therefore reads as follows:

All parameters being equal, the higher the warranty, the higher the consumers' WTP for a product made of recycled materials.

2.4

2.4 Smartphones as Product of Investigation

The scope of this thesis is to investigate consumer acceptance of the CE. This entails to find out what determines consumer preferences towards circular economic activities. What influences decision-making in the context of circular products and services? In order to answer these questions, but necessarily narrow down the volume of research, smartphones will be chosen as the product of investigation in this master's thesis. This choice has several reasons.

First, as depicted in chapter 2.2.2, *Figure 8,* smartphones offer a high potential for circularity, yet circular activities have not sufficiently been implemented for this kind of product (Ellen MacArthur Foundation, 2013). Hence, this research might offer some insights on what can be done to successfully implement it.

Second, smartphones are an extremely important and widely spread product all around the world. According to Greenpeace, seven billion smartphones worldwide have been produced within the last decade (Jardim, 2017). In terms of smartphone users, in 2020 there were approximately 3.8 billion smartphone users worldwide, which accounts for almost 50% of the world population (O'Dea, 2020). As a result, the smartphone is one of the most popular and extensively used consumer durable products in the world.

Third, and very important for this type of research is the extensive value, that smartphones contain in terms of materials. The 15 most important materials, smartphones contain, are either very expensive and time-consuming to extract, rarely available or associated with human rights violations, and therefore very valuable (Holz & Fischer, 2019). Problems with the manufacturing process of smartphones occur according to Greenpeace in four different ways. First, the extraction of metals, needed for the production of new smartphones often endangers mine workers and results in armed conflicts within less developed countries. Second, necessary chemicals are hazardous to health for workers, with them often not even knowing about. Third, in order to extract materials, high loads of energy are required, which in turn results in an increase of climate-damaging energy demand. Fourth, rare take-back programs of phones and materials, increase the waste that result from thrown-away valuable materials that are sometimes even harmful for the environment (Jardim, 2017).

Adding on to these facts, the lifecycle of smartphones is extremely short – after less than two years the average western citizen is upgrading his/her smartphone to a new one (Armstrong, 2017). This combination of high values and high disposal rates results in extremely high losses of valuable resources in the context of conventional smartphone production and consumption.

As a result, smartphones are an extremely interesting product for the scope of this research, as they enable a great retention of valuable resources when transformed into circular products.

2.4.1 The Circular Smartphone

So how can conventional smartphones be transformed into circular ones? Smartphones promise major opportunities for CE based models – mainly by shifting from conventionally manufactured smartphones towards Resource Recovery or Product Life Extension approaches (Ellen MacArthur Foundation, 2013). Sharing and Product as a Service Business models are hence of smaller relevance, when investigating this type of product. This is due to the following reasons. Smartphones have a high level of utilization. Products, suitable for sharing options have the characteristic of low utilization and high ownership, so utilization can be boosted via sharing activities. For smartphones, these characteristics don't apply, therefore sharing is not an option. Product as a Service activities might be upcoming in the future also for smartphones, however, today there is not a lot of evidence for that kind of business transformation. In other words, there are rarely any manufacturers of smartphones renting them out instead of selling them nowadays. Other than that, as stated before, Product Life Extension and Resource Recovery are also very relevant from a consumer literature perspective, as consumers have to consciously decide for a more sustainable product instead of tapping into new spheres of consumption which is the case for Product as a Service and Sharing business models. Consequently, in this master's thesis specifically consumer preferences towards **remanufactured/refurbished smartphones** and **smartphones made of recycled materials** will be investigated. Deriving from definitions in literature (e.g. Accenture strategy, 2014; Ellen MacArthur Foundation, 2013; Mugge et al., 2017) for remanufacturing/refurbishing (already used in chapter 2.1.1) and recycling, these will be defined as following:

> *A remanufactured/refurbished phone* is a phone that has been used (thus second-hand) and returned into a good working condition by disassembly, cleaning, replacing and/or repairing major components that are faulty, damaged or close to failure.

> A *phone made of recycled materials* means that the materials used to produce this phone are not originally extracted from mines, but they are recovered from other products, are then recycled and used to produce the phone.

Assumptions applied to smartphones

Chapter 2.3.4 and 2.3.5 summarize literature investigating reasons for consumers to buy life extended products or resource recovered. Only few of the research papers specifically target

smartphones as product of investigation (Mugge et al., 2017; Singhal & Tripathy, 2019; van Weelden et al., 2016). Therefore, hypotheses will be derived from the overall findings on product life extended and resource recovered products and applied as underlying assumptions for remanufactured/refurbished smartphones and smartphones made of recycled materials. From the literature it can be assumed that the point at which consumers switch from a new smartphone to a remanufactured/refurbished or one that is made of recycled materials is influenced by price, environmental benefit and quality concerns. As already mentioned above, preference will be estimated by using WTP as dependent variable. Following the above made assumptions, the hypothesis for smartphones are summarized and read as follows:

1) All parameters being equal, the higher the environmental benefit
    a. the higher the consumers' WTP for a remanufactured/refurbished phone.
    b. the higher the consumers' WTP for a phone made of recycled materials.

2) All parameters being equal, the higher the warranty
    a. the higher the consumers' WTP for a remanufactured/refurbished phone.
    b. the higher the consumers' WTP for a phone made of recycled materials.

Resource Recovery vs. Product Life Extension.

This master's thesis aims at investigating new value propositions for a CE as well as comparing different approaches towards it by differentiating between different circular business models in terms of market acceptance. At the current state, however, to the best of the authors' knowledge, literature does not provide any research on the comparison between products made of recycled materials and remanufactured/refurbished ones. Consequently, only assumptions with regard to consumer behavior (in this case related to smartphones) can be made and will be tested in practical part of the thesis.

Smartphone manufacturers are today slowly using more and more recycled materials for their phones. For example, Apple published their product environmental report in 2019 about the iPhone 11, saying that the taptic engine of the phone is made for the first time with 100% recycled rare earth materials. Important to note, the taptic engine of the iPhone accounts for only 25% of all rare earth materials within the phone. Further, Apple has not been able to reduce CO2 emissions compared to the previous Iphone XR (*Product Environmental Report Iphone 11*, 2019). In terms of price, the iPhone 11 was substantially cheaper than the previous phones, which is due to technical differences and not specifically communicated as a result of its

recycled heart (Williams, 2019). The environmental component is generally very rarely promoted as unique selling point of this product. The sales, however, of the iPhone 11 have succeeded any of their previous models (Söldner, 2020). These facts let assume that consumers' quality perception of phones made of recycled materials is similarly high to all the non-recycled phones Apple has launched. This might result, of course, from the brand, but it also shows that recycled materials do not substantially downgrade the phone in terms of quality perception.
When looking at refurbished phones, on the other hand, for example at the company refurbed, who is also selling Apple iPhones among others, it is obvious to see that the company is advertising lower prices, environmental benefits and promote the higher warranties as compared to new products. Hence, these features are explicitly emphasized in order to signal quality despite the second-hand nature of the phones (*Refurbed.at*, 2020). Summarizing these observations, it can be claimed that remanufactured/refurbished smartphones are perceived as being of lower quality - for which consumers are ready to pay less - than smartphones made of recycled materials.

Deriving from the literature review and combining with the analysis of sellers like Apple and refurbed.at the following will be assumed:

All parameters being equal, consumers' WTP is higher for phones made of recycled materials than for remanufactured/refurbished phones.

Furthermore, and referring again to the above described observations, it can be assumed that warranty is more important for indicating quality for remanufactured/refurbished phones than for recycled ones. Smartphones made of recycled materials are often sold by the manufacturer, hence they are perceived as more similar to new phones, however with an environmental component. Refurbished/remanufactured phones, in comparison, are perceived as 'used' and therefore lower in quality. Thus, warranty indications might have a bigger trade-off effect on remanufactured/refurbished phones. Therefore, the last hypothesis reads as follows:

All parameters being equal, warranty has a more significant effect on the consumers' WTP for remanufactured/refurbished phones than it has on phones made of recycled materials.

2.4.2 Summary of Hypotheses and Controls

This chapter summarizes the hypotheses, derived from the literature review, combines them logically and sequences them in the way they have been tested in chapter 4.

1) All parameters being equal, the higher the environmental benefit a. the higher the consumers' WTP for a remanufactured/refurbished phone. b. the higher the consumers' WTP for a phone made of recycled materials.
2) All parameters being equal, the higher the warranty a. the higher the consumers' WTP for a remanufactured/ refurbished phone. b. the higher the consumers' WTP for a phone made of recycled materials.
3) All parameters being equal, warranty has a more significant effect on the consumers' WTP for remanufactured/refurbished phones than it has on phones made of recycled materials.
4) All parameters being equal, consumers' WTP is higher for phones made of recycled materials than for remanufactured/refurbished phones.

In addition to these influences, there might be other factors which determine the WTP of remanufactured/refurbished phones and phones made of recycled materials, namely gender, age, income and educational level. These will be included into the research model as control variables. Different researchers, investigating the CE from a consumer perspective have found that these variables have effects on the purchase intention of circular products (e.g. Cerulli-Harms et al., 2018; Hazen et al., 2017; Lieder et al., 2018; Mugge et al., 2017; Wang & Hazen, 2016).

For example, Hazen et al. (2017) found that switching intention towards remanufactured goods is influenced by age, gender and educational levels as well as partially by income of the subjects. Lieder et al. (2018) as well as Cerulli-Harms et al. (2018) especially revealed a difference between age groups with respect to quality-related features of circular products. More particularly, older subjects were attributing more relevance to quality characteristics and especially had a stronger need for information regarding quality of the products. In summary, it appeals that gender, age, income and educational level might mediate the findings and therefore are relevant to control.

3. Methodology

This chapter first introduces the overall research model and specifically describes how the conjoint analysis is designed for this thesis. Further, it describes the selection of attributes and levels. It concludes with the pretest and data collection.

3.1 Introduction to Choice-based Conjoint Analysis

Inferring from the literature review, previous research mostly took one product or service transferred into one of the circular business models and investigated influencing factors on various dependent variables such as consumers' purchase intention, WTP, risk-benefit perception, perceived value etc.

This thesis' focus is to look at different circular business activities from a market acceptance, thus consumer point of view. Thus, the aim is to investigate value propositions for a CE by testing for consumer preferences towards circular products. According to literature, there are two broad methods to elicit individual's preferences on a utility basis: revealed preference methods and stated preference methods. Whereas revealed preference methods use real market data to investigate individual's choices, stated preference methods hypothetically ask decision makers to state their preferences among different alternatives (Ali & Ronaldson, 2012; Louviere, Hensher & Swait, 2000.

As in this thesis, no real-life data can be utilized because the products of investigation are relatively new to the market, stated preference method is found to be appropriate. More particularly, this master's thesis uses conjoint analysis, as the chosen stated preference elicitation method.

Conjoint analysis is a quantitative research method, enabling researchers to better understand decision-maker preferences towards the combinations of attributes or characteristics that constitute a product or service. In particular, consumer preferences are described by utility functions. These functions enable researchers to quantify and measure preferences and to derive a picture about future demand developments. The utility function is composed of different part-worth utilities that refer to different product attributes. Preferences can then be measured by evaluating the combinations of part-wort utilities that maximize overall utility (Rao, 2013).

Other than understanding consumer preferences, conjoint analysis also enables researchers to measure how a change in price could affect the demand of a product, implicating the general acceptance of products by the market. As a result, conjoint analysis is very well suited when the researched product is to be launched on the market in the near future and managers want to

find out for which combinations of product features, consumers are willing to pay what price (Hill, 2017; Rao, 2013).

According to literature, there are different types of conjoint analysis. On the one hand, there are the original rating-based conjoint systems. Here, respondents have to rate or rank product concepts with the help of sliding scales, thus they indicate how much they prefer (from e.g. 1 to 9) to buy one product in comparison to others. On the other hand, new conjoint systems have evolved over time, the so-called choice-based approaches. These studies confront respondents with a choice scenario from which they have to choose repeatedly one discrete concept, i.e. one product, from a choice task, displaying different concepts (Orme, 2013; Rao, 2013).

In this master's thesis, Choice-based Conjoint (named CBC in the following) will be used for investigation, using the program *Sawtooth Software*[4] for set-up and analysis. The decision to use CBC is due to a number of advantages.

First of all, answering a CBC is very similar to real purchase decisions, that consumers are confronted with on a day-to-day basis. They have to choose their favorite combination of product features among others, like they would have to do in a shop as well. Secondly, many researchers prefer CBC analysis due to the possibility of including a "none" option. Respondents can show their disinterest and as a result, researchers will know which product concepts are less likely to be chosen. In addition, the "none" option indicates at which price demand is likely to decrease. A third advantage of CBC analysis is the fact, that it is very well suited for the examination of interactions between few numbers of attributes. That means, not only the effect that one feature has on the utility of the consumer can be measured, but also if specific combinations of features are relevant for preference elicitation. Despite of these advantages, one major concern regarding conjoint analysis in general, is the fact that respondents are expected to process a high load of information. However, by reducing the number of attributes, information overload can be minimized. Additionally, in a CBC, researchers are only able to collect a small part of information, relatively to original systems where respondents rank or rate the products (Hill, 2017).

For the study to be conducted in this master's thesis, CBC analysis is very well suited, since the aim is to gain insight into the market acceptance of different circular product transformation scenarios. Hence, by using CBC, consumer preferences towards different CE business models can be measured. More particularly, this methodology will enable to find out, towards which business model, consumers show higher preferences and what specific combinations of product features determine these preferences. Also, by introducing the dual response none option, it will

[4] The author received a student grant for the Sawtooth Software license

be researched whether consumers would really buy these circular products on a marketplace or rather stick to the conventional non-circular product. This can answer the question of whether CE practices would generally be accepted on the market.
Supportive of the choice of method is the fact that latest research has started investigating consumer preferences towards sustainability characteristics with the help of conjoint analysis (e.g. Aguilar & Cai, 2010; Huh, Kwak, Lee, & Shin, 2014; Osburg, Strack, & Toporowski, 2016; van Heek, Arning, & Ziefle, 2017). When it comes to investigations of CE value propositions, however, to current knowledge only the paper by Lieder et al. (2018) has used CBC. As a result, it can be claimed that the current state of art offers extensive opportunities for research, in order to close this gap.

3.2 Research model for preference estimation – the Hierarchical Bayes regression

In order to estimate consumer preferences from this choice data, mainly Hierarchical Bayes (HB) regression method will be used. Hierarchical Bayes models are really the combination of two things: i) a model written in hierarchical form that is ii) estimated using Bayesian methods.

What sets Bayes estimation apart from other estimations is that it investigates the probability distribution of parameters, given the obtained data, instead of investigating the probability distribution of data, given the parameters (like non-bayes estimation does) (*CBC/HB V5*, 2016).
Regression analysis in general is a method that attributes weights (regression coefficients) to explanatory variables (independent variables), which together are able to predict the dependent variable.
In the context of preference elicitation - and in this case CBC- , regression coefficients are called ‘part-worths’ or ‘importance weights’. Hierarchical Bayes regression, in particular, is often used where the independent variables are part of a matrix that displays the concepts and the dependent variable depicts preference ratings (Sawtooth Software, Inc., 2009).
This method enables to estimate individual part-worth utilities, despite the fact that the number of choices might be limited. Offering HB analysis, Sawtooth Software computes these part-worth utilities with a Monte Carlo Markov Chain algorithm by "borrowing" data from population information i.e. means and covariances (Sawtooth Software, Inc., 2009).

The hierarchical model has two levels. The higher level describes individual’s part worth utilities by a multivariate normal distribution:

$$\beta_i \sim \text{Normal}(\alpha, D)$$

where β_i is "a vector of part worths for the i^{th} individual", α is "a vector of means of the distribution of individuals' part-worths" and D is a matrix of variances and covariances of the distribution of part-worths across individuals" (Sawtooth Software, Inc., 2009, p. 7).
The lower and second level estimates the probability of choosing a concept, given the individual part-worth is governed by a multinomial logit model (Sawtooth Software, Inc., 2009). The probability p_k of the i^{th} individual choosing the k^{th} concept in a particular task is

$$p_k = \exp(x_k' \beta_i) / \Sigma_j \exp(x_j' \beta_i)$$

where x_j is a vector of values describing the j^{th} alternative in that choice task (Sawtooth Software, Inc., 2009).
The parameters to be estimated are the vectors β_i of part-worths for each individual, the vector α of means of the distribution of regression weights, the matrix D of the variances and covariances of that distribution. (Sawtooth Software, Inc., 2009).

3.3 Selection of Attributes and Levels for the Choice-based Conjoint

Having chosen the general research method - CBC analysis -, the next step for the set-up of the study is to carefully select attributes and levels. From the literature review it can be seen that economic, environmental and quality-related reasons are influencing consumers when purchasing resource-recovered or life-extended products. Hence, attributes for the conjoint analysis have been defined accordingly. The choice of different levels belonging to these attributes are sought to offer a deeper understanding towards distinct preference shifts from one combination to another.

The first attribute derives from the circular **business model**. In the case of smartphones, this is either Resource Recovery or Product-Life Extension (for more specific explanation see chapter 2.2.1). Converting these into the consumer perspective, they can decide between a 'remanufactured/refurbished smartphone' or a 'smartphone made of recycled materials'. In order to ensure that respondents understand the differences between those types of products, in the survey they are exposed to the definitions of 'remanufactured/refurbished smartphones' as well as 'smartphones made of recycled materials', which are additionally underlined by pictograms *(see below).*

'A remanufactured/refurbished phone is a phone that has been used (thus second-hand) and returned into a good working condition by disassembly, cleaning, replacing and/or repairing major components that are faulty, damaged or close to failure.'

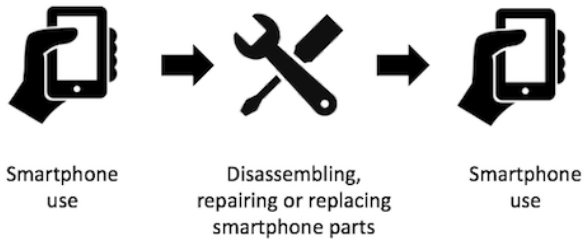

Figure 10 Extract from the survey describing a Remanufactured/ Refurbished smartphone in pictograms

'A *phone made of recycled materials* means that the materials used to produce this phone are not originally extracted from mines, but they are recovered from other products, are then recycled and used to produce the phone.'

Figure 11 Extract of the survey describing a smartphone made of recycled materials in pictograms

The second attribute in this CBC analysis is **price**. Manufacturers save costs, when selling recycled or remanufactured/refurbished smartphones in comparison to new ones. Additionally, literature shows that consumers would only purchase circular products if they are comparably lower priced than conventional products. In order to test previously defined hypotheses and WTP, price levels will be chosen so that circular smartphones are at the most 40% cheaper than a new phone. Different companies, offering refurbished smartphones use price reduction in this range (*Backmarket*, 2020; *Refurbed.at*, 2020) and also Apple has sold the Iphone 11, which is partly made of recycled materials around 30% cheaper than previous launches (Miller, 2019).

The respondent must hence compare between a new phone with a price of € 800 (this price is reflecting the majority of the most popular smartphone brands within the last decade (Patel, 2019)) and circular phones with price reductions of 20, 30 and 40%. Concrete levels of this attribute are therefore €640/ €560/ €480, which are absolute prices, reflecting -20% / -30% / -40% of the price the new smartphone.

Third, deriving from the literature review, environmental benefits are an important attribute for decision-makers. Therefore, the next attribute is going to be '**savings in CO2 emissions'**. The company *Refurbed* posits that refurbishing can save up to 70% of CO2 emissions in comparison to manufacturing a new phone, which they even add up to 100% by planting a tree for each sold refurbished phone (*Refurbed.at*, 2020). Further, Lieder et al. (2018) let respondents choose between remanufactured washing machines, accounting for 30% or 50% CO2 reduction. Deriving from previous literature as well as practical facts, linear levels as a percentage of emissions when manufacturing a new smartphone have been chosen: 30% / 50% / 80% savings in CO2 emissions compared to a new smartphone. A rationale for the choice, also presented to respondents, is the fact, that CO2 savings depend on the amount of recycled materials used (for phones made of recycled materials) and the number of parts changed/repaired (for remanufactured/refurbished phones).

Fourth, as an indicator for quality, granted **warranty** for the phone will be used. It is assumed that consumers will perceive a smartphone as of higher quality/condition, the higher the warranty of this phone is. Aligned with warranties issued by refurbed.at and backmarket.at levels will be from 6 to 24 months (*Backmarket*, 2020; *Refurbed.at*, 2020). In the survey, subjects will have to choose between 6 / 12 / 24 months of warranty.

Important to note generally, is that in order to understand preferences, this study considers trade-offs among attributes such as price, environmental impact and quality, as well as other 'unknown' attributes, related to consumer's perception to the type of phone (translating into the business model fit).
Further, this study intends to investigate the WTP for circular smartphones. And as literature suggests that consumers consider both, the price of the remanufactured as well as the price of the conventional product, when taking their purchase decision (Hazen et al., 2017; Michaud & Llerena, 2011), it is necessary to offer respondents a reference point, in this case namely conventional smartphones. Hence, in this study, the subject is always asked to compare the

products generated by the conjoint with a reference ‘new smartphone with a price of 800€’. In order to emphasis this once again, in the end of a task, the subject is always asked if he/she would really buy the phone on the marketplace or rather prefers a new smartphone. Sawtooth Software calls this type of reality check dual- response None option. This type of none has the advantage of increasing the number of respondents who tick ‘no’, which better reflects the real purchase decision than a ‘normal’ none option (*CBC/HB V5*, 2016).

Table 1 summarizes all attributes and levels for this conjoint analysis. *Figure 12* shows how an exemplary task looks like for the respondent of this survey.

ATTRIBUTES	**LEVELS**
Business Model	Remanufactured/ Refurbished phone
	Phone made of recycled materials
Price	€640 (20% difference to a new phone)
	€560 (30% difference to a new phone)
	€480 (40% difference to a new phone)
Savings in CO2 emissions	30%
	50%
	80%
Warranty	6 months
	12 months
	24 months

Table 1 *Attributes and Levels*

Figure 12 Example for one task of the survey

3.4 Designing the Choice-based Conjoint Analysis

Full factorial design. First of all, in this master's thesis, a full factorial design will be used. A full factorial design is a CBC design which enables all combinations of levels of an attribute with all levels of every other attribute. On the contrary, a fractional factorial design considers only a smaller share of all attributes and levels and therefore excludes some combinations. Fractional factorial designs are chosen when the number of attributes and levels is too high in order to assess all possible effects.
In this thesis, however, with 4 attributes and 2x3x3x3 = 54 combinations of levels, the number of chosen levels and attributes is sufficiently small to fulfill the requirements of a full factorial design - which is the best option to choose (Louviere et al., 2000; Rao, 2013).
A full factorial design is further beneficial since it is able to guarantee independence of each attribute, which is of very high statistical value - in comparison to a fractional factorial design (Louviere et al., 2000; Rao, 2013).

Randomized versus fixed design. In this thesis, an entirely randomized design is chosen. Instead of inserting fixed concepts into the study, the Sawtooth software has generated the concepts, thus the choice sets, randomly. Further, versions differ among respondents, thus every subject receives a randomly selected choice set (Chrzan & Orme, 2000). Randomized designs are advantageous when the aim is to analyze all interactions possible, even though previous to the study they might have not been assessed as important. When working with not yet known combination of features on the market, as it is the case for this study, it enables researchers to entirely assess the importance of each combination unbiased. Since it is yet unknown how consumers value the circular business model or level of CO2 reduction when it comes to smartphones, with a randomized design it is possible to find out how important the different combinations of price, quality, sustainability and type of phone are (Hill, 2017; *Sawtooth Software Inc.*, 1999).

Principles of randomized designs – Evaluation criteria of randomized designs. Randomized CBC designs follow three different principles, used to evaluate designs and assess their statistical efficiency. These principles are referred to as Minimal Overlap, Level Balance and Orthogonality (Hill, 2017).
Minimal Overlap is a criterion, aiming to achieve a low amount of overlap of levels within a task. Algorithms are trying to maximize diversity among levels within a task. Hence, for

example, if each attribute of a study has three levels, in a task with three concepts, each level would be shown once (Hill, 2017).

With Level Balance and thus, utility balance, researchers target to put each level equally often into a choice set (Hill, 2017; Rao, 2013). Referencing Rao (2013) this ensures that the "utilities of the alternatives in a choice set are approximately equal" and "the variance of the probabilities of choice of alternatives within a choice set will be reduced" (p. 138).

Orthogonality, as a third design evaluation criterion, implies that levels are chosen in a way that they are not depending on other levels of attributes. Researchers must be able to evaluate the utility of a level independently from other levels (Hill, 2017; Rao, 2013).

Four methods for randomized design in the tool. Sawtooth software offers four design methods for randomized designs. They are depicted as follows: complete enumeration, shortcut method, balanced overlap and random method.

Complete enumeration strategy takes all possible combinations, thus concepts into account and chooses them in a way for the subject to provide the most nearly orthogonal design. Further, a complete enumeration design ensures minimal overlap within a task; thus, concepts are shown to be as diverse as possible within each task (Hill, 2017; *Sawtooth Software Inc.*, 1999).

When using **the shortcut method,** the software computes the concepts based on previous concepts shown to one single respondent. If some attributes and levels have already been used a lot, they will show in fewer numbers in the upcoming concepts. The shortcut method manages the principle of minimum overlap as well as the complete enumeration method (Hill, 2017; *Sawtooth Software Inc.*, 1999).

A third strategy offered by the Sawtooth Software is the **random method**. By random sampling of choice sets, it permits overlaps within concepts as well as completely identical concepts within single tasks. Allowing overlap within tasks can be advantageous when the main focus of the study is to evaluate interaction effects. When it comes to main effect analysis, this method, however, has a very low efficiency rate (Hill, 2017; *Sawtooth Software Inc.*, 1999).

Fourth, the so-called **balanced overlap** strategy enables a happy medium between the complete enumeration and random method. It allows less overlaps than the random strategy, however, still permits level-overlap within tasks (Chrzan & Orme, 2000; Hill, 2017; *Sawtooth Software Inc.*, 1999).

Choosing a design strategy for the study. Latest research found that study designs, providing a low amount of overlap, are very efficient when it comes to the investigation of main effects. In

contrast, designs with a high level of overlap are suited very well for examining interaction effects (Chrzan & Orme, 2000).

As a result, Sawtooth software Inc. recommends using a mixture of both for CBC studies, hence guaranteeing at least some amount of overlap (Hill, 2017). Overlap can be achieved by either choosing strategies such as balanced overlap and random strategy or by allowing more concepts per task than the number of levels of each attribute.

In order to keep the information, respondents have to process, as low as possible, it is appropriate to offer not more than 3 concepts per task. Consequently, overlap has to be achieved through the choice of design – either by using balanced overlap or random strategy design. The Sawtooth tool enables to test the study design upfront and gives an estimation on how strong the designs are. By testing Balanced Overlap and Random strategy for the set-up design, comprising 9 tasks with 3 concepts each and approximately 150 participants (as this was the target sample size), it was shown that Balanced Overlap exceeded the strength of Random strategy. Further, standard errors for attribute levels were overall smaller in the Balanced Overlap design *(see annex for further details).*

3.5 Pretest and Data collection

Having set up the study and conducted the testing of design in Sawtooth, the next step before launching the survey has been the conduction of a pretest. The survey was sent to six people, in order to check for comprehension issues as well as to ensure the dual control principle. Afterwards, some minor changes were made – especially the visual explanation of remanufactured/refurbished phones and phones made of recycled materials (see chapter 3.1.2). After that, the study was hosted on a Sawtooth-owned server. In order to reach the goal of 150 study participants, the survey link has been sent to the researcher's extended network, three postings on LinkedIn were made (to a Sustainability and CE group and to the overall public). Data collection was concluded with a Facebook posting. Data collection took place from 18.06.2020 – 29.06.2020.

4. Results

This chapter presents the results of the survey. First it provides an overall description of the sample. This is followed by a simple Counts analysis of the data. In the third part of this chapter the utilities will be estimated in order to receive the importance of each attribute. Demographic data will be cross analyzed, and in the last chapter, results of the WTP estimation will be presented.

4.1 Sample Description

In total 213 respondents answered the study of which 161 completed the whole survey. Consequently, the final sample is 161. In order to receive a better picture about the collected data, this chapter describes the sample, examining the distribution of age, gender, income and educational background.

Figure 13 shows the age distribution of the sample in years. The majority of respondents were between 20 and 30 years old (76.4%).

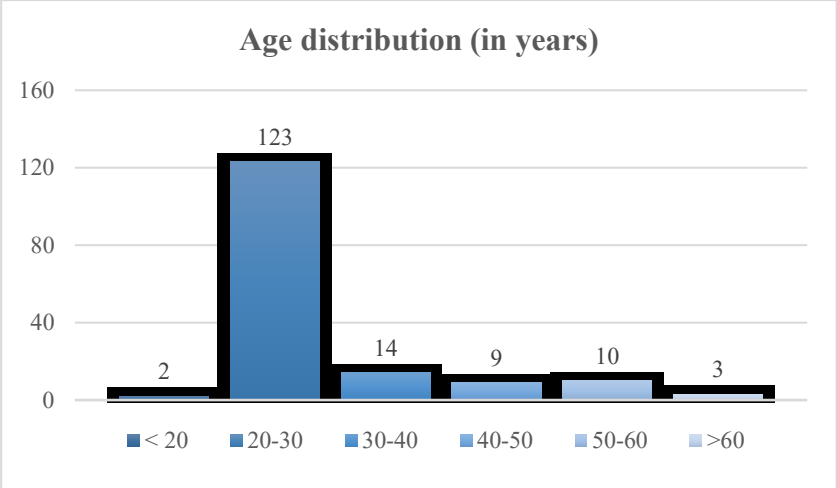

Figure 13 Age distribution

Of the 161 respondents that have answered the survey completely, 86 subjects (53.4%) were female and 75 (46.6%) male. In this respect the sample is rather balanced *(*see *Figure 14).*

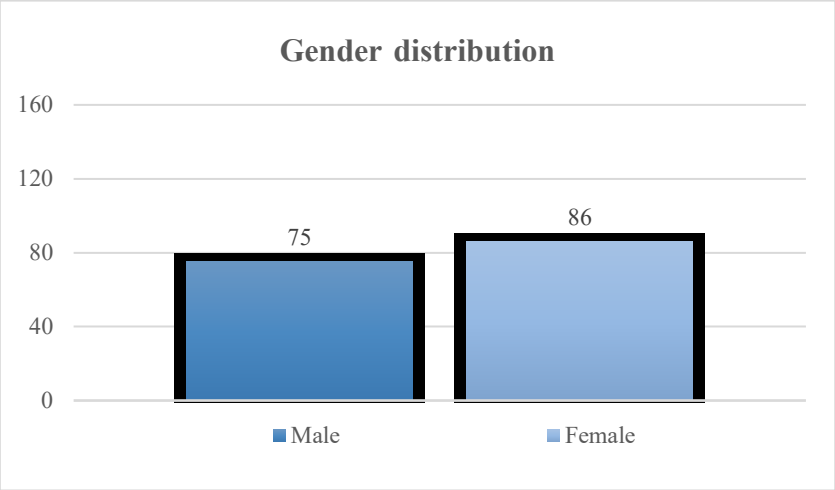

Figure 14 Gender distribution

When it comes to income distribution, 56 respondents claimed to have a net income below €1000, which are approximately 34.8%. 50 people (31.1%) said to have between €1000 and €2000 at their monthly disposition, 38 (23.6%) have a monthly net income between €2000 and €3500 and 17 subjects (10.6%) earn above €3500 net per month (see the data in *Figure 15*). Average

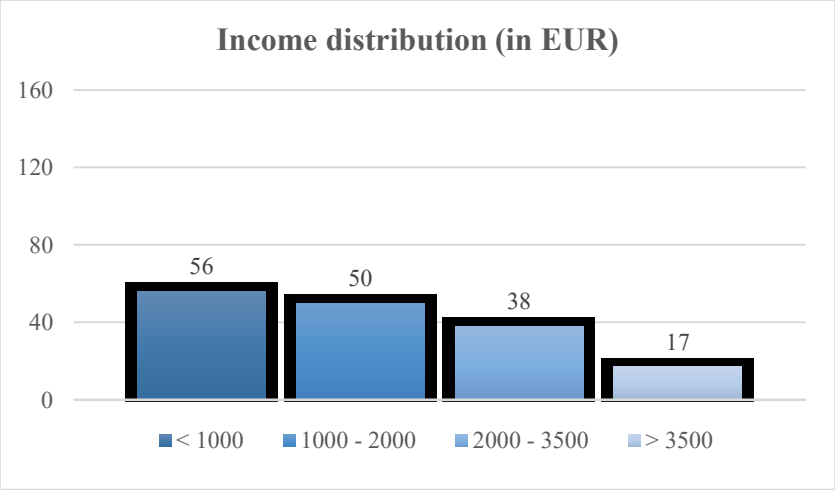

Figure 15 Income distribution

The last question on demographics was targeting the educational background of the respondents. Survey data shows that 30 of the 161 respondents (18.6%) indicated to have a high school diploma as their highest educational level. 77 people (47.8%) indicated to have a bachelor's degree, 52 (32.3%) a master's degree and 2 (1%) to be a PhD or equivalent.

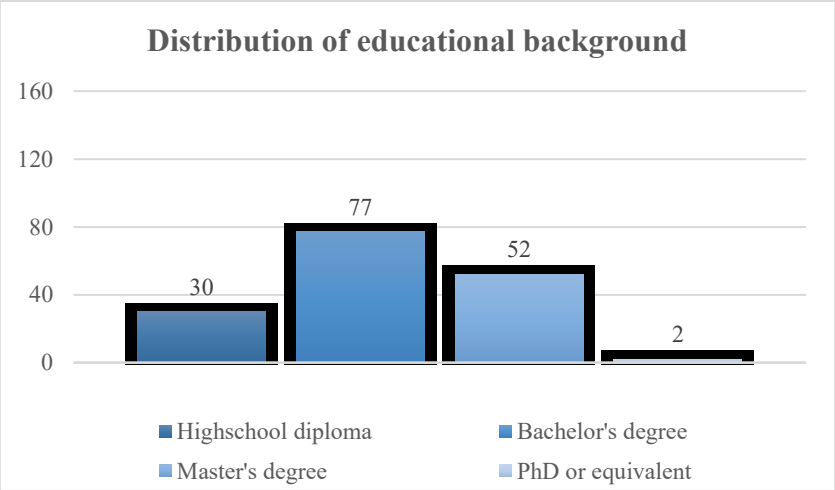

Figure 16 Distribution of educational background

4.2 Counts Analysis

In order to get a first impression of the data collected, Sawtooth recommends the so-called Counts analysis. The counts analysis provides an overview on how often a level has been chosen by respondents, relative to the overall appearance of this level in the survey. Hence, in this type of analysis the software counts the number of a level chosen and divides it by the appearance of that level. Overall, the relative importance of each level can be derived.

Main Effects. The main effects analysis shows for each level, the proportion of how many times it has been chosen relative to the times it occurred in the accumulated survey data. The outcomes of analyzing main effects for each level are depicted in *Table 2.*

Business Model	
	Total
Total respondents	161
Reman. /Refurb. Smartphone	0.306
Smartphone made of recycled materials	0.361
Within Att. Chi-Square	9.938
D.F.	1
Significance	**p< 0.01**

Savings in CO2 emissions	
	Total
Total respondents	161
30% savings in CO2 emissions	0.203
50% savings in CO2 emissions	0.314
80% savings in CO2 emissions	0.483
Within Att. Chi-Square	173.317
D.F.	2
Significance	**p< 0.01**

Price	
	Total
Total respondents	161
€ 640 (-20%)	0.197
€ 560 (-30%)	0.309
€ 480 (-40%)	0.494
Within Att. Chi-Square	196.104
D.F.	2
Significance	P< 0.01

Warranty	
	Total
Total respondents	161
6 months	0.181
12 months	0.356
24 months	0.463
Within Att. Chi-Square	176.063
D.F.	2
Significance	p< 0.01

Table 2 Main effects - Counts analysis

Generally, the data shows that each attribute was significant with a p-value smaller than 0.01. In other words, each attribute had a significant impact on choice.

Looking at the single attributes, comparing the counts, it can be seen that for **'Business Model'** respondents chose 'smartphone made of recycled materials' a little more often than 'remanufactured/refurbished smartphone' (36.1% vs. 30.6%). Since this attribute only consists

of two levels, and at the same time subjects had to choose between three concepts, in each task one of the two levels was shown twice. This is why the relative choices of these levels don't add up to 1. In order to receive a better comparison, the proportions need to be adapted by dividing them by the sum of the two. Hence, 0.306/0.667= 0.459 and 0.361/0.667= 0.541 results in a relative importance of remanufactured/refurbished phone (45.9%) and phone made of recycled materials (54.1%). That is, respondents chose phones made of recycled materials around 8% more often than remanufactured/refurbished smartphones.

The highest '**savings in CO2'** emissions have been chosen more than double as often as the lowest savings in CO2 emissions (48.3% vs. 20.3%). Medium savings in CO2 emissions have been chosen approximately 30% of the time they occurred.

For the attribute **'Price'** it can be derived that respondents chose the cheapest price level 2.5 times as often as the most expensive one (49.4% vs. 19.7%). Hence, the cheapest price level was chosen in approximately 50% of the cases it has showed up.

The highest '**warranty'** of 24 months was selected 46.3% of the times it occurred, whereas the lowest warranty of 6 months was only selected 18.1% of the times it was shown. The warranty of 12 months was chosen 35.6% of the times.

Interaction effects. Within the Counts analysis, Sawtooth software also calculates interaction Chi-Square tests for all attributes. Overall, only one interaction has shown to be significant with a p-value smaller than 0.01. The attributes 'Savings in CO2 emissions' and 'Price' have shown to interact from this analysis. *Table 3* depicts how often a combination of levels was chosen relative to the number this combination appeared in the survey.

First, at each of the price levels, the likelihood to choose a concept increases, the higher the CO2 savings of this concept. Further, results show that the combination of the highest savings in CO2 emission with the lowest price were most popular, selected 66.5% of the time it occurred. Interestingly, the combination of the highest price and highest savings in CO2 was more popular than the combination of any price with 30% savings in CO2 emissions (34.2% vs. 32.7%, 19.0% & 8.8%) (see also marked line in *Figure 17*). 'Highest price and highest savings' was even more popular than middle savings and middle price. Hence, for this scenario, respondents were more likely to choose a higher over a lower price, if savings were correspondingly higher. Further, Figure 17 visualizes that for the highest price, the likelihood to choose the scenario increases extensively, when switching from 50% to 80% savings in CO2 emissions. This increase is not as dramatically at the other price levels *(*see *Figure 17).*

Price X Savings in CO2 emissions		
		Total
Total respondents		161
€ 640 (-20%)	30% savings in CO2 emissions	0.088
€ 640 (-20%)	50% savings in CO2 emissions	0.158
€ 640 (-20%)	80% savings in CO2 emissions	**0.342**
€ 560 (-30%)	30% savings in CO2 emissions	0.190
€ 560 (-30%)	50% savings in CO2 emissions	0.294
€ 560 (-30%)	80% savings in CO2 emissions	0.444
€ 480 (-40%)	30% savings in CO2 emissions	0.327
€ 480 (-40%)	50% savings in CO2 emissions	0.497
€ 480 (-40%)	80% savings in CO2 emissions	0.665
Within Att. Chi-Square		**15.393**
D.F.		**4**
Significance		**p <0.01**

Table 3 Interaction effects - Counts analysis

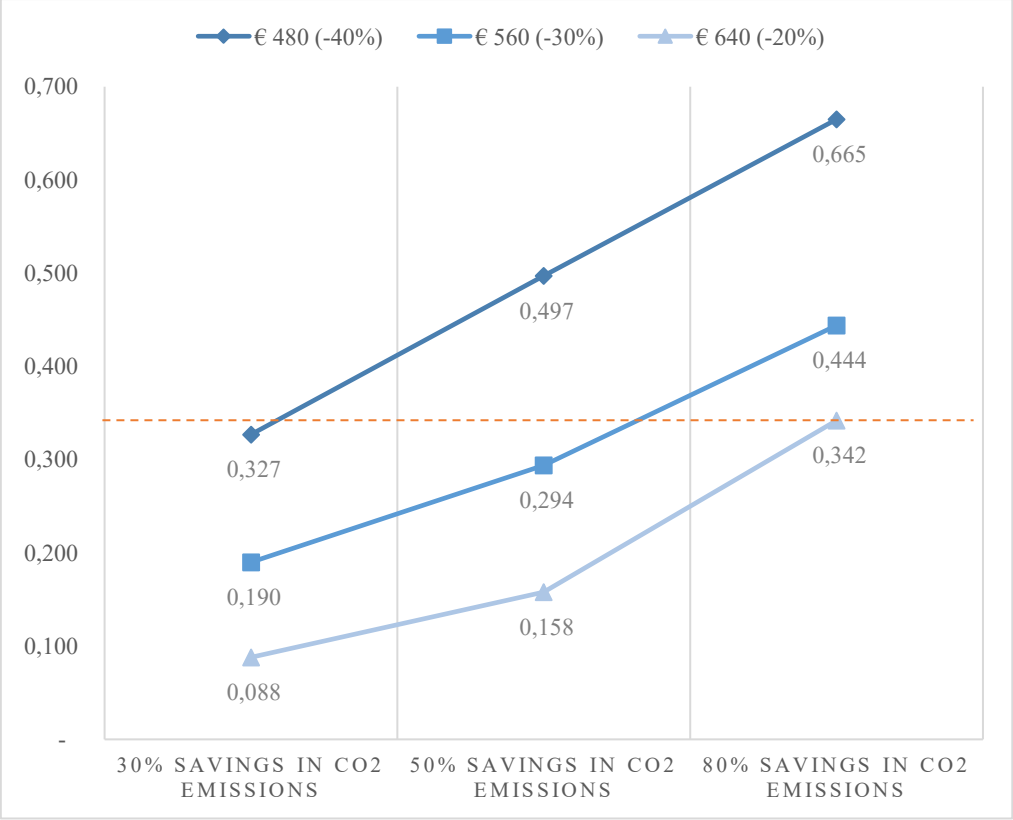

Figure 17 Interaction effects - Counts analysis

4.3 Part-worth utility estimation

While Counts analysis only provides an overall picture, HB estimation has proved to be the most popular method of analysis for the estimation of part-worth utilities in CBC Studies (Howell, 2009). Sawtooth Software has calculated the part-worth's, following the research model, described in chapter 3.2. Average part-worth utilities for each level are depicted in *Table 4*.

Attribute - Levels	Average Utilities	Standard Deviation	Lower 95% CI	Upper 95% CI
Business Model				
Remanufactured/Refurbished Smartphone	-12.37	28.26	-16.74	-8.01
Smartphone made of recycled materials	12.37	28.26	8.01	16.74
Price				
€ 640 (-20%)	-57.53	38.03	-63.40	-51.66
€ 560 (-30%)	1.99	15.10	-0.34	4.32
€ 480 (-40%)	55.54	36.47	49.90	61.17
Savings in CO2 emissions				
30% savings in CO2 emissions	-57.13	33.30	-62.28	-51.99
50% savings in CO2 emissions	3.01	9.61	1.52	4.49
80% savings in CO2 emissions	54.13	29.75	49.53	58.72
Warranty				
6 months	-63.90	42.29	-70.43	-57.36
12 months	17.30	18.07	14.51	20.09
24 months	46.60	42.86	39.98	53.22
NONE	-78.55	149.82	-101.69	-55.40

Table 4 HB analysis - Average part-worth utilities

The part-worth utilities in the above table show the likelihood a concept was selected, if the specific level was included in this concept. Within an attribute, the part-worth utilities sum up to zero due to rescaling of utilities. A high positive utility value for a specific level means that the respondents' likelihood to choose a concept was high, if this level was included. On the contrary, a high negative utility value suggests that the respondent's likelihood to select a concept was low, if it contains a specific level. Findings show that the overall utility for smartphones made of recycled materials is higher than the one of remanufactured/refurbished

smartphones. That means, all other levels being equal, for respondents, phones made of recycled materials present a higher utility and therefore more benefit.
Price, warranty and savings in CO2 emissions clearly show predictable patterns. Respondents' likelihood to choose a concept was highest for the cheapest price i.e. € 480 and lowest for the highest price € 640 (55.5 vs. – 57.5). The same holds for the attribute 'savings in CO2 emissions'. If the level '30% savings in CO2 emissions' was part of a concept it was the least likely to be chosen (-57.1). Consistent with the previous attribute, the level '80% savings in CO2 emissions' had the highest utility with 54.1. Regarding warranty, also the highest warranty was the level with the highest utility and vice versa. Interestingly, however, the difference in utilities between 6 months warranty and 12 months warranty is substantially higher (approx. by 80) than the difference in utilities between 12 and 24 months (approx. by 29).

HB Estimation further provides an overview on the average importance of attributes in a CBC analysis. Average importance of attributes and standard deviations are depicted in *Table 5.*

Attribute	Average Importance	Standard Deviation	Lower 95% CI	Upper 95% CI
Business Model	10.95	10.84	9.28	12.63
Price	29.67	16.57	27.11	32.23
Savings in CO2 emissions	28.31	14.72	26.03	30.58
Warranty	31.07	16.80	28.47	33.66

Table 5 HB analysis - Average Importance of attributes

Results show that the average importance was highest for warranty. That is, for respondents, the level of warranty was pivotal in their choice of a specific concept. Therefore, warranty was on average even more important than price. In addition, interesting to see is that price, savings in CO2 emissions and warranty are relatively similarly important to subjects with a value of around 30%. Only the attribute Business Model shows a substantially lower importance in comparison to the other attributes. It can be claimed that respondents attribute only approximately 66% less importance to the business model than they do to the other features. In other words, price, savings in CO2 emissions and warranty are three times more important for respondents than the type of the phone, thus the business model.

4.4 Willingness-to-pay estimation (Market Simulation Results)

In order to receive a more managerially useful view on results of the study, the market simulator - a tool offered by Sawtooth Software - was utilized for further analysis. According to Orme (2010) choice simulation is the most important tool, when analyzing results from CBC analysis. It transforms raw conjoint data (part-worth utilities) – in this case received through HB estimation - into actual market choices.

Market simulation helps determining the decision-makers' WTP by assessing the price at which respondents are preferring to choose one set over another. In this chapter, first, the overall acceptance of circular phones, compared to new phones will be tested, second, the impact of different attributes on the choice of remanufactured/refurbished smartphones and smartphones made of recycled materials will be simulated and third, estimated preference shares are used to differentiate consumer choices between the two types of smartphones. Simulation was based on the randomized first choice approach.

Comparison of remanufactured/refurbished smartphones, smartphones made of recycled materials and new smartphones

Remanufactured/Refurbished smartphones vs. smartphones made of recycled materials vs. new (none)
All other parameters being equal (price: €560, warranty: 12 months, savings in CO2 emissions: 50%)

	Shares of Preference	Std Error	Lower 95% CI	Upper 95% CI
Remanufactured/Refurbished smartphone	34.8%	2.0%	30.8%	38.8%
Smartphone made of recycled materials	48.2%	2.1%	44.1%	52.3%
Buy new smartphone instead (None)	17.0%	2.3%	12.5%	21.4%

Table 6 Remanufactured/Refurbished smartphone vs. smartphone made of recycled materials vs. new

In the first step consumer choice between a remanufactured/refurbished smartphone and a smartphone made of recycled materials was simulated. Further, the respondents who ticked in the second step 'In reality, I would not choose the phone, but rather buy a new one', are in the above table shown as 'nones'. Keeping all other parameters equal (at middle price, middle warranty and middle CO2 emissions), resulting preference shares show that 34.8% would choose the remanufactured/refurbished smartphone, 48.2% would buy the one made of recycled materials and 17% would reject the two and rather buy the conventional, new smartphone. As a result, and consistent with the findings above, consumers prefer the smartphone made of recycled materials over the remanufactured/refurbished one. Further, under the set conditions, only less than one fifth of the respondents would decide for the new smartphone.

The impact of environmental benefits on the WTP

The impact of environmental benefits on the WTP for remanufactured/refurbished smartphones.

Determining the impact of environmental benefits on the WTP, every scenario was simulated against the none option, which in this specific case indicates for respondents to refuse the remanufactured/refurbished phone, but to buy the new smartphone instead. *Table 7* shows the shares of preferences for the remanufactured/refurbished phone at each level of savings in CO2 emissions, while increasing the price of the phone. Warranty is fixed to six months.

WTP Remanufactured/Refurbished smartphone – Impact of savings in CO2 emissions
All other parameters being equal (Type of phone: remanufactured/refurbished, warranty 6 months)

	Shares of Preference	Std Error	Lower 95% CI	Upper 95% CI
Price €480				
Buy remanufactured/refurbished (30% savings in CO2)	60.0%	3.3%	53.5%	66.5%
Buy new smartphone instead (none)	40.0%	3.3%	33.5%	46.5%
Buy remanufactured/refurbished (50% savings in CO2)	69.6%	3.2%	63.2%	75.9%
Buy new smartphone instead (none)	30.4%	3.2%	24.1%	36.8%
Buy remanufactured/refurbished (80% savings in CO2)	75.3%	3.1%	69.3%	81.3%
Buy new smartphone instead (none)	24.7%	3.1%	18.7%	30.7%
Price €560				
Buy remanufactured/refurbished (30% savings in CO2)	47.4%	3.1%	41.4%	53.5%
Buy new smartphone instead (none)	52.6%	3.1%	46.5%	58.6%
Buy remanufactured/refurbished (50% savings in CO2)	61.1%	3.4%	54.5%	67.7%
Buy new smartphone instead (none)	38.9%	3.4%	32.3%	45.5%
Buy remanufactured/refurbished (80% savings in CO2)	68.1%	3.3%	61.7%	74.5%
Buy new smartphone instead (none)	31.9%	3.3%	25.5%	38.3%
Price €640				
Buy remanufactured/refurbished (30% savings in CO2)	19.3%	1.8%	15.7%	23.0%
Buy new smartphone instead (none)	80.7%	1.8%	77.0%	84.3%
Buy remanufactured/refurbished (50% savings in CO2)	44.1%	3.0%	38.1%	50.0%
Buy new smartphone instead (none)	55.9%	3.0%	50.0%	61.9%
Buy remanufactured/refurbished (80% savings in CO2)	57.5%	3.4%	50.9%	64.0%
Buy new smartphone instead (none)	42.5%	3.4%	36.0%	49.1%

Table 7 WTP Remanufactured/Refurbished smartphone - the impact of savings in CO2 emissions

Simulation results reveal that at a price of €480, respondents would always choose the remanufactured/refurbished smartphone over the new one (marked in green). In other words, if offered at the lowest price, regardless of the offered savings, the remanufactured/refurbished smartphone is the preferred one. At the middle price (€560), the majority of respondents would go for the new phone, if savings were only at a level of 30%. However, an increase in savings to 50% already shifts the majority of respondents to the remanufactured/refurbished phone. That is, for an environmental benefit of 50% savings in CO2 emissions, the majority of respondents is ready to pay €560 for a remanufactured/refurbished phone and refuses to buy the new phone. Further, at the highest price level, respondents are only ready to buy the remanufactured/refurbished smartphone if savings in CO2 emissions exceed 50%. At savings of 30 or 50% in CO2 emissions, consumers would rather buy the new phone instead of the remanufactured/refurbished one. Interestingly, at any of the price levels, the increase from 50% to 80% has a lower effect on the preference share for remanufactured/refurbished phones, than the one from 30% to 50%. This is particularly interesting since the difference between 30 and 50% is actually only 20% whereas the increase from 50 to 80% is higher with 30% increase. Putting it the other way around to be consistent with the hypothesis formulation: at emissions savings of 30%, the majority of respondents would only be ready to pay a price of €480 for the remanufactured/refurbished phone and not more. At 50% savings, the respondents would be ready to buy it at a price of €560, and only if the phone offers 80% savings, the majority of respondents would be ready to pay the highest price: €640.

Hypothesis 1a: All parameters being equal, the higher the environmental benefit, the higher the consumers' WTP for a remanufactured/refurbished phone – supported

The impact of environmental benefits on the WTP for smartphones made of recycled materials.

When examining the impact of environmental benefits on the WTP for smartphones made of recycled materials, overall results suggest similar findings as for remanufactured/refurbished phones. Consistent with previous findings, at each single price, the increase of savings in CO2 emissions results in an increase of preference shares for smartphones made of recycled materials and in a decrease of preference shares for the alternative new smartphone *(Table 8).*

WTP smartphone made of recycled materials – Impact of savings in CO2 emissions
All other parameters being equal (Type of phone: recycled, warranty 6 months)

	Shares of Preference	Std Error	Lower 95% CI	Upper 95% CI
Price €480				
Buy recycled (30% savings in CO2)	65.6%	3.1%	59.4%	71.7%
Buy new smartphone instead (none)	34.4%	3.1%	28.3%	40.6%
Buy recycled (50% savings in CO2)	75.0%	3.0%	69.2%	80.8%
Buy new smartphone instead (none)	25.0%	3.0%	19.2%	30.8%
Buy recycled (80% savings in CO2)	80.9%	2.7%	75.6%	86.3%
Buy new smartphone instead (none)	19.1%	2.7%	13.7%	24.4%
Price €560				
Buy recycled (30% savings in CO2)	52.4%	3.1%	46.4%	58.4%
Buy new smartphone instead (none)	47.6%	3.1%	41.6%	53.6%
Buy recycled (50% savings in CO2)	65.8%	3.2%	59.5%	72.0%
Buy new smartphone instead (none)	34.2%	3.2%	28.0%	40.5%
Buy recycled (80% savings in CO2)	73.8%	3.0%	68.0%	79.7%
Buy new smartphone instead (none)	26.2%	3.0%	20.3%	32.0%
Price €640				
Buy recycled (30% savings in CO2)	24.6%	2.1%	20.4%	28.7%
Buy new smartphone instead (none)	75.4%	2.1%	71.3%	79.6%
Buy recycled (50% savings in CO2)	48.3%	3.0%	42.4%	54.1%
Buy new smartphone instead (none)	51.7%	3.0%	45.9%	57.6%
Buy recycled (80% savings in CO2)	62.0%	3.1%	55.8%	68.1%
Buy new smartphone instead (none)	38.0%	3.1%	31.9%	44.2%

Table 8 WTP Smartphone made of recycled materials - the impact of savings in CO2 emissions

Exactly like for the remanufactured/refurbished smartphone, results for the recycled one suggest that respondents would prefer the recycled over the new phone regardless of savings, if the price is fixed at €480. However, unlike the remanufactured/refurbished smartphone, subjects would also prefer the recycled phone regardless of savings at a price of €560. That means, the WTP for smartphones made of recycled materials is higher than for remanufactured/refurbished phones.

Increasing the price to €640, the savings need to be above 50% in order for respondents to choose the recycled over the new phone. Hence, for smartphones made of recycled materials, savings have a major impact on the WTP a price of €640 and, more particularly, on the shift from the middle to the high price.

Hypothesis 1b: All parameters being equal, the higher the environmental benefit, the higher the consumers' WTP for a phone made of recycled materials – supported

The impact of warranty on the WTP

The impact of warranty on the WTP for remanufactured/refurbished smartphones.

Examining the impact of warranty on WTP, again preference shares for the remanufactured/refurbished phone in comparison to the none-option (= buying the new phone instead) have been simulated. *Table 9* depicts results of the market simulation, increasing price levels for different warranty levels of remanufactured/refurbished smartphones.

WTP Remanufactured/Refurbished smartphone – Impact of warranty
All other parameters being equal (Type of phone: remanufactured/refurbished, 30% savings in CO2 emissions)

	Shares of Preference	Std Error	Lower 95% CI	Upper 95% CI
Price €480				
Buy remanufactured/refurbished (6 months warranty)	60.0%	3.3%	53.5%	66.5%
Buy new smartphone instead (none)	40.0%	3.3%	33.5%	46.5%
Buy remanufactured/refurbished (12 months warranty)	77.2%	2.9%	71.5%	82.9%
Buy new smartphone instead (none)	22.8%	2.9%	17.1%	28.5%
Buy remanufactured/refurbished (24 months warranty)	80.8%	2.7%	75.5%	86.2%
Buy new smartphone instead (none)	19.2%	2.7%	13.8%	24.5%
Price €560				
Buy remanufactured/refurbished (6 months warranty)	47.4%	3.1%	41.4%	53.5%
Buy new smartphone instead (none)	52.6%	3.1%	46.5%	58.6%
Buy remanufactured/refurbished (12 months warranty)	70.5%	3.2%	64.3%	76.6%
Buy new smartphone instead (none)	29.5%	3.2%	23.4%	35.7%
Buy remanufactured/refurbished (24 months warranty)	75.2%	3.0%	69.3%	81.1%
Buy new smartphone instead (none)	24.8%	3.0%	18.9%	30.7%
Price €640				
Buy remanufactured/refurbished (6 months warranty)	19.3%	1.8%	15.7%	23.0%
Buy new smartphone instead (none)	80.7%	1.8%	77.0%	84.3%
Buy remanufactured/refurbished (12 months warranty)	51.7%	2.9%	45.9%	57.4%
Buy new smartphone instead (none)	48.3%	2.9%	42.6%	54.1%
Buy remanufactured/refurbished (24 months warranty)	59.9%	3.1%	53.9%	66.0%
Buy new smartphone instead (none)	40.1%	3.1%	34.0%	46.1%

Table 9 WTP Remanufactured/Refurbished smartphone - the impact of warranty

Findings suggest that at a warranty of 6 months, respondents would only be willing to pay €480 for a remanufactured/refurbished smartphone. At higher prices (€560 & €640), the majority would shift to buying a new phone instead.

Further, increasing the warranty to 12 months has a relatively big impact on the respondents' WTP for remanufactured/refurbished smartphones. Already at this warranty, the majority of respondents is ready to pay the highest price for the remanufactured/refurbished phone instead of choosing the new smartphone. Same holds, obviously for a warranty of 24 months, where again 8% more would buy the circular phone for €640. Interestingly, the preference shares increase a lot more dramatically when raising warranty from 6 to 12 months relatively to the improvement from 12 to 24.

Hypothesis 2a: All parameters being equal, the higher the warranty, the higher the consumers' WTP for a remanufactured/refurbished phone – supported

The impact of warranty on the WTP for smartphones made of recycled materials.

Consistent with the findings on the impact of warranty on remanufactured/refurbished smartphones, results show an impact on phones made of recycled materials as well. *Table 10* summarizes simulations results in this regard.

WTP smartphone made of recycled materials– Impact of warranty
All other parameters being equal (Type of phone: recycled, 30% savings in CO2 emissions)

	Shares of Preference	Std Error	Lower 95% CI	Upper 95% CI
Price €480				
Buy recycled (6 months warranty)	65.6%	3.1%	59.4%	71.7%
Buy new smartphone instead (none)	34.4%	3.1%	28.3%	40.6%
Buy recycled (12 months warranty)	82.9%	2.5%	77.9%	87.8%
Buy new smartphone instead (none)	17.1%	2.5%	12.2%	22.1%
Buy recycled (24 months warranty)	86.0%	2.4%	81.3%	90.6%
Buy new smartphone instead (none)	14.0%	2.4%	9.4%	18.7%
Price €560				
Buy recycled (6 months warranty)	52.4%	3.1%	46.4%	58.4%
Buy new smartphone instead (none)	47.6%	3.1%	41.6%	53.6%
Buy recycled (12 months warranty)	75.5%	2.9%	69.8%	81.3%
Buy new smartphone instead (none)	24.5%	2.9%	18.7%	30.2%
Buy recycled (24 months warranty)	80.0%	2.7%	74.6%	85.4%
Buy new smartphone instead (none)	20.0%	2.7%	14.6%	25.4%
Price €640				
Buy recycled (6 months warranty)	24.6%	2.1%	20.4%	28.7%
Buy new smartphone instead (none)	75.4%	2.1%	71.3%	79.6%
Buy recycled (12 months warranty)	58.5%	2.9%	52.8%	64.2%
Buy new smartphone instead (none)	41.5%	2.9%	35.8%	47.2%
Buy recycled (24 months warranty)	66.0%	3.0%	60.1%	71.8%
Buy new smartphone instead (none)	34.0%	3.0%	28.2%	39.9%

Table 10 WTP Smartphone made of recycled materials - the impact of warranty

Overall, results show that the higher the warranty of a smartphone made of recycled materials, the more people would choose this type of phone over a conventional new phone.

Findings suggest that for a smartphone made of recycled materials, respondents would be willing to pay €560 – even at a warranty of only 6 months. A phone made of recycled materials would need to have 12 months warranty at least in order for the majority of respondents to pay €640 for it. An increase of warranty levels from 12 to 24 months does consistently with remanufactured/refurbished phones not result in an as large increase in preference shares than the shift from 6 to 12 months.

Hypothesis 2b: All parameters being equal, the higher the warranty, the higher the consumers' WTP for a phone made of recycled materials. – supported

When testing for hypothesis 3, determining the impact of warranty on remanufactured/refurbished smartphones in comparison to smartphones made of recycled materials, results of *Table 9* and *10* need to be compared. Generally, respondents are willing to pay a higher price for smartphones made of recycled materials than for remanufactured/refurbished smartphones – preference shares are higher at any warranty. Further, for a remanufactured/refurbished smartphone with a warranty of 6 months, the majority of respondents is only ready to pay €480. For a smartphone made of recycled materials, though, they would already pay €560 at this same warranty. In addition, an increase from 6 to 12 months warranty pushes respondents to buy the remanufactured/refurbished phone as well as the smartphone made of recycled materials at a price of €640. Hence, results slightly differ among the two types of smartphones, due to generally higher WTP for smartphones made of recycled materials. However, the level of warranty does not affect any of the two more than the other. As a result, hypothesis 3 cannot be supported.

Hypothesis 3: All parameters being equal, warranty has a more significant effect on the WTP for remanufactured/refurbished phones than it has on phones made of recycled materials. – rejected

WTP for Remanufactured/Refurbished Smartphones vs. Smartphones made of recycled materials

WTP for Remanufactured/Refurbished smartphones vs. smartphones made of recycled materials
All other parameters being equal (warranty: 24 months and savings in CO2 emissions: 80%)

Label	Shares of Preference	Std Error	Lower 95% CI	Upper 95% CI
Remanufactured/Refurbished smartphone at price €480	41.8%	1.7%	38.5%	45.1%
Smartphone made of recycled materials at price €480	58.2%	1.7%	54.9%	61.5%
Remanufactured/Refurbished smartphone at price €560	41.6%	1.7%	38.3%	45.0%
Smartphone made of recycled materials at price €560	58.4%	1.7%	55.0%	61.7%
Remanufactured/Refurbished smartphone at price €640	41.6%	1.7%	38.3%	45.0%
Smartphone made of recycled materials at price €640	58.4%	1.7%	55.0%	61.7%
Remanufactured/Refurbished smartphone at price €480	66.1%	2.7%	60.8%	71.4%
Smartphone made of recycled materials at price €560	33.9%	2.7%	28.6%	39.2%

Table 11 WTP Remanufactured/Refurbished smartphones vs. smartphones made of recycled materials

Testing for hypothesis four 'the difference in WTP for remanufactured/refurbished phones relatively to the WTP for smartphones made of recycled materials' a number of scenarios have been simulated with the choice simulator. All other parameters were equally fixed to 24 months warranty and 80% savings in CO2 emissions. Note that also for any other fixed, equal parameters, the same results occurred). Results show that, all other parameters being equal, at any price level (€480, €560 and €640) more people are willing to choose a smartphone made of recycled materials over a remanufactured/refurbished smartphone (~58% vs. ~42%). That is, the WTP is higher for smartphones made of recycled materials than for remanufactured/refurbished smartphones. In order to derive the point at which consumers switch to the remanufactured/refurbished phone, the price for the phone made of recycled materials was increased to €560, comparing it with a remanufactured/refurbished smartphone at the lowest price (€480). Results show that under these conditions 66.1% of respondents would choose the remanufactured/refurbished phone over the recycled one. Hence, the WTP for a smartphone made of recycled materials lies somewhere between €480 and €560.

Hypothesis 4: All parameters being equal, consumers' WTP is higher for phones made of recycled materials than for remanufactured/refurbished phones – supported

4.5 Analysis on Demographic Segments

As described in chapter 2.4.2, research suggests that data about respondents' age, gender, income and education could have an impact on consumer decision-making in the context of circular products (Cerulli-Harms et al., 2018; Hazen et al., 2017; Lieder et al., 2018). Therefore, in this study, corresponding data was collected.

Literature shows that sample sizes smaller than 30 would not result in significant medium-sized effects (Cohen, 1990). Hence, for the demographic analysis, segments have been clustered according to this criterium. Using HB analysis and a t-test to test for significances in average importance values, gender segmentation (male, female) as well as age segmentation (below and above 30) have shown differences in attribute importance for choice and will be explained in more detail in the following. Opposingly, income and educational background did not have an effect on attribute importance (*see annex*).

Gender segmentation. Analyzing attribute importance based on gender distribution, it is noteworthy that average importance of attributes differs among males and females *(*see *Table 12).* Whereas females attribute significantly lower importance to price (even less important than CO2 savings and warranty) than males (26.89 vs. 33.08, $p < .05$), for male respondents, price is the most crucial attribute for choice. Further, average importance of savings in CO2 emissions is significantly higher for women than for men (30.96 vs. 25.22, $p < .05$). Significances have been estimated using an independent t-test (see annex).

		Female (86 respondents)		**Male** (75 respondents)	
Attribute	Total	Average importance	Standard deviation	Average importance	Standard deviation
Business Model	10.95	11.70	10.63	10.91	10.66
Price	29.67	26.89	10.86	33.08	20.76
Savings in CO2 emissions	28.31	30.96	15.72	25.22	12.91
Warranty	31.07	30.45	15.84	30.79	18.00

Table 12 HB analysis - Average Importance of attributes (Gender segmentation)

Age segmentation. Examining age distribution against the average importance of attributes, it is observable that respondents who are below 30 years old, are significantly less influenced by the business model (or type of phone) than respondents above 30 years (9.78 vs.15.07, $p < .05$). In turn, for younger respondents, price has a significantly bigger effect on choice than it does for older respondents (32.22 vs. 21.03, $p < 0.05$). Lastly, respondents below 30 years attribute significantly less importance to warranty than subjects who are older than 30 (29.6 vs. 16.58, $p < .05$). Significances have been estimated using an independent t-test (see annex).

		Below 30 years (125 respondents)		**Above 30 years** (36 respondents)	
Attribute	Total	Average importance	Standard deviation	Average importance	Standard deviation
Business Model	10.95	9.78	10.14	15.07	11.38
Price	29.67	32.22	17.19	21.03	9.63
Savings in CO2 emissions	28.31	28.41	13.48	28.14	17.25
Warranty	31.07	29.6	16.58	35.76	15.47

Table 13 HB analysis - Average Importance of attributes (Age segmentation)

5. Discussion

The discussion is divided into two chapters. In the first one, research results will be summarized and discussed. Afterwards, value propositions for a CE will be derived and implications for businesses and managers will be given.

5.1 Summary and Discussion of Results

The scope of this master's thesis was to examine consumer preferences in the context of the CE in order to assess the overall market acceptance and to derive new value propositions for this type of economy. Therefore, a consumer preference study with CBC analysis was conducted, researching the comparison of different circular business model approaches, which practically translate into different product types. More particularly, research has been conducted in the context of smartphones, investigating the hypothetical transformation of these consumables into circular products, i.e. remanufactured/refurbished smartphones and smartphones made of recycled materials.

General acceptance of circular products.

Overall, results of the study have shown that from a consumer perspective, there is high interest in circular product offers - when connecting consumer perceptions with environmental benefits, quality-indicating warranty and when simultaneously comparing them to the corresponding new, conventional product at a higher price. Findings posit that if these types of smartphones are offered to consumers holding those features, only less than one fifth of respondents would remain with the conventional smartphone *(Table 6).* In addition, market simulation showed that depending on the different combinations of features, the majority of respondents would be willing to buy the circular product instead of the new one. Consequently, in general consumers highly accept new circular product offerings, coming with specific features.

Comparison of product types.

Referring to the question of how to approach consumers with circular smartphones, results suggest that smartphones made of recycled materials are more preferred than remanufactured/refurbished smartphones (48.2% vs. 34.8%). A higher share of consumers is willing to pay a slightly higher price for a resource-recovered smartphone relatively to a life-extended one if all other parameters are equal. For example, for a smartphone made of recycled materials that saves 80% emissions in CO2 and has a warranty of 24 months, the majority of

consumers are ready to pay between €480 and €560. For a remanufactured/refurbished smartphone that has the same features, the majority of consumers is only willing to pay less than €480. As hypothesized, this might result from the fact that remanufactured/refurbished smartphones entail the second-hand component and hence, pose more perceived risks for consumers. Smartphones made of recycled materials, instead, contain materials that stem from another product – however the smartphone per se is newly constructed. Until now, consumer literature only tackles consumer risk investigation for remanufactured/refurbished smartphones. Research shows that many consumers implicate buying a remanufactured/refurbished phone with risks related to performance, financial factors (misspending money), time (losing time if the phone needs maintenance or needs to be returned) and obsolescence (fear of having an outdated phone with regard to technological factors) (e.g. van Weelden et al., 2016). Additionally, outcomes of van Weelden's (2016) study reveal that consumers would wish for a trusted retail market, selling these types of phones. Regarding smartphones made of recycled materials, research lacks consumer studies and hence, reasons for higher acceptance for this type of phone can only be assumed. Deriving from real-life examples, there is a market for remanufactured/refurbished electronics. More particularly, different online shops are presenting the concept of retailing remanufactured/refurbished electronics (e.g. refurbed.at, backmarket.de). Recycled products, on the contrary, are up until now rather sold by the manufacturer itself – like e.g. Apple, incorporating recycled materials into their Iphone 11 or Adidas, offering a new product line, selling sportswear from recycled ocean plastic (adidas America Inc., n.d.; *Product Environmental Report Iphone 11*, 2019). Hence, in addition to the perceived risks of a remanufactured/refurbished smartphone, the lack of trust resulting from the fact that they are rather sold by the independent retailers instead of the manufacturer, might be a reason for consumers to prefer the smartphone made of recycled materials over the remanufactured/refurbished one.

Concluding with the differentiation between the two types of circular smartphones, it is important to note that generally, the business model (translating into the type of phone) was overall of a rather low importance to consumers, compared to the other attributes (see chapter 4.3). As a result, reasons for the slightly higher preference for smartphones made of recycled materials are important to evaluate in further research, however, the fact that consumers accepted both type of products is crucial to take away.

Influence of product features.

Besides analyzing the differences in consumer preference towards CE business models, another goal of this master's thesis was to investigate the different features these types of phones need to have, in order to be accepted by the market. Consistent with the literature on consumer acceptance of resource recovered and product-life extended products, price, environmental benefits and quality-related features are decisive for consumers to purchase them.

Price. From an economic perspective, thus in the view of the company, pricing of circular products is pivotal in order to assess potential engagement into a CE. For both, recycled and remanufactured/refurbished products, literature provides proof that consumers expect a lower price relatively to the corresponding new product. This is especially due to the perceived functional or performance risk, these products entail (e.g. Essoussi & Linton, 2010; van Weelden et al., 2016; Wang et al., 2013). Regardless of the level of savings in CO2 emissions or warranty, consumers were in any case rather willing to buy the circular phone at a price reduction of 40% (= €480) than the new phone with a price of €800. Further, the higher the price for the circular smartphone, the less respondents were willing to buy it and consequently switched to the new phone instead. Importantly, the majority of consumers accepted a higher price for smartphones made of recycled materials, whereas when posing the same price on remanufactured/refurbished phones, consumers already switched to the conventional one.

WTP estimation has shown to be very dependent on the other two features – warranty and savings in CO2 emissions and thus, they determine price setting for firms. Findings show that these two attributes have a critical impact on the overall acceptance of circular products and on consumers' WTP.

Environmental benefit. Consequently, first, results regarding environmental benefits will be summarized. Results of the CBC have shown that environmental benefit increases WTP for both circular products and hence, was overall a major component for preference elicitation. Interestingly, environmental benefit was especially important for lower earning respondents, thus subjects with net incomes smaller than €2000.

In terms of WTP estimation for remanufactured/refurbished phones, results suggest that in order to be willing to pay a price of €560 for this type of smartphone, savings in CO2 emissions were needed to be at least 50%, compared to the new phone. Consistently, the majority of consumers accepted a price of €640 only if the remanufactured/refurbished smartphone saved 80% CO2

emissions relatively to the new counterpart. Hence, environmental benefits had an extreme impact on the WTP for remanufactured/refurbished smartphones (20-30% savings were able to achieve an increase in WTP by €80). Other than for product-life extended products, environmental benefits also showed to affect the WTP for smartphones made of recycled materials (resource recovered ones). In the case of these types of phones, however, the impact was especially notable at the highest price level. Regardless of savings, consumers would already be willing to pay €560 for smartphones made of recycled materials. In order to make consumers pay €640, however, savings already needed to account for 80% of the new smartphone. This shows that for smartphones made of recycled materials, WTP already starts at a higher level. However, savings were crucial to reach WTP of €640. Therefore, for both remanufactured/refurbished smartphones and smartphones made of recycled materials, consumer preferences where crucially influenced by the environmental component. In other words, the environmental component of circular products drives buyers towards engaging in the CE and to compensate for the 'not new' perception.

Quality. Second, consistent with Lieder et al. (2018), who investigated value propositions for a CE at the example of remanufactured washing machines, research in this thesis reveals that warranty is the most important attribute for respondents of the study. Hence, the level of warranty for both, remanufactured/refurbished smartphones and smartphones made of recycled materials is the major determinant for consumers to buy circular products and therefore, to engage in the CE. Having used warranty as a proxy for quality in this thesis, it means that warranty is crucial to reduce uncertainty of decision-makers. In the case of remanufactured/refurbished smartphones 12 months warranty has a major impact on consumers' WTP. In fact, at a warranty of 6 months, respondents would not pay more than €480 for a remanufactured/refurbished phone, whereas at a warranty of 12 months, WTP increases to €640. The increase to 24 months warranty did not show a similar effect as the one from 6 to 12 months. For smartphones made of recycled materials, similar results hold. However, since this type of phone is generally the preferred one among consumers, WTP already starts at a higher level. Therefore, for smartphones made of recycled materials, 12 months warranty might even be able to increase WTP above the price levels that have been tested in this thesis.
In summary, for both circular phones, savings need to be very high in order to achieve the highest WTP, whereas a warranty level of 12 months is already sufficient to reach this case. Therefore, even 'lower levels' of warranty influence the consumers' preference towards circular products extensively and are majorly responsible for the shift towards these types of products.

Consequently, combining middle levels of warranty with high environmental benefits results in a very strong consumer support of the CE and results in WTP that might account for less than 20% price reduction in comparison to a new smartphone.

Demographics.

Results of this thesis reveal further that demographic differences result in differences of preference elicitation. That means, for example in terms of gender, women are less sensitive to price than men. For women, environmental benefit is more important when deciding for the phone to purchase than price. whereas for men price is significantly the most crucial determinant of their choice. This is an interesting finding as it can be applied for marketing of environmental-friendly products in specifics to women.

Analysis on different age groups has also shown significant results. For older people, the type of phone is more important in regards of their choice than for young (below 30) respondents. Also, older subjects attribute higher importance to quality indicators (warranty) than below 30s. But - for young respondents' price is very crucial when choosing a phone. As it would appear obvious that this is primarily a result of lower income in younger years, analyzing choices of respondents who are below 30 and at the same time receive low incomes did not show significant high importance values for price (see annex). Hence, this assumption cannot be proofed. Generally, also education and income did not have significant effects on attribute importance unlike expected.

5.2 Circular Economy Value Propositions and Managerial Implications

In accordance with the CE concept, shifting from conventional smartphones to remanufactured/refurbished smartphones or smartphones made from recycled materials, creates value for a CE. By either prolonging the life cycle of the product or in case of recycling, by linking value chains, resources can be retained and reintroduced into the resource cycle. In order to achieve the shift towards a CE – away from the predominating linear economy – market and consumer acceptance is a prerequisite. Research in this master's thesis shows that the creation of new value propositions, thus the value companies promise to deliver to their customers with a new product, are price adjustments, environmental components and warranty. Further, the comparison between two approaches to a CE (Product-Life Extension vs. Resource Recovery) has shown that consumers direct their preferences towards Resource Recovery business models in the case of smartphones (smartphones made of recycled materials). Therefore, when transforming business models towards circular ones, smartphone manufacturers should

incorporate recycling mechanisms into their production processes, hence engage in reverse supply chain systems and manufacture their products out of recycled materials. Even though smartphones made of recycled materials were preferred, the overall acceptance for life-extended products (here remanufactured/refurbished smartphones) was also shown to be given. Deriving from these results, a two-way approach could be valuable for companies. That means, first manufacturers should implement take-back programs for used products. For the ones that are still in a good shape, companies should engage in remanufacturing/refurbishing, i.e. exchanging faulty or damaged parts. For the ones that are in a worse shape or that are generally older model productions, manufacturers should consider recycling. This would enable them to act more sustainable and as this thesis has shown, is accepted and appreciated by the market.
In addition, since consumers perceive CE value propositions generally very positively, manufacturers need to explain these types of products carefully to consumers (as done in the conjoint study as well).
In terms of pricing, research has shown that consumer WTP for smartphones made of recycled materials is slightly higher than WTP for remanufactured/refurbished smartphones. However, in order to be able to charge higher prices for circular phones, WTP can overall be increased through the promotion of environmental components and service offerings, such as warranty.

Results of this research suggest that if Circular products are associated with savings in CO2 emissions i.e with the reduction of the environmental footprint compared to a new product, this can have significant impact on perception of the product and on WTP. Consequently, companies should focus on awareness creation in this regard. When promoting circular products, they should emphasize this benefit and feature, which automatically comes with the business model transformation. More particularly, they should try to achieve high values of savings in CO2 emissions compared to conventional products (above 50%). When not being able to achieve this through manufacturing, managers could use other measures to reach higher savings, e.g. by planting trees in order to offset remaining CO2 emissions like e.g. the company 'refurbed' does (see (*Refurbed.at*, 2020)).

Besides environmental features, quality indicators are extremely important when it comes to slowly introducing consumers to the CE. Results of this thesis suggest that manufacturers should necessarily offer product warranties for their circular products, since it increases WTP and acceptance dramatically. Especially for remanufactured/refurbished products, warranty is crucial for achieving stepwise increases of WTP for these products. When it comes to

smartphones made of recycled materials, warranties are especially able to skim the top level WTPs, since generally consumers have shown to be willing to pay more for this type of phone than for remanufactured/refurbished smartphones.

In summary, managers can reach acceptance and skim WTP for circular products by explaining them properly, by promoting their positive effect on the environment and by offering product warranties. By these means, manufacturers can compensate for the lower perceived quality of circular products and offer them at comparably high prices.

6. Limitations and Recommendations for further Research

This master's thesis entails a complete literature review on consumer behavior towards CE business models and hence, shows that research is up until now relatively scarce on this very specific topic. Additionally, it reveals that the few existing researchers have used completely different approaches for examination. For example, despite the fact that conjoint analysis seems to be a very suitable method in this scope, only one paper (Lieder et al., 2018) used conjoint analysis in this context. Investigating the acceptance of different business models and the engagement of consumers towards them, this thesis offers a valuable contribution to today's state of the art as well as new value propositions for a CE in the context of smartphones.

However, due to the limited scope of this master's thesis, the investigation of CE market acceptance was bounded to one product. As depicted in chapter 2.2.2, a lot of different products offer potentials for a circular approach. In order to deepen findings in this regard, future research should further examine the variety of products, offering potential for value creation in a CE and their acceptance from a consumer side. Also, the product smartphone is only offering value propositions for Resource Recovery and Product-Life Extension approaches. Future research should also further investigate the other business models in order to receive a more detailed picture.

Furthermore, due to the rather generalized approach, this master's thesis left out the effect of brand and information provision. Nevertheless, researchers revealed that brand plays a significant role for circular products of high functional risk (Hamzaoui-Essoussi & Linton, 2014) and investigators find controversial results regarding information provision about remanufactured products (Michaud & Llerena, 2011; Singhal & Tripathy, 2019; Y. Wang & Hazen, 2016). Therefore, especially when following up on the topic of smartphones, in order to strengthen findings on newly developed value propositions for a CE, brand and information should be further investigated.

Evaluating the methodology used in this thesis, conjoint analysis has shown to be an efficient approach for investigation of the topic. First, it is suitable to compare preferences for circular vs. 'old' business model approaches as well as to compare different transformation scenarios of the CE. Second, by evaluating product features, it can offer new value propositions for a CE and third, it is crucial to derive WTP estimations. In order to derive more concrete findings on switching behavior from conventional to circular products and especially offer more information on the conventional product, it would have been helpful to incorporate the 'new smartphone' into conjoint analysis as a separate level instead of just noting the comparison into

the header. However, with CBC analysis, a lot of prohibitions would have been necessary, linking CO2 savings with the business model. Since prohibitions might lead to misleading implications, this master's thesis refrained from introducing them. Future research might, however, take this slight downside of CBC analysis in a CE context into consideration.

Furthermore, results have shown that utility estimation on demographic data has indeed revealed to be significant, for example in the scope of gender and age distribution. Income and educational background did not reveal any significant impact on the preference for circular smartphones. This stands in contradiction to the findings of Hazen et al. (2017), who have found out that switching intention towards remanufactured goods is among others influenced by educational levels as well as partially by income. Further research might follow up in this regard.

Remaining with the topic of service levels, analysis of this thesis has shown that warranty is the driving factor for consumers to engage in circular products. Especially the increase from 6 to 12 months warranty did have significant effects on WTP - indeed effects were significantly more relevant than for the increase from 12 to 24 months. Deriving from these findings, future research might investigate warranty levels more sensitively, that is, examining the effect of smaller warranty increases in order analyze WTPs more concretely.

7. Conclusion

In conclusion, this master's thesis has successfully investigated consumer acceptance of a CE by examining the transformation from the linear model of resource consumption to the circular one. Using the example of smartphones, research results have shown that circularity is highly accepted by the market and that in this case, the two approaches (Resource Recovery and Product-Life extension) are successful concepts to implement a CE. Additionally, findings reveal that when associating CE practices with specific value propositions, consumers or the market are ready for a transformation to a more sustainable way of resource consumption. Especially for the younger generations, this topic is of high importance (Gatterer, n.d.; Gazzola, Pavione, Pezzetti & Grechi, 2020) and hence, acceptance of new approaches is very visible within these age-groups (respondents of this thesis were to a large extent between 20-30 years old).

Further, investigating different product features, study results present that quality-indicating characteristics like e.g. warranty and environmental components, like e.g. CO2 savings, affect WTP estimations for circular products. As a matter of fact, it shows that consumers highly value sustainable products - being less harmful to the environment -, however that quality perceptions of circular products are still rather low, so that quality-indicating tools like warranty are necessary to compensate for the perceived risks, these products seem to be connected up until know.

So, in order to reach full awareness and consciousness of these new consumption possibilities in the long-run, economic actors, research and politics need to work closely together, providing information to consumers and businesses, implementing regulations, as well as offering transparency within supply chain operations in order to anchor these new ways of thinking, consuming and producing in our day-to-day lives.

Overall, this master's thesis is a first step towards fostering behavioral and economic change in order to tackle the resource consumption challenge we will face in the future. Concepts like the CE approach are necessary to find solutions on sustainable and pro-environmental consumption and are able to give a first impulse on how future economic action could look like and a milestone to build upon.

8. References

Accenture strategy. (2014). *Circular Advantage. Innovative Business Models and Technologies to Create Value in a World without Limits to Growth* (Vol.24). Accenture. https://www.accenture.com/t20150523t053139__w__/us-en/_acnmedia/accenture/conversion-assets/dotcom/documents/global/pdf/strategy_6/accenture-circular-advantage-innovative-business-models-technologies-value-growth.pdf

adidas America Inc. (n.d.). *Adidas and Parley Collection | adidas US*. https://www.adidas.com/us/parley

Aguilar, F. X., & Cai, Z. (2010). Conjoint effect of environmental labeling, disclosure of forest of origin and price on consumer preferences for wood products in the US and UK. *Ecological Economics*, *70*(2), 308–316. https://doi.org/10.1016/j.ecolecon.2010.09.002

Ali, S., & Ronaldson, S. (2012). Ordinal preference elicitation methods in health economics and health services research: Using discrete choice experiments and ranking methods. *British Medical Bulletin*, *103*, 21–44. https://doi.org/10.1093/bmb/lds020

Antikainen, M., & Lammi, M. (2016). *Consumer acceptance of novel sustainable circular services*. 14. https://www.researchgate.net/publication/308903016_Consumer_acceptance_of_novel_sustainable_circular_services

Armstrong, M. (2017). *Infographic: Smartphone Life Cycles Are Changing*. Statista Infographics. https://www.statista.com/chart/8348/smartphone-life-cycles-are-changing/

Backmarket. (2020). Company Website. https://www.backmarket.at/smartphones-gebraucht.html

Bardhi, F., & Eckhardt, G. M. (2012). Access-Based Consumption: The Case of Car Sharing. *Journal of Consumer Research*, *39*(4), 881–898. https://doi.org/10.1086/666376

Benson, D., Gravey, V., & Jordan, A. (2016). Environmental policy. In M. Cini & N. P.-S. Borragán (Eds.), *European Union Politics* (5th edition, p. 373). Oxford University Press.

Bocken, N. M. P., de Pauw, I., Bakker, C., & van der Grinten, B. (2016). Product design and business model strategies for a circular economy. *Journal of Industrial and Production Engineering*, *33*(5), 308–320. https://doi.org/10.1080/21681015.2016.1172124

Borrello, M., Caracciolo, F., Lombardi, A., Pascucci, S., & Cembalo, L. (2017). Consumers' Perspective on Circular Economy Strategy for Reducing Food Waste. *Sustainability*, *9*(1), 141. https://doi.org/10.3390/su9010141

Bové, A.-T., D'Herde, D., & Swartz, S. (2017). *Sustainability's deepening imprint*. McKinsey & Company.

Catulli, M., Cook, M., & Potter, S. (2017). Consuming use orientated product service systems: A consumer culture theory perspective. *Journal of Cleaner Production*, *141*, 1186–1193. https://doi.org/10.1016/j.jclepro.2016.09.187

CBC/HB v5. (2016). Sawtooth Software, Inc.

Cerulli-Harms, A., Dr., Suter, J., Wouter, L., Duke, C., Dr., Rodriguez Diaz, A., Porsch, L., Peroz, T., Kettner, S. Dr., Thorun, C., Prof. Dr., Svatikova, K., Vermeulen, J., Smit, T., Dekeulenaer, F., & Lucica, E. (2018). *Behavioural Study on Consumers' Engagement in the Circular Economy* (2016 85 06). European Commission. https://ec.europa.eu/info/sites/info/files/ec_circular_economy_final_report_0.pdf

Chrzan, K., & Orme, B. (2000). An overview and comparison of design strategies for choice-based conjoint analysis. *Proceedings of the Sawtooth Software Conference*. Sawtooth Software conference, Sequim, WA.

Clausen, J., Blättel-Mink, B., Erdmann, L., & Henseling, C. (2010). Contribution of Online Trading of Used Goods to Resource Efficiency: An Empirical Study of eBay Users. *Sustainability*, *2*(6), 1810–1830. https://doi.org/10.3390/su2061810

Cohen, J. (1990). Things I have learned (so far). *American Psychologist*, *45*(12), 304–1312.

COM (2014) 398 final. (2014). *European Union: European Commission, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions—Towards a circular economy: A zero waste programme for Europe*. http://icams.ro/icamsresurse/2018/proceedings/XI_Towards_Circular_Economy_04.pdf

COM (2015) 614 final. (2015). *European Union: European Commission, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions—Closing the loop—An EU action plan for the Circular Economy*. https://eur-lex.europa.eu/resource.html?uri=cellar:8a8ef5e8-99a0-11e5-b3b7-01aa75ed71a1.0012.02/DOC_1&format=PDF

COM (2019) 640 final. (2019). *European Union: European Commission, Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions—The European Green Deal*. https://eur-lex.europa.eu/resource.html?uri=cellar:b828d165-1c22-11ea-8c1f-01aa75ed71a1.0002.02/DOC_1&format=PDF

COM (2020) 98 final. (2020). *European Union: European Commission, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee of the Regions—A new Circular Economy Action Plan*. https://eur-lex.europa.eu/resource.html?uri=cellar:9903b325-6388-11ea-b735-01aa75ed71a1.0017.02/DOC_1&format=PDF

Ellen MacArthur Foundation. (2013). *Towards the Circular Economy—Economic and business rationale for an accelerated transition*. Ellen MacArthur Foundation. https://www.ellenmacarthurfoundation.org/assets/downloads/publications/Ellen-MacArthur-Foundation-Towards-the-Circular-Economy-vol.1.pdf

Elzinga, R., Reike, D., Negro, S. O., & Boon, W. P. C. (2020). Consumer acceptance of circular business models. *Journal of Cleaner Production*, *254*, 119988. https://doi.org/10.1016/j.jclepro.2020.119988

Essoussi, L. H., & Linton, J. D. (2010). New or recycled products: How much are consumers willing to pay? *The Journal of Consumer Marketing; Santa Barbara*, *27*(5), 458–468. http://dx-doi-org.uaccess.univie.ac.at/10.1108/07363761011063358

Euromonitor Research. (2017, October 14). Ethical Living is Pushing Companies to Become Socially Conscious. *Market Research Blog*. https://blog.euromonitor.com/megatrend-ethical-living/

Gatterer, H. (n.d.). *Megatrend Neo-Ökologie*. Retrieved May 21, 2020, from https://www.zukunftsinstitut.de/dossier/megatrend-neo-oekologie/

Gaur, J., Mani, V., Banerjee, P., Amini, M., & Gupta, R. (2019). Towards building circular economy: A cross-cultural study of consumers' purchase intentions for reconstructed products. *Management Decision*, *57*(4), 886–903. https://doi.org/10.1108/MD-07-2018-0728

Gazzola, P., Pavione, E., Pezzetti, R., & Grechi, D. (2020). Trends in the Fashion Industry. The Perception of Sustainability and Circular Economy: A Gender/Generation Quantitative Approach. *Sustainability*, *12*(7), 2809. https://doi.org/10.3390/su12072809

Graedel, T. E., & Allenby, B. R. (2003). *Industrial Ecology* (2nd ed.). Prentice Hall.

Grasso, M. M., McEnally, M., Widdows, R., & Herr, D. G. (2000). Consumer Behavior toward Recycled Textile Products. *The Journal of The Textile Institute*, *91*(2), 94–106. https://doi.org/10.1080/00405000008659530

Gullstrand Edbring, E., Lehner, M., & Mont, O. (2016). Exploring consumer attitudes to alternative models of consumption: Motivations and barriers. *Journal of Cleaner Production*, *123*, 5–15. https://doi.org/10.1016/j.jclepro.2015.10.107

Hamari, J., Sjöklint, M., & Ukkonen, A. (2016). The sharing economy: Why people participate in collaborative consumption. *Journal of the Association for Information Science and Technology*, *67*(9), 2047–2059. https://doi.org/10.1002/asi.23552

Hamzaoui-Essoussi, L., & Linton, J. D. (2014). Offering branded remanufactured/recycled products: At what price? *Journal of Remanufacturing*, *4*(1), 9. https://doi.org/10.1186/s13243-014-0009-9

Harteis, C. (2018). Machines, Change and Work: An Educational View on the Digitalization of Work. In C. Harteis (Ed.), *The Impact of Digitalization in the Workplace: An Educational View* (pp. 1–10). Springer International Publishing. https://doi.org/10.1007/978-3-319-63257-5_1

Hazen, B. T., Mollenkopf, D. A., & Wang, Y. (2017). Remanufacturing for the Circular Economy: An Examination of Consumer Switching Behavior. *Business Strategy and the Environment*, *26*(4), 451–464. https://doi.org/10.1002/bse.1929

Hill, A. R. (2017). *The CBC System for Choice-Based Conjoint Analysis* (Technical Paper Series). Sawtooth Software, Inc.

Hire Hilti Tools. (2020). [Company website]. Hilti Innovations Available for Hire. https://www.hilti.co.uk/content/hilti/E1/GB/en/services/sales-services-and-procurement/tool-hire-locator.html

Holz, M., & Fischer, L. (2019, October 1). iPhone: Nicht wegschmeißen! *Die Zeit*. https://www.zeit.de/2019/40/iphone-smartphone-altgeraet-verwertung-elemente-metalle

How Uber Works for Drivers and Riders | Overview. (2020). [Company website]. Uber. https://www.uber.com/at/en/about/how-does-uber-work/

Howell, J. (2009). *CBC/HB for Beginners*.

Huh, S.-Y., Kwak, D., Lee, J., & Shin, J. (2014). Quantifying drivers' acceptance of renewable fuel standard: Results from a choice experiment in South Korea. *Transportation Research Part D: Transport and Environment*, *32*, 320–333. https://doi.org/10.1016/j.trd.2014.08.006

IRP. (2020). *Resource Efficiency and Climate Change: Material Efficiency Strategies for a Low-Carbon Future.* Hertwich, E., Lifset, R., Pauliuk, S., Heeren, N. A report of the International Resource Panel. United Nations Environment Programme, Nairobi, Kenya.

Jardim, E. (2017). *10 Jahre Smartphone—Die globalen Umweltfolgen von 7 Milliarden Mobiltelefonen*. Greenpeace.

Kaza, S., Yao, L., Bhada-Tata, P., & Van Woerden, F. (2018). *What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050* (Urban Development Series: World

Bank).

Korhonen, J., Honkasalo, A., & Seppälä, J. (2018). Circular Economy: The Concept and its Limitations. *Ecological Economics*, *143*, 37–46. https://doi.org/10.1016/j.ecolecon.2017.06.041

Kraaijenbrink, J. (2020). *3 Reasons Why You Should Use This Crisis To Make A Change*. Forbes. https://www.forbes.com/sites/jeroenkraaijenbrink/2020/05/13/3-reasons-why-you-should-use-this-crisis-to-make-a-change/

Le Quéré, C., Jackson, R. B., Jones, M. W., Smith, A. J. P., Abernethy, S., Andrew, R. M., De-Gol, A. J., Willis, D. R., Shan, Y., Canadell, J. G., Friedlingstein, P., Creutzig, F., & Peters, G. P. (2020). Temporary reduction in daily global CO 2 emissions during the COVID-19 forced confinement. *Nature Climate Change*, *10*(7), 647–653. https://doi.org/10.1038/s41558-020-0797-x

Lewandowski, M. (2016). Designing the Business Models for Circular Economy—Towards the Conceptual Framework. *Sustainability*, *8*(1), 43. https://doi.org/10.3390/su8010043

Liao, B. (2018). Warranty as a competitive dimension for remanufactured products under stochastic demand. *Journal of Cleaner Production*, *198*, 511–519. https://doi.org/10.1016/j.jclepro.2018.07.013

Lieder, M., Asif, F. M. A., & Rashid, A. (2020). A choice behavior experiment with circular business models using machine learning and simulation modeling. *Journal of Cleaner Production*, *258*, 120894. https://doi.org/10.1016/j.jclepro.2020.120894

Lieder, M., Asif, F. M. A., Rashid, A., Mihelič, A., & Kotnik, S. (2018). A conjoint analysis of circular economy value propositions for consumers: Using "washing machines in Stockholm" as a case study. *Journal of Cleaner Production*, *172*, 264–273. https://doi.org/10.1016/j.jclepro.2017.10.147

Louviere, J. J., Hensher, D. A., & Swait, J. D. (2000). *Stated Choice Methods: Analysis and Applications*. Cambridge University Press; nlebk. http://search.ebscohost.com/login.aspx?direct=true&db=nlebk&AN=73144&site=ehost-live

Lyle, J. T. (1996). *Regenerative Design for Sustainable Development*. John Wiley & Sons.

Magnier, L., Mugge, R., & Schoormans, J. (2019). Turning ocean garbage into products—Consumers' evaluations of products made of recycled ocean plastic. *Journal of Cleaner Production*, *215*, 84–98.

McDonough, W. (2020). *William McDonough Waging Peace Through Commerce*. William McDonough. https://mcdonough.com/

McDonough, W., & Braungart, M. (2002). *Cradle to Cradle: Remaking the way we make things*. North Point Press.

McKinsey & Company. (2015). *Europe's circular-economy opportunity*. https://www.mckinsey.com/business-functions/sustainability/our-insights/europes-circular-economy-opportunity

Michaud, C., & Llerena, D. (2011). Green consumer behaviour: An experimental analysis of willingness to pay for remanufactured products. *Business Strategy and the Environment*, *20*(6), 408–420. https://doi.org/10.1002/bse.703

Miller, C. (2019, September 21). iPhone X vs iPhone 11 comparison: Should you upgrade? *9to5Mac*. https://9to5mac.com/2019/09/21/iphone-x-vs-iphone-11-comparison-should-you-upgrade/

Möhlmann, M. (2015). Collaborative consumption: Determinants of satisfaction and the likelihood of using a sharing economy option again. *Journal of Consumer Behaviour*, *14*(3), 193–207. https://doi.org/10.1002/cb.1512

Mugge, R., Jockin, B., & Bocken, N. (2017). How to sell refurbished smartphones? An investigation of different customer groups and appropriate incentives. *Journal of Cleaner Production*, *147*, 284–296.

National Research Council. (1988). *Globalization of Technology: International Perspectives*. The National Academies Press. https://www.nap.edu/read/1101/chapter/4

O'Dea, S. (2020). *Smartphone users worldwide 2020*. Statista. https://www.statista.com/statistics/330695/number-of-smartphone-users-worldwide/

OECD. (2019). *Global Material Resources Outlook to 2060: Economic Drivers and Environmental Consequences*. OECD Publishing. https://read.oecd-ilibrary.org/environment/global-material-resources-outlook-to-2060_9789264307452-en

Orme, B. K. (2010). *Getting started with conjoint analysis: Strategies for product design and pricing research* (Fourth edition). Research Publ.

Orme, B. K. (2013). *Which Conjoint Method Should I Use?* (p. 7). Sawtooth Software, Inc.

Osburg, V.-S., Strack, M., & Toporowski, W. (2016). Consumer acceptance of Wood-Polymer Composites: A conjoint analytical approach with a focus on innovative and environmentally concerned consumers. *Journal of Cleaner Production*, *110*, 180–190. https://doi.org/10.1016/j.jclepro.2015.04.086

Patel, I. (2019, February 26). Prices of major smartphones from Samsung and Huawei have skyrocketed since 2017. *Xda-Developers*. https://www.xda-developers.com/prices-

major-smartphones-samsung-huawei/

Prieto-Sandoval, V., Jaca, C., & Ormazabal, M. (2018). Towards a consensus on the circular economy. *Journal of Cleaner Production*, *179*, 605–615. https://doi.org/10.1016/j.jclepro.2017.12.224

Product Environmental Report Iphone 11. (2019). [Product Environmental Report]. Apple Inc.

Rao, V. R. (2013). *Applied conjoint analysis*. Springer.

Refurbed.at. (2020). [Company website]. refurbed™ – Wie neu, nur besser. https://www.refurbed.at/imprint/

Rexfelt, O., & Hiort af Ornäs, V. (2009). Consumer acceptance of product-service systems: Designing for relative advantages and uncertainty reductions. *Journal of Manufacturing Technology Management*, *20*(5), 674–699. https://doi.org/10.1108/17410380910961055

Royal DSM. (2018). *Purpose led, performance driven. Royal DSM: Growth and value*. https://www.dsm.com/content/dam/dsm/corporate/en_US/documents/dsm-purpose-book-creating-brighter-lives-for-all.pdf

Sawtooth Software Inc. (1999). [CBC User manual].

Sawtooth Software, Inc. (Ed.). (2009). *The CBC/HB System for Hierarchical Bayes Estimation Version 5.0 Technical Paper*. Technical Paper available at http://www.sawtoothsoftware.com

Singhal, D., & Tripathy, S. (2019). Acceptance of remanufactured products in the circular economy: An empirical study in India. *Management Decision*, *57*(4), 953–970.

Söldner, M. (2020, March 4). *Analyse: IPhone-Verkaufszahlen wachsen wieder*. Macwelt. https://www.macwelt.de/news/Analyse-iPhone-Verkaufszahlen-wachsen-wieder-10765595.html

Stahel, W. (2010). *The Performance Economy*. Springer.

Stahel, W. R. (2016). Circular economy. *Nature; London*, *531*(7595), 435–438. http://dx-doi-org.uaccess.univie.ac.at/10.1038/531435a

Stahel, W. R. (2019). *The Circular Economy: A User's Guide*. Routledge. https://doi.org/10.4324/9780429259203

Tussyadiah, I. P., & Pesonen, J. (2018). Drivers and barriers of peer-to-peer accommodation stay – an exploratory study with American and Finnish travellers. *Current Issues in Tourism*, *21*(6), 703–720. https://doi.org/10.1080/13683500.2016.1141180

UNEP. (2011). *Recycling Rates of Metals—A Status Report.* A Report of the Working Group on Global Metal Flows to the International Resource Panel.Graedel, T.E; Allwood, J;

Birat, J-P; Reck, B.K; Sibley, S.F; Sonnemann, G; Buchert, M; Hagelüken, C.

United Nations. (2019a). *The Sustainable Development Goals Report 2019*. United Nations publication issued by the Department of Economic and Social Affairs.

United Nations. (2019b). *World population prospects 2019: Highlights*. Department of Economic and Social Affairs, Population Division.

United Nations. (2020). *Sustainable consumption and production*. United Nations Sustainable Development. https://www.un.org/sustainabledevelopment/sustainable-consumption-production/

van Heek, J., Arning, K., & Ziefle, M. (2017). Reduce, reuse, recycle: Acceptance of CO 2 - utilization for plastic products. *Energy Policy*, *105*, 53–66. https://doi.org/10.1016/j.enpol.2017.02.016

van Weelden, E., Mugge, R., & Bakker, C. (2016). Paving the way towards circular consumption: Exploring consumer acceptance of refurbished mobile phones in the Dutch market. *Journal of Cleaner Production*, *113*, 743–754.

Wang, P., Che, F., Fan, S., & Gu, C. (2014). Ownership governance, institutional pressures and circular economy accounting information disclosure: An institutional theory and corporate governance theory perspective. *Chinese Management Studies*, *8*(3), 487–501. https://doi.org/10.1108/CMS-10-2013-0192

Wang, Y., & Hazen, B. T. (2016). Consumer product knowledge and intention to purchase remanufactured products. *International Journal of Production Economics*, *181*, 460–469. https://doi.org/10.1016/j.ijpe.2015.08.031

Wang, Y., Hazen, B. T., & Mollenkopf, D. A. (2018). Consumer value considerations and adoption of remanufactured products in closed-loop supply chains. *Industrial Management & Data Systems*, *118*(2), 480–498. https://doi.org/10.1108/IMDS-10-2016-0437

Wang, Y., Wiegerinck, V., Krikke, H., & Zhang, H. (2013). Understanding the purchase intention towards remanufactured product in closed-loop supply chains: An empirical study in China. *International Journal of Physical Distribution & Logistics Management; Bradford*, *43*(10), 866–888. http://dx-doi-org.uaccess.univie.ac.at/10.1108/IJPDLM-01-2013-0011

Williams, A. (2019). *iPhone 11 vs iPhone XS: We compare the new, and the old, Apple flagships*. TechRadar. https://www.techradar.com/news/iphone-11-vs-iphone-xs

Wu, H., Shi, Y., Xia, Q., & Zhu, W. (2014). Effectiveness of the policy of circular economy in China: A DEA-based analysis for the period of 11th five-year-plan. *Resources,*

Conservation and Recycling, *83*, 163–175.
https://doi.org/10.1016/j.resconrec.2013.10.003

9. Annex

Literature table

Business model	Authors, year	Product	dependent variable	independent variable	Model	additional information	category
Product as a Service	Gullstrand Edbring et al. 2016	furniture	engagement towards access-based consumption (renting,leasing)	effect on motivations: flexibility economic reasons temporary nature of use environmental reasons effect on barriers desire to own hygiene concerns unfamiliarity with the concept economic obstacles (in the long term it is more expensive to rent) anxiety (what if furniture breaks?) environmental concerns	interviews and online survey		Flexibility Economic Reasons Environmental Reasons
Product as a Service	Catulli et al. 2013	baby and nursery products	reaction to service based baby and nursery equipment	positive culture and practices branded goods social responsibility negative issues of control and risk fear of contamination the role of trust	interviews (qualitative)		Environmental Reasons
Product as a Service	Rexfelt and Hiort af Ornäs 2009	different products offered as service (TV, clothing, car rental..)				no relation of sustainability and PaS	Environmental Reasons

Product as a Service	Antikainen and Lammi 2016	Couch, washing machine, clothes	acceptance of novel sustainable circular services	**Couch** Quality flexibility and practicality seeking variety **washing mashine** flexibility and practicality **clothes** economic reasons (interesting to lease if clothes are originally very high priced)	interviews (qualitative)		Flexibility Economic Reasons
Sharing	Gullstrand Edbring et al. 2016	furniture	engagement in sharing economy	Motivators practical for seldom used products economic reasons environmental reasons Access to community Barriers hygiene concerns desire to own fear of product unavailability lack of trust in others impractical and complicated	in-depth interviews		Economic reasons Environmental reasons Social/ Community Reasons

Sharing	Hamari et al. 2016	collaborative consumption service	attitude behavioral intentions	positive effect on attitude towards CC sustainability (intrinsic motivation) enjoyment (intrinsic motivation) positive effect on behavioral intention towards CC enjoyment (intrinsic motivation) economic benefits (extrinsic motivation) attitude towards CC positively influenced behavioral intention	Self-Determination Theory (Deci and Ryan 1985)	reputation as a extrinsic motivation did not directly influence attitude or behavioral intent!	Economic reasons Environmental reasons
Sharing	Tussyadiah and Pesonen 2018	peer to peer accommodation	user intention to use peer to peer accommodation	social appeal (i.e desire for community, sustainability) economic appeal (i.e cost saving)	factor analysis		Economic reasons Environmental reasons Social/ Community Reasons
Sharing	Möhlmann 2015	carsharing (car2go) and Airbnb	satisfaction with a sharing option likelihood of choosing a sharing option again	<u>Car sharing</u> **effect on satisfaction with a sharing option** cost savings familiarity service quality trust utility **effect on likelihood od choosing sharing option again** community belongig utility <u>Airbnb</u> **effect on satisfaction with a sharing option**	no theory, just effect of one on another	environmental impact did not drive any of the dependent variables	Economic reasons Social/ Community Reasons

				cost savings familiarity trust utility **effect on likelihood of choosing sharing option again** familiarity utility			
Resource Recovery	Magnier et al. 2019	products made of Ocean plastic	purchase intention willingness to pay price premium	**positive effect on purchase intentions:** anticipated conscience (affective benefit related to the adoption of ocean-plastic product) interpreted as sustainable reason value for money interpreted as quality in the thesis functionality expectations (perceived high functionality of ocean plastic products) negative effect on purchase intentions: contamination risks (perceptions of contamination) **positive effect on WTP-pay:** Recognizability (the degree to which the fact that the product is made of ocean plastic is visible) anticipated conscience safety (high perceived safety of the product positively influences WTP)	theory of perceived risks, using a cost-benefit trade-off approach. Perceived risks and perceived benefits influencing purchase intentions and WTP	the authors also clustered the respondents into different groups of consumers	Environmental reasons Quality-related Reasons

Resource Recovery	Russo et al. 2019	bio-based products (made out of bio-waste)	willingness to pay intention to switch purchase intention	green self-identity has a positive indirect effect on WTP-pay green self-identity positively influences intention to switch and purchase intention age directly influences WTP pay, intention to switch and purchase intention (older consumers --> higher WTP, SI, PI) past purchases influences WTP pay, intention to switch and purchase intention (people that already have purchased this good --> higher WTP, SI, PI)	Prospect theory (Tversky and Kahneman, 1992)		Environmental reasons
Resource Recovery	Grasso et al. 2000	recycled textile products	willingness to pay	**price** had a major impact on the consumer purchase decision of recycled textile products, when price was lower for recycled products, consumers were more willing to choose the recycled over the new product --> consumers were not willing to pay more for recycled products! (no price premium) **environmental labeling** environmental concerns did not motivate consumer to buy recycled products in this study			Economic Reasons
Resource Recovery	Essoussi & Linton 2010	recycled products	Willingness to pay	value of recycled products		found that recycled products are perceived as having a lower value than conventional products	Quality-related Reasons

Product-life extension	Gaur et al. 2019	Remanufactured products in general	purchase intention	cultural and societal differences towards environmental consciousness	interviews	the authors executed in-depth interviews in order to show that purchase intentions towards remanufactured products differ depending on culture and society of the consumer (here USA vs India)	Environmental Reasons
Product-life extension	Hazen et al. 2017	remanufactured laptop computers	Switching intention	**Direct effect** Price attitude government incentives environmental benefits **Indirect effect** price, government incentives and environmental benefits have a higher positive effect on SI if consumer has a positive attitude towards remanufactured goods	Push-Pull-Mooring theory of Migration		Economic Reasons Environmental Reasons
Product-life extension	Michaud and Llerena 2011	remanufactured cameras	Willingness to pay	consumers value remanufactured products lower than recycled or new ones (consumers indicated in a qualitative interview, that the quality of these products is perceived as lower) consumers decreased their WTP for the conventional product when they were informed about the different environmental impact of the products, but did not increase the WTP for remanufactured products	Auction experiment	no real dependent variable	Economic Reasons Quality-related Reasons

Product-life extension	Singhal and Tripathy 2019	remanufactured laptop, phones	purchase intention	attitude (extent to which an individual has a positive or negative assessment towards a particular behavior) subjective norm (social pressure exerted on an individual) personal benefit (could be low cost, incentive, discounts) Remanufactured product knowledge (awareness about features, quality of the product) Risk perception marketing strategy Green awareness does have an impact on the attitude of the consumer, but it does not directly influence purchase intentions!	model based on the "Theory of planned behavior by Ajzen" (1991)		Economic Reasons Environmental Reasons Quality-related Reasons
Product-life extension	Clausen et al. 2010	products traded on ebay	engagement in second-hand trading	Results of the study: for ebay users, the environmental aspect plays a minor role however, other aspects like enjoyment, practical and financial factors are a lot more driving the decision to trade on ebay	no model	only ebay-users were inquiried	Economic Reasons Quality- related Reasons
Product-life extension	Gullstrand Edbring et al. 2016	furniture	engagement in second-hand consumption	effect on motivators economic reasons environmental reasons desire to be unique effect on barriers concerns for hygiene pests	interviews and online survey		Economic Reasons Environmental Reasons

Product-life extension	van Weelden et al. 2016	refurbished phones	risk-benefit perception	perceived benefits financial benefit environmental benefits absence of undesirable innovative features unique product features higher performance than second-hand products perceived risks performance risk time risk financial risk obsolescence risk personal, contextual and product-related factors influence the risk-benefit perception of consumers towards refurbished phones (more detailed in Zotero)	in-depth interviews, EKB decision model (Engel et al. 1968)		Economic Reasons Environmental Reasons
Product-life extension	Wang and Hazen 2016	remanufactured automobile engines	purchase intention	positive effect on perceived value cost knowledge green knowledge quality knowledge inversely correlated with perceived risk cost knowledge quality knowledge --> perceived value and perceived risk both predict purchase intention	Prospect theory (Tversky and Kahneman, 1992)		Economic Reasons Environmental Reasons Quality-related Reasons

Product-life extension	Wang et al. 2018	remanufactured automobile parts	perceived value --> purchase intention	Environmental benefits price advantage perceived quality --> all had a indirect effect on purchase intention and a direct effect on perceived value perceived quality had a direct effect on perceived risk which affected perceived value and this in turn affected PI	Diffusion of Innovation theory		Economic reasons Environmental reasons Quality- related Reasons
Product-life extension	Wang et al. 2013	remanufactured automobile parts	purchase attitude -> purchase intention	direct effect on purchase intention purchase attitude (strongest) perceived behavioral control product knowledge (negative effect) subjective norm direct effect on attitude, therefore indirect effect on PI product knowledge perceived risk perceived benefit	theory of planned behavior (Fishbein and Ajzen, 1975)	perceived risk and perceived benefit did not hava a direct effect on PI	Quality- related Reasons
Product-life extension	Mugge et al. 2017	refurbished phones	purchase intention	positive impact perceived environmental benefits awareness of refurbishing negative impact perceived performance risk consumer innovativeness financial benefits did not have an impact on PI of refurbished phones	EKB decision model (Engel et al. 1968)	additionally they did a cluster analysis of different consumer groups (this study is an extension of the study of van Weelden)	Environmental Reasons

Product as a Service Product-Life Extension	Lieder et al. 2018	remanufactured washing machines	consumer preferences	environmental benefits price and payment scheme (flexible payment vs. Purchase) service level	Conjoint analysis		Economic Reasons Environmental Reasons Quality- related reasons
Product-life extension	Liao 2018	remanufactured products	willingness to pay	warranty			Quality- related Reasons

Design Testing - Balanced Overlap vs. Random strategy design

	Balanced Overlap	**Random strategy**
Attribute Level	Standard Error	
Remanufactured/Refurbished Smartphone	0.02934	0.03498
Phone made of recycled materials	0.02934	0.03498
€ 640 (-20%)	0.04222	0.05053
€ 560 (-30%)	0.04186	0.04917
€ 480 (-40%)	0.04190	0.04968
30% savings in CO2 emissions	0.04226	0.04997
50% savings in CO2 emissions	0.04217	0.04878
80% savings in CO2 emissions	0.04258	0.05026
6 months warranty	0.04231	0.05047
12 months warranty	0.04189	0.04957
24 months warranty	0.04275	0.04875
None option	0.07601	0.07218
Design strength	**704. 52196**	**507.08978**

Attribute importance – Gender (t-test)

Significance estimation t-test males vs. Females

	business model		price		CO2 reduction		warranty	
	males	**females**	**males**	**females**	**males**	**females**	**males**	**females**
Average importance	10.91	11.70	33.08	26.89	25.22	30.96	30.79	30.45
standard deviation	10.66	10.63	20.76	10.86	12.91	15.72	18.00	15.84
Standard error	1.23	1.15	2.40	1.17	1.49	1.70	2.08	1.71
pooled std error	1.68		2.67		2.26		2.69	
t -test	-0.47		2.32		-2.5		0.13	
	not sign		significant (>1.96)		significant (>1.96)		not sign	

Attribute importance – Age (t-test)

Significance estimation t-test below 30 years vs. above 30 years

	business model		**price**		**CO2 reduction**		**warranty**	
	Below 30 years	**Above 30 years**	**Below 30 years**	**Above 30 years**	**Below 30 years**	**Above 30 years**	**Below 30 years**	**Above 30 years**
Average importance	9.78	15.07	32.22	21.03	28.41	28.14	29.59	35.76
standard deviation	10.14	11.38	17.19	9.63	13.48	17.25	16.58	15.47
Standard error	0.91	1.90	1.54	1.61	1.21	2.87	1.48	2.58
pooled std error	2.10		2.22		3.12		2.97	
t -test	-2.52		5.03		0.09		-2.07	
	significant (>1.96)		significant (>1.96)		not sign		significant (>1.96)	

Attribute importance - Income (t-test)

Significance estimation t-test income levels

	business model			price			CO2 reduction			warranty		
	Below € 1000	**€ 1000-2000**	**Above € 2000**	**Below € 1000**	**€ 1000-2000**	**Above € 2000**	**Below € 1000**	**€ 1000-2000**	**Above € 2000**	**Below € 1000**	**€ 1000-2000**	**Above € 2000**
Average importance	10.07	10.64	13.55	29.01	31.32	29.28	29.82	30.35	23.74	31.10	27.70	33.44
standard deviation	11.44	8.36	11.98	13.22	13.66	19.10	15.06	8.91	15.57	16.25	11.95	18.80
Standard error	1.53	1.18	5.36	1.77	1.93	8.54	2.01	1.26	6.96	2.17	1.69	8.41

	pooled std error	**t-test**	**pooled std error**	**t-test**	**pooled std error**	**t-test**	**pooled std error**	**t-test**
pooled std error (below € 1000 & €1000-2000)	1.93	-0.30 Not sign.	2.62	-0.88 Not sign.	2.37	-0.22 Not sign.	2.75	1.24 Not sign.
pooled std error (€1000-2000 & above €2000)	5.49	-0.53 Not sign.	8.76	0.23 Not sign.	7.08	0.93 Not sign.	8.58	-0.67 Not sign.
pooled std error (below €1000 & above €2000)	5.57	-0.62 Not sign.	8.72	-0.03 Not sign.	7.25	0.84 Not sign.	8.69	-0.66 Not sign.

Attribute importance – Education (t-test)

Significance estimation t-test education levels (high school diploma, bachelor, master's degree)

(except PhD which was too less respondents)

	business model			price			CO2 reduction			warranty		
	High school diploma	**Bachelor's degree**	**Master's degree**	**High school diploma**	**Bachelor's degree**	**Master's degree**	**High school diploma**	**Bachelor's degree**	**Master's degree**	**High school diploma**	**Bachelor's degree**	**Master's degree**
Average importance	11.54	9.85	11.38	28.00	31.15	29.47	30.25	26.40	29.89	31.10	32.60	29.25
standard deviation	10.00	9.73	11.16	10.95	15.67	18.62	12.48	15.20	13.59	16.81	14.97	17.24
Standard error	1.83	1.11	1.55	2.00	1.79	2.58	2.28	1.73	1.88	3.07	1.71	2.39

	pooled std error	**t-test**	**pooled std error**	**t-test**	**pooled std error**	**t-test**	**pooled std error**	**t-test**
pooled std error (highschool diploma & bachelor' degree)	2.14	0.79 Not sign.	2.68	-1.17 Not sign.	2.37	1.35 Not sign.	3.51	-0.43 Not sign.
pooled std error (bachelor's degree & master's degree)	1.90	-0.81 Not sign.	3.14	-1.00 Not sign.	2.56	-1.36 Not sign.	2.94	1.14 Not sign.
pooled std error (highschool diploma & master's degree)	2.39	0.06 Not sign.	3.26	-0.45 Not sign.	2.96	0.12 Not sign.	3.89	0.48 Not sign.

Average importance – Age & Income

		Below 30 years and below €1000 income (55 respondents)	**Below 30 years and between €1000 and €2000** (42 respondents)
Attribute	Total	Average importance	Average importance
Business Model	10.95	10.35	9.90
Price	29.67	28.85	31.58
Savings in CO2 emissions	28.31	28.90	31.45
Warranty	31.07	31.89	27.06