Pointing in circles is not a way to circular economy

Barriers to a circular use of ICT products from a user organisation’s perspective

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SARA ÖSTERBERG
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by

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Att peka i cirklar leder inte till cirkulär ekonomi

Barriärer för en cirkulär användning av ICT-produkter utifrån en användarorganisations perspektiv

av

Catja Carlson
Sara Österberg
Abstract

The circular economy, in which products, materials and resources circle back into the system rather than ending up as waste, offers the possibility to decouple economic growth from environmental degradation. For the sector of information and communication technologies (ICT), where the products contain a wide range of critical raw materials and have a large environmental impact during their manufacturing phase, a shift from today’s linear consumption is especially important. While such a transition requires action from actors on all system levels, the users have a unique position to drive the transition through a change in their behaviour. The aim of this thesis is to build knowledge about how user organisations can enable a transition to a circular ICT sector. A case study was performed at a large ICT reseller in Sweden where the current use of internal laptops and smartphones was investigated and analysed. The data collection resulted in the identification of 15 barriers that we claim hinder the case company from becoming a circular user of ICT products. A categorisation of the barriers further showed that the majority of them are found on an organisational level. We argue that among them, the most impactful barrier is an ambiguous responsibility for the post-use collection of products within the organisation. The thesis is concluded with the notion that organisations do indeed have large possibilities to drive a shift in the ICT sector but have a number of barriers to overcome first. Fortunately, the majority of the barriers are internal and can be directly addressed by managerial actions.

Keywords: Circular economy; Sustainability; ICT products; Circular electronics; Reuse; Refurbishment; Barriers to circular economy; Management
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Sammanfattning


Nyckelord: Cirkulär ekonomi; Hållbarhet; ICT-produkter; Cirkulär elektronik; Återanvändning; Rekonditionering; Barriärer för en cirkulär ekonomi; Ledning
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Catja Carlson & Sara Österberg
Stockholm, June 2019
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## Abbreviations

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<tr>
<td>B2B</td>
<td>Business to Business</td>
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<tr>
<td>CE</td>
<td>Circular Economy</td>
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<td>EU</td>
<td>European Union</td>
</tr>
<tr>
<td>GDPR</td>
<td>General Data Protection Law</td>
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<tr>
<td>ICT</td>
<td>Information and Communication Technology</td>
</tr>
<tr>
<td>ID</td>
<td>Identification</td>
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<td>IT</td>
<td>Information Technology</td>
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<tr>
<td>LCA</td>
<td>Life Cycle Assessment</td>
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<td>OEM</td>
<td>Original Equipment Manufacturer</td>
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<tr>
<td>RQ</td>
<td>Research Question</td>
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<td>SDGs</td>
<td>Sustainable Development Goals</td>
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1 Introduction

In this chapter, we provide a background to the existing problem of linear consumption and waste management in the ICT-sector. In addition, we give a brief introduction to the concept of circular economy and its possibilities to tackle stated problems. Lastly, we concretise our purpose, the research questions and outline the disposition of the report.

1.1 Background

The way that we consume ICT products can accurately be described as wasteful. As societies all around the world become increasingly digitised, the demand for information and communication technologies (ICT) grows (World Economic Forum, 2019). Influenced by the rapid speed of technological development, consumers are eager to buy the latest electronic devices on the market (Ellen MacArthur Foundation, 2018). Since the cost of buying a brand new product often is lower than the price of repairing an old one, many electronic products have a short lifespan and are prematurely considered to be waste (Baldé et al., 2017). As ICT products have their major social and environmental impacts during the manufacturing phase (Bakker et al., 2014; Suckling and Lee, 2015), disposing of products without maximising their lifetimes imply that the materials, energy and labour that went into making them are wasted (Gama et al., 2016). As a consequence of the excessive consumption of electronic products, the generation of electronic waste (e-waste) is the fastest-growing waste stream globally, amounting up to 48.5 million tonnes in 2018 (World Economic Forum, 2019). That is a major problem since e-waste contains hazardous substances that cause environmental degradation and health problems if leaked (Cucchiella et al., 2015). Another part of the issue is that electronic devices, such as laptops and smartphones, contain a very wide range of critical raw materials and precious metals sourced from all around the world (Williams et al., 2008). In the pace of which these materials are currently consumed, the electronics industry faces the issue of resource scarcity in the near future (World Economic Forum, 2019). There is no doubt that we need to find a solution to this global issue. It is time to change the way we ‘take, make and dispose’ electronic products.

A major cause of the wasteful consumption of electronics is the current economic model (Baldé et al., 2017). The model is often referred to as a linear economy and within it, economic growth is tightly coupled with natural resource extraction (Andersen, 2007) and the generation of excessive amounts of waste and pollution (Castellani et al., 2015). The linear economic paradigm is exposed to growing criticism since it does not promote sustainable development, where the wellbeing of people and the planet is considered alongside economic development (Brundtland, 1987; Raworth, 2017). In reaction to this, a new economic model called ‘circular economy’ (CE) has been created and it offers the potential to decouple economic growth from environmental degradation and natural resource depletion (Murray et al., 2017; Wijkman and Skånberg, 2015). Apart from presenting a more sustainable model for global
production and consumption from an environmental perspective, the emerging circular economy is also foreseen to contribute to significant economic growth and to create hundred thousands of new job opportunities within the European Union (EU) alone (Ellen MacArthur Foundation, 2012; Gama et al., 2016).

Even though the idea of transitioning to a circular economy has been well received by both businesses and policymakers, the level of its implementation is still low (Ritzén and Sandström, 2017; WBCSD, 2017). Given the holistic nature of the circular economy model, it requires a systematic shift where actors at the macro, meso and micro levels of the economy take action (Stahel, 2016). The measures undertaken in one part of the system can either enable or hinder the possibilities for circularity in other parts of the system (Geels, 2018). Thus, it is important to adopt systems thinking in the decision making at all levels, to create synergies and remove barriers (Ghisellini et al., 2016; Meadows, 2008). To understand how various parts of the systems in a circular economy are interlinked, several researchers have identified what barriers that different actors experience (Araujo Galvão et al., 2018; Tura et al., 2019). Some barriers are internal and can be overcome by the actor itself, while others are external and depend on changes in other parts of the system to be resolved (Jones and Comfort, 2017). As for the transition to a circular economy within the EU, Kirchherr et al. (2018) found that one of the barriers that currently has the most adverse impact on the implementation of CE was ‘lacking consumer interest and awareness’. This is alarming since others have identified that users and consumers can play a pivotal role as enablers for CE, as their behaviour will ultimately determine the success of circular initiatives and businesses (Camacho-Otero et al., 2018; Jones and Comfort, 2017).

Returning to the currently unsustainable electronics industry, The World Economic Forum (2019) has recently expressed that the industry needs to break its current linear patterns and become a circular system instead. Due to the interdependence in a circular system, such a shift requires action from all actors involved in the products’ life cycles - from design and manufacturing to recycling of materials (Bressanelli et al., 2018). Within the existent barrier literature in this field, several articles point out insufficient volumes in the reverse flow of goods as a critical barrier to both circular business models and circular supply chains for ICT products (Angelis et al., 2018; Kissling et al., 2013; Whalen et al., 2018). This is a consequence of the low collection rates of obsolete electronics, from both consumers and companies (Bakker et al., 2014; Cucchiella et al., 2015; Ongondo and Williams, 2011). To overcome this issue, it is evident that the electronics industry depends on buyers of ICT products to change their behaviour, i.e. to start acting as circular users of ICT products instead of linear consumers (Ellen MacArthur Foundation, 2018). In addition to the identified barriers, the studies of ICT reuse businesses also concluded that high-quality products in good condition are a success factor for product lifetime extension (Kissling et al., 2013; Ongondo et al., 2013). With this background, ICT products used by corporations have optimal prerequisites for being reused but a key challenge is to retain them in the circular flow (Govindan and Hasanagic, 2018; Inrego, 2018). If the corporate buyers of ICT products were to adopt more circular mindsets, they could support the diffusion of circular solutions and create better business opportunities in a circular electronics sector (Sabbaghi et al., 2017).
Unfortunately, recent market statistics published by a Swedish ICT reuse organisation showed that the way that Swedish corporations handle their internally used laptops and smartphones does not promote a transition to a circular electronics sector (Inrego, 2018). In 2018, about 929,000 corporate computers were scrapped or stored by their end-of-use, even though their lifetimes in many cases could have been doubled if they had been sent to refurbishment instead (Inrego, 2018). The failure to reuse those electronic devices is problematic from an environmental perspective since the extraction of virgin materials could have been significantly reduced if the lifetimes of devices were longer (Bakker et al., 2014; Castellani et al., 2015). Further, it corresponds to a lost economic value of about 1.1 billion SEK on the second-hand market (Inrego, 2018). These statistics speak for themselves, Swedish corporations have not yet adopted the circular behaviour needed in order to be part of a circular economy in the electronics sector.

1.2 Purpose

The purpose of this study is to investigate how user organisations can enable a transition to a circular electronics sector. To fulfil this purpose, we aim to build knowledge of how corporations should use ICT products in a circular economy and what barriers that hinder them from doing so today. Further, we aim to identify which barriers that are in the direct control of the user organisations and which require the system they operate in to change. Since no previous research seems to have explored the barriers to circular economy seen from a user organisation’s perspective, we believe that our research can contribute with valuable new knowledge.

1.3 Research Questions

We aim to fulfil the purpose of this study by answering the following main research question (RQ).

Main RQ  How do barriers from different system levels of circular economy impact the possibility for organisations to be circular users of ICT products?

In order to answer the main research question, the research was guided by three more specific questions. The focus of the first research question is to identify barriers to a circular use of ICT products from the perspective of a user organisation. The second research question aims to specify what phase of the products’ lifetimes that each of the identified barriers affects, which contributes to an understanding of how the barriers impact the possibility for organisations to be circular users of ICT products. Lastly, the aim of the third research question is to clarify what system level of circular economy that the barriers originate in which makes it possible to assess if they are internal or external to the organisation.
The main research question is subsequently derived by combining the answers to RQ1-3 and its answer will increase our understanding of what is required for user organisations to overcome the identified barriers and discuss how that can contribute to a transition to a circular electronics sector.

RQ 1  What barriers hinder an organisation from a circular use of ICT products?

RQ 2  What phase of the products’ lifetimes do the barriers impact?

RQ 3  How do the barriers relate to different system levels of circular economy?

1.4 Sustainability Standpoint

This thesis is based on the assumption that ‘circular economy’ is more sustainable than the current economic model that is referred to as the ‘linear economy’. Since the concept of circular economy is most often related to environmental and economic sustainability (Kirchherr et al., 2017), the contribution of this thesis is mainly concerned with these two pillars of sustainability even though social sustainability is also somewhat included. In relation to the United Nations’ Sustainable Development Goals (SDGs), this thesis mainly contributes to SDG 12: Responsible Production and Consumption (United Nations, 2015).

1.5 Delimitations

- This study only considers corporate use of laptops and smartphones, with the organisational level as the unit of analysis. Individual and private users are not included. Further, while a company use a range of ICT products, only laptops and smartphones are included in this research.
- As the chosen organisation has no possibility to affect the design or manufacturing processes for ICT products, the study does not investigate how changes in said processes can increase the circularity in the organisation’s use of laptops and smartphones. The study is therefore based on the existing product range on the market.
- The study is performed at one single large organisation in Sweden, therefore the findings and analysis are not general. Studies in other organisations or in other countries may result in additional or different insights.
1.6 Disposition

*Table 1 - Disposition of the report*

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Chapter Description</th>
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<tbody>
<tr>
<td>1. Introduction</td>
<td><em>Describes the background and the problem, followed by the purpose of the study and the research question. Further, the delimitations of the study are discussed. The purpose of the chapter is to provide the reader with context and understanding of the relevance of the research.</em></td>
</tr>
<tr>
<td>2. Literature Review</td>
<td><em>Explores the previous research in the field. The review discusses the background of circular economy in general, followed by an exploration of the literature on different system levels and how circular economy relate to electronics.</em></td>
</tr>
<tr>
<td>3. Theoretical Framework</td>
<td><em>Builds on the literature review and outlines a theoretical framework used for the categorisation of barriers to circular economy. The purpose of the chapter is to provide an understandable framework that is used in the analysis of the findings.</em></td>
</tr>
<tr>
<td>4. Methods</td>
<td><em>Presents the research methods of the study. The case study and its context are outlined and the research process and methods for data collection are presented and discussed in relation to the purpose of the study. The chapter is concluded by presenting which measures of validity and reliability that were taken to ensure high research quality.</em></td>
</tr>
<tr>
<td>5. Findings &amp; Analysis</td>
<td><em>Analyses the findings of the study, guided by the theoretical frameworks. Includes a description of the empirical context, an analysis of the current use of laptops and smartphones and an identification and categorisation of barriers to circular use within the case company.</em></td>
</tr>
<tr>
<td>6. Discussion</td>
<td><em>Discusses the findings of the study and their managerial implications in relation to the literature review. Further, the perspective is expanded and the implications for all system levels are discussed. Lastly, we discuss the limitations of the study and the potential for future research.</em></td>
</tr>
<tr>
<td>7. Conclusions</td>
<td><em>Concludes the thesis by outlining the main findings of the thesis and its contribution to existing literature.</em></td>
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2 Literature Review

To fulfil the purpose of this study and to investigate how user organisations can enable the transition to a circular electronics sector, we begin this chapter with a review of the background of circular economy and its basic principles. We subsequently continue with an overview of literature from the macro, meso and micro system levels of circular economy to build an understanding of how barriers within each system level affect user organisations and vice versa. The last part of the chapter focuses on the transition to a circular electronics sector and what a circular use of ICT products is.

2.1 Circular Economy

There is a growing field of literature on the theme of a circular economy. Both researchers (Merli et al., 2017), businesses (Jones and Comfort, 2017) and regulatory bodies (Geissdoerfer et al., 2017) show increasing interest in the topic as it offers a possibility to overcome the shortcomings of the current linear economic system. The concept circular economy originally stems from various research areas including ‘cradle to cradle’ (Braungart and McDonough, 2002), ‘the performance economy’ (Stahel, 2008), ‘biomimicry’ (Benyus, 1997), ‘regenerative design’ (Lyle, 1996) and ‘industrial ecology’ (Lifset and Graedel, 2001). Having its background in so many different fields implies that the circular economy embeds theories from several schools of thought. Indeed, the term circular economy has gained traction in a variety of academic fields, spanning from natural resource management to environmental economics and management sciences (Angelis et al., 2018). The fact that all of the aforementioned research areas explore the circular economy from their respective perspectives indicates the comprehensiveness of the CE concept. However, the implication of comprising research from such diverse fields is that it is difficult to sort it into a specific academic discipline. Stahel declared “...the circular-economy idea has been slow to gain traction. As a holistic concept, it collides with the silo structures of academia, companies and administrations.” (Stahel, 2016, p. 3). This statement is consistent with the observations of other researchers concerning that the fragmentation of the CE literature makes it difficult to link it to implementation and implications for supply chain management and business models (Angelis et al., 2018; Lewandowski, 2016). These findings in the literature made it suitable to carry out an interdisciplinary literature review that includes various academic fields relevant to fulfil the purpose of this study - to deepen the understanding for how a circular corporate use of laptops and smartphones can be achieved.

Another implication of the width of the circular economy is that no ultimate definition has been established yet, which causes confusion about what circular economy is (Kirchherr et al., 2017). For the clarity of this research, we use a definition that has been widely adopted in business reports and in European policy documents (Merli et al., 2017).
“In a circular economy, the value of products and materials is maintained for as long as possible. Waste and resource use are minimised, and when a product reaches the end of its life, it is used again to create further value.”

(European Commission, 2016)

One of the most influential institutions in the transition towards circular economy is the non-governmental organisation ‘Ellen MacArthur Foundation’. The Ellen MacArthur Foundation raises awareness about the circular economy by spreading knowledge and form collaborations between businesses, policymakers and academia (Merli et al., 2017). Part of the contribution of the Ellen MacArthur Foundation is the distribution of learning resources and infographics that are generally used in communication about CE. Two of these foundational frameworks for the circular economy are the ReSOLVE framework and the butterfly diagram, which both build on the principles from the waste hierarchy. The ReSOLVE framework for the circular economy consists of six action areas: Regenerate, Share, Optimise, Loop, Virtualise and Exchange (Ellen MacArthur Foundation, 2012; developed in collaboration with McKinsey & Company - ( Heck and Rogers, 2014)).

Figure 1 - The butterfly diagram of circular economy
(Howard et al., 2018); adapted from (Ellen MacArthur Foundation, 2012)

The butterfly diagram is a graphical representation of the flow of materials, divided into a double-sided loop diagram (Figure 1). The left side of the diagram represents the flow of biological nutrients, that are renewable by nature and hence biodegradable. The right side of the loop represents technical materials such as metals and most plastics, i.e finite materials that require industrial processes to be restored to
their original form. It is worth noticing that the Ellen MacArthur Foundation (2015) distinguishes between ‘consumers’ in the biological flow of nutrients and ‘users’ in the technical flow of nutrients. In the biological flow, materials can be cascaded as their value decline (e.g. a piece of clothing can be reused as a cleaning cloth and subsequently as insulating material). In the technological loop, however, three guiding principles are ‘the power of the inner circle’, ‘the power of circling longer’ and ‘the power of pure inputs’ (Ellen MacArthur Foundation, 2015).

“The power of the inner circle refers to the idea that the tighter the circle, the more valuable the strategy. Repairing and maintaining a product, for example, a car preserves most of its value. If this is not possible anymore, individual components can be reused or remanufactured. This preserves more value than just recycling the materials. Inner circles preserve more of a product’s integrity, complexity, and embedded labour and energy.”

“The power of circling longer refers to maximising the number of consecutive cycles and/or the time in each cycle for products (e.g. reusing a product a number of times or extending product life). Each prolonged cycle avoids the material, energy and labour of creating a new product or component. For products requiring energy, though, the optimal serviceable life must take into account the improvement of energy performances over time.”

“The power of pure inputs, finally, lies in the fact that uncontaminated material streams increase collection and redistribution efficiency while maintaining quality, particularly of technical materials, which in turn extends product longevity and thus increases material productivity.”

(Ellen MacArthur Foundation, 2015, p.8)

One of the biggest research areas within the circular economy umbrella is waste management (Merli et al., 2017). ‘The waste hierarchy’ is a list of waste management strategies sorted in falling order based on their desirability from an environmental perspective. Since the different waste management strategies all start with an ‘R’, the waste hierarchy is commonly denoted as the ‘the R’s framework’. Kirchherr et. al (2017) described that many authors regard the R framework as a ‘how-to’ of circular economy and thus a core principle. There are several different R frameworks used by various actors. Among them, the 3R framework (reduce, reuse, recycle) seems to be the most prevailing one (Ghisellini et al., 2016). The most extensive R’s framework that we have found in this literature review is the one presented by Potting et. al., 2017, represented in the figure below (Figure 2).
The power of the inner circle is analogous with the waste hierarchy in its ranking of how valuable different end-of-use strategies for technological products are, with respect to capturing their embedded value of materials, energy input and labour (Ellen MacArthur Foundation, 2015). Hence, the preferred end-of-use strategies for a technological product are: (i) second-hand use of the product in its current condition; (ii) repair/maintenance of the product to prolong durability; (iii) refurbishment of an old product to bring it up to date for further use; (iv) remanufacture broken product with replacement of relevant components or use parts from discarded product to build a new product of the same product type; and lastly (v) recycle materials (Ellen MacArthur Foundation, 2012). Recycling is the least preferred end-of-use strategy since the quality of the materials is often downgraded and part of the materials still end up as landfill or energy recovery from materials (Braungart et al., 2007), which is at the bottom stage of the waste hierarchy.

Since the circular flows of natural resources are at the very core of circular economy, many parts of our societies need to be redesigned to support these closed flows of biological and technological nutrients (Murray et al., 2017). One foundational aspect is to have a functioning waste infrastructure in place to enable corporations, consumers and users to act in accordance with the waste hierarchy (Cucchiella et al., 2015). Another is to make whole industries collaborate to close the loops of their supply chains and thereby reduce the extraction of natural resources and generation of waste (Lieder and Rashid, 2016). Thirdly, individual people have a role to play since they can influence both corporations and policymakers. The list of actors that are part of the transition from a linear to a circular economy can be

<table>
<thead>
<tr>
<th>Strategies</th>
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<tr>
<td>R0 Refuse</td>
<td>Make product redundant by abandoning its function or by offering the same function with a radically different product.</td>
</tr>
<tr>
<td>R1 Rethink</td>
<td>Make product use more intensive (e.g. by sharing product)</td>
</tr>
<tr>
<td>R2 Reduce</td>
<td>Increase efficiency in product manufacture or use by consuming fewer natural resources and materials.</td>
</tr>
<tr>
<td>R3 Reuse</td>
<td>Reuse by another consumer of discarded product which is still in good condition and fulfills its original function.</td>
</tr>
<tr>
<td>R4 Repair</td>
<td>Repair and maintenance of defective product so it can be used with its original function.</td>
</tr>
<tr>
<td>R5 Refurbish</td>
<td>Restore an old product and bring it up to date.</td>
</tr>
<tr>
<td>R6 Remanufacture</td>
<td>Use parts of discarded product in a new product with the same function.</td>
</tr>
<tr>
<td>R7 Repurpose</td>
<td>Use discarded product or its parts in a new product with a different function.</td>
</tr>
<tr>
<td>R8 Recycle</td>
<td>Process materials to obtain the same (high grade) or lower (low grade) quality.</td>
</tr>
<tr>
<td>R9 Recover</td>
<td>Incineration of material with energy recovery.</td>
</tr>
</tbody>
</table>

Figure 2 - The R’s of circular economy
Adapted from (Potting et al., 2017)
made long, which shows is the great complexity of CE. Evidently, all system levels of society are involved and depend on each other in such a large-scale change (Geels, 2018). Another important aspect to consider is that this transition will take a long time and require significant financing, hence stakeholders at all system levels need to think of the long-term benefits if we are to overcome the economic barriers that exist within each system level of the circular economy (Ghisellini et al., 2016).

2.2 The System Levels of Circular Economy

The academic literature of CE is divided into three main lines of actions, representing the macro, meso and micro system levels (Figure 3) (Ghisellini et al., 2016). As mentioned, it is important to keep in mind that all system levels are interlinked and that the implementation requires a systemic change (Geels, 2018; Kirchherr et al., 2017). Due to this, we provide a review of literature from all system levels of circular economy and highlight the barriers that exist within each. The barriers are presented based on a categorisation framework for circular business developed by Tura et al. (2019), which is explained thoroughly in the next chapter. With this theoretical background we can later elaborate on how CE on the corporate level impacts and is impacted by the other system levels of CE.

![Figure 3 - The system levels of circular economy](Adapted from Ghisellini et al., 2016)
2.2.1 Macro System Level

According to a literature review carried out in 2017, a majority of the CE literature focuses on the macro systems perspective, i.e. the required change of social and economic dynamics (Merli et al., 2017). Stahel is one of the leading researchers on the macroeconomic dynamics in the circular economy and his research takes a systematic approach on how taxes, business models and jobs are affected by what he calls an economic paradigm shift (Stahel, 2016). Stahel has presented a circularity framework for the flow of materials where he highlighted the need for closing, slowing and narrowing resource loops (Bocken et al., 2016; Stahel, 2010) as an extension to Braungart & McDonough’s cradle-to-cradle flows (2002) (Figure 4). Closing resource loops is more commonly known as materials recycling, i.e. reusing materials from post-use products as input to new products. However, it is worth acknowledging that technological materials are not suited to be recycled in perpetuity since it at some point stops providing a net benefit (Andersen, 2007). Slowing resource loops concerns the flow of materials, in the form of produced goods, through society. This means that the rate of product throughput must be decreased, i.e. the utilisation period of products should be extended through the design of more durable products and business models that capture the economic value of activities that enable reuse (Bocken et al., 2016). The last strategy, narrowing resource loops, is inherited from the linear economy rather than something new for CE (Bocken et al., 2016). It refers to increased resource efficiency, i.e. using less material input for each product, but is not a guarantee for achieving environmental savings (Stahel, 2010).

![Figure 4 - Categorisation of linear and circular approaches for reducing resource use](source: Bocken et al., 2016 based on Braungart and McDonough, 2002; Stahel, 2010)
In general, it is agreed upon that national policy implementations could, and rightfully should, drive a systematic change towards more circular practices and structures (Bastein et al., 2014; Dalhammar and Milios, 2016; Westblom, 2015; Wilts et al., 2016). The EU launched its ‘European Action Plan for Circular Economy’ in 2014 (European Commission, 2015). However, in an analysis of the existing EU policy landscape Milios (2018) identified a large gap among policies concerning distribution, use and reuse of products. Consequently, he argued, there is no apparent driver for resource efficiency in these stages, neither at an individual consumer level nor among businesses and public sector stakeholders.

While some deem it difficult to set policies in the use phase, Maitre-Ekern and Dalhammar (2016) argued that policies and regulations to improve product reparability and durability in the manufacturing stage would inevitably affect and extend the lifetimes of ICT products. Related to this, they raised the issue of short warranties and expensive maintenance and repairs for products. The combination, they claimed, does not create incentives for the user to keep, much less repair products once the warranty time is exceeded, nor does it create incentives for manufacturers to make more durable products. This is an example of policy acting as a barrier to a more circular electronics sector, in this case as an institutional barrier. On the contrary, legally enforced longer warranties could, in theory, address both aspects. An alternative method could be to directly enforce durability by setting legal requirements on products expected lifetimes and reparability (Milios, 2018). However, Wilts et al. (2016) questioned the effectiveness of such enforcement due to the time frame required from setting technical requirements of durability to implementations.

2.2.2 Meso System Level

Taking a step down to the meso systems perspective, the literature mainly focuses on eco-industrial parks and industrial symbiosis, two topics in that concern cross-collaboration between companies or industries that involves the exchange of resources (Ghisellini et al., 2016). Research about supply chains can also be allocated to this level since that is another form of corporate interaction that extends beyond a single company (Masi et al., 2017; Merli et al., 2017). In a literature review of circular economy, the authors pointed out that “further attention should be devoted to studying potential circular exchanges into supply chains” (Merli et al., 2017, p. 711).

Supply chains that are built on the principles of the circular economy are called circular supply chains (CSC) or closed-loop supply chains (Angelis et al., 2018). The fundamental difference between linear supply chains and circular supply chains is that materials can remain within the system for much longer when they are looped, which limits the input of new natural resources and generates less waste (Braungart et al., 2007). A linear supply chain covers the stages involved in delivering products to consumers, whereas a circular supply chain also includes the reverse flow of goods (Angelis et al., 2018). The Ellen MacArthur Foundation described logistics (both forward and reverse) as “a key challenge and an enabler for circularity in the electronics sector” (Ellen MacArthur Foundation, 2018, p. 11) and called for further exploration by both research and businesses in this area.
The term ‘reverse logistics’ include the activities for collecting, sorting/testing, recovering and redistributing products that are post-use (Sangwan, 2017). A well-established challenge in reverse logistics and reuse operations is the uncertainty in both timing and quantity of returns, which imposes difficulties in capacity planning, staffing and adversely impacts the possibility of achieving economies of scale (Bressanelli et al., 2018). In addition to this, both the mix and the quality of the supplied end-of-use products may vary greatly which can make product disassembly and remanufacturing difficult (Angelis et al., 2018).

Since the throughput of products in the circular supply chain is ultimately both lower-volume and slower compared to the flow in linear supply chains, the focus of a circular supply chain is a collaborative value capture rather than efficiency (Angelis et al., 2018). This requires both new business models and a new type of supply chain management, with focus on more collaboration between different supply chain actors (Bressanelli et al., 2018; Ellen MacArthur Foundation, 2018).

However, even in linear supply chains, Mujuni Katunzi (2011) argued that the inability to collaborate is the most significant obstacle to overcome in supply chain management. There is a silo-mentality that exist in supply chains due to the fact that “everyone works in his or her best interest, in order to achieve the best level of performance, regardless of the effect that might have upon others” (Hotăran, 2009). The mentality is often described as a constraint to the process integration and knowledge transfer that is needed to be successful in supply chain collaboration, hence acting as an impactful barrier on the meso system level (Mujuni Katunzi, 2011; Paton and McLaughlin, 2008). Further, while discussing the importance of linking the whole supply chain in a circular economy, Schmid and Ritzrau (2018) argued that organisations fail in seeing the business opportunities that come with trustful collaboration and holistic-management approaches due to their silo-orientated optimisation rationale.

2.2.3 Micro System Level

Zooming in further, research on circular economy has also been carried out from a micro system perspective which often focuses on the individual enterprise, consumers or products (Ghisellini et al., 2016). Some of the research streams at this level are product design (Bakker et al., 2014; Bocken et al., 2016), production and remanufacturing (Lieder and Rashid, 2016), purchasing and public procurement (Crafoord et al., 2018; Fernández and Kekäle, 2005), business models (Bocken et al., 2016; Lewandowski, 2016) and consumption (Camacho-Otero et al., 2018). All of these research areas have gained traction as the concept of “sustainable production and consumption” is higher prioritised by businesses (Kissling et al., 2012).

In general, the relationships between suppliers and buyers are different in circular supply chains compared to linear supply chains (Howard et al., 2018). This is often due to that the ownership remains with the supplier so that instead of paying for the ownership of physical products, the users pay based on access, performance or for having exclusive user rights via leasing contracts (Lewandowski, 2016).
According to Bocken et al. (2016), these types of business models allow companies to capture financial benefits from going circular that they cannot achieve in linear business models. An advantage of business models where the ownership remains with the Original Equipment Manufacturers (OEMs) is that they create incentives for the OEMs to make products more durable and repairable since it is then in their interest to utilise the products for as long as possible. There are also many businesses that solely focus on extending the lifetimes of products by activities such as repair, refurbishment and upgrading (Lewandowski, 2016; Vanegas et al., 2018).

Even though the idea of transitioning to a circular economic model has been widely welcomed in theory, the level of implementation in businesses is still low (Ritzén and Sandström, 2017). The World Business Council on Sustainable Development has declared that “Businesses are keen to take action, but aren’t sure where or how to start.” (WBCSD, 2017, p. 6). An organisational barrier to changing operations of companies is that the concept of circular economy mainly seems to be on the agenda of sustainability professionals (Kirchherr et al., 2018). A recurring problem with implementing any sort of sustainability initiatives in organisations is that managers fail to understand that environmental and socio-economic issues affect all functions in the organisation, thus they simply assign the issues to a separate unit (Doppelt, 2017). Further, when evaluating firms’ awareness and behaviour when developing a circular economy, Lui and Bai (2014) identified a large organisational barrier generated by silo structures. They argued that the often low integration between planning and operation in organisations sustain cultural differences, generate animosity and can hinder circular implementations. Similarly, Tura et al. (2019) found that circular projects need resources from different departments but are hindered by conflicts that arise due to difficulties to collaborate over department borders. This shows that similarly to how the silo mentality is a barrier to collaboration between different businesses in supply chains, it is also a barrier to internal cooperation within organisations. All of these examples are supported by (Kirchherr et al., 2018) who found hesitant corporate culture to be one of the most impactful barriers to the circular economy.

On a more positive note, there are already successful examples of businesses that have made the shift from generating profits from selling large volumes of new products, to generate profits from various parts of the flow of goods (Bocken et al., 2016). For ICT products, where lifetime extension has been identified as the best strategy from a circular perspective, businesses that make it economically viable to continually reuse products and components are required (Bakker et al., 2014). This includes businesses involved in repairing, refurbishment and remanufacturing activities as well as next life sales (Lewandowski, 2016). Several researchers have investigated the barriers to the success of such businesses and indicate that both regulation, market conditions and consumer behaviour can hinder the feasibility of ICT reuse businesses. In a global study of ICT reuse businesses, Kissling et al., (2013) found that the most hindering barriers were related to the access to sufficient volumes of post-use electronics in decent condition. The high rating of this barrier was due to a combination of unfavourable legislation, regional waste management infrastructure and that some OEMs actively oppose that their products re-enter the market - all of which are beyond the control of the reuse businesses since the
barriers belong to the macro and meso system levels. On the other hand, the success factors that earned the highest rankings in the study by Kissling et al. (2013) were those related to product and process quality, i.e. that the reuse products are reliable and hold high quality, quality controls during reuse preparation and secure removal of user data. The second highest ranked success factor for ICT reuse businesses was good stakeholder relationships, both up- and down-stream in the supply chain.

Whalen et al. (2018) built on the framework of (Kissling et al., 2012) and performed case studies at two Swedish ICT reuse companies where they had the companies first map and later rate barriers for their businesses. While the majority of their findings were equivalent to Kissling et.al (2013), they actually found that the highest ranked barrier is the consumers’ (both corporate and individual) unwillingness to purchase used products. This social barrier was partly explained by that consumers appeared to be stuck in a linear pattern, but also inaccurately believe that refurbished and remanufactured products are not as good as new ones (Whalen et al., 2018).

In line with the barriers to circular supply chains, the literature on the micro level highlights the collection of obsolete electronics from the users as the main challenge for the continuous circling of laptops and smartphones (Bakker et al., 2014; Cucchiella et al., 2015. This has been connected to the consumers’ lack of knowledge, in the sense that they do not understand the value of their used electronic devices and how to return them (Ellen MacArthur Foundation, 2018). Further, the consumers’ concern about data security and fear that personal data might be retrieved and used inappropriately creates another barrier for the return flow of products (Whalen et al., 2018). Govindan and Hasanagic (2018) highlighted the importance of knowledge raising as an enabler for circularity, both regarding circular economy in general and more specifically regarding recycling, remanufacturing and reuse in order to overcome some of the technological and informational barriers that exist. Given the central role that users and consumers have as enablers to the circular economy (Kirchherr, 2018), there is a general call for research about consumption in a circular economy (Govindan and Hasanagic, 2018; Kalmykova et al., 2018; Merli et al., 2017), which is the issue we address with this research.
2.3 Circular Economy in the Electronics Sector

Both the Ellen MacArthur Foundation and the World Economic Forum have provided reports concerning what the future of electronic products may look like (Ellen MacArthur Foundation, 2018; World Economic Forum, 2019). A central message is that the lifetimes of electronic devices need to be maximised, either by the original user or by circling between different users until the devices are no longer useable. Both reports emphasise that it is in the interest of all actors in the electronics industry to leave the linear paradigm of electronic products in favour of the circular economy. They also stress that collaboration between different actors within the industry will be crucial to accelerate the transition as it requires a rethink of product design, supply chains, business models and consumption (Ellen MacArthur Foundation, 2018) and all of these areas affect each other (Bocken et al., 2016; Howard et al., 2018; Schmid and Ritzrau, 2018).

In a lifecycle optimisation study, Bakker et al. (2014) concluded that pure material recycling is not an eco-efficient option compared to prolonging the useful lifetime of electronic products by promoting reuse, repair and remanufacturing. According to their study, the optimal lifetime of a laptop should be at least seven years. In line with this, almost all Life Cycle Assessments (LCA) of smartphones show that the majority of the environmental impact of laptops and smartphones is during the resource extraction and manufacturing stage of their life cycles (Suckling and Lee, 2015). As a consequence, reuse and remanufacturing of existing phones is preferred over the manufacturing of new ones (ibid.). Furthermore, a large portion of the precious metals that are found in electronic products is difficult or impossible to recycle (Cucchiella et al., 2015). These findings highlight that it is important to extend the lifetimes of existing devices to retain their value for as long as possible before they are returned to the loop of pure materials to become a part of new products.

For the future of electronic products, product design and production are considered to be key building blocks to release the full potential of the powers of the inner circle and circling longer (Ellen MacArthur Foundation, 2015; Govindan and Hasanagic, 2018). To adopt a ‘systems approach’ in product design and manufacturing requires for designers to take the entire electronic device lifecycle into consideration and to design for longevity, durability, repairability and upgradeability (Bocken et al., 2016). In their circular vision for electronics the World Economic Forum emphasised that ideally, best-practise of design should be shared within the industry (2019).

In the ideal case, the OEMs should develop business models that extend the support for reuse and remanufacture (Bocken et al., 2016). Some large OEMs of electronic products have indeed started moving in this direction (Ellen MacArthur Foundation, 2018). However, large manufacturing companies are often locked in linear business models (Angelis et al., 2018) since they depend on having large sales volumes and frequently launch new products to the market which makes the consumer electronics industry a so-called high-clockspeed industry (Fernández and Kekäle, 2005). Thus, the OEMs face the risk that extended product lifetimes and second-hand sales cannibalise on the sales of new products.
(Lewandowski, 2016; Ongondo et al., 2013) and thereby it is currently not in their interest that products are easily repaired. This is arguably a powerful supply chain barrier against a more circular electronics sector. Given that the large manufacturers of laptops and smartphones operate worldwide, their ability to develop efficient reverse logistics is also hindered by geographical distribution. As a result of this, Angelis et al. (2018) suggested that it may be more suitable for small and medium enterprises to drive the business model innovation to support circular supply chains for laptops and smartphones.

2.3.1 A Circular Use of Electronics

By evaluating the circular economy frameworks, i.e. the ReSOLVE framework, the butterfly diagram (Figure 1) and the R’s of circular economy (Figure 2) from the perspective of ICT products, there are some conclusions to be drawn about how corporations can proceed from being linear consumers of laptops and smartphones to becoming circular users. Since laptops and smartphones are made from technical nutrients, their circularity is guided by the principles of ‘the power of the inner circle’, ‘the power of circling longer’ and ‘the power of pure inputs’ (Section 2.1) throughout purchasing, use phase and end-of-use. With these descriptions in mind, individuals and companies can gradually move over from linear consumption patterns to a more circular use.

The most desirable purchasing alternative from a circularity perspective is to buy second-hand devices so that products that are already in the loop can circle for longer (Castellani et al., 2015). The second best purchasing alternative is to buy products designed for durability and repairability, to make sure that new products that enter the system can retain their value by circling in the inner loops for as long as possible (Bakker et al., 2014).

Concerning the use phase, the aim is to optimise the use of ICT products to reduce the number of new products that enter the loop. This can be achieved by various measures, for example by sharing devices between users or by extending the lifetimes of the devices through maintenance and repair (Riisgaard et al., 2016). An optimised use of products should also imply that they are not left unutilised during longer periods of time since their values decline rapidly as new products enter the market (Bracquene et al., 2018; Fernández and Kekäle, 2005).

When a user no longer wants to keep a device, it should be returned to the loop. This implies that post-use devices should be collected with a reverse logistics service involving data removal followed by sorting and testing to determine how the value of the products can be kept as high as possible with respect to their present conditions (Ellen MacArthur Foundation, 2018). The ranking of end-of-use strategies are (i) refurbishment in preparation for second-hand sales and reuse, (ii) remanufacturing or harvesting of parts and lastly, (iii) recycling of materials.
3 Theoretical Framework

*In this chapter, we present the theoretical framework that was developed during the research process.*

From the literature of barriers to implementation of circular business, Tura et al. (2019) created a systematic categorisation of barriers to circular business, consisting of institutional, economic, supply chain, organisational, technological and informational and social factors. In order to identify which of the barriers that are within the direct control of an organisation, we have combined this categorisation of barriers with the system levels of the circular economy (Ghisellini et al., 2016). Barriers on the macro and meso system levels are considered to be external since they are associated with the policy landscape, market conditions and the supply chains within the electronics industry. On the contrary, barriers on the micro system level are considered to be internal since they concern the organisation itself, corporate culture, internal policies and capabilities. We have chosen to change the categorisation of supply chain factors to *industrial* as it clarifies that the barriers within this category are beyond the control of an individual organisation. We argue that the term supply chain factors could be associated with the organisation’s own supply chain, which they would have the possibility to influence. A representation of the analytical framework is presented in Table 2 and the following paragraph gives a brief explanation of the categories based on Tura et al. (2019).

### Table 2 - Framework for categorisation of barriers

<table>
<thead>
<tr>
<th>Barriers - Emphasis Area</th>
<th>Institutional</th>
<th>Economic</th>
<th>Industrial</th>
<th>Organisational</th>
<th>Technological &amp; Informational</th>
<th>Social</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complex and overlapping regulation</td>
<td>High costs and lack of financial capability and support</td>
<td>Lack of network support and partners</td>
<td>Incompatibility with existing (linear) operations and development targets</td>
<td>Lack of information and knowledge</td>
<td>Lack of social awareness and uncertainty of consumer responsiveness and demand</td>
<td></td>
</tr>
<tr>
<td>Lack of governmental support</td>
<td>Lack of tools and methods to measure (long-term) benefits of CE projects</td>
<td>Strong industrial focus on linear models</td>
<td>Silo thinking and fear of risks</td>
<td>Lack of technologies and technical skills</td>
<td>Lack of market mechanisms for recovery</td>
<td></td>
</tr>
<tr>
<td>Lack of CE know-how of political decision-makers</td>
<td>Lack of collaboration and resources</td>
<td>Conflicts with existing business culture and lack of internal cooperation</td>
<td>Conflicts with existing business culture and lack of internal cooperation</td>
<td>Lack of clear incentives</td>
<td></td>
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19
Institutional barriers are often deep-rooted structural barriers such as industry policies developed for linear operating models. In addition, institutional barriers include regulations such as taxation policies that require government intervention to be changed. Some of the identified economic barriers are the high cost of new technologies, perceived economic risk and lack of measurements for the long-term benefits of circular solutions which all impact the financial support of circular businesses. Similarly to institutional barriers, the most prominent industrial barriers are those that create a linear lock-in. As earlier mentioned, businesses in a linear supply chain tend to focus on optimising their own operations whereas circular supply chains require a more holistic perspective and more collaboration. A common denominator between industrial and organisational barriers is the shortcoming of long-term and system thinking. This leads to those barriers embedded in the individual firm, such as insufficient managerial support, failures in communicating CE benefits and incompatibility with current operations and business culture. There are also more structural organisational barriers such as silo structures between departments and hierarchical systems that inhibit both knowledge transfer and the implementation of CE within the firm. The lack of knowledge, technologies and information are all obstacles to circular business since they create challenges to identify, develop and implement solutions that support CE. Lastly, the social barriers to circular business are on the individual level among consumers and employees and they include lack of awareness and inadequate incentives.
4 Methods

In this chapter, we present the research methods of the study. The case study and its context are outlined and the research process and our methods for data collection are presented and discussed in relation to the purpose of the study. We conclude the chapter by presenting which measures of validity and reliability that were taken in order to maintain a high research quality.

4.1 Case Study

Given the novelty of circular economy as a research area (Murray et al., 2017) and the exploratory purpose of this study, the case study methodology was considered to be suitable for this research (Yin, 1994). The case study methodology is relevant when researchers aim to investigate and understand complex contemporary issues in real-world settings (Eisenhardt, 1989) and seek to answer a research question that starts with ‘how’ or ‘why’ (Yin, 1994). Harrison et al., (2017) highlighted that the case study strategy is especially suitable when the boundaries between the phenomenon and its context are not clearly evident, which applies well in the case of corporate use of laptops and smartphones.

The literature chapter brought forward several barriers to circularity in the ICT sector, many of which do impact the possibility for corporations to be circular users of laptops and smartphones. However, we also presented examples from cases where both the reuse business models and the infrastructure are in place which show that even though regulatory and economic barriers might exist in those cases, they are not impactful enough to inhibit reuse businesses. We set out to find an ICT user organisation that already had a functioning collaboration with a reuse partner in place but nevertheless does not manage to reuse all of the internally used laptops and smartphones, to understand what barriers that impact product circularity from a user organisation’s perspective. Our search for a company that would fit these criteria resulted in contact with a large Nordic business-to-business (B2B) information technology (IT) reseller corporate group, hereafter referred to as ‘Jupiter’. After a couple of meetings, it was clear that a case study at the company could contribute with new knowledge within the field of circular economy for ICT products as well as result in useful and hands-on recommendations for organisations that seek to decrease the environmental impact of employees’ laptops and smartphones.

The focus of the case study was on two of the entities within the group, namely the Swedish branch of the corporation, hereafter referred to as ‘Jupiter Sweden’, and the logistical function of the corporation hereafter referred to as ‘Jupiter Logistics’. Jupiter offers complete IT infrastructure solutions for Nordic businesses in both the public and the private sector. The organisation’s product range is based on partnerships with large international ICT manufacturers and IT system providers. Jupiter uses the product range in combination with internal knowledge to provide their customers with specialised and individual services including software configuration and retake after use.
An additional fact that makes the case of Jupiter Sweden interesting to look at is that the company has initiated a number of internal and external initiatives to increase sustainability within the IT sector, where one of them has had a sole focus on higher retake rates of ICT equipment. The setting was chosen due to the unique combination of having Jupiter Sweden’s market-leading position and advocacy for sustainability together with Jupiter Logistics’ highly developed retake and refurbishment function, all under the same corporate roof. In addition, the 2,500 employees of Jupiter Sweden spread over 35 offices all over the country made the organisation interesting from a corporate ICT user perspective.

4.2 Research Process

The research project was initiated in mid-January 2019. We started by familiarising with the empirical setting, i.e. Jupiter Sweden and Jupiter Logistics. The first day at the office of Jupiter Sweden included a 90-minute introductory session with the Chief of Sustainability and an initial meeting with the Chief Information Officer in order to establish the purpose of the research.

The first weeks of the project were characterised by ambiguity as we tried to understand the context. Piece by piece, we understood the decentralised corporate structure and wide range of business areas of Jupiter that were not known to the researchers before the project start. The first phase of the research can be described as very reiterative (Collis and Hussey, 2013), going back and forth between the literature and the empirical context with occasional guidance from the academic supervisor. It became clear that the company as a whole needed to increase the understanding for circularity of ICT products, however, it was more difficult to pinpoint exactly what problems the organisation needed to solve and what was feasible within the timeframe of the thesis. Three exploratory interviews were carried out with the objective to inform our choice of research questions. After establishing the research questions, a more structured phase of data collection took place. In the empirics, this data collection phase started with a study visit at Jupiter Logistics’ refurbishment centre. The site visit was followed by four in-depth interviews, and later by seven shorter structured interviews. Figure 5 shows a graphical representation of the full research process. The process that we went through is best described as an abductive approach that to a high extent resemble what Dubois and Gadde described as a systematic combining (2002). In hindsight, it is evident that this approach contributed to our own learning and developed our ability to contribute with qualitative research (Flyvbjerg, 2006).
The purpose of the interviews was to collect qualitative data that addressed RQ 1: “What barriers hinder an organisation from a circular use of ICT products?” and RQ 2: “What phase of the products’ lifetimes do the barriers impact?”. After answering these two, data analysis guided by the theoretical framework led us to answer RQ 3: “How do the barriers relate to different system levels of circular economy?”. By combining the answers to RQ 1, RQ 2 and RQ 3 we could finally respond to the main research question: “How do barriers from different system levels of circular economy impact the possibility for organisations to be circular users of ICT products?”.

The literature review was ongoing in parallel with the empirical data collection, making the theoretical background and framework simultaneously emerge with the data collection and analysis. We chose to include knowledge from both academic literature and grey literature, due to that other experienced researchers consider the non-peer-reviewed works on circular economy too important to be disregarded (Geissdoerfer et al., 2017; Ghisellini et al., 2016; Kirchherr et al., 2017). During the literature review, we noticed a gap in the existent CE barrier literature, that no previous studies have identified barriers to a circular electronics sector seen from a user firm perspective. By fulfilling the purpose of our research, we are confident that we will contribute with a new valuable perspective to the current knowledge. In Appendix A (Table 12) we present an overview of the current CE barriers literature that is applicable to the electronics sector.

To overcome some of the limitations of narrative literature reviews (Tranfield et al., 2003) we deliberately initiated our literature review with reading existing literature reviews carried out by others (Angelis et al., 2018; Bressanelli et al., 2018; Camacho-Otero et al., 2018; Geissdoerfer et al., 2017; Ghisellini et al., 2016; Govindan and Hasanaagic, 2018; Homrich et al., 2018; Kirchherr et al., 2017; Masi et al., 2017; Merli et al., 2017).
4.3 Data Collection

One of the most prominent strengths of case study research is the possibility to collect data from multiple sources (Eisenhardt, 1989; Harrison et al., 2017; Yin, 1994). In this study, a triangulation between interviews, an examination of internal documents and in-field observations was carried out. Using these various data collection methods allowed us to develop a rich contextual understanding combined with the in-depth understanding of the research phenomena. We collected a mix of quantitative and qualitative data to achieve a synergistic view of evidence (Eisenhardt, 1989). The quantitative data was used to understand and describe the current state of circularity in the use of laptops and smartphones within the case study company, while anecdotes and explanations shared during the interviews helped understand why the current state of product circularity prevailed (Mintzberg, 1979; Shah and Corley, 2006). The quantitative data was collected via email from various organisational sources during the research period. Following the line of reasoning by Mintzberg (1979), this ‘hard’ data helped us understand and describe patterns in the empirical setting. In fact, we experienced some trouble in accessing the quantitative data for the internal use of laptops and smartphones, partly as there was no data to be found before the year of 2018 and partly as the data received was believed to have large numbers of unrecorded units. This later turned out to be explained by the findings of the research.

4.3.1 Contextual Understanding

Part of the agreement with the thesis sponsor was to have access to seats in the office space at the head office of Jupiter Sweden. This enabled a thorough understanding of the case study organisation which aided the collection and interpretation of data during the research period (Collis and Hussey, 2013). Early on in the process, we made the conscious choice of spending a minimum of two days each week at the office and working from other locations during the rest of the time, in order to allow for scientific distance and reduce the risk of bias (Stoecker, 1991). To understand the general level of knowledge about circular ICT we talked to other employees that we met in the office. The things we did not understand intuitively we asked our supervisors at the company, with whom we also met weekly to discuss the progress and direction of our study.

Field notes were taken down during the days at the case company and at the study visit. One single document for general field notes was shared between the two researchers and stored in the case study database. The notes that were written down concerned both direct observations of what was seen and heard at the case company and our own thoughts around the observations that were made. By collecting the reflections about our experiences in the case study context in real-time we achieved an overlap of data collection and data analysis (Eisenhardt, 1989).
4.3.2 Interviews

A total group of fourteen corporate actors were interviewed, representing different functional areas, hierarchical levels and geographies of the organisation. Figure 6 represents the logic of the interview selection before we continue to explain how the interviews were carried out.

Table 3 - First round of interviews

<table>
<thead>
<tr>
<th>Interviewee</th>
<th>Role</th>
<th>Organisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interviewee 1</td>
<td>CEO</td>
<td>TCO Development</td>
</tr>
<tr>
<td>Interviewee 2</td>
<td>Head of Sustainability &amp; Business Development</td>
<td>Jupiter Logistics</td>
</tr>
<tr>
<td>Interviewee 3</td>
<td>IT-Services Manager</td>
<td>Jupiter Sweden</td>
</tr>
</tbody>
</table>

1 TCO Development is a third-party organisation that provides the global sustainability certificate ‘TCO Certified’ for ICT products, independent of the industry and buyers. Products must meet comprehensive social and ecological sustainability criteria to become TCO Certified (TCO Development AB, 2018).
4.3.2.2 Site Visit
The site visit at the logistics and refurbishment centre was divided into three segments; an in-depth briefing about the site’s refurbishment process, a guided tour through the production site and a follow-up session for further questions. During the first hour, Interviewee 2 described the refurbishment process in detail, using explanatory drawings on a whiteboard to aid the researchers understanding. The briefing was conducted in an open manner where the researchers were free to ask questions ad lib. Both researchers took notes and digitally documented the drawings during the session.

Following this was a tour of the production site that began at the refurbishment station of smartphones and tablets where the researchers were introduced to the station manager and offered the possibility to ask him/her questions about the process. With the objective to learn as much as possible, this was done simultaneously as taking notes and observing the stations’ functions. The next part of the tour was at the station for the refurbishment of laptops and computers. The tour followed every step of the production line and again, the researchers were offered to ask questions to a technician with over ten years of experience. The visit was concluded with a brief sit down with Interviewee 2 where the researchers were given room to ask any additional question and clarify potential uncertainties.

4.3.2.3 Second Round of Interviews
In order to collect data from the most knowledgeable informants for each step of the products’ lives, the interviewee selection for the second round (Table 4) was based on references from Interviewee 2 and 3 and validated as suitable informants by the corporate supervisor. Choosing knowledgeable informants that view the research phenomena from different perspectives is a good approach to mitigate bias in the data collection (Eisenhardt and Graebner, 2007) and this was suitable for us given the intention to understand all stages of product lives within Jupiter. Since that the stages of product lives are a sequence of events, it was appropriate to ask each interviewee questions about the preceding and subsequent stages to the stage they worked with, which led to that the interviews partly overlapped. Shortly after each interview, we discussed the findings and on the occasion of noticing dissonance between the dictums of different interviewees we asked clarifying questions by email.

Table 4 - Second round of interviews

<table>
<thead>
<tr>
<th>Interviewee</th>
<th>Role</th>
<th>Organisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interviewee 4</td>
<td><em>Head of Products Services</em></td>
<td>Jupiter Sweden</td>
</tr>
<tr>
<td>Interviewee 5</td>
<td><em>Project Manager IT</em></td>
<td>Jupiter Sweden</td>
</tr>
<tr>
<td>Interviewee 6</td>
<td><em>Purchasing &amp; Second-hand Market Manager</em></td>
<td>Jupiter Logistics</td>
</tr>
<tr>
<td>Interviewee 7</td>
<td><em>Head of Asset Management</em></td>
<td>Jupiter Sweden</td>
</tr>
</tbody>
</table>
4.3.2.4 Third Round of Interviews

In order to validate our analysis of the data collected from the first two interview rounds, we chose to do a final round of interviews with local office managers were the interviewees were selected based on geographical location. To achieve a fair overview of the organisation at least one interview was conducted in each of Jupiter’s larger regions; North, Central, West, South. Unfortunately, due to time limitations, we were unable to perform an interview with a local office manager in the fifth region, Capital.

Table 5 - Third round of interviews

<table>
<thead>
<tr>
<th>Interviewee</th>
<th>Role</th>
<th>Organisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interviewee 8</td>
<td>Local Office Manager</td>
<td>Jupiter Sweden, South Region</td>
</tr>
<tr>
<td>Interviewee 9</td>
<td>Local Office Manager</td>
<td>Jupiter Sweden, North Region</td>
</tr>
<tr>
<td>Interviewee 10</td>
<td>Local Office Manager</td>
<td>Jupiter Sweden, North Region</td>
</tr>
<tr>
<td>Interviewee 11</td>
<td>Local Office Manager</td>
<td>Jupiter Sweden, West Region</td>
</tr>
<tr>
<td>Interviewee 12</td>
<td>Local Office Manager</td>
<td>Jupiter Sweden, Central Region</td>
</tr>
<tr>
<td>Interviewee 13</td>
<td>Local Office Manager</td>
<td>Jupiter Sweden, Central Region</td>
</tr>
<tr>
<td>Interviewee 14</td>
<td>Local Office Manager</td>
<td>Jupiter Sweden, West Region</td>
</tr>
</tbody>
</table>

4.3.3 Interview Tactic

Both researchers were present during the interviews, taking on different roles as suggested by Eisenhardt (1989). One took the role as an interviewer with a focus on asking the questions from the predetermined interview guide or manuscript and interacting with the interviewee. The other focused on documentation of the interviewee’s responses and was responsible for securing that the recording was in order and taking down notes of what was said in real time as a backup. By using this interview method, the researchers secured that the issues were fully explored (Collis and Hussey, 2009). It is worth noting that as the interviewees were very spread out geographically, the majority of the interviews were performed via video link. In addition, the interviews were held in Swedish since that was the language of both interviewees and researchers. Hence, the answers were translated to English in the data analysis which creates a risk of nuances being lost in translation.

For the first two interview rounds, we chose to conduct semi-structured interviews since we needed each interviewee to explain the step-by-step logic for the stage of product life of his/her expertise (Collis and Hussey, 2009). As the step-by-step logic was not clear to the researchers before the interviews, we followed predetermined interview guides that allowed follow-up questions to be added when new details were revealed or whenever further clarification was needed (Appendix B).
The interview guides contained a mix of questions of different types, here presented following the categorisation presented by Collis & Hussey (2009). Open questions were used with the purpose of exploring the interviewee’s area of expertise and gather broad information. The interviewees were often encouraged to give as much detail as possible in their answers. The open questions were commonly followed up by probes or closed questions that encouraged the informants to further explain the topics of interest to the research or give away specific factual information. In some cases, a set of answers was followed up by a summarising question with the purpose of avoiding ambiguity and validate the answers. To secure that no important information had been left out, we concluded by asking the informants if they wanted to add anything that they considered to be relevant for our research.

In the final interview round, the interviews were conducted in a structured manner following a predetermined interview manuscript (Appendix C). The structured interview format was suitable since it enabled comparison of the answers given by different office managers to fulfil the purpose of retaining a more general view about the knowledge, spread and attitude to circular use of laptops and smartphones in the organisation. By the last interviews of the third round, we experienced a saturation of ideas (Beitin, 2012). However, we can not eliminate the possibility that further interviews could have provided additional perspectives but that was not feasible within the timeframe.

4.3.4 Ethical Considerations

Prior to the data collection, ethical considerations were taken and translated into a tangible action plan including anonymity, confidentiality and voluntary participation (Collis and Hussey, 2009). In accordance with principles for research ethics from the Swedish Research Council (Vetenskapsrådet, 2002) all interviewees were informed about the purpose of the study and the conditions of their participation through a written handout (Appendix D). The handout also stated that the interview would be anonymised, that the interviewee would be given the possibility to confirm their answers before the report was published and that the interview would be recorded, if they approved.

By the start of each interview, the researchers confirmed with interviewees that they had read and understood the handout and the interviewees had to orally consent to be recorded. Further, in the event of interviewees being literally cited in the report, they were asked to approve the quote via email before the report was published. This in order to avoid taking their words out of context and prevent misinterpretation or translation errors.
4.4 Research Quality

The case study research strategy has been addressed with repeated queries regarding both its risk of being biased and its methodological rigour (Gibbert et al., 2008). A number of measures were taken to prevent the research from being biased (Christie et al., 2000) i.e spending limited time within the empirical setting, using the most knowledgeable informants and collecting of both qualitative and quantitative data to attain a synergistic view of the evidence. In addition to this, the research was designed and carried out with the aim of achieving an as high research quality as possible with respect to construct validity (making sure that the study investigates the right phenomena), external validity (often called generalisability), internal validity (the integrity of the research design) and reliability (transparency and replicability) as suggested by Yin (1994). Whilst disclosing the real name of the case organisation is advised to provide the research with high transparency (Gibbert et al., 2008) we chose to use a pseudonym instead to reassure the anonymity of the interviewees. The methodological actions that were taken throughout the research process are presented in Table 6.
Table 6 - Methodological actions to ensure a high research quality

<table>
<thead>
<tr>
<th>Qualitative measure</th>
<th>Methodological action</th>
<th>Example</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construct validity</td>
<td><em>Triangulation between multiple sources of data</em></td>
<td>See 4.3</td>
<td>(Collis and Hussey, 2009; Yin, 1994)</td>
</tr>
<tr>
<td></td>
<td><em>Multiple data collection strategies to achieve triangulation of evidence</em></td>
<td>See 4.3</td>
<td>(Eisenhardt, 1989; Flyvbjerg, 2006; Gibbert et al., 2008)</td>
</tr>
<tr>
<td></td>
<td><em>A structured interview process with a well-reasoned selection of interviewees</em></td>
<td>See 4.3.2 &amp; 4.3.3</td>
<td>(Christie et al., 2000)</td>
</tr>
<tr>
<td></td>
<td><em>Explanation of how data access was achieved</em></td>
<td>See 4.2 &amp; 4.3</td>
<td>(Yin, 1994)</td>
</tr>
<tr>
<td></td>
<td><em>Establishment of a chain of evidence in the findings</em></td>
<td>See 4 &amp; 5. List of all activities taken available on request.</td>
<td>(Yin, 1994)</td>
</tr>
<tr>
<td></td>
<td><em>Reflection of how the actual course of research affected data collection process</em></td>
<td>See 6.4</td>
<td>(Yin, 1994)</td>
</tr>
<tr>
<td></td>
<td><em>Have key informants review a draft of findings</em></td>
<td>Preliminary findings were presented at the company and a draft was shared among sponsors.</td>
<td>(Yin, 1994)</td>
</tr>
<tr>
<td>External validity</td>
<td><em>Selection of a relevant case</em></td>
<td>See 4.1</td>
<td>(Flyvbjerg, 2006)</td>
</tr>
<tr>
<td></td>
<td><em>Provision of details about the case study setting</em></td>
<td>See 4.1 &amp; 5.1</td>
<td>(Gibbert et al., 2008)</td>
</tr>
<tr>
<td></td>
<td><em>Including multiple business units within the case study organisation and external experts</em></td>
<td>See 4.3</td>
<td>(Eisenhardt, 1989)</td>
</tr>
<tr>
<td></td>
<td><em>Empirical evidence accessed from an embedded case study</em></td>
<td>See 4 &amp; 5</td>
<td>(Eisenhardt and Graebner, 2007)</td>
</tr>
<tr>
<td>Internal validity</td>
<td><em>Formulation of a clear research framework</em></td>
<td>See 3</td>
<td>(Gibbert et al., 2008)</td>
</tr>
<tr>
<td></td>
<td><em>Use pattern matching to compare empirically observed patterns with patterns established in previous studies</em></td>
<td>See 5.3 &amp; 6</td>
<td>(Eisenhardt, 1989; Yin, 1994)</td>
</tr>
<tr>
<td></td>
<td><em>Search for evidence for ‘why’ behind relationships</em></td>
<td>See 5.4</td>
<td>(Eisenhardt, 1989)</td>
</tr>
<tr>
<td>Reliability</td>
<td><em>Presentation of interview protocols</em></td>
<td>Available on request.</td>
<td>(Yin, 1994)</td>
</tr>
<tr>
<td></td>
<td><em>Establishment of case study database</em></td>
<td>Available on request.</td>
<td>(Yin, 1994)</td>
</tr>
</tbody>
</table>
5 Findings & Analysis

In this chapter, the findings of the study are presented and analysed. It starts off with a description of the empirical context, followed by an analysis of the current use of laptops and smartphones within the organisation in relation to the preferred circular use of electronics. Further, we answer RQ1: “What barriers hinder an organisation from a circular use of ICT products?” by presenting the findings in the form of barriers to a circular corporate use of laptops and smartphones, categorised according to the barrier framework. In the last section of the chapter, we will zoom out from the specific barriers to get an overview and to answer RQ2: “What phase of the products’ lifetimes do the barriers impact?” and RQ3: “How do the barriers relate to different system levels of circular economy?”. Through this we can identify which barriers are internal or external and analyse how that impacts Jupiter Sweden’s possibility to become a more circular user and thus, answer our main research question: “How do barriers from different system levels of circular economy impact the possibility for organisations to be circular users of ICT products?”.

5.1 The Empirical Context

We start off by describing the empirical context to clarify how the collaboration between Jupiter Sweden and the refurbishment partner Jupiter Logistics works. Figure 7 gives an overview of how products flow between different functions and how Jupiter Logistics’ centre has dual functions as both logistics and refurbishment centre. With this setup, they can combine outbound logistics of delivering products to the customers of Jupiter Sweden and reverse logistics to supply the refurbishment with post-use devices. The service is either included in a custom package or ordered separately at a fixed cost. A user organisation that orders the service receives a cabinet in a chosen size, which can be filled up with any kind of old IT equipment. The cabinet is then transported to the logistics and refurbishment centre. The centre receives about 40-50 cabinets every other day and considers the supply of products to be satisfactory.

Jupiter Logistics is a stand-alone organisation within the corporate group, working with all the Nordic entities of the company. When orders are placed for new equipment within Jupiter Sweden, the configuration and shipment are carried out by Jupiter Logistics. Further, Jupiter Logistics also executes the retake service, i.e. the collection of post-use devices. The service is either included in a custom package or ordered separately at a fixed cost. A user organisation that orders the service receives a cabinet in a chosen size, which can be filled up with any kind of old IT equipment. The cabinet is then transported to the logistics and refurbishment centre. The centre receives about 40-50 cabinets every other day and considers the supply of products to be satisfactory.
The first step in the refurbishment process is sorting, firstly after product type and secondly after the possibility to be reused. All products that are broken beyond repair that cannot be reused are sent to a recycling partner or sold in parts. There are also functioning products that are sent straight to recycling due to their low value on the second-hand market, this is more common among smartphones due to their high devaluation rate. The remaining products are transferred to the refurbishment process where they are wiped of their internally stored data and cleared of external identification labels. Depending on the products current condition they are marked with either an A, B or C grading, which decides the second-hand sale price according to a set scheme. As a final step, they are sorted by brand and model and placed on pallets, ready to be sold to brokers that bring them to the second-hand market. Due to the selective demands in the Nordic market, products in poor condition or that are considered outdated are often sold to foreign retailers or remanufacturers. A percentage from the revenue of the sold products is refunded to the user organisation with the objective to give an economic incentive for the customers to use the service. The majority of the laptops received by Jupiter Logistics are reusable which is mostly due to the fact that the customers of Jupiter Sweden are only corporations and businesses, who generally purchase laptops with a higher and more professional standard, both from a durability and a performance perspective. According to Interviewee 2, laptops of this quality would probably be durable through nine years of use and since most of them are not used more than three years when they arrive at the refurbishment centre, most of them are fully functional and easily resold.
5.2 The Use of Corporate Laptops and Smartphones

Based on the findings in the literature review, the different circular strategies are now evaluated from the perspective of the current use of laptops and smartphones at Jupiter Sweden. Internally, the organisation provides laptops and smartphones for their employees to use in business purposes. From management, a ceiling price per product is set and the range is limited to a number of different models from three of Jupiter’s main partner brands. In the event of an employee wanting a laptop that is more expensive than the ceiling price, the difference is taken from the salary. The range of smartphones is larger and the employees are free to choose from practically any smartphone on the market. Similarly to laptops, employees can choose a smartphone that goes above the ceiling price and pay for the difference themselves.

When it comes to purchasing strategy, the preferred option is to purchase used devices. However, due to the nature of Jupiter Sweden’s business idea and the organisations’ close partnerships with OEMs, today’s setting does not allow for employees to purchase second-hand equipment. It is argued that it becomes somewhat paradoxical if an organisation that partly makes its revenue from selling new ICT equipment would purchase second-hand equipment internally. In this situation, the second-best thing to do from a purchasing perspective would be to base the decisions on durability and repairability. Today Jupiter Sweden purchase devices on the basis of quality, performance and price. As mentioned, high-quality and high-performance devices can almost always be refurbished or remanufactured and ultimately reused after three years of use, as long as they are not broken beyond repair. From this perspective, Jupiter Sweden is currently in a linear lock-in when it comes to what products the company purchases, due to its current business model and the current state of the industry. Since the product selection does not hinder the possibility to extend use phases or prepare for reuse further on, the products themselves do not act as a barrier for a higher circularity in other stages of their life cycles. Because of these findings in the case study setting, we delimited this report from looking further into other purchasing alternatives and will only return to purchasing in the discussion in section 6.

Concerning the use phase, the employees are required to keep their laptops and smartphones for a minimum of three and two years respectively. The chosen time intervals are set by the depreciation time and once it has expired the employees are entitled to exchange their devices if they wish. In accordance with the preferred circular practice to reduce the number of products in an organisation by extension of the lifetime, Jupiter Sweden offers maintenance and repairs for the employee's devices, but only as long as they are covered by the warranty. Another suggested strategy is the concept of sharing devices, but since the current business model at Jupiter requires each employee to have their own laptop and smartphone in order for them to perform their tasks, the situation makes it difficult to adopt this strategy.
At end-of-use, the products should be kept as intact as possible. When the employees choose to exchange their equipment, Jupiter Sweden has a policy stating that an order for a retake of the old equipment should be placed. The collection is done by the local offices and the retake service executed by Jupiter Logistic is financed by the IT-department, who are also entitled to the refund. The upgrade is voluntary and there is no managerial or automated reminder to make sure the old device is collected for reuse. Jupiter Logistics ensures that the products are handled properly in order for them to retain their highest value. Since this is the sequence of events for the most circular alternative for end-of-use of products from Jupiter Sweden, we hereby divide it into the two stages of ‘collection’ and ‘reuse’. By ‘collection’ we mean the activity of collecting products from the local office and transporting them to the refurbishment centre and in the notion ‘reuse’ we include all activities carried out at Jupiter Logistics in preparation for external reuse (sorting, clearing of data and attributes, second-hand sales).

Figure 8 represents a quantitative snapshot of the internal use of laptops and smartphones, divided into use phase, collection and reuse. The purchasing figures are from 2015 for laptops and 2016 for smartphones based on the expected length of use phases within the organisation of three and two years respectively. The collection figures are based on the products that were received and recorded by Jupiter Logistics from Jupiter Sweden during 2018, a total number of 92 laptops and 99 smartphones. Comparing the number of new laptops that got purchased internally in Jupiter Sweden three years before, about 15% of them were collected. For smartphones, the percentage is slightly lower and from the smartphones since about 13% came back with the retake service. Once at the refurbishment centre, 78% of the laptops and 58% of the smartphones could be refurbished and sold for reuse, while the rest were sent to recycling. In total, this means that only 12% of Jupiter Sweden’s purchased laptops and 8% of the smartphones ended up being reused. Looking at the distribution among the offices using the service, only 11 out of the 35 offices used the retake service to send back laptops and smartphones. Two thirds of the laptops received at the centre originated from the Swedish headquarters of the organisation, while two thirds of the smartphones originated from a small local office in the South region.
The quantitative data points towards a large gap between the number of products purchased and the number of products that end up being reused, with the largest drop off in the collection stage. Indeed, one reason for the gap could be that some may use their laptops or smartphones past the depreciation time, but we argue the number of returned products should be somewhat equivalent to the number of bought products still as that would only create a delay and products from previous years would be collected instead. The quantitative data shows that (i) the use phases of products are short compared to the expected lifetimes of devices and (ii) the organisation does currently not ensure that all the products are collected which leads to that only a fraction of the internally used laptops and smartphones arrive at the refurbishment facility. These findings indicate that there is room for becoming more circular during both the use phase and the end-of-use for this organisation, so the focus in the coming sections is to bring clarity to how.

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2 Due to the fact that Jupiter Sweden has, up until recently, not kept track of the number of products purchased for the employees each year, the number of laptops purchased in 2015 is an estimation made from reviewing purchased units of the following years and the number of employees at Jupiter Sweden at the time. Further, the researchers have through the interview noted a dissonance with the dataset received by Jupiter Logistics and therefore suspects a large number of unrecorded units which applies to all stages. The implications of this is further discussed in the limitations of the study.
5.3 Barriers to a Circular Use of Laptops and Smartphones

In this section, we present our findings that correspond to RQ 1: “What barriers hinder an organisation from a circular use of ICT products?”. From the interviews we were able to identify 15 barriers that we argue explain the current low success rate in a circular use. Following, the 15 barriers are presented by category from the theoretical framework, together with anecdotal explanations to give the reader an authentic understanding of the barriers.

5.3.1 Institutional Barriers

Two of the identified barriers belong to the first category, institutional barriers. Firstly ‘Regulatory reuse barriers’ and second ‘Warranty time’ (Table 7). While there are many regulatory incentives that would indeed aid and enable a circular use of products, some political sustainability regulations do affect the Swedish reuse market in a negative way. One example lifted in more than one of our interviews is the quite newly enforced Swedish chemical tax. The regulation adds a tax on all technical products that contain specific chemicals, laptops and smartphones included. The problem with the tax is that it takes no regard to whether the product is sold as new or second-hand. Effectively this means that the chemical tax is paid for the same product twice, or thrice, depending on how many times it is sold onwards. The only way to be freed from paying for a used product is to prove that the tax has already been paid on that specific device.

The warranty time decides the depreciation time as Jupiter Sweden sees no economic incentive for the employees to keep the products longer as this is only associated with a risk of high repair costs if they were to break down. An extended warranty time would directly affect and extend the first use phase of the product. Indeed, to extend the warranty time can be argued to be under the responsibility of the OEMs to change and could, therefore, be categorised as an industrial barrier. However, while the OEMs are stuck in their linear mindset, regulations could be set in order to enforce longer warranties on products.

Table 7 - Institutional barriers

<table>
<thead>
<tr>
<th>Institutional barriers</th>
<th>Data collection point</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observed barriers and anecdotal explanations</td>
<td>Site visit</td>
</tr>
<tr>
<td>B1: Regulatory reuse barriers</td>
<td>Interviews 2, 6</td>
</tr>
<tr>
<td>&quot;The chemical tax in itself is a good idea, but it is poorly executed. Partly since it does not extend outside the borders of Sweden, a tax at an EU level would have had a larger effect. Further, to enforce the tax on used products directly hinders the possibilities for Sweden to reach our climate goals.&quot; - Interviewee 6</td>
<td></td>
</tr>
<tr>
<td>B2: Warranty time</td>
<td>Interviews 2, 3, 4, 13</td>
</tr>
<tr>
<td>&quot;Normally, you would change your laptop every third year, and your smartphones every other year, it is connected to the warranty time. After it has expired it becomes too expensive to keep the products.&quot; - Interviewee 2</td>
<td></td>
</tr>
</tbody>
</table>
5.3.2 Industrial Barriers

In the next category of barriers, industrial barriers, we identified ‘High technological clockspeed’, ‘Low second-hand value’ and ‘User ID lock’ (Table 8). As you will notice, these three barriers are all correlated with each other. Due to the high technological clockspeed for both laptops and smartphones, three years is enough time to make a product seemingly outdated, even if it is far from being obsolete. Naturally, Jupiter’s main partners are pushing them to sell the latest products to customers and there is a belief that this cannot be done if Jupiter’s representatives are themselves using old products at the customer meetings. Consequently, smartphones and laptops that would have enough capacity to fulfil the needs of the user will be discarded because they are not the latest release.

The rapidity in new releases also affects the second-hand value of the products. Even if it is on the second-hand market, the customers are not interested in products that are considered to be too outdated. Especially, this affects the second-hand value of smartphones, as a new release from the big manufacturers degrades the old products from the same brand and they could go from relevant to outdated in a day. Further, for a product that is outdated and old, it might difficult to access spare parts and it could be very expensive to repair it. The brokers that purchase the products from Jupiter Logistics want to be able to offer their second-hand customers warranties and therefore there is no value in purchasing and then selling a device that might not be repairable. If a product does not have a sufficient value on the second-hand market it is sent to recycling, even if it is fully functioning.

In the refurbishment process, a common aggravation when wiping the products of data is that some products are locked with an individual user ID that is basically impossible for the technicians to work around. Apart from trying to track down each individual for each product, the only other way to solve the issue is to get override codes from the OEMs of the product. However, this is easier said than done as OEMs often refuse to hand out the aforementioned codes. This is mostly an issue with smartphones as laptops are more often locked with an organisational ID which is easier for Jupiter Logistics to get from the user organisations. If a product can not be accessed, it cannot be internally wiped from data and therefore it cannot be sold for reuse.
Table 8 - Industrial barriers

<table>
<thead>
<tr>
<th>Industrial barriers</th>
<th>Observed barriers and anecdotal explanations</th>
<th>Data collection point</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>B3: High technological clockspeed</strong></td>
<td>“In reality, a laptop is durable enough to keep for a longer time but then is the issue of what we are showing to our customers. We need to be able to show the latest product and say to them ‘Dear customer, this is what we are selling, this is something you can get as well!’” - Interviewee 3</td>
<td>Site visit Interviews 2, 3, 6</td>
</tr>
<tr>
<td><strong>B4: Low second-hand value</strong></td>
<td>“When the big smartphone OEMs launch new product series, the market value of old models from the same OEM drops with 20% overnight, while the normal devaluation rate is 3-5% per month” - Interviewee 6</td>
<td>Site visit Interviews 2, 6</td>
</tr>
<tr>
<td><strong>B5: User ID lock</strong></td>
<td>“14% of the smartphones we receive are fully functional, but has to be sent to recycling since they are locked with an individual ID” - Station manager at the refurbishment centre</td>
<td>Site visit Interview 2 Observation</td>
</tr>
</tbody>
</table>

5.3.3 Organisational Barriers

The category of organisational barriers is where the largest amount of barriers were found. These barriers are ‘Ambiguous responsibility for post-use collection’, ‘Decentralised and complex organisational structure’, ‘Limited spread of internal retake practices’, ‘Limited monitoring and feedback of internal retake policies’, ‘Limited internal product tracking’ and ‘Organisational acceptance of hoarding and taking home old products’ (Table 9).

When letting the respondents answer to whom they consider to be responsible to make sure ICT products that are used internally are collected for refurbishment, an interesting finding occurred. Some of our respondents answered that it is officially the responsibility of the IT-department to manage the full lifetime of laptops and smartphones internally and make sure that they are sent for refurbishment by their end of use. The IT-department did agree with this to a certain extent but acclaimed that their responsibility was solely setting the systems and the policies for a retake when it came to making sure the polices were actually followed they placed the responsibility on the middle managers in the organisation. In the interviews with the local office managers, some took the responsibility themselves while some pointed to the sustainability department, others to the employees and a third group actually as far up as to the CEO of Jupiter Sweden.
The issue of this ambiguousness is further amplified by the decentralised and hierarchical organisational structure of Jupiter Sweden since such a setting allows for more negligence and finger-pointing. In Jupiter Sweden’s case, the complexity of the organisation causes additional issues in the sense of reporting and managerial responsibility. It is quite common for employees to work from a local office even if they do not officially belong to that specific cost centre and their manager might be based elsewhere. Seeing that the local office managers only take responsibility for the equipment of the employees reporting indirectly or directly to them, the equipment of the employees with managers elsewhere might fall through the cracks.

The policies that are created for the retake service is something that is proudly flaunted within the organisation. There is an informational website set up on the company’s intranet with guides and instructions to why and how the employees should make sure that their equipment is collected and sent to refurbishment. However, while the awareness of the policies existence is believed to be rather high, the knowledge and anchoring of their content are not. Again, the decentralised structure has lead to the offices being very self-determining and the practices regarding retake differ from office to office. What they have in common though, is that they all deem to think they are successful in their processes and most are positive when estimating the success of Jupiter Sweden’s ICT collection rates in general. However, several local office managers did confess that the estimation was rather built on hope than actual facts and numbers as they get no feedback about the retake.

While the IT-department takes responsibility for setting the retake policies, they neither have the resources nor the responsibility to monitor the progress of them. They, in unanimity with the local office managers, did not have any knowledge about the success of the retake within the organisation but believed it to be high. When making an estimation, Interviewee 5 believed that the organisation managed to collect close to 100% of the old laptops, while for smartphones he/she was not equally optimistic. The limited monitoring and feedback obviously create a false image of the success of the policies and practices, which in turn leads to passivity in the efforts to improve. If you believe that everything works perfectly, it is difficult to create a sense of urgency needed to drive change.

One reason for the organisation’s failure to monitor is that in today’s setting it is difficult to know where all products are and where they end up. Jupiter Sweden has recently introduced a system which enables them to track all laptops within the organisation to a further extent than earlier. However, the system only includes new laptops, thus there is no way of knowing how many old products there are within the organisation and if they are actively used or not. Indeed, they could be used beyond their warranty time, but they could also be taken home to be used for private purposes or be left in oblivion in a cabinet or a drawer somewhere. The issue is even larger for smartphones as they have no tracking at all today while it is also believed to be more common to bring smartphones home or forget about them.
Table 9 - Organisational barriers

<table>
<thead>
<tr>
<th>Organisational Barriers</th>
<th>Data collection point</th>
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<tbody>
<tr>
<td><strong>B6: Ambiguous responsibility for post-use collection</strong></td>
<td>Interviews 2, 3, 4, 5,</td>
</tr>
<tr>
<td>&quot;We challenge the IT-department to own the internal collection process.&quot;</td>
<td>8, 9, 10, 11, 12, 13, 14</td>
</tr>
<tr>
<td>- Interviewee 4</td>
<td>Observation</td>
</tr>
<tr>
<td>“It is a shared responsibility to make sure that the product is collected. But formally, it is on the IT-department” - Interviewee 5</td>
<td></td>
</tr>
<tr>
<td>“It is the IT-department that creates the processes, but the responsibility belongs to the middle managers.” - Interviewee 3</td>
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</tr>
<tr>
<td>“I would say that the local office managers have the formal responsibility.”</td>
<td>Interviewee 8</td>
</tr>
<tr>
<td>“From a legal perspective, it is our CEO, but in everyday life the responsibility falls upon the employees.” - Interviewee 9</td>
<td></td>
</tr>
<tr>
<td><strong>B7: Decentralised and complex organisational structure</strong></td>
<td>Interview 7, 10</td>
</tr>
<tr>
<td>“The culture in Jupiter is very self-determining at the local offices.”</td>
<td>Observation</td>
</tr>
<tr>
<td>- Interviewee 7</td>
<td></td>
</tr>
<tr>
<td><strong>B8: Limited spread of internal retake practices</strong></td>
<td>Interviews 4, 8, 9, 10,</td>
</tr>
<tr>
<td>“I need to get a new phone next month but I have no idea what to do with my old one.”</td>
<td>11, 12</td>
</tr>
<tr>
<td>- Observation during a meeting with sustainability representatives</td>
<td>Observation</td>
</tr>
<tr>
<td><strong>B9: Limited monitoring and feedback of internal retake policies</strong></td>
<td>Interviews 3, 5, 10,</td>
</tr>
<tr>
<td>“We do not control that the laptop is collected, not in the sense that the IT-department has a supervising function.” - Interviewee 3</td>
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</table>
| 12, 14                                                                                 | Observation
| **B10: Limited internal product tracking**                                             | Interviews 3, 5, 6, 8, |
| “A big disadvantage is that you would think that we have a good follow up and are able to see who has which device, but that is not the case.” - Interviewee 12 |
| 9, 12, 14                                                                             | Observation           |
| **B11: Organisational acceptance of hoarding and taking home old products**           | Interviews 4, 5, 9, 12 |
| “If a product is not collected, it might be brought home or end up in a drawer. It is worse with smartphones than with laptops, they could end up as kids toys [...] it’s just the way it has always been at Jupiter” - Interviewee 5 |
| - Interviewee 5                                                                        | Observation           |

The culture of acceptance towards bringing home old products is deeply rooted and therefore many employees and managers ignore set policies regarding reuse. Seen from an environmental perspective, it is not necessarily wrong to let employees bring their discarded electronic devices home if that entails that the products will remain in use by the household for the rest of their functional lifetimes. However, this is not something that the company can take for granted. Neither can the company guarantee that the products will be handed in for refurbishment or recycling by the end of their lifetimes. This means, that by accepting that employees bring old devices home there is a pertaining risk that the products and their embedded materials are not returned to the technological loop - either due to being dumped in the regular trash or due to the products ending up in oblivion. Seeing beyond the environmental aspects of letting employees take their old devices home, it is both a lost economic opportunity and a data security risk for the company.
Lastly, many of the local office managers described a hoarding behaviour in which they, when an employee upgraded their equipment or left the company, keep the old equipment as a backup for external consultants or interns. This might not be a big issue if it is only a matter of a few laptops and smartphones, but in this case, the impact of the hoarding behaviour is amplified by the decentralised organisational structure. To give a simple example, if each office were to stockpile ‘only’ five laptops and five smartphones it adds up to a total of 350 devices. Following the argument above, it is not necessarily wrong that a product is not sent directly to reuse if the first lifecycle is extended. However, there is the issue of that products lose not only their economic value but also their possibilities to be refurbished for every year that passes beyond its warranty time. To keep products lying around just in case they are needed is a good thought in the perspective of not having to buy new equipment for temporary personnel but could in the long-haul cause economic losses and lead to products missing the chance to stay in the inner circle.

5.3.4 Technological and Informational Barriers

In the category of technological and informational barriers, we identified ‘Lack of knowledge about economic value’, ‘Lack of knowledge about data security risks’ and ‘Lack of knowledge about environmental value’ as barriers to circular use of laptops and smartphones (Table 10). These barriers originally came from that two of the interviewees mentioned that there are at least three clear incentives for companies to collect their employee’s laptops and smartphones for refurbishment. These drivers are residual economic value, information security and environmental impact. According to interviewee 4, all of these drivers are becoming more influential for various reasons. Information security has gained increasing focus with the enforcement of the European General Data Protection Regulation (GDPR). Companies environmental concerns are ramped up by climate change and the pressure from consumers to take responsibility. At the same time, the residual economic value of electronic products is affected by the growing market for second-hand electronics and the industry’s increasing focus on circular economy. If an organisation realises the value of at least one of these three incentives, that should be a sufficient incentive to make sure that all post-use devices are refurbished. However, from the site visit, we understood that the awareness of these three reasons to collect end-of-use devices is not acknowledged enough.

Companies most often base their decisions on what is best economically. This does not appear to be the case with the retake of electronics devices since sending laptops and smartphones to refurbishment and second-hand sale is the option that offers the best economic return. According to our observations and the interviews, this seems to be due to that they to see the economic value of used electronic products. After products have been depreciated, organisations consider them to be worthless. This is clearly a misconception since the real value of the products is not zero just because the accounting records say it is. In reality, the used laptops and smartphones do still have economic values and that is dependent on their prices on the second-hand market and on the cost of preparing them for reuse.
The information security incentive is due to that most corporate laptops and smartphones contain personal and/or corporate data that should be erased before the device is passed on to any other user. At the site visit in the logistics centre, it was clear that organisations with a high awareness of information security (often due to having highly sensitive data e.g. authorities, public healthcare and highly innovative companies) were overrepresented among the laptops sent in for refurbishment. However, the experience of Jupiter Logistics is that many companies do not seem to realise the information security risk that they take if devices are not cleared-out when they leave the company. If this is not properly done, there is a risk that the electronic device ends up in the hands of someone else and that the sensitive information stored in the device is recreated.

The third incentive for collecting electronic devices post-use is to make the right thing with respect to the environment. Since the majority of the environmental impact of laptops and smartphones is that of the manufacturing phase, the best thing that a company can do with its used devices is to make sure that they continue to circle for as long as possible. If it is not an alternative that the device is reused internally, leaving it for refurbishment and second-hand use is the preferred alternative. The least preferred option would be to leave the devices in oblivion somewhere since that implies that the materials have totally exit from the technological loop. In contrast, having devices sent straight to recycling leads to that the loop of materials is closed, but with that alternative neither the value of the inner loop nor the value of circling longer is captured. Several of the interviewees did talk about recycling the laptops when leaving the organisation. The fact that the collection-rate of laptops and smartphones is so low at Jupiter Sweden shows that something else than reuse happens to most devices by their end of use.

<table>
<thead>
<tr>
<th>Table 10 - Technological and informational barriers</th>
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<tbody>
<tr>
<td><strong>Technological and Informational Barriers</strong></td>
</tr>
<tr>
<td><strong>Observed barriers and anecdotal explanations</strong></td>
</tr>
<tr>
<td><strong>B12: Lack of knowledge about economic value</strong></td>
</tr>
<tr>
<td>“What they thought was that after three years, the value is depreciated, thus, it is ‘worthless’. But that is not the case.” - Interviewee 4</td>
</tr>
<tr>
<td><strong>B13: Lack of knowledge about data security risks</strong></td>
</tr>
<tr>
<td>“For the companies, there is a safety aspect in knowing that sensitive data doesn’t end up in the wrong hands.” - Interviewee 2</td>
</tr>
<tr>
<td><strong>B14: Lack of knowledge about environmental value</strong></td>
</tr>
<tr>
<td>“For reuse, the single biggest challenge is to get the individuals to understand WHY.” - Interviewee 4</td>
</tr>
</tbody>
</table>

During the interviews with the local office managers, all respondents were asked to explain the incentives for collecting laptops and smartphones after internal use phases from their point of view. This was done to find out how well spread the knowledge about the residual economic value, data security risks and environmental value of post-use ICT products is within this specific organisation.
As one could have expected from an organisation that sells an ICT retake service to its own customers, all respondents gave at least one of the aforementioned reason as an argument to using the retake service for post-use devices. In total, six out of seven mentioned the environmental benefits of reuse compared to other end-of-use strategies, while three out of seven mentioned the secure removal of data and three out of seven also highlighted the social sustainability aspects of reuse. Due to the fact that it is the IT-department that both purchases the equipment and gets the refund for it, it is difficult for the local offices to see the monetary incentive of the refund. However, several of the local office managers mentioned that being good at circular use internally can be beneficial for Jupiter Sweden in relation to their customers and the market since the organisation pushes the Swedish ICT sector towards circularity and should ‘live as they learn’ and ‘walk the talk’. So, in the case for Jupiter Sweden, we can not rightfully claim that the organisation suffers from a lack of knowledge about neither the economic value, the data security risks or the environmental value of product reuse. However, we do have evidence from the low post-use collection numbers revealed by the quantitative data that the organisation does not successfully act on this knowledge. Further, the earlier described hoarding of laptops and smartphones indicate that the knowledge about the economic and environmental value of post-use products is not deep enough to see the implications of this from a circular perspective.

### 5.3.5 Social Barriers

The only social barrier identified was ‘Questionable product ownership’ (Table 11), caused by the current purchasing model for laptops and smartphones where employees are allowed to choose products above the ceiling price under the condition that they pay for the difference themselves. This creates a situation where the ownership of the product could be challenged by the employees. Looking specifically at smartphones, the ceiling price at Jupiter today is quite low in comparison to the market price of the latest releases from any of the most popular brands. Following earlier arguments that the employees are eager, and encouraged, to have the latest products, many of them will choose a smartphone that they would have to partly pay for themselves. Since it is the IT-department is entitled to the refund from Jupiter Logistics, the employees further lose the incentive to send their old equipment for reuse as it would be as if the organisation would get paid for their property.

<table>
<thead>
<tr>
<th>Social Barriers</th>
<th>Data collection point</th>
</tr>
</thead>
<tbody>
<tr>
<td>B15: Questionable product ownership</td>
<td>Interview 5</td>
</tr>
<tr>
<td>“Many employees have paid for a part of their phone, which brings them to consider it as their own property.” - Interview 5</td>
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</tbody>
</table>
5.4 The Impact of Barriers from Different System Levels of Circular Economy

In this section, we will clarify which of the barriers belong to the macro, meso and micro levels and determine if they act as barriers to an extended use phase, collection or reuse, hence answer the main RQ: “How do barriers from different system levels of circular economy impact the possibility for organisations to be circular users of ICT products?”.

![Figure 9 - The impact of barriers from different systems levels of circular economy.](image)

In Figure 9, the barriers are sorted according to what phase of the circular use each barrier impacts vertically (RQ 2) and which of the system levels of circular economy that each barrier belongs to horizontally (RQ 3). An interesting pattern emerges. What we can see from the figure is that the institutional barriers and the industrial barriers (B1-B5) impact the possibility to extend the use phases of products internally and the possibility to reuse products, i.e. to refurbish and resell them. Since these barriers belong to the macro and meso system levels, they are not in the direct control of the company and therefore its possibility to influence them is limited. In contrast, the post-use collection of products is hindered by organisational, technological and informational, and social barriers (B6-B15). All of these barriers are allocated at the micro system level and can be considered internal. We argue that this is positive since it gives Jupiter a very good chance of overcoming these barriers by itself. Further, since the collection is where most products today exit from the circular flow, it can be argued that these barriers are the most impactful barriers to a circular use of laptops and smartphones in this case study company.
To briefly summarise this chapter, we have found that Jupiter Sweden does currently not have the possibility to become more circular in its purchasing selection of products but that there is a possibility to become more circular in the use phase and end-of-use of products. We have also presented and analysed 15 barriers that currently hinder a higher level of circularity and been able to show that all barriers to the critical collection stage are internal. The implication of our findings is that they show that the company does not depend on anyone else to overcome the most impactful barriers to a circular use of laptops and smartphones.
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6 Discussion

This chapter of the paper presents a discussion of the findings, with comparisons to findings of similar research and the managerial implications of the internal barriers. We also zoom out from the micro system level to discuss how a shift in user behaviour can impact the higher system levels and drive change towards a more circular electronics sector. Following that there is a more critical discussion of the circular economy as a whole and finally a discussion of the limitations of the study and future research directions.

6.1 Internal Barriers

While the literature raises the issue of low quality in returning products, poor reverse logistics infrastructure and lack of supply chain collaboration (Angelis et al., 2018; Bressanelli et al., 2018; Kissling et al., 2013) as major reasons for low rates of reuse of ICT products, the findings of this study underline that addressing those problems is only a first step in creating a more circular electronics sector. Due to the high performance of the devices used by Jupiter Sweden and the existing collaboration and retake infrastructure set up with Jupiter Logistics, the company has all prerequisites to reuse all of their laptops and smartphones. Yet, they do not succeed with that and our findings reveal a number of barriers to why that is, where as mentioned the majority of them are internal.

A common denominator for the technological and informational barriers is the lack of knowledge about the value in making sure your equipment is reused. The finding that these barriers exist is coherent with i.e. Govindan and Hasanagic’s (2018) statement regarding knowledge raising being an enabler for circularity. However, based on this study, we argue that increased knowledge is not enough to incentivise organisations to become circular users of their ICT products. As previously stated, our findings show that while the issue is raised in our interviews, Jupiter Sweden does not suffer from a lack of knowledge regarding the economic, the environmental or security-related value. Still, the existing organisational acceptance of hoarding and taking home old products shows an example of how, if the knowledge is not rooted enough, old patterns and organisational culture hinder a circular use. Further, if there is a true understanding of the security-related issues with not making sure your device is correctly wiped, it should create a fear that the personal data might be retrieved and hence become a driver for circular use.

Surely, the decentralised organisational structure further complicates the implementation of any circular initiatives. The findings of Doppelt (2017) are confirmed by Jupiter Sweden having their sustainability department as a separate small unit with only six, out of 2,500, co-workers working tightly with management from the headquarters and with limited reach to the whole organisation.
Thus, the decisions to drive the organisation to become more circular are made on a managerial level and if not integrated properly with the rest of the organisation, potential cultural differences between offices or departments will sustain and hinder the implementation (Liu and Bai, 2014). It becomes clear that in this specific organisation it is not enough to write a policy and expect it to be followed, it will have limited reach and will be overthrown by existing practices and culture. Further, processes and functions such as monitoring, feedback and tracking systems will not appear organically and as long as no one is taking charge and controlling them, the change will be hard to come by. It is clear that many of the barriers the organisation face derive from the ambiguity in who is actually responsible. Therefore, this barrier could be considered as the most stressing to address.

From this, the managerial implications of this study are rather clear. For an organisation struggling to become circular in their use of ICT products due to a low post-use collection rate, the focus should be on ownership, increased communication and internal processes. In a situation where the responsibility is uncertain there is a need for clearer directions from management. This study also shows the need for working systems and processes for the post-use collection to be successful. However, while handling these issues could indeed aid the organisation in becoming more circular, the challenge of integrating the processes in all corners of the organisation remains. The difficulties with communication and driving change in a vastly decentralised and divided organisation are not unique for this setting in any way. For this issue, one should turn to literature and studies regarding organisational theory and change management.

### 6.2 Towards a Circular Electronics Sector

Ideally, to reach a circular electronics sector, the OEMs should take the lead by seizing the business opportunities in increasing supply chain collaboration, design for durability and repairability and include functions such as refurbishment and remanufacturing in their service offers (Bocken et al., 2016). However, as previously mentioned, they are stuck in a linear lock-in which calls for action from the other system levels (Angelis et al., 2018). From a macro perspective, our findings show an example of how policymakers by regulating the warranty time could enforce change and drive the market towards more circular behaviours. However, our findings also show an example of how regulations, such as the Swedish chemical tax, that do not proceed from the CE system thinking, can negatively impact the circular flow of products. Evidently, policymakers have both possibilities and power but need to be considerate of all aspects of a circular system in their decision making.

Turning to the micro level, the findings and the managerial implications have been discussed above. However, one aspect is important to remember. Even if an organisation overcomes their internal barriers for post-use collection, they will as long as they continue to purchase new products, still be a consumer rather than a user of devices. Ultimately, organisations do need to change their behaviour and start purchasing second-hand equipment. It is only when this happens in addition to them succeeding in their
post-use collection that they can drive a change in the market. This would lead to new business opportunities for reuse businesses and it would increase the flow of products in reverse logistics, increasing the possibilities of achieving economies of scale (Bressanelli et al., 2018). Further, many of the barriers raised by reuse businesses today, such as insufficient supply and difficulties in selling products (Kissling et al., 2013; Whalen et al., 2018), would be eliminated.

However, the largest opportunity from this is the users’ possibility to push the OEMs out of their linear systems since the demand for new products would decrease. They would be forced to rethink their strategies and business models. Suppose that they instead of selling products would consider a product-as-service model or leasing. A business idea that could include the OEMs taking charge over reminders, post-use collection and the reverse logistics from the users. Many of the organisational barriers identified in this study would in this scenario cease to exist as it would no longer be on the responsibility of the organisation to make sure the products are reused. Further, these models would also create incentives for the OEMs to design and manufacture durable products, as there now would be an economic gain in doing it.

6.3 Is a Circular Electronics Sector More Sustainable?

So far, this thesis has been based on the postulation that the transition to a circular economy is a way to reach a more sustainable society. But is it really? Geissdoerfer et al., (2017) showed that there are many different perceptions of how the terms ‘circular economy’ and ‘sustainability’ are related, and there is an ongoing debate among scholars on the subject. A majority of the research carried out within the field focuses on environmental sustainability as a starting point for the analysis and in many studies, the economic pillar is also included (Bocken et al., 2016; Ellen MacArthur Foundation, 2012; Lieder and Rashid, 2016). As for the third pillar of the sustainability spectra, the social dimension is only marginally considered in the CE literature (Merli et al., 2017).

However, in the case of ICT products, we argue that a circular economy affects all three pillars of sustainable development since these products have distinct impacts on social sustainability, both positive and negative. Due to the transboundary movement of electronic products, there is a geographic mismatch of where products are first used and where products end up as e-waste (Baldé et al., 2017). It is partly due to that many devices that have had their first life cycle in a country as Sweden ends up being sold as second-hand or third-hand products in developing countries. While this is positive given that it provides those markets with affordable electronic devices, that contribute to outcomes such as financial inclusion and internet access (Williams et al., 2008; World Economic Forum, 2019), there are also negative consequences. As much of the recycling of electronics takes place elsewhere than specialised recycling facilities (Williams et al., 2008), the social dimensions of a circular economy for electronics is the negative impacts on the health of people working in the e-waste and recycling sectors, many of whom are women and children (World Economic Forum, 2019).
Critics to CE turn against regulatory bodies and non-governmental organisations that often highlight the economic benefits of circular economy as the foremost reason to shift the way we produce and consume goods (Valenzuela and Böhm, 2017). They argue that if mainly driven by capitalism, the circular economy might only become yet another engine of economic growth, especially if it is regarded as a silver bullet to overcome prevalent environmental problems without slowing down our rate of consumption. Zink and Geyer (2017) questioned if the closing of product and material loops that are the very central idea of a circular economy does actually lead to reduced primary production. They even go as far as saying that there is a risk that it creates an opposite effect, i.e. that circular economy activities might instead increase primary production. In the article, the authors called this a ‘circular economy rebound’ due to its proposed similarities to the energy efficiency rebound effect\(^3\). The fundamental point of their arguments is that many of the system diagrams in the circular economy are viewed as pure engineering models of products and materials, hence missing the economic nature of circular economy which is that by each step in the butterfly diagram there is a market. If we fail to keep this in mind, Zink and Geyer (2017) argued that is a risk of assuming that there is a 1:1 displacement within each step, i.e. that every kilogram of recycled material replaces one kilogram of virgin material and that every refurbished or remanufactured smartphone replaces a brand new smartphone. But, since recycling of materials requires less energy than the extraction of new resources and remanufacturing requires less labour, energy and resources than the manufacturing of new products, the cost of materials and products will decline (Gama et al., 2016), which from an economic point of view usually leads to increasing demand.

To return to the findings of our case study, what we observed was that the corporation was not mature for purchasing second-hand products but could become a more circular user by making sure that post-use devices are reused by others. This confirms that as long as secondary goods are viewed as less desirable by the buyers on the high-end markets (Camacho-Otero et al., 2018; Kissling et al., 2013; Whalen et al., 2018), they are unlikely to substitute the purchase of a new product. This leads to that refurbished and remanufactured goods compete in other markets than the new products, often in markets with less purchasing power (Williams et al., 2008). This would mean that the belief that refurbished and remanufactured products ‘reduce’ the consumption and production of new products is false. According to the reasoning of Zink and Geyer (2017), what we rather contribute to by developing a more circular electronics sector is that more people will be able to afford a smartphone at all. And whilst we have already emphasised that there are many benefits from giving a larger share of the global population access to digital technologies, it will also contribute to increasing the amount of energy that is consumed

\(^3\) The rebound effect for energy efficiency refers to the phenomena of when the improved energy efficiency of a device or a vehicle makes it cheaper to use, which results in that it is used more than before - hence making the net outcome in energy consumption unchanged.
by our personal electronic devices worldwide. This means that what we should benchmark the material and energy input of refurbishing or remanufacturing a smartphone and its continued use against is not the manufacturing of a new smartphone - it is no smartphone at all (Zink and Geyer, 2017).

So, what needs to happen within the electronics industry to avoid the circular economy rebound effect? One part of the solution would be to make sure that refurbished and remanufactured electronic devices become equal substitutes to brand new devices. To achieve this, product design and marketing are likely to be important enablers, since they might be able to change consumers’ perceptions of secondary products (Gama et al., 2016). If this can be successfully achieved, it might actually draw even the high-end consumers away from buying primary produced devices.

### 6.4 Limitations & Future Research Directions

This research was designed with influence from several well-renowned case study scholars, i.e. Eisenhardt (1989), Yin (1994) and Flyvbjerg (2006), with the intention of achieving a high research quality. However, despite the methodological actions taken to ensure the validity and reliability of the thesis, it does have limitations which we discuss in this section.

Firstly, the study is performed at a single case company with a unique setting and position on the market which limits the generalisability of the findings. In addition to this, the study has had a sole focus on laptops and smartphones which is only a small fraction of the electronics sector. These two product categories are also unique in that they are personal devices. We hereby call upon others to supplement our research by investigating circularity in other user organisations to enable comparisons to be made between different types of organisations, organisational contexts and/or how the possibilities for a circular use varies between different electronic devices.

Secondly, there are limitations in both the qualitative and quantitative data collection. To start with the qualitative data collection, we criticise our choice of interview participants. This does not concern the first and the second rounds of interviews where the choice of interviewees was made with respect to having the most knowledgeable informants for each interview topic, but rather the third round of interviews where we focused on assessing the practices at different offices as well as the spread of knowledge and policies. The selection of interviewees for the third round was based on a list of suggestions from employees working with sustainability. This can have resulted in selection bias and there is a risk that we only included office managers that are actively involved in sustainability issues. In addition, we only talked to office managers which makes it difficult to assess how well knowledge, policies and practices are anchored further down in the organisation. In hindsight, the research would have achieved a higher validity if the range of interviewees in the third round was more diverse.
The main difficulty that occurred during the study was to access the quantitative data for purchasing, time of use and collection to the refurbishment centre, and verify it to be correct. The lack of product tracking and monitoring of post-use collection is not only a barrier for the organisation but has also been a barrier to this study. Today, the organisation is better on keeping track of the products that are used internally and the data collected from 2018 and onwards is according to company representatives trustworthy. However, there is a lot of unrecorded data from previous years and to be able to make any sort of comparisons, estimates had to be made. The quantitative data should, therefore, be considered more as guiding to understand the setting, and should rather be interpreted as an indication.

Since the presented findings represent knowledge built from a single case study, comparable studies from other organisations would improve the generalisability of the results. Further, since this case study was carried out in a corporation that was locked into a linear purchasing of new laptops and smartphones, future studies should also address the issue of corporate use of second-hand devices.
7 Conclusions

This study contributes to the circular economy barriers literature by investigating what hinders the transition to a circular electronics sector seen from a user organisation perspective. For a user organisation that already has the infrastructure and support services for a circular use of laptops and smartphones in place, our study shows that a majority of the products supplied to the refurbishment partner are of high quality and can be resold for extended lifetimes. However, the main point of failure that was identified in this case study was the insufficient collection of electronic devices after serving their purpose within the organisation, leading up to that the value of products is not fully preserved. These findings correspond well with previous research that has pointed out the low volumes of collected electronics as a key barrier to achieving economies of scale for reverse logistics and businesses within product lifetime extension, which are essential in a circular supply chain. This indicates that user organisations have a key role to play as enablers to a more circular electronics sector. The findings indicate that a combination of organisational, technological and informational and social barriers led up to the low post-use collection of laptops and smartphones, all of which can be directly impacted by managerial actions internally. The main conclusion to be drawn from this research is that being in a system that supports a circular use of ICT products does not itself result in circularity, but the user organisation must also overcome internal barriers by raising knowledge and start using systems for product tracking and monitoring. To overcome the internal barriers, addressing the issue of responsibility is key to success since our case study illustrates that pointing fingers in circles does not result in a circular use of ICT products.
List of References


Schmid, D., Ritzrau, W., 2018. Why the circular economy must link up the whole supply chain. World Econ. Forum.


TCO Development AB, 2018. TCO Certified - Generation 8, for notebooks.


Appendix

A. Overview of Circular Economy Barrier Literature

Table 12 contains an overview of existant literature on the topic barriers to circular economy (relevant for ICT products) found during the literature review of this study. As can be seen in the table, no previous literature has investigated barriers to circular economy seen from a user organisation’s perspective, which is therefore a gap in the literature that this study contributes to.

Table 12 - Overview of existent circular economy barrier literature

<table>
<thead>
<tr>
<th>System level of barrier literature</th>
<th>Topic</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Macro</td>
<td>Regulations</td>
<td>(Dalhammar and Milios, 2016)</td>
</tr>
<tr>
<td></td>
<td>Materials recycling</td>
<td>(Baxter et al., 2017)</td>
</tr>
<tr>
<td></td>
<td>Waste management</td>
<td>(Zacho et al., 2018)</td>
</tr>
<tr>
<td>Meso</td>
<td>Supply chain / reverse logistics</td>
<td>(Bressanelli et al., 2018; Govindan and Hasanagic, 2018; Masi et al., 2018)</td>
</tr>
<tr>
<td>Micro</td>
<td>Business models</td>
<td>(Heyes et al., 2018; Kissling et al., 2013; Mont et al., 2016; Ongondo et al., 2013; Westblom, 2015; Whalen et al., 2018)</td>
</tr>
<tr>
<td></td>
<td>Circular business</td>
<td>(Garcés-Ayerbe et al., 2019; Liu and Bai, 2014; Ritzén and Sandström, 2017; Rizos et al., 2016; Tura et al., 2019)</td>
</tr>
<tr>
<td></td>
<td>Product design</td>
<td>(Tecchio et al., 2017)</td>
</tr>
<tr>
<td></td>
<td>Products &amp; solution</td>
<td>(Hobson et al., 2018)</td>
</tr>
</tbody>
</table>
B. Interview Guide

Introduction
- Is it ok that we record the interview?
- Did you read our information handout? *(If not, please take a minute to read through it)*
- Who are we? *(KTH, what’s the purpose of the study etc)*

Initiating question
- Tell us about you and your role at Jupiter?

Area-specific questions
*Each interviewee was asked around ten questions related to their area of expertise, thus the questions were different in each interview. Below is a number of sample questions from each interview:*

**Purchasing**
- What reasons are there for an employee to get a new laptop/smartphone?
- For how long does an employee keep a laptop/smartphone on average?
- What determines the selection of products for the employees to choose from?

**User phase**
- How does Jupiter keep track of the smartphones/laptops used by the employees?

**Retake services**
- What is needed for an organisation to reach a 100% retake of IT-equipment?
- Please, take us through the process of the retake service.

**Refurbishment**
- Please, take us through the process from when a product arrives at the refurbishment centre until it is sold?
- What are the main reasons that a laptop/smartphone cannot be refurbished?

**Second-hand sale**
- Please, take us through the process of setting prices for the used products.
- What factors affect the value of a used smartphone/laptop?

**General retake related questions**
*These questions were asked to all interviewees except interviewee 5 as the researchers reasoned him/her to be too far from the issue to be able to contribute with reliable data.*

- What incentives are there for an organisation to collect and send their old IT-equipment to a refurbishment centre?
- What reasons are there for Jupiter not to collect and send a 100% of your IT-equipment for refurbishment?
- What can Jupiter do in order to increase the number of collected and reused smartphones and laptops?
• Who at Jupiter is responsible for making sure that the old products are collected and sent for reuse?

Final questions

The first question was to sum up and to get the interviewee to elaborate on the issues from a bigger perspective. The final question was to make sure that the interviewee got the chance to say everything he/she wanted to say.

• In the long run, what would contribute to a more sustainable use of laptops and smartphones in organisations? Meaning, what can be done to drive circularity and extend product lifetimes?

• Is there anything you would like to add?

Concluding remarks

We will not use your name in any way and in the published report we will anonymise the organisation’s name. We would like to describe your role and therefore would like to ask what title is and how it is best described in English?

Finally, we would like to ask if it is okay for us to contact you if we have any further questions?

Thank you for participating and contributing to our data collection!
C. Interview Manuscript

Introduction
- Is it okay that we record the interview?
- Did you read our information handout? (If not, please take a minute to read through it)
- Who are we? (KTH, what is the purpose of the study etc)
- Which office are you managing and how many employees work there?

Post-use collection
- Can you describe your responsibility in the handling of the laptops and smartphones that are used by the employees at your office?
- At your office, what happens with the employee’s old laptop/smartphone when an employee quits or gets a new one?
- Do you know how to send your laptop/smartphone for reuse?
- Would you say that the employees at your office know how to send their laptop/smartphone for reuse?
- According to you, why is it important to collect and send laptops and smartphones for reuse?
- Would you say that Jupiter Sweden in your region is successful in collecting and sending equipment for reuse?
- Would you say that Jupiter Sweden at a national level is successful in collecting and sending equipment for reuse?
- At a national level, who is responsible for making sure that equipment is collected and sent for reuse at Jupiter Sweden?
- Did you ever use the retake service provided by Jupiter Logistics?
- According to you, what needs to be done at Jupiter Sweden in order for the organisation to become more successful with collecting and sending equipment for reuse?

Final question
- Is there anything you would like to add?

Concluding remarks
We will not use your name in any way and in the published report we will anonymise the organisation’s name. Thank you for participating and contributing to our data collection!
D. Interview Handout

Before your scheduled interview concerning circular ICT

Information about the thesis project:

As an interviewee, you are participating in a case study that is conducted at Jupiter Sweden by Catja Carlson and Sara Österberg as a part of their Master’s Thesis in Industrial Engineering and Management at KTH Royal Institute of Technology.

The case study is performed on behalf of the sustainability department at Jupiter Sweden. Contact persons at the company are XXX and XXX. Supervisor at KTH is Andreas Feldmann.

The aim of the study is to investigate the internal use of laptops and smartphone from a sustainable perspective. It has a clear focus on success factors and barriers of circular flows. The study will be delivered in a written report and will be published at the Digital Scientific Archives (DiVA) as well as shared internally at Jupiter Sweden and Jupiter Logistics.

Important information about your interview:

- To participate in the study is voluntary.
- As an interviewee, you will be given the ability to give your consent to being recorded. The recordings will be deleted after the study is terminated.
- As an interviewee, you will be anonymised in the report.
- As an interviewee, your answers will be used as informative material for the report and in the event of your quotes being literally cited you will be given the possibility to confirm them before the report is published.

You are welcome to contact us if you have any questions before or after your interview.

Catja and Sara
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