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E-Waste Prevention in Sweden: Fostering Computer Refurbishment and Reuse

An Assessment of the Market, Actors and Barriers

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"We must thoroughly understand the problem and begin to see the possibility of evolving a new life-style, with new methods of production and new patterns of consumption: a life-style designed for permanence."

- E.F. Schumacher

"I only feel angry when I see waste. When I see people throwing away things we could use."

- Mother Teresa

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Abstract

The thesis at hand aims to provide an overview of the reuse market(s) for desktop and laptop computers in Sweden in order to support policy-makers and computer reuse organisations in developing strategies and measures to foster computer reuse and thus reducing the volume of related e-waste as outlined in the national Waste Prevention Plan 2014-2017. Existing types of computer reuse organisations, the barriers they face and their types of suppliers and (receiving) customers were assessed via telephonic in-depth interviews with representatives of nine computer reuse organisations in Sweden. Research and analysis framework were developed along the typical reverse supply chain activities of computer reuse organisations consisting of sourcing, collection, inspection, preparation for reuse, redistribution and follow up-services. Combined with the five dimensions 'financial structure', 'business offer', 'supply chain' and '(receiving) customers' and 'purpose/corporate function' for assessing the operating model(s), three different types of computer reuse organisations were identified.

Those with an IT Asset Management operating model accounted for the biggest group. It offers collection, data sanitation, preparation for reuse and remarketing and preparation (of new computers) services to their suppliers who were identified as private sector companies, public administration institutions and schools. The largest part of refurbished computers was sold to resellers, brokers and computer reuse organisations abroad. Social Enterprises mainly offer collection, data sanitation services for donated computers from municipalities, schools and individuals. They are resold solely domestically to eligible individuals and non-profit organisations. Computer reuse organisations with Close the Digital Divide operating model also offer collection and data sanitation services. Their suppliers typically consist of companies, public administration institutions and educational bodies as well as kretsloppsparks. Computers are resold mainly to non-profit and non-governmental organisations conducting projects in less-developed countries.

Three common barriers which all types of computer reuse organisations were found to face consist of the lack of access to sufficient volumes of used computers, the concerns of potential suppliers about the safety of their data earlier stored on their computers hard-drives (despite the fact that solid data safety measures exist in basically all cases) and the lack of knowledge about the suitability and reliability of used computers by potential buyers for their needs. Besides, a variety of barriers could be identified which are specific to the single operating models and thus types of organisations though.

Thus, in regard to tackle the three identified common barriers, policy-makers should focus on adjusting current legislation in such a way that its primary focus is shifted from recycling towards reuse, providing the necessary infrastructure for the non-consumer but also the consumer-stream. Furthermore, legislation should provide incentives or impose requirements on computer users ensuring and incentivising them to consider reuse of their computers instead of recycling them. Co-operations between different types of computer reuse organisations may also provide opportunities for increased supply with and reuse of computers. Computer reuse organisations are recommended to found an industry association to act as advising organ to support policy-makers but also to conduct joint information campaigns about the safety of computer refurbishing operations in regard to data handling but also the reliability and suitability of refurbished computers for potential customers' needs.

Keywords: E-waste prevention Sweden, Computer reuse market Sweden, Computer reuse organisations, Barriers to computer reuse organisations, Suppliers to computer reuse organisations, Customers of computer reuse organisations.

Executive Summary

A growing global population and an increasing global middle class, aspiring towards 'western' lifestyles implicating unsustainable consumption and production patterns have led to a situation of growing global resource demand in which humankind is not living in a sustainable equilibrium but in many respects exceeding the earth's natural boundaries. While currently a small part of the global generation is responsible for much of the resource demand and pollution, the situation is likely to worsen in the future and will further increase the pressure on the planet and its ecosystems thereby exacerbating resource scarcity and growing waste streams. These issues are especially prevalent in the sector of electrical and electronic equipment (EEE), specifically in the case of computers. Reuse is seen as a promising option in response to these issues as it aims at extending the lifetime of computers and in doing so (potentially) reducing the need for newly manufactured ones, therefore also contributing to a reduction of the related waste volume and need for resources.
Sweden has acknowledged this in regard to electronic products in its latest Waste Prevention Plan for the years 2014 – 2017 as put forward by the national Environmental Protection Agency ('Naturvårdsverket'). Due to a lack of information regarding the related reuse markets including that for computers, its actors and inherent barriers, the development and implementation of suitable measures and strategies to foster and increase the reuse of computers in Sweden and the extension of their lifetime are currently hampered.

Thus, the purpose of this thesis is to support in closing this information gap by posing the following research questions: Which types of organisations are engaged in computer reuse in Sweden? What are the barriers they face and how could they be overcome? What types of actors function as their suppliers and (receiving) customers? How large is the share of (re)sold computers is that is exported by the identified computer reuse organisations'?

Due to the shortage of data on the topic, an exploratory and qualitative research approach was chosen. Several methods were applied for data collection and analysis, allowing for triangulation and thus higher quality of the collected data and results. An initial literature review allowed for the exploration and gathering of already available theoretical knowledge on the topic and the research questions in a general but also for the specific Swedish context. The findings served as a basis for the development of a research framework (as none deemed useful was available) and interview guides. Eventually, in-depth telephone interviews with representatives of nine computer reuse organisations were conducted. The retrieved data was complemented by an analysis of the respective organisations' websites and additionally provided documents. Finally, the findings were analysed by use of the developed research framework.

The framework was built around the typical reverse supply chain activities of computer reuse organisations ranging from the acquisition/sourcing of used computers, via the collection/logistics, the inspection and sorting process, the preparation for reuse as well as remarketing and redistribution to follow-up services. The different types of suppliers identified in literature were added as 'sources of input' to the reverse supply chain starting with the acquisition process. Likewise, the different types of receiving customers found in literature were subsequently integrated to remarketing/redistribution as the pre-final reverse logistics sub-process. In order to distinguish between different types of computer reuse organisations, the framework/typology of reuse operating models of organisations engaged in the reuse of information and communications technology and large household appliances developed by Kissling et al. (2012) was utilised. It bases on four, respectively five analytical dimensions, namely: the financial structure, the business offer, the supply chain and the (receiving) customers of the organisations as well as the purpose/corporate function.

To foster understanding, clarify emerging questions from the interviews and gain further insights into the topic and current practices regarding the reuse of electrical and electronic equipment and computers in Sweden, complementary background interviews were conducted with an expert from the Swedish Waste Management and Recycling Association ('AvfallSverige') as well as two researchers from the International Institute for Industrial Environmental Economics (IIIEE).

Results

Three different types of computer reuse organisations could be identified and differentiated between based on their operating model with its four, respectively five dimensions.
The first operating model was only found with commercial companies (accounting for six of the assessed nine organisations) and is in its finance dimension mainly commercially/for-profit oriented. In literature it has been described as *IT Asset Management* operating model. The main customers of this type of computer reuse organisations are for-profit companies from across all industries (accounting for 60-80% of the total volume), in some cases also located abroad (10-15%). Public administration institutions/organisations on all levels together with schools and universities as well as hospitals were found to make up the rest (20-40%). The business offer of such computer reuse organisations covers everything from the collection of used computers, inventory management and tracking, data wiping and/or destruction of hard-drives and certifications for this as well as cleaning and testing of the hardware, repair activities and installation of new software and redistribution activities as well as warranty services and sales of software. The pre-configuration and installation of hard- and software, the delivery of new computers while collecting used computers in cooperation with computer manufacturers are often also part of the portfolio. Other offerings also comprise the secure storage of extra stock of computers for companies and the letting of used computers for a limited period of time. In regard to (receiving) customers, almost all assessed organisations (except for one) were found to sell the vast majority of the refurbished computers to resellers, brokers or local computer reuse organisations abroad (70-90%), mainly in East, West and Central Europe. In Sweden, private and public schools were found to account for up to 50, respectively 75% of the domestic sales while private sector organisations, especially retailers, made up between 20 and 25%. Private persons accounted for between 5 and 20% of the domestic sales leaving public sector organisations (except for schools) only a marginal role.

The second and third operating models were (in regard to the financial structure) only found with non-profit organisations and have in literature been described as *Social Enterprise* and *Close the Digital Divide* operating model(s). Their business offers typically comprise the collection of used computers, cleaning and testing of the hardware, the exchange/repair of faulty parts, data wiping (not in all cases with certifications) or exchange of hard-drives against new ones, the installation of new operating systems and the redistribution of the refurbished computers together with warranty services. Other offerings include repair services and error diagnostics as well as hardware and software upgrades to customers bringing their own computers for such services.
Nevertheless, organisations with such non-profit operating models differ in regard to their types of suppliers, (receiving) customers and their main purpose. Those with a Social Enterprise operating model (two of the assessed nine) mainly aim at providing individuals diagnosed with a psychological condition or long-term unemployed with meaningful work and at helping them with rehabilitation and reintegration into the job market by offering training/educational possibilities. They were found to receive the used computers solely from domestic donators, mainly public (corporate) organisations (~40%) and specifically municipalities and schools (~40%) while private persons and organisations from the private sector were found to account for the rest (combined ~20%). In regard to (receiving) customers, computer reuse organisations with such a Social Enterprise operating model were

found to resell the refurbished computers solely domestically, to non-commercial organisations in general (accounting for about 25% of sales of one of the assessed organisations that could provide figures) and eligible groups of individuals/private persons (accounting for about 75% of the sales) such as people in a bad economic situation or with a health condition (e.g. pensioners, long-term sick, disabled people, students).
In contrast to this, is the main purpose of organisations with a Close the Digital Divide operating model (one of the assessed nine) to drive digital development in less-developed countries and regions of the world – either by providing people with further opportunities for (digital and other) education and self-empowerment or by supporting the development of (administrational) infrastructure, such as in hospitals while also trying to prolong the lifetime of obsolete computers – and in doing so reducing the environmental impacts. The assessed organisation was found to receive between 98 and 99% of its supply from domestic donators. Here, private sector organisations from all types of industries emerged as the biggest group of suppliers accounting for about 60% of the total amount received. Roughly one-third (32-35%) of the sourced used computers stemmed from public (corporate) organisations, specifically public administration institutions from all levels (from municipalities up to state agencies) but also schools and universities. While individuals/private persons made up for the rest (5-8%), the assessed reuse organisation was also found to co-operate with a so-called *kretsloppspark*[1] as part of an on-going pilot project. Looking to the (receiving) customers of the Close the Digital Divide organisation, about 99.5% of the refurbished computers were found to be resold to non-governmental and non-profit organisations which reuse them in educational (about 60%) and health-related (about 40%) projects abroad, typically in less-developed countries in Africa, the Middle East and Asia. Regarding domestic sales, customers are solely non-profit organisations either working with individuals with psychological conditions aiming to help them with (re)integration into the job market or such working in the immigration sector trying to help people with integration via language and culture courses.

When turning to the barriers, computer reuse organisations in Sweden face, specific barriers were found for organisation's with IT Asset Management operating model (five barriers), the Social Enterprise one (four), respectively the Close the Digital Divide (nine) one. These will due to space restrictions not be further elaborated on here but can be found discussed in detail under Chapters 5.2.1, 5.3.1 and 5.4.1 respectively. Nevertheless, three common barriers which organisations across all types of operating models were found to face, hampering the reuse of computers in the Swedish context, emerged.
Firstly, a lack of access to sufficient volumes of used equipment was identified meaning that the computer reuse organisations were able to sell more computers than they could get hold of. This seemed to at least partly having to do with the second barrier which was identified as potential suppliers' concerns about the safety of their data saved on the hard-drives in their computers. Almost all interview partners reported that this would prevent many of such potential suppliers from selling or donating their used computers for reuse – despite the fact that solid data safety and sanitation measures such as data wiping with software (or in extreme cases by destroying hard-drives mechanically) being in line with/approved by military standards paired with CCTV and other security measures are in most (all commercial) cases available and certifications for data wiping/destruction offered. While not having researched the specific reasons for not selling or donating computers for reuse of customers from their perspective, it seems that there is a lack of information on the customer side regarding the operations of computer reuse organisations in the Swedish context. The third barrier that was found was the lack of knowledge about the suitability of used computers by potential buyers

[1] A kretsloppspark (Swedish for 'circularity park') in the Swedish context consists usually of a regular waste collection and recycling station but furthermore offers people the possibility to donate things for reuse if they want to do so and consider them to still be reusable (Ljunggren Söderman, Palm & Rydberg, 2011).

for their needs as they were reported to usually have an image of very old, slow and/or broken machines in mind – seemingly related to old ones stashed in basements at home.

Recommendations

In order to tackle the three general barriers and foster computer reuse, policy-makers should focus on adjusting current legislation in such a way that its primary focus is shifted from recycling towards reuse, such as providing the necessary infrastructure. Kretsloppsparks as identified in the case of the assessed computer reuse organisation with a Close the Digital Divide operating model provide a first step into this direction from which also Social Enterprises could profit in terms of supply. Legislation should furthermore be adjusted so that it creates (better) incentives for or imposes requirements on businesses and public sector organisations/institutions to donate or sell their used computers instead of recycling them. In order to allow for concrete suggestions in this regard, further studies with a focus on the reasons for potential suppliers of used computers to not sell/donate their computers for reuse are needed.
In addition, public procurement regulations should be adjusted or reformulated in such ways that they do not only not prevent public organisations and institutions from buying and selling used computers (and other equipment) but instead demand/request them to do so whenever possible via stricter requirements. – As they were found to only play a marginal role as (receiving) customers and computer reuse organisations would like to see them as frontrunners showing the suitability and reliability of used computers and thus acting as role models for potential customers from the private sector as well as individuals helping to further develop the domestic market.

Computer reuse organisations themselves are recommended to found some kind of industry association which could not only serve as a central point of contact and information for policy-makers but also conduct joint information campaigns on the processes in computer refurbishing. This could on the one hand help in increasing the supply with used computers as (potential) suppliers may become (more) aware of how secure/safe the refurbishing processes regarding data protection are (especially in comparison to recycling as outlined in Chapter 5.1.1). On the other hand could information campaigns also aim at changing people's image of used computers as old, broken and slow and instead show how well-performing and reliable used refurbished computers are and thus help growing the domestic demand and market(s).
In order to increase the supply with used computers, computer reuse organisations with a Social Enterprise and Close the Digital Divide operating model should consider co-operations with kretsloppsparks or (e-)waste collection stations. Nevertheless, more information about the suitability of computers sourced via this streams and the volume is needed in order to develop further strategies in this regard.
Furthermore, co-operations between Social Enterprises and IT Asset Management reuse organisations could also offer an opportunity as some of the latter were (due to the high labour-related costs) found to scrap already broken and not very quickly repairable computers instead of preparing them for reuse. It remains unclear though how big the supply from commercial CROs would be or if they are willing to engage in such co-operations requiring further investigation.

While there is a developed computer reuse industry existent in Sweden, there is still a lot of room for improvement and increased reuse of computers. Providing creative solutions for increasing the supply with used computers and (further) developing a substantial domestic market will be crucial but also demand the co-operation between a variety of actors. In doing so, the short development cycles and new trends in the industry, such as the steadily increasing market share of tablets should not be disregarded.

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Abbreviations

ASU	-	Arizona State University
CEO	-	Chief executive officer
CO2eq	-	Carbon dioxide equivalent
CRO	-	Computer reuse organisation
CtDD	-	Close the Digital Divide (in regard to operating models of computer reuse organisations)
EEE	-	Electrical and electronic equipment
EoL	-	End of life
EPA	-	Environmental Protection Agency
EU	-	European Union
GWP	-	Global warming potential
ICT	-	Information and communication technology
IIIEE	-	International Institute for Industrial Environmental Economics (at Lund University, Sweden)
IT	-	Information technology
ITAM	-	IT Asset Management (in regard to operating models of computer reuse organisations)
KG	-	Kilogram(s)
kWh	-	Kilowatt hour
LHA	-	Large household appliances
MAR	-	Microsoft Accredited Refurbisher
MRR	-	Microsoft Registered Refurbisher
NATO	-	North Atlantic Treaty Organisation
NGO	-	Non-governmental organisation
NPO	-	Non-profit organisation
OEM	-	Original equipment manufacturer
PCB	-	Printed circuit board
RAM	-	Random access memory
REE	-	Rare earth elements
REEE	-	Reusable electrical and electronic equipment
SE	-	Social Enterprise (in regard to operating models of computer reuse organisations)
U.N.	-	United Nations
VAT	-	Value-added tax
WEEE	-	Waste electrical and electronic equipment
WFD	-	Waste Framework Directive (2008/98/EC) of the European Union

1 Introduction

This chapter aims to provide background information for, and establish the significance of, the topic researched in the thesis at hand. The focus lies on the need to foster reuse of desktop computers and laptops in order to reduce the negative environmental impacts associated with computers and to increase the positive socio-economic impacts which computer reuse can bring. The proximate chapters provide the justification for the choice of topic and specify its objectives and research questions before the scope of the thesis is defined and limitations are pointed out. The last part of this chapter describes the targeted audience before it closes by discussing ethical considerations and providing an outline of the thesis structure.

1.1 Background

In the last three decades, since the publishing of the 1987 Brundtland report 'Our Common Future', it has become evident that humankind is not living in a sustainable equilibrium but in many respects exceeds the earth's natural boundaries (World Commission on Environment and Development [WCED], 1987). While currently a small part of the global generation is responsible for much of the pollution and resource demand, the situation is likely to worsen in the future (Meadows, Randers & Meadows, 2004; Randers, 2012). A growing global population and an increasing global middle class, aspiring towards 'western' lifestyles, implicate unsustainable consumption and production patterns. These are likely to further increase the pressure on the planet and its ecosystems thereby exacerbating resource scarcity and growing waste streams (Assadourian, 2010; Kharas & Gertz, 2010).

1.1.1 The Environment, Computers and the Case for Reuse

These issues are especially prevalent in the sector of electrical and electronic equipment (EEE). The demand in this sector for resources including scarce materials, such as rare earth elements (REE), has been growing steadily during the last decades, contributing to increased pressure on the planet (Huisman, 2012; Humphries, 2012; Ongondo, Williams, & Cherrett, 2011).

Within the product category of EEE, computers are seen as especially resource intensive in manufacturing as shown by several studies (see Andrae and Andersen (2010) and Teehan and Kandlikar (2012) for an overview). While the specific figures between studies differ, they range in terms of energy from below 555 to around 1,600 kilowatt hours (kWh) for a regular desktop computer without display (Andersen & Andrae, 2010; Teehan & Kandlikar, 2012). Regarding the global warming potential (GWP) which tries to capture how much a product contributes to the global warming during one or all phases of its life, the studies attribute roughly between 100 and 800 kilogram carbon dioxide equivalent (CO2eq) (Teehan & Kandlikar, 2012). Other studies also provide estimated figures regarding the volume of some of the materials used during the production phase. These estimates arrive at 766, respectively 1,090 litres of water, 230.5 kg of fossil fuels, 21.5 kg of chemicals and leaving behind about 28 kg of non-hazardous and 0.5 kg of hazardous waste (Jönbrink, 2007; Williams, 2003). Laptop computers have a somewhat lower resource demand with a calculated water usage of 532 litres during the production process and leaving behind about 4.5 kg of non-hazardous and 0.2 kg of hazardous wastes (Jönbrink, 2007).

Furthermore, while according to figures from technology industry analyst company Gartner, global computer sales have been as high as 288.7 million in 2015, the product lifetimes and the time between innovation cycles have been decreasing (Babbitt, Kahhat, Williams, & Babbitt, 2009; Gartner as cited in Richter, 2016; Gartner, 2016; Widmer, Oswald-Krapf, & Sinha-

Khetriwal, Schnellmann, & Böni, 2005). This, together with the practice of disposing of such equipment before reaching its actual end of life (EoL), is contributing to a growing volume of waste from electrical and electronic equipment (WEEE) (Agamuthu, Cooper, & Herat, 2012; Baldé, Wang, Kuehr, & Huisman, 2015). This waste stream is estimated to reach an annual volume of 50 million tons globally by 2018 (Baldé, Wang, Kuehr, & Huisman, 2015).

Despite contributing to the growing global e-waste stream, in many cases computers end up in less developed countries once reaching their EoL where they often cause adverse effects on the environment and human health (Perkins, Brune Drisse, Nxele & Sly, 2014; Robinson, 2009). This is due to the missing formal recycling infrastructures in such places (Osibanjo & Nnorom, 2007) where recycling of WEEE is conducted by informal sectors (Chi, Streicher-Porte, Wang & Reuter, 2011; Sthiannopkao & Wong, 2013). In this instance, primitive measures are often utilized, such as acids or open burning in inappropriate facilities, to extract valuable materials from the printed circuit boards (PCBs) installed in the computers (Perkins, Brune Drisse, Nxele & Sly, 2014; Townsend, 2011). Leftover parts and components are often dumped in the environment leading to severe pollution of water bodies, soil and air causing health issues for workers and people in neighbouring areas as indicated by the well-researched case of the Chinese region of Guiyu[2] (Dagan, Dubey, Bitton & Townsend, 2007; Garlapati, 2016; Sepúlveda et al., 2010; Townsend, 2011).

'Reuse' is seen as a promising option in response to these issues of and related to growing resource scarcity and amounts of WEEE production (Fitzpatrick et al., 2012; Ijomah & Danis, 2012; Kissling et al., 2012). It aims at extending the lifetime of (EEE) products and in doing so (potentially)[3] reducing the need for newly manufactured ones (Truttmann & Rechberger, 2006).

Results in regard to computers show that their reuse can bring environmental, social and economic benefits. Findings from an ICT reuse project in Germany show that the life time of computers can be significantly prolonged or even doubled when prepared for reuse at the end of their first life (Dietrich et al., 2012). This option becomes especially compelling when taking into consideration the increase of leasing models and contracts where computers (and other ICT equipment) are usually exchanged before reaching their end of life (Intlekofer, Bras & Ferguson, 2010). Furthermore, companies and public institutions alike are increasingly focusing on environmentally and socially sound disposal processes of used computers and ICT equipment where reuse offers great opportunities (Babbitt, Williams & Kahhat, 2011).

In regard to social benefits, studies have shown that by preparing ICT equipment and computers for reuse, more work places per ton of treated equipment are created compared to recycling (O'Connell, Hickey & Fitzpatrick, 2012; UNIDO & Microsoft, 2009). Reuse also allows socially focused organisations to provide (meaningful) jobs or training opportunities for people who are e.g. un-/low-skilled, disabled have been on sick leave or unemployed for a long term and have difficulties to find back into the job market (Fitzpatrick et al., 2012; Ijomah & Danis, 2012; O'Connell, Fitzpatrick & Hickey, 2010).

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[2] See for example Deng et al. (2006), Leung, Luksemburg, Wong, & Wong (2007), Leung, Duzgoren-Aydin, Cheung and Wong (2008), Li et al. (2010), Li, Yu, Sheng, Fu and Peng (2007), Wang et al. (2011), Wong et al. (2007), Wong, Wu, Duzgoren-Aydin, Aydin and Wong (2007), Xing, Chan, Leung, Wu and Wong (2009) and Xu et al. (2012).

[3] This may not in all situations be the case and potentially even lead to overall increased environmental impacts in terms of energy usage. Schischke, Kohlmeyer, Griese and Reichl (2003) argue that this can arise from computer reuse as the latter provides more people (due to lower prices) with access to computers and thus can increase the overall energy demand leading to the so-called rebound effect.

At the same time used computers also give low-income communities and people with limited economic resources access to computers helping to close this so-called 'digital divide' and fostering economic development (Kahhat & Williams, 2009; Williams et al., 2008). The former applies not only in the case of less-developed countries but also to the European context where a digital divide has been identified between regions and within societies (Brandtzæg, Heim & Karahasanović, 2011; Hickey & Fitzpatrick, 2008; van Dijk, 2009). In addition, the worldwide computer reuse industry has already reached a significant size with employing an estimated 860,000 people while providing a turnover of around 10 billion US dollars thus contributing to certain national and the global economies (Williams et al., 2008).

Furthermore, in comparison to manufacturing new computers, the practice of reuse can allow for a reduced need to transport as it can reduce the way to market. This argument is based on the fact that facilities preparing computers or other electronics products for reuse need less technical endowments and can thus be built more decentralised than facilities manufacturing new computers which usually possess a centralised structure (Fitzpatrick et al., 2012).

Thus, while reuse brings not only socio-economic but also environmental benefits, it is important to acknowledge that reuse cannot replace the need for recycling systems in which computers should eventually be treated once reaching their final end of life (Truttmann & Rechberger, 2006).

1.1.2 The Swedish Waste Prevention Plan and Computer Reuse

Sweden has also acknowledged the importance of conserving natural resources, reducing (e-) waste and to increasing resource efficiency. Thus, the latter two are two of the goals set by Naturvårdsverket, the Swedish Environmental Protection Agency (EPA), in their recently published Waste Prevention Plan for the years 2014 to 2017 (Naturvårdsverket, 2015a). It defines several strategies of how resource efficiency and waste prevention of electronics in Sweden shall be fostered and enhanced – namely among others by prolonging the (technically possible) lifetime as well as increasing the reuse of such products (Naturvårdsverket, 2015a).

The need for such measures becomes obvious when looking at the product category of computers. The results of an unpublished study commissioned by the Swedish company Inrego, which has specialised in the reuse of computers and other information technologies (IT) equipment, estimates that in 2012 alone roughly 277,000 desktop and laptop computers which had become obsolete in the business sector could have been reused (Inrego, 2012). This would account for about 25.2% of the total volume of 1.1 million new computers sold to companies and public authorities in Sweden in 2011 (Lind, 2014).

1.2 Problem Definition

Although Naturvårdsverket (2015a) has put forward the waste prevention plan with electronics as a focus area, it acknowledges that as of now only marginal information about the related reuse markets, its actors and the inherent barriers are available (Naturvårdsverket, 2015a, 2015b). This also holds for the product category of desktop and laptop computers where even public and research institutions query the lack of data on used equipment for example on exports (Svenska MiljöEmissionsData [SMED], 2012).

More information about the reuse market(s), its actors and the barriers inherent to the market(s) is needed to facilitate the development and implementation of suitable measures and strategies by different actors (such as policy-makers, computer reuse organisations and others) to foster and increase the the reuse of computers in Sweden and the extension of their lifetime.

While this addresses a specific practical problem in the Swedish context, the study at hand also aims to extend the existing scientific knowledge. So far publications and studies on the types of actors (reuse organisations, suppliers and customers) defining the market have only been issued addressing a global scale and in other cases only one specific type of ICT reuse organisation and/or only in certain national contexts, namely the UK, the U.S. and the region of Québec in Canada (Dhanda & Peters, 2005; Kissling et al., 2012; Marcotte, Hallé & Montreuil, 2008; Ongondo, Williams, Dietrich, & Carroll, 2013; Williams & Kuehr, 2003). The same applies to the barriers the assessed reuse organisations are facing. Here it has to be added that the objects of interest were in two studies not specifically desktop and laptop computers but ICT equipment in general (thus e.g. also including monitors, switches, etc.) (Kissling et al., 2013; Ongondo et al., 2013). Thus, the study at hand aims to not only provide a complete picture of the involved types of actors (reuse organisations, suppliers and customers) in a national reuse market but also to assess the barriers for different types of organisations engaged in computer reuse as suggested by Kissling et al. (2012).

1.3 Objective and Research Questions

Thus, the purpose of this research is to close the information gap proclaimed by Naturvårdsverket by assessing the types of organisations engaged in computer reuse in Sweden, their types of suppliers as well as the types of receiving customers. This information will first allow to further understand the market at work and provide a basis for developing measures and strategies to support the computer reuse organisations in their work. It will also potentially identify certain groups of suppliers and customers which are already actively and positively participating in the market and thus can be assumed to have developed certain experience. This would make them interesting for further research or to point out as role models for other groups of suppliers and/or customers. Knowing about the groups of customers and suppliers already participating in the market will also allow for (potentially) identifying certain groups of actors which are as of now not at all or only marginally taking part in the computer reuse market. In addition the reasons for the non-participation of these potential groups could then be assessed in future research and allow for the development of suitable measures to increase participation.

In regard to the market(s), it also seems important to geographically assess where used computers are redistributed to be reused. By gaining first insights into how big the share of desktop computers and laptops is that are redistributed/reused domestically in Sweden, versus those that are exported from Sweden for reuse, this information will allow for determining if there is a need for measures fostering the domestic use of used computers.

Looking at barriers potentially inherent to computer reuse markets will provide a first insight about how computer reuse may be hindered in the Swedish context and allow responsible parties such as policy-makers and practitioners alike to develop measures to overcome these barriers and to foster computer reuse in a Swedish context. In the context of the study at hand it was decided to assess the barriers in the computer reuse market(s) by researching what computer reuse organisations perceive as barriers to their operations. While this provides a first insight, the results should in further research be complemented by assessing barriers in regard to other actors (for example what keeps (certain types of) potential suppliers from selling used computers when deemed obsolete – or potential receiving customers from buying used computers for further reuse).

Therefore, the following research questions were derived:

1. ***What does the reuse market(s) for desktop computers and laptops in the Swedish context look like?***

    a. ***What types of organisations are engaged in reuse activities of desktop computers and notebooks in Sweden?***

    b. ***What types of actors function as suppliers to and receivers/receiving customers of used computers and computers prepared for reuse of such computer reuse organisations?***

    c. ***How big is the share of the organisations' sold desktop computers and laptops that is reused in Sweden compared to the share that is exported?***

2. ***What are the barriers organisations involved in reuse activities of desktop computers and notebooks in Sweden are facing?***

3. ***How can the identified barriers be overcome and reuse of desktop computers and notebooks in Sweden fostered?***

1.4 Scope and Limitations

In the following the scope of the study at hand is described before the limitations are discussed.

1.4.1 Scope

The geographical scope for the research at hand covers Sweden exclusively. In terms of products, this study focuses on desktop computers and laptops but covers neither servers nor additional equipment (such as network switches) as these components seem to be less suitable for reuse once reaching their EoL (Kissling et al., 2012).

In order to be eligible as interview partners for the research at hand, organisations involved in computer reuse had be engaged in at least two or more of the activities a computer reuse organisation usually covers: collection, after-use services (e.g. data wiping), preparation for reuse activities and redistribution (Kissling et al., 2012).
The term 'organisations' refers in the context of this study to all types of legal institutions – as opposed to a potential informal sector.

1.4.2 Limitations

As the geographical scope of the research only covered the country of Sweden, the results of the study should not be lightly generalized as the conditions (such as culture or legal frameworks) in other countries are likely to differ and thus might lead to different results.

Furthermore, interviews were conducted with representatives of only 9 organisations. While the figure seems rather low to draw valid general conclusions it has to be pointed out that it covers the biggest part of organisations working with computer reuse in Sweden. This has also been backed up specifically in the case of companies where several interview partners

confirmed that due to the market consolidation during the last years only about a handful of bigger companies are remaining in the Swedish market.

One commercial company decided to not take part in the study due to concerns regarding leakage of information to competitors although the interview partner was ensured anonymity. Furthermore, due to the competition between the commercial actors in the market, some of the interviewees decided to not provide certain data or in ways making it hard to compare.

One further potential limitation is the language barrier. Some of the interview partners seemed to be more confident to provide information in their native tongue and thus two interviews were conducted in Swedish. As this is not the native language of the author, the data collected during these interviews might not be as accurate as the data collected during interviews conducted in English. In addition, some of the reviewed documents were only available in Swedish opening up for the possibility of translation errors.

Another confinement is the limited available literature on some aspects of computer reuse which is in some cases also comparably old. In order to be able to still conduct the research, several compromises were made. First, it was decided to also include such old(er) as well as non-academic ('grey') literature. Secondly, for aspects where no literature focusing on computers (reuse) was available, literature dealing with ICT equipment and/or (W)EEE in general was included. Where this practice was applied in the study, it has been stated.

While, due to these constraints, the overall generalizability of the findings of this study has limitations, the results can nevertheless provide valuable insights in the Swedish market for computer reuse, its actors and perceived barriers.

1.5 Ethical Considerations

During the course of the research it became obvious that competition between the commercial companies involved in computer reuse activities in the Swedish market is rather tough and information about the market and organisations' strategies are often considered as critical and sensitive. In order to allow the interview partners to nevertheless provide information, all of them were asked for their consent to participate in the research and if they would wish for anonymisation of their own name and that of the organisation they were representing – as for example suggested by Flick (2006). While a majority of the interviewees did not demand anonymisation, some interviewees made use of this option. Thus, it was decided to make the names of all interview partners anonymous and the respective organisation they would represent. Firstly, to allow for consistency regarding the naming during the analysis process but also to prevent the possibility that conclusions on the answers of specific companies could be drawn.

In order to ensure the quality of the collected data, all interviews were recorded. Thus, in order to guarantee safety, the recordings were only stored in password-secured devices/accounts.

1.6 Audience

This study targets three main audiences. First of all, policy-makers on all organisational levels (local to national) working with or intending to foster and increase the reuse of EEE and specifically computers. The findings aim to provide information about what issues need to be addressed but also about which different actors should be considered when implementing specific measures or developing suitable policies.

The findings may also be of interest to researchers working in the field of computer and/or ICT reuse as this study is the first one to assess types of suppliers and receiving customers of as well as barriers to reuse organisations of desktop computers and laptops specifically (as opposed to ICT equipment in general). Furthermore, the results might be of interest as they show that (at least in the Swedish context) the types of suppliers and receiving customers of and barriers to computer reuse organisations (CROs) seem to depend on the latter's operating model. Although data was collected in the Swedish context and thus may not be applicable in other circumstances or contexts, some of the findings may nevertheless provide a basis for further research.

The results of the study may also be of interest to organisations engaged in computer reuse in Sweden as they provide a bigger picture of the types of suppliers and receiving customers of different types of reuse organisations, potentially allowing to approach/address certain not yet (fully) penetrated market segments in potentially common efforts. Additionally, it would highlight opportunities for cooperation between computer reuse organisations of different types as well as with public actors.

The study might also be a resource for people with a general interest in computer reuse in Sweden or in general, and may also provide interesting insights to individuals and institutional actors already being active or interested in potentially taking part in computer reuse in the future.

1.7 Disposition

Chapter one justifies the research by providing background information about the positive sustainability impacts associated with computer reuse and the status of computer reuse in Sweden as well as by placing the research at hand into the greater context of the research field. It furthermore states the objectives and the linked research questions before the scope of the study is defined and limitations are pointed out. Subsequently, ethical considerations related to the conducted research are addressed and the targeted audiences are described before Chapter one closes with giving an overview about the structure of the study at hand.

The second chapter firstly defines the term 'reuse' and assesses the currently available lifetime extension strategies for computers before turning to computer reuse organisations. In the further course of the chapter, the findings from the reviewed literature are presented in terms of the typical activities as well as suppliers and (receiving) customers of computer reuse organisations. It finishes with discussing the identified barriers to CROs in the Swedish context as well as in general.

Chapter three describes the overall methodology of the research and the specific methods used for data collection. Furthermore, the framework which has (based on the preliminary findings from Chapter two) been developed for data collection is presented and introduced.

In the fourth chapter, the findings obtained during the data collection phase are presented and in the subsequent fifth chapter critically analysed and discussed. The fifth chapter also provides a discussion of the methodology and methods, the research/analytical framework, the research objectives as well as the generalizability of the findings.

Based on the results from the preceding chapter, the thesis comes to an end with conclusions being drawn and recommendations on how the findings translate into practice being provided in the sixth and last chapter.

2 Literature Review

In the beginning of this literature review, the meaning of the term 'reuse' is clarified and defined as it is applied further in the course of the study at hand. In the second sub-chapter lifetime extension strategies which are connected to the reuse of computers are introduced and discussed. The second part of the literature review shifts the focus to organisations engaged in computer reuse discussing the available literature regarding their activities, different types of such organisations identified by former research, their respective types of suppliers of used computers as well as their receiving customers. The literature review then closes with an overview about the barriers such computer reuse organisations are facing.

It should be stated that in regard to Sweden which is the geographical focus of this study, almost no preceding research has been carried out yet. Thus, most of the literature reviewed in the following chapters takes a more general stance.

2.1 Defining 'Reuse'

In the following, an overview about issues related to defining the term 'reuse' is given before two widely used definitions of 'reuse' in the field of EEE are introduced and discussed. One of them will be used as a basis for the study at hand.

Literature reveals a broad variety of definitions of the term 'reuse' depending on specific contexts and even varying within specific research fields and industrial sectors (Parkinson & Thompson, 2003; Ziout, Azab, & Atwan, 2014). For example the car recycling industry refers to the practice of 'reuse of parts' as 'recycling' (Ziout, Azab, & Atwan, 2014).
Another issue in defining 'reuse' is the fact that it is in some cases used as an umbrella term for different types of recovery options such as recycling, remanufacturing or repair activities while on other occasions 'reuse' is just seen as one specific (product) recovery option besides others (compare e.g. Ijomah, Hammond, Childe, & McMahon, 2005; Johnson & Wang, 1995; Jun, Cusin, Kiritsis, & Xirouchakis, 2007; King, Burgess, Ijomah, & McMahon, 2006; Melissen & De Ron, 1999; Ming, Williams, & Dixon, 1997; Parkinson & Thompson, 2003; Thierry, Salomon, van Nunen, & van Wassenhove, 1995; Wadhwa, Madaan, & Chan, 2009; recent overviews and discussions are provided by Gharfalkar, Ali and Hillier (2015) and Ziout, Azab and Atwan (2014)). For the case of 'reuse' being used as an umbrella term, Gharfalkar et al. (2015) also show that the grouped recovery options even vary between different publications and some might for example consider 'repair' as a reuse option while others do not.

While the mentioned issues are of general nature, they also apply to the context of (W)EEE where 'reuse' has been researched from many different perspectives (see e.g. Pérez-Belis, Bovea and Ibáñez-Forés (2014) for an overview). Having said this, two of the most widely used definitions of 'reuse' in the context of (W)EEE shall be introduced and discussed.

They are provided by the European Waste Framework Directive (2008/98/EC)[4] and in a Whitepaper on a common definition of 'reuse' and related terminologies issued by the StEP Initiative[5] ([StEP] 2009). These two definitions are used by a wide set of central actors in the

[4] Directive 2008/98/EC provides the basic definitions and regulations and thus lays the basis for Directive 2012/19/EU which is also known as the so called 'WEEE Directive' regulating the treatment of obsolete electrical and electronic equipment within the European Union. Thus, while not directly regulating the handling and thus also the reuse of WEEE, Directive 2008/98/EC provides the crucial definitions regarding 'reuse' (and other aspects).

[5] The StEP Initiative is an initiative which aims at bringing together manufacturers, recyclers, academics, governments and other organisations wanting to contribute to solve the global problem of e-waste (StEP, n.d. a). It is further presented in the course of this chapter.

field but also in academic publications on reuse of ICT and EEE (see e.g. Kissling et al., 2013, 2012; Ongondo et al., 2013; WRAP, 2011). While other definitions exist they are less influential and/or less comprehensive and detailed (StEP, 2009).

Waste Framework Directive (2008/98/EC)

The Waste Framework Directive (WFD) from 2008 (2008/98/EC) sets the frame for waste management within the different member states of the European Union by defining the basic principles, definitions and underlying concepts. It furthermore defines when waste must no longer be considered as waste and sets the principles of sound waste management requiring that the environment and human health are not harmed or negatively affected (Directive 2008/98/EC). It furthermore demands that the waste hierarchy as shown in *Figure 2.1* is considered when waste-related policies and regulations are implemented. The Directive also sets reuse and recycling targets for specific waste streams and directs the issuing of so-called waste prevention plans from all EU member states (EC, 2015a; EC, 2015b).

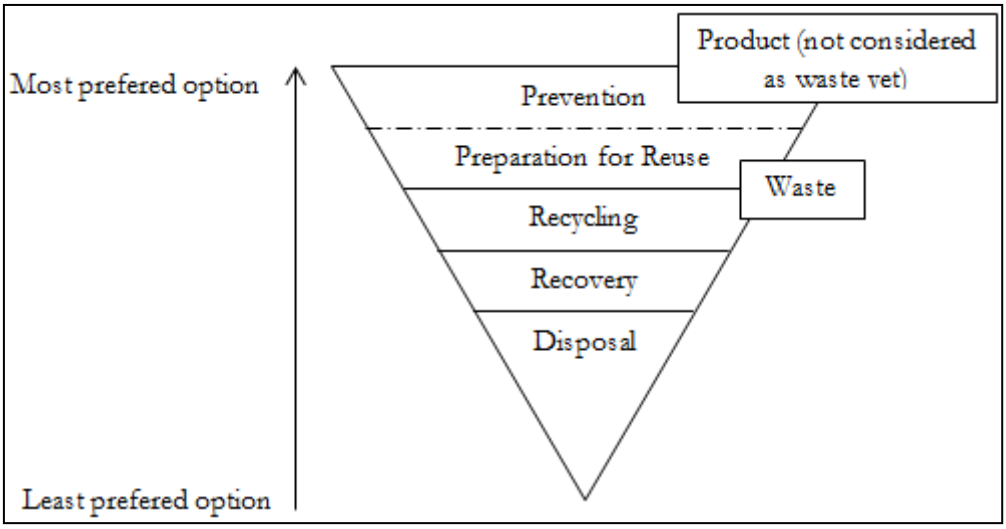

Figure 2-1.Own adaptation of the waste hierarchy as laid out in Directive 2008/98/EC of the European Parliament and the Council

Source: Directive 2008/98/EC; EC, 2015b.

Waste prevention explicitly mentions 'reuse' and the extension of products' life spans as measures to reduce the quantity of waste. The former is defined in article 3(13) of the WFD as "any operation by which products or components that are not waste are used again for the same purpose for which they were conceived" (2008/98/EC, p. L312/10). Looking at the given definition of waste as "any substance or object which the holder discards or intends or is required to discard" (2008/98/EC, p. L312/9) still leaves some unclarity about when an object or substance can be considered as waste and thus the definition of 'reuse' does not apply.[6] This fuzziness is also acknowledged in a guiding document to the framework directive where it is stated that certain flexibility and the consideration of factual circumstances is demanded when looking at cases (EC, 2012). But even in case a product or component has become waste, the WFD considers reuse through the extension of its lifetime in what is called 'preparing for reuse'. It is defined as "checking, cleaning or repairing recovery operations, by

[6] The guiding document on the Waste Framework Directive (EC, 2012) provides the discarding of a product into a dust bin by its owner as an example for a situation in which the intention of the owner is clear and the product has to be considered as waste.

which products or components of products that have become waste are prepared so that they can be re-used without any other pre-processing" (2008/98/EC, p. L312/10).

While the definition of 'reuse' and the distinction between 'reuse' and 'preparing for reuse' is related to the definition of waste this does not mean that products or components have to have entered a waste stream or waste collection system in order to be considered for 'preparing for reuse' and might still have an economic value (EC, 2012). Nevertheless this kind of definition is prone to misunderstandings and might be easier to understand when differentiated in 'direct reuse' and 'reuse after preparation'.

Whitepaper on a Common Definition of Reuse by the StEP Initiative

The second definition of 'reuse' which is widely used stems from the so-called StEP Initiative (StEP, 2009). This international initiative conducts research, provides trainings and develops strategies and gives advice aiming to help in solving the current global problems associated with e-waste (StEP, n.d. b; StEP, n.d. c). In doing so it sees – besides others – the reuse or refurbishing of electrical and electronic products or components and the recovery and recycling of materials in an as efficient as possible manner as its main goals (StEP, n.d. a). The StEP Initiative furthermore provides a platform for discussion of e-waste related issues and solutions between a variety of stakeholders including manufacturers, governments, recycling and other organisations interested in the topic as well as academia (StEP, n.d. a).

In order to foster reuse and the extension of EEE's lifetime, StEP (StEP, n.d. d) sees the development "of globally consistent re-use standards for EEE products from both the business communities and the public" as necessary (StEP, n.d. d; StEP, 2009). StEP (2009) argues that this is needed as the variety of existing definitions in different contexts poses a barrier to developing reuse solutions and causes confusion among stakeholders from different backgrounds such as government, business, academia and consumers.

Thus, in 2009, StEP's task force on reuse issued a whitepaper to suggest and clarify a common definition of 'reuse':

> "Re-use of electrical and electronic equipment or its components is to continue the use of it (for the same purpose for which it was conceived) beyond the point at which its specifications fail to meet the requirements of the current owner and the owner has ceased use of the product." (StEP, 2009, p. 6)

Similar to the definition given in Directive 2008/98/EC, this definition also emphasizes the aspect of continued functionality for the same purpose but directly incorporates the aspect of ownership. Thus, when an owner of EEE has stopped using it, another (new) owner will start using the electrical and electronic equipment and thus implying a change of ownership of the EEE product(s) or its/their components – in contrast to the definition in the WFD, where this aspect of ownership is not addressed (Directive 2008/98/EC).

Nevertheless, further similarities between both definitions exist. They acknowledge that 'reuse' covers not only the reutilization of a product as a whole but also of single components should the product as a whole not be able to fulfil the potential requirements of a potential new user. But then the Whitepaper goes again further in specifically mentioning that the reuse of an

EEE product or of single components "then substitutes the use of a new product"[7] (StEP, 2009, p. 6) (StEP, 2009).

Furthermore, similar to the Framework Directive, the StEP (2009) document distinguishes between 'direct reuse' of EEE and 'preparation for reuse' where the latter is defined to comprise "any operation performed to bring used electrical and electronic equipment or its components into a condition to meet the requirements of a next potential owner" (StEP, 2009, p. 7). While this definition is less detailed then the 'preparation for reuse' options of checking, cleaning and repairing mentioned in the WFD, the Whitepaper provides in a next step detailed descriptions of activities which are potentially part of preparation for reuse activities. These comprise: disassembly, cleaning (including the deletion of data/data wiping), inspection, the exchange of components, the retrieval of components, the reprocessing of components (either mechanical, electronic or by the help of information technology/software processes), reassembly (might include the recombination of parts from different machines/equipment cores), testing (StEP, 2009). These activities constitute the four alternative 'preparation for reuse' options of remanufacturing, refurbishing (also referred to as 'reconditioning'), repair and upgrade which will be further discussed in the following chapter (StEP, 2009).

Looking at the two introduced and discussed definitions of 'reuse' and 'preparation for reuse' and its related terminologies it can be said that they are in many cases very similar. For example they agree on the core issue that 'reuse' refers to the continued use of a product or its components for the originally intended purpose. Nevertheless, the definition provided by StEP (2009) seems to be fitting better for the purpose of this research as it introduces the aspect of changing ownership of a product or component for continued reuse. Furthermore, the definition of 'preparation for reuse' is more detailed in describing how such activities usually look like in practice. In addition, the definition of 'reuse' and 'preparation for reuse' seems to be easier to grasp and understand as it does not rely on the (legal) definition of waste and thus will help avoid confusion by the audience of this study. Due to these reasons, the author decided to use the earlier presented definitions of 'reuse' and its related activities as provided by the StEP Initiative (2009) as the basis for the study at hand.

2.2 Lifetime Extension Strategies for Computers

In order to allow for computers to be reused and thus extending their lifetimes, different strategies have been identified.

In an early publication on the topic Williams and Sasaki (2003) describe and distinguish between reselling, upgrading and refurbishing as potential strategies once a computer reaches its first EoL. Their definition of 'reselling' is rather broad and may have been better captured by the term 'redistribution' as they not only refer to the practice of reselling per se but also include donations[8] which aim to support social causes (Williams & Sasaki, 2003).

'Upgrading' of computers is described as the practice of exchanging certain components or parts such as the microprocessor or hard drives with the aim of increasing the capabilities or the performance – to allow its users to use more resource demanding software. Such a replacement of parts may not in all cases be possible or viable as upgrading new components might be costlier than purchasing a new computer. In addition, technical specifications may

[7] The author sees this statement from the whitepaper as an optimal scenario which nevertheless might in many cases not hold in reality.

[8] Williams and Sasaki (2003) see donations as 'zero price' reselling actions.

have changed due to the short innovation cycles in the ICT industry (Babbitt, Kahhat, Williams & Babbitt, 2009; Williams & Sasaki 2003; Yu, Williams, Ju & Yang, 2010). The third strategy called 'refurbishing' is sometimes used synonymously with 'upgrading' but is somewhat different "as it connotes restoration to original condition" (Williams & Sasaki, 2003, p. 185). In contrast to that 'upgrade' refers to the improvement of a computer's performance or capabilities over its original ones (Williams & Sasaki, 2003).

Based on Williams and Sasaki (2003), Hickey (2009) also distinguishes between 'reselling', 'upgrading' and 'refurbishing' as lifetime extension strategies but also discusses 'remanufacturing' as a potential additional strategy for computers. The latter refers to "the process of returning a used product to at least OEM original performance specification […] and giving the resultant product a warranty that is at least equal to that of a newly manufactured equivalent" (Ijomah, 2002, p. 186).

But Hickey (2009) draws the conclusion that due to several issues[9] related to missing secondary markets, unfavourable product designs and various hindrances in reverse logistics (which describes "the process of planning, implementing and controlling backward flows of raw materials, in-process inventory, packaging and finished goods, from a manufacturing, distribution or use point, to a point of recovery or point of proper disposal" (European Working Group on Reverse Logistics as cited in De Brito & Dekker, 2004, p. 5) 'remanufacturing' cannot be seen as feasible for computers – at least for consumer market(s). This seems to look different in other market segments such as for servers, professional laptops and desktop computers where remanufacturing is part of original equipment manufacturers' (OEMs') business operations (Dell, n.d.; HP, n.d.; Quariguasi Frota Neto & Bloemhof, 2011).

The most recent distinction between different lifetime extension strategies for computers has been issued by Ijomah and Danis (2012). While 'reselling' is missing, they include the earlier discussed practices of refurbishing, remanufacturing and upgrading and introduce 'repair' as a new, separate strategy. Occasionally, these four strategies may also be referred to as 'preparation for reuse' activities as for example defined by the StEP Initiative (2009) for EEE in general.

The option of repairing refers to the "act of fixing or correcting a fault, defect or damage" (Ijomah & Danis, 2012, p. 150) and thus means that the computer is restored to a working condition. This also includes aesthetic ones such as scratches or dents. After the fixing/correction process, basic testing is performed in order to check if the unit is working properly and to ensure that the formerly occurring problem has been resolved. Furthermore, it should be noted that repairing is usually also part of a refurbishing or remanufacturing process (Ijomah & Danis, 2012).

The second option, 'refurbishing', includes not only repairing but also cleaning of the respective computer. The aim is to bring it back to a full working condition which meets certain specifications similar but inferior to a new product (Ijomah & Danis, 2012; StEP, 2009). In some cases though, refurbished computers may come with increased capabilities or functionalities compared to its original post-manufacturing state and full working order while the fact that they were refurbished entails limitations in warranty (Ijomah & Danis, 2012).

[9] Please see chapter 2.2.2 in Hickey (2009) for further details.

Remanufacturing is a more advanced and complex process compared to refurbishing. During remanufacturing a computer is disassembled in a comprehensive manner in order to allow for "thorough cleaning, testing and diagnosis of all the disassembled parts" (Ijomah & Danis, 2012, p. 151) before being put back together. In case one or several components are not working or deemed obsolete these are usually either repaired or exchanged for new/newer ones. Furthermore, remanufacturing may also include modifications or adjustments of software which may have been developed since the computer was first manufactured. Upgrades might bring increased performance or new functionalities up to a similar or the same technological level of newly developed computers (Ijomah & Danis, 2012).

The design and composition of a refurbished computer may, due to a myriad of potential changes, be altered significantly so that "the disassembly process can either preserve the identity of the original product (via its serial number), or a completely new system identity can be created (supported by a new serial number)" (Ijomah & Danis, 2012, p. 151).

The aim of remanufacturing of a computer is to bring it back into an as-new or comparable condition meeting at least its original specifications. Thus, in the process, machines are tested to similar or equal levels as new machines and usually sold under the label 'as new' whereby the warranty is either the same or similar to brand-new units (Ijomah & Danis, 2012).

An upgrade usually refers to all actions through which the original functionality and/or performance of a computer is enhanced via exchange or addition of hardware components and/or software. Similar to the process of repairing, testing is only performed to such an extent as to check that the upgrade has been installed and works in the right way (Ijomah & Danis, 2012). While some technological upgrades may in some cases increase a computer's performance and/or improve its functionality beyond its original specified levels, this depends on if the original design and components allow for such measures (Ijomah & Danis, 2012).

While these distinctions and definitions of lifetime extension strategies provided by Ijomah and Danis (2012) apply specifically to computers, the StEP Initiative (2009) distinguishes between the same four 'preparation for reuse' options for EEE in general. These are defined almost identically and are distinguished based on partly the same, partly similar criteria. *Table 2-1* provides an adaptation of an illustration issued by StEP (2009) in order to carve out the main differences between the four 'preparation for reuse' or 'lifetime extension strategies'.

Table 2-1. Distinction of different lifetime extension strategies/preparation for reuse activities

	Disassembly depth	**Output specification**	**Degree of change in unit's composition and design**
Remanufacture	Complete disassembly	Original functionality and reliability	May be changed significantly
Refurbish	Not complete, only to ensure required specification	Original functionality	Not changed significantly
Repair	Only to exchange or reprocess defective component	Functioning condition	Not changed significantly
Upgrade	Dependent on upgrade operation	Upgraded performance and/or functionality	Significantly changed

Source: StEP, 2009.

While these are the, or at least some of, the central operational activities of a typical computer reuse organisation, the latter are typically engaged in a broader set of activities or processes. These are elaborated on in more detail in the first sub-chapter of the following chapter.

2.3 Computer Reuse Organisations

The following sub-chapters aim to first present the typical activities organisations engaged in computer reuse cover and what different types of organisations exist. Furthermore, the types of suppliers, as well as the (receiving) customers of such organisations are discussed and presented before the chapter closes with a review of the barriers computer reuse organisations face as identified in literature.

2.3.1 Activities

In order to gain a better understanding of computer reuse organisations and types thereof it seems relevant to present and discuss the activities such organisations typically cover.

While the strategies for lifetime extension/preparation for reuse activities introduced in the last chapter are a crucial part of the operations of such organisations, these only represent one cantle (see e.g. Kissling et al., 2012). According to Wang and Pecht (2011), "reuse is related to reverse logistics" (Wang & Pecht, 2011, para. 5)[10]. The latter has been defined differently by different authors at different times, often potentially causing confusion[11] (Fernández Quesada, 2013). In many cases it has been narrowed down to the 'reverse' flow of products from customers or different points in the forward supply chain back to the original manufacturer/producer of the product(s) (see e.g. Dowlatshahi, 2000; Krikke, van Harten & Schuur, 1999; Rogers & Tibben-Lembke, 1999). In this respect, Rogers and Tibben-Lemke (1999) introduced the most common definition of reverse logistics as "the process of planning, implementing, and controlling the efficient, cost effective flow of raw materials, in-process inventory, finished goods and related information from the point of consumption to the point of origin for the purpose of recapturing value or proper disposal" (Rogers & Tibben-Lemke, 1999, p. 2). Although widely accepted, this definition is problematic as it does not allow for the inclusion of other destinations than the OEMs or producers within the reverse flow of products, such as to third parties who may either take care of the products' disposal, recycling, repair (and other lifetime extension strategies/practices) and redistribution to secondary markets. Other definitions offer a broader understanding and consider this aspect such as the one by the European Working Group on Reverse Logistics defining reverse logistics as "the process of planning, implementing and controlling backward flows of raw materials, in-process inventory, packaging and finished goods, from a manufacturing, distribution or use point, to a point of recovery or point of proper disposal" (cited in De Brito & Dekker, 2004, p. 5).

In regard to reverse supply chain practices in the computer industry, Rahman and Subramanian (2012) identified (i) (direct) 'reuse', (ii) 'repair', (iii) 'refurbish', (iv) 'remanufacture', (v) 'recycle', (vi) 'dispose' as well as (vii) 'resell' as typical which thus comprise more than the introduced lifetime extension strategies (based on Ashayeri, Heuts, Jansen, & Szczerba (1996); Dalrymple et al. (2007); Forge (2007); Goosey & Kellner (2002); Hall & Williams (2007); Knemeyer, Ponzurick, & Logar (2002); Krikke, van Harten, & Schuur (1999); Mayers, France, Cleverly, Kabouris, & Planas (2002); Ravi, Shankar, & Tivari (2005); Shih (2001); Tan &Kumar (2008); Tan, Yu & Arun (2003)). In contrast to Ijomah and Danis (2012) and the StEP Initiative (2009) they did not include 'upgrade' as a distinct option (Rahman & Subramanian, 2012).

[10] Some authors distinguish between the terms 'reverse logistics' and 'reverse supply chain management' (see e.g. Stock, 2001) whereas others acknowledge the interchangeable use of both terms such as Skjott-Larsen, Schary, Mikkola and Kotzab (2007). In the course of the thesis at hand the latter option is followed and both terms are used synonymously.

[11] See for example Fernández Quesada (2013) for a discussion of the different issues related to and sources causing confusion in this field.

The findings of other studies focusing on specific aspects regarding organisations engaged in computer reuse mainly confirm the practices found by Rahman and Subramanian (2012) in terms of preparation for reuse activities but partly go further in scope and/or detail regarding the description of the overall activities of such actors. Although the mentioned studies differ regarding the focus and scope, they allow for drawing a comprising picture of the activities and processes of organisations engaged in computer reuse.

While preparation for reuse activities as illustrated above surely constitute one of the main activities/processes of computer reuse organisations, their activities start much earlier. The acquisition or sourcing of computers for reuse is considered as the first step in the process chain (Kissling et al., 2012; O'Connell & Fitzpatrick, 2013; White, Masanet, Rosen, & Beckman, 2003).

In a second step the acquired units are usually collected from the supplying customers or donators and some organisations also offer on-site data destruction services as part of this process if demanded by a customer/donator (Kissling et al., 2012; Marcotte, Hallé & Montreuil, 2008; O'Connell & Fitzpatrick, 2013; White et al., 2003). Furthermore, the collected computers are individually tagged (e.g. via a barcode) in order to allow for identification at a later stage to support inventory management (Marcotte, Hallé & Montreuil, 2008; O'Connell & Fitzpatrick, 2013).

Thirdly, the collected machines are usually (visually) inspected and sorted based on several criteria such as the quality, colour or model as well as its chances to be successfully remarketed (Marcotte, Hallé & Montreuil, 2008; O'Connell & Fitzpatrick, 2013; White et al., 2003). Afterwards, the units are stored until enough are available to start the preparation for reuse process for a whole batch of computers; storage may also be secured by measures like CCTV to guarantee the safety of data hard drives of the collected computers (Marcotte, Hallé & Montreuil, 2008; O'Connell & Fitzpatrick, 2013).

The next step consists of the preparation for reuse activities as introduced in Chapter 2.2. They are accompanied by several steps including cleaning and the removal of any signs which would allow for the identification of the former owner of a computer in order to allow for brand protection (O'Connell & Fitzpatrick, 2013). Furthermore, the functionality is tested and the data on the hard-drives are destructed for which many organisations seem to offer a certification to the supplying customers/donators (Dhanda & Peters, 2005; Kissling et al., 2012; Marcotte, Hallé & Montreuil, 2008; O'Connell & Fitzpatrick, 2013; Ongondo et al., 2013; Williams & Kuehr, 2003). After data sanitation, an operating system and other potential software may be installed although this is not always the case (Dhanda & Peters, 2005; Marcotte, Hallé & Montreuil, 2008; O'Connell & Fitzpatrick, 2013; Ongondo et al., 2013; Williams & Kuehr, 2003). Afterwards the computers may in cases be packaged together with accessories such as mouse and keyboard before put in storage for redistribution (Marcotte, Hallé & Montreuil, 2008).

In case a computer is not deemed repairable, it is disassembled in order to make its parts and components available for reuse, recycling or to sell them (Marcotte, Hallé & Montreuil, 2008; White et al., 2003). The recycling and/or disposal of parts and materials that cannot be reused, is usually outsourced to external partners (Kissling et al., 2012).

The fifth and final step consists of the remarketing and redistribution process where organisations sell or donate computers they have prepared for reuse – but also single components and parts (Dhanda & Peters, 2005; Kissling et al., 2012; Marcotte, Hallé & Montreuil, 2008; O'Connell & Fitzpatrick, 2013; Ongondo et al., 2013; Williams & Kuehr,

2003). This may in the case of some organisations also involve the export to for example less-developed countries in order to provide people with access to IT infrastructure (Cumps, Van den Eynde & Viaene, 2013; Dhanda & Peters, 2005; Kissling et al., 2013; Williams & Kuehr, 2003). In such cases of exporting computers to countries without a well-functioning or established recycling system for e-waste, some organisations are also engaged in take-back programs to ensure proper recycling and disposal of the redistributed computers once they reach their end of life (Cumps, Van den Eynde & Viaene, 2013; Kissling et al., 2013). Sometimes also other follow-up services related to redistribution are offered or provided consisting of training how to use/handle ICT equipment/computers, warranties as well as technical support (Kissling et al., 2012; Cumps, Van den Eynde & Viaene, 2013; O'Connell & Fitzpatrick, 2013; Ongondo et al., 2013). Thus, the typical activities of computer reuse organisations can be summarized and illustrated as process steps according to *Figure 2-2*.

Figure 2-2. Range of activities potentially covered by organisations engaged in computer reuse illustrated as a chevron process

Source: Own illustration based on Dhanda and Peters (2005), Kissling et al. (2012), Marcotte, Hallé and Montreuil(2008), O'Connell and Fitzpatrick (2013), Ongondo et al.(2013), Rubinstein (2004), White et al. (2003), Williams and Kuehr (2003).

As a side note, it should be pointed out that some organisations might outsource some of the mentioned processes as found by Kissling et al. (2012). Furthermore, the range of activities covered and in what way they are performed, may vary between organisations. This aspect will become more obvious in the following chapter where different types of computer reuse organisations, their offers and activities are introduced.

2.3.2 Types

Assessing the available literature on computer reuse in terms of how different engaged organisations differ from each other, two general types of such organisations can be distinguished – namely for-profit and non-profit ones (see e.g. Dhanda & Peters, 2005; Kissling et al., 2012; Marcotte, Hallé & Montreuil, 2008; Rubinstein, 2004; Williams & Kuehr, 2003). To conduct a more detailed and deeper differentiation between different for-profit and non-profit organisations seems rather hard as for example the specific characteristics, types and activities of non-profit organisations seem to differ in different countries. To the knowledge of the author no such differentiation in order to develop a typology has taken place to date.

The closest related typology is one developed by Kissling et al. (2012) based on four different operating models of reuse organisations focusing on ICT equipment and large household appliances (LHA). Although at first this does not seem to be a perfect match to research computer reuse (organisations), it still seems fair to use this typology in the study at hand due to two reasons: firstly, no other, more specific or better fitting typology is deemed available and secondly, it has to be stated that in three out of the four[12] identified generic operating

[12] Organisations operating under the remaining operating model included in Kissling et al.'s (2012) typology were identified to mainly handle network equipment such as rack servers, switches and routers thus not being relevant for the scope of the thesis at hand. This operating model will nevertheless also be introduced in the course of this chapter. The operating

models for ICT equipment (as opposed to one identified operating model for LHA which is not further considered here), desktop computers and laptops together account for the major share of the different organisations' handled products (Kissling et al., 2012).

The typology has been developed as part of a research project supported by the earlier introduced StEP Initiative comprising of 27 case studies from Africa, Europe, North and South America. In regard to the scope, the study focused on organisations with for-profit and non-profit operating models and only considered those which had the status of a legal entity (as opposed to the informal sector) (Kissling et al., 2012).

The authors of the study developed four, respectively five different dimensions to categorize between and describe reuse operating models: the financial structure, the (business) offer, the supply chain and the customers of the organisations as well as the purpose/corporate function. Based on the collected data they looked for similarities and differences regarding the assessed organisations which led to a first distinction into non-profit- and for-profit-based operating models based on the finance dimension and the corporate function. In a second step, the customers, the composition of the supply chain and the organisations' offers regarding products and services were the determining criteria – for non-profit as well as for-profit ones. Eventually, the researchers arrived at the four reuse operating models for ICT equipment depicted in *Figure 2-3*. The three relevant for the scope of the study at hand are indicated by the dotted orange line and are introduced in the following while the Network Equipment Recovery operating model will not be further considered nor introduced as its focus is on networking equipment like switches, routers as well as servers which are outside the scope of the study at hand (Kissling et al., 2012).

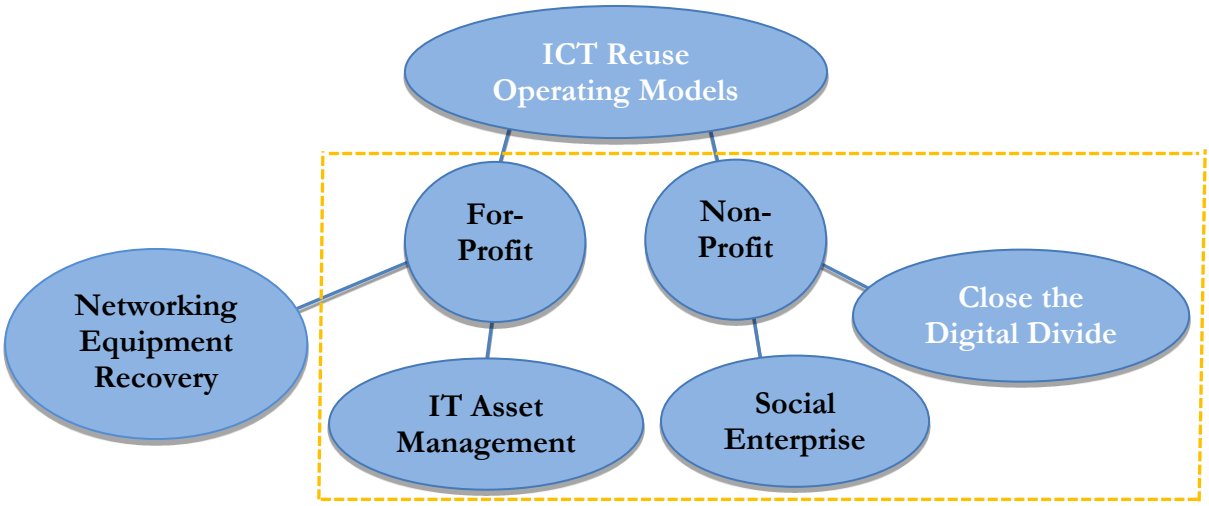

Figure 2-3. Typology of operating models of ICT reuse organisations

Source: Own illustration after Kissling et al. (2012).

IT Asset Management Model

Organisations operating under an IT Asset Management (ITAM) operating model have been identified as specialists in the processes of preparing used desktop computers and laptops for reuse which account for 60 to 85% of the total equipment volume prepared for reuse. In

model for organisations dealing mainly with LHAs will not be considered and introduced here though as it is also out of the scope of the study at hand.

regard to the *supply chain*, the biggest part of the input typically stems from corporate commercial and public users who either own the equipment themselves or take part in a take back program offered by their contracted OEM or leasing company. In the first case, the corporate users commission ITAM organisations to prepare the equipment for reuse before redeploying it again within their own organisation or selling/donating it to their employees. In the second case of leasing returns or product take back programs, the ITAM organisations are contracted and responsible for the collection, preparation for reuse as well as remarketing of the computers and ICT equipment in contrast to redeployment. In both cases, the authors found that the equipment's potential for reuse can be high (between 25 and 95%) as such public and commercial users typically use it only for 2 to 3 years before exchanging it for new equipment (Kissling et al., 2012). Other, less important sources of used computers and other ICT equipment are distributors and retailers, individual users, computers from OEMs' in-house use as well as IT service companies (Kissling et al., 2012). The number of processed units per year varies but has been found to lie between 2,000 and 20,000 for smaller organisations and between 500,000 and 1,000,000 for bigger ones who operate internationally (Kissling et al., 2012).

As already indicated in the last paragraph, the *offer* of ITAM organisations covers everything from the collection over the preparation for reuse to the remarketing of ICT equipment prepared for reuse. This includes the secure handling and deletion of data (often with certification as data security is of great concern to the customers) as well as a certification that the reuse of the equipment will be compliant with specific standards and regulations. Furthermore, recycling services are offered to a certain extent where ITAM organisations contract external partners for the final processing of sorted materials from equipment unfeasible for reuse as well as for the handling and final disposal of materials and/or parts classified as hazardous waste (Kissling et al., 2012).
In regard to what has been brought up regarding the sources of used computers in the supply chain section, it can be added that ITAM organisations either buy the equipment themselves to prepare it for reuse and remarket it as well. Or that they perform the collection, preparation for reuse activities and remarketing by order of the party that contracted them – usually the earlier mentioned public and commercial corporate users (Kissling et al., 2012).

The other two options typically offered are firstly, the earlier described preparation for reuse through redeployment in the customer's own organisation which might also sell or donate it to its employees and secondly, what Kissling et al. (2012) call "refurbishment for donation programmes" (Kissling et al., 2012, p. 92). In the latter, customers can supply used computers and ICT equipment for reuse and define groups of recipients deemed eligible to receive the units once prepared for reuse. Such recipients are typically organisations engaged in the health or education sector but may also be general non-governmental organisations (NGOs) or non-profit organisations (NPOs) (Kissling et al., 2012). Often customers are also offered warranties which usually do not exceed 12 months (Kissling et al., 2012).

According to the authors, the *customers* of organisations with an ITAM operating model can be divided into four broad categories. A major share of the equipment prepared for reuse is sold to distributors and retailers which are taking care of the further redistribution and remarketing. Other customer groups are on the one hand the already described corporate users which take back the equipment for redeployment and on the other hand the recipients of the 'refurbishment for donation programmes'. The last category consists of individuals who are served through web portals and online shops of ITAM organisations (Kissling et al., 2012).
It should be pointed out that the served and reached markets vary in terms of its area and can span anywhere from regional to global (Kissling et al., 2012).

In terms of the finance dimension, Kissling et al. (2012) state that the purpose of ITAM organisations is usually a for-profit one while the yearly income between different sorts of such organisations varies significantly. Smaller organisations have been found to generate a yearly income between $200,000 and $500,000 USD, whereas these figures lie between $25 and $30 million USD for medium-sized organisations. These incomes stem not only from the sale of computers and other ICT equipment prepared for reuse or of single parts and components but also from the sale of collected and pre-sorted parts and materials destined for recycling. Other income streams are services including collection and certified data sanitation (Kissling et al., 2012).

Close the Digital Divide Model

The general activities of organisations with a Close the Digital Divide (CtDD) operating model are similar to organisations with an ITAM operating model as they "also refurbish desktop and notebook computers, but they distribute them at low prices to eligible institutional recipients in developing countries" (Kissling et al., 2012, p. 97) to provide them with access to computers or other ICT equipment and/or services for which a computer is needed to be able to make use of – for example the world wide web (Kissling et al., 2012).

The *supply chain* of organisations with such an operating model can be described as mainly focusing on desktop computers (including additional devices such as monitors) making up 80-90% of the respective organisations input as well as laptops which account for between 10 and 15%. Organisations with a CtDD operating model count corporate public and commercial users as their main suppliers which are responsible for 40 and 100% of ITAM organisations' overall input. Another group of suppliers are individuals/private persons. In the case of one assessed organisation, the authors found that 40% of the sourced equipment stemmed from non-commercial actors such as NGOs and NPOs – this seems to be an exception though (Kissling et al., 2012). Due to the big fraction of equipment from commercial users which tend to swap their computers and ICT equipment more regularly, the potential for reuse of these computers and ICT equipment with up to 90% is rather high. In other cases, for example when coming from other sources the reuse potential may be as low as 40% (Kissling et al., 2012). The total supply of received units varies between 1,000 and 42,000 per year (Kissling et al., 2012).

In regard to the (business) *offers*, those typically include the collection, preparation for reuse activities, including secure data sanitations, and the provision of certifications verifying the equipment is being reused and taken care of in a compliant manner. In some cases, CtDD organisations were found to focus on sourcing of used equipment and the identification of eligible recipients of the equipment and had outsourced collection and preparation for reuse activities (Kissling et al., 2012). If preparation of used equipment for reuse is performed in-house, then the pre-sorting of parts and materials for recycling is also part of the organisations' activities whereas the final recycling and disposal of hazardous materials is usually outsourced to specialists (Kissling et al., 2012).

While the preparation for reuse usually takes place in the country of collection[13], the CtDD organisations afterwards ship the ICT equipment to less-developed countries where a local office of the organisation itself or a local partner organisation (often NPOs or social enterprises) take care of the distribution on-site. These are furthermore responsible for support, in case of technical issues, but may, depending on the organisation and its goals, also offer training and education related to ICT. One prominent aspect also covered by some

[13] These have been found to mostly be European or North American countries (Kissling et al., 2012).

CtDD organisations or its partners is to ensure the collection of the distributed equipment once rendered obsolete and its subsequent recycling and disposal. One of the goals of such activities and partnerships is to initiate and/or develop the recycling systems within the regions or countries the CtDD organisations (and their local partners) serve (Kissling et al., 2012).

The (receiving) *customers* are either individuals/private persons or organisations with a good cause. These are predominantly "educational institutions, but also medical institutions or local NGOs and not-for profit organisations" (Kissling et al., 2012, p. 94).

In terms of the *finance* dimension, a key aspect is the non-profit orientation of CtDD organisations. In order to keep the operational costs as low as possible, CtDD organisations are dependent on volunteers working for them. In order to nevertheless be able to cover the arising costs from its operations, such organisations either sell the equipment for somewhat low(er) prices and/or engage in fundraising activities. The income from such strategies differs between organisations but amounts to a total of between $800,000 and $2,300,000 USD per year. Here, the returns from the sales of whole products and equipment as well as from single parts and or components accounts in most researched cases for the biggest share while returns from services offered and the sales of materials for recycling are on average only marginal. In some cases fundraising can generate the major share of the income.

Social Enterprise Model

As an introductory note, it should be pointed out that:

> "the significant difference between the Bridge the Digital Divide model and the Social Enterprise" (sic!) model is the intended primary beneficiary of the activity. For social enterprises, it is the social benefit such as the employment and training gained through the act of refurbishment that is the primary goal of the organisations" (Kissling et al., 2012, p. 95).

Regarding the *supply chain* of organisations with a Social Enterprise (SE) operating model, the focus is on desktop computers and laptops which account for 50-100% and 0-30% of the sourced items, respectively. The majority of computers are sourced from large public and commercial corporate organisations. Other sources of used computers are private persons/individuals as well as in some cases also distributors or OEMs. Exceptions were two organisations located in developing countries which sourced almost all of their supply from CtDD organisations based in North America or Europe (Kissling et al., 2012). Depending on the size of the organisation the number of received units per year varied from between 1,000 and 500,000 (Kissling et al., 2012). Furthermore, the research found that the average potential for reusing the sourced equipment lay between 35 and 85% (Kissling et al., 2012).

The (business) *offers* of organisations operating a SE model typically comprise the collection of the donated equipment, the (often certified) data destruction as well as certifications verifying that the equipment will be reused in compliant ways. Related to the last part is also the provision of a take back program/service by some SE organisations to ensure proper recycling and disposal. While in regard to recycling a pre-sorting might be conducted, the main recycling processes and the disposal of hazardous wastes are typically outsourced (Kissling et al., 2012). Furthermore, recipients or customers are often offered warranties. Further services comprise "training and capacity building support" (Kissling et al., 2012, p. 97).

Typical *customers* of organisations with a SE operating model or eligible recipients are mainly organisations involved in education and health-related work but also NPOs and NGOs.

Another (smaller) group of customers are private persons with low incomes. The authors of the study describe also one case where equipment ready for reuse was sold to distributors and retailers which did also handle used computers and ICT equipment (Kissling et al., 2012).
The main distinction in regard to CtDD organisations is related to the market. While CtDD organisations export the ICT equipment for reuse, organisations with an SE operating model sell their refurbished equipment only within the country they operate in (Kissling et al., 2012).

In regard to the *financial* dimension, the findings regarding the yearly revenue reach from $500,000 to $38,500,000 USD. This money either stems from products as well as components/parts sold, from material sales to recyclers or from customers' fees for making use of the services offered by the SE organisations. Some also generate income via funding from public or private sources (Kissling et al., 2012).

While the given descriptions of the three different operating models of reuse organisations focusing on ICT equipment have been rather detailed, *Table A I-1* in Appendix I points out the vertices on which the typology developed by Kissling et al. (2012) is based. Nevertheless one should be aware of the fact the distinctions might not be as clear cut as presented and operating models might overlap or several models may be operated simultaneously within one reuse organisation.

Although the different types of operating models of ICT reuse organisations which have been introduced already reveal quite a bit of information about the suppliers and customers of computer reuse organisations, both groups of actors are assessed and discussed in more detail in the following two chapters.

2.3.3 Suppliers

Before taking a closer look at the suppliers and (receiving) customers of computer reuse organisations, it shall be pointed out that not much information on these parties is available. Thus, several comparably old sources as well as those dealing with ICT equipment (instead of computers specifically) have been included. Furthermore, it has to be stated that the main focus of all publications discussed in the following is not on suppliers or receivers of computer reuse organisations but reveal such information only as 'by-product' of their respective actual topic.

In the early days of computer reuse-related research, the sources of used computers had rather been speculated about than factual as a publication by Williams and Kuehr (2003) shows. In a chapter of the seminal book 'Computers and the Environment', the two authors point out that used computers may be supplied from different sources in the consumption sector but only refer to them as "main potential sources of PCs for the used market" (Williams & Kuehr, 2003, p. 201). These are described as private consumers, companies, governmental institutions and organisations and the educational sector. Furthermore, they assume that leasing companies selling off used computers after their first EoL would account for a significant share of the secondary market(s) (Williams & Kuehr, 2003).

Since then, the research on computer reuse has revealed more information – also regarding suppliers. The most comprehensive information regarding a distinction between different types/groups of suppliers can be found in the publication on types of operating models of EEE/ICT reuse organisations by Kissling et al. (2012), which has been presented in the preceding chapter, as well as research conducted by Ongondo et al. (2013), who assessed the activities and barriers of socio-economic enterprises engaged in computer reuse within the UK.

As shown in the preceding chapter, Kissling et al. (2012) distinguishes suppliers and receivers per type of operating model of ICT reuse organisations. For those mainly operating under an IT Asset Management (ITAM) model, the used computers usually stem from commercial and public (corporate)[14] users which may make up between 30 and 100% of an ICT reuse organisation's overall input. In such a case the computers are either owned directly by the supplying parties which contract the ITAM organisation for recovery of the used computers or they are owned by original equipment manufacturers which operate a take back program for EoL computers to their customers. The OEMs then outsource the collection, refurbishment and remarketing/redistribution of the supplied used computers to ITAM organisations (Kissling et al., 2012). Other suppliers of used computers for organisations with an ITAM operating model are distributors and retailers (making up 0-15% of total supply), individual users (0-20%), IT service companies (0-5%) as well as OEMs (0-15%) where the computers seem to stem from the internal use of the manufacturers and not from their customers (Kissling et al., 2012).

Looking at organisations with a Close the Digital Divide operating model, the donated equipment usually stems from corporate and public users which make up between 40 and 100% of the total supply. These types of suppliers for CtDD organisations have also been confirmed by Cumps, Van den Eynde and Viaene (2013) who conducted a case study on the Belgian organisation 'Close The Gap' based on the typology developed by Kissling et al. (2012). Another typical supplying group identified was individuals, accounting for bettwen 0 and 40% of the overall inut of CtDD organisations. A peculiarity was one case study partner where about 40% of the input would stem from non-commercial users such as non-profit (NPOs) and non-governmental organisations (NGOs) (Kissling et al., 2012).

Organisations involved in ICT reuse operating under a Social Enterprise (SE) model typically obtain up to 80% of the used equipment from private and public corporate users while the rest is usually provided by individual users. In some cases, Kissling et al. (2012) also identified distributors and OEMs as sources of used computers, accounting for 0-50% and 0-80% of overall input, respectively. Two organisations with headquarters in less-developed or developing countries were found to source from organisations with a CtDD operating model which were based in North America and Europe (Kissling et al., 2012).

In the second earlier mentioned study, Ongondo et al. (2013) assessed the operations of so-called socio-economic enterprises in the United Kingdom (UK). These are "charities, voluntary organisations and not-for-profit companies […] involved in the repair, refurbishment and reuse of various products" (Ongondo et al., 2013, p. 2601). The focus of the study was on socio-economic enterprises focusing on the reuse of ICT equipment including computers and aimed to find out more about the activities of, barriers to and amount of units handled by such organisations. Among others, the results showed that the equipment was sourced from private businesses (85.7% of the surveyed organisations stated this), the public administration (76.2%), individuals (57.1%), leasing companies (4.8%) as well as from public collection points (14.3%) (Ongondo et al., 2013). Regarding the latter, no further information is provided by the authors but it is assumed that this refers to collection facilities managed by public authorities where households can leave their WEEE.

[14] 'Corporate' is in the case of public and private organisations/users used as an addition when describing their roles in regard to computer reuse. In doing so the author follows the practice of Kissling et al. (2012) who initially started using this terminology in their first and hitherto cutting-edge publication from 2012.

Other studies mainly confirm these types of suppliers but also add some new (and at times more specific) insights regarding the suppliers such as educational institutions as identified by Kahhat and Williams (2009) and Babbitt et al. (2011) which are introduced in the following.

In a study researching the import of used computers to Peru and their EoL treatment, Kahhat and Williams (2009) describe that computer reuse organisations (and other parties interested in used computers) source used computers (at least partly) from commercial organisations, the government sector as well as from academic and educational institutions via public auctions. They also state that the same actors sometimes donate used computers to charities/non-profit organisations. It remains unclear though if among such charities are also organisations engaged in computer reuse activities.

Babbitt, Williams and Kahhat (2011) assessed the disposition and EoL management of electronics at higher education institutions in the United States. An initial case study at Arizona State University (ASU) was complemented with information from survey results from other higher education institutions. In regards to ASU they found that 30% of the desktop computers and 18% of the laptops are sold for refurbishing and resale usually being conducted by small(er) companies. Export for resale (desktop computers) and export for reuse (laptops) were found to account for 22% and 28%, respectively, however no information on the receivers was provided. Information from the survey showed that some of the participating educational institutions are part of so-called 'OEM technology renewal programs' where equipment is leased from OEMs which take back the used equipment after a three year period for remarketing purposes or recycling (Babbitt, Williams & Kahhat, 2011). As laid out by Kissling et al. (2012), OEMs might in this case also entrust computer/ICT reuse organisations to handle collection, refurbishing and remarketing and related processes on their behalf.

Describing the development, effectiveness and transferability of a so-called reuse network for ICT equipment, aiming at increasing the reuse of ICT products and components "by exchange of used equipment over a resource exchange internet platform" (Dietrich et al., 2014, p. 123), Dietrich et al. (2014) describe that, in the case of Austria, used ICT equipment is usually leased and returned to the leasing companies after the contracted period ends. They then send it in most cases to Eastern Europe, Germany or the Netherlands for refurbishing before selling it off to developing countries (Dietrich et al., 2014).
In the case of Germany, the authors mention that ICT equipment sourced by the Reuse Network usually stems from retailers which are supplied by large commercial organisations such as insurance companies or public enterprises (Dietrich et al., 2014).

White et al. (2003) assessed the management challenges and environmental consequences of reverse manufacturing in the computer industry. In doing so the authors also looked at the different related processes, including acquisition, and found that commercial companies involved in reverse manufacturing of used computers had in many cases contracts with OEMs which would supply them with used equipment. Other considered actors were subsidiary companies to OEMs, which would mainly get their supply from in-house use or from upgrade/leasing contracts with large users of computers, such as banks and other financial corporations. Smaller companies active in reverse manufacturing of computers seem to also accept computers from individuals or would try to establish business with a variety of computer end-users which are not defined in more detail. It has to be pointed out though that the activities by most of the researched actors had a focus on dismantling and regaining parts and components rather than preparing computers for reuse (White et al., 2003).

In contrast to most of the formerly mentioned studies, Höhn and Brinkley (2003) looked at the environmental management of products/product aspects at the IT-company IBM. Describing the EoL management of product returns arriving at IBMs product-end-of-life management (PELM) centres, the authors distinguish between different sources where these products usually came from. Before reaching their EoL, these products have usually been employed by either IBM in-house, by businesses (not specified in more detail), are end-of-lease returns or have been sent in by small customers or private persons (Höhn & Brinkley, 2003).

Based on the reviewed literature, four main types of suppliers of used computers can be distinguished, namely: commercial (corporate) users, public (corporate) users, non-commercial users and individuals/private persons. These together with further identified sub-types are presented in *Table A II-1* in Appendix II.

While the sources of used computers for organisations engaged in computer reuse have been assessed, it still remains unclear, who the (receiving) customers of such organisations are once the sourced used computers have been prepared for reuse. Hence, the next chapter aims at shedding light on this question.

2.3.4 Receiving Customers

As with suppliers, the most comprehensive information on receiving customers of reuse organisations focusing on reuse of ICT equipment and computers is provided by Kissling et al. (2012) and Ongondo et al. (2013).
Kissling et al. (2012) assessed the different groups/types of receiving customers in order to use it as dimension/criteria to distinguish between different operating models of ICT reuse organisations and to describe each of these operating models.

As for the organisations operating an IT Asset Management model, the authors found that a big part of the computers and equipment prepared for reuse is sold to retailers or distributors. This accounts for 0 to 75% of the assessed organisation's total output (Kissling et al., 2012).
Other receiving customers are the supplying (commercial or public) corporate users themselves when the used equipment is refurbished by ITAM organisations as a partner and then redeployed within the supplying customer's organisation (0-60% of ITAM organisations' output). In such cases the computers and other equipment may either be used further in another organisational department/unit or donated/sold to employees (Kissling et al., 2012).
A third type of receiving customer is related to donation programs where the ITAM organisations prepare used computers and ICT equipment for reuse as contractor for the supplying corporate users before the units are donated to eligible receivers (5-85% of output). This usually comprises educational, health and medical institutions as well as non-profit and non-governmental organisations (Kissling et al., 2012). The last type of receiving customers are private persons which account for 5-30% of the overall output (Kissling et al., 2012).

In regard to the CtDD operating model, receiving customers are usually partner organisations in the served (mainly less-developed) countries which take care of the further local distribution. Receiving customers or recipients of these partner organisations are non-profit corporate users such as medical and educational institutions, NGOs and NPOs but also individual users. The first group of final recipients accounts for 90-100% of the total volume of distributed equipment and computers by CtDD organisations whereas individuals only account for between 0 and 10% of the overall output volume (Kissling et al., 2012).

Receiving customers of organisations operating a Social Enterprise model can mainly be divided into non-commercial organisations such as NGOs and institutions providing

education and health/medical services (accounting for 10-100% of the respective organisations overall output) and rather poor private persons with low incomes (accounting for 0-55%). One organisation was found to mainly redistribute the computers prepared for reuse to retailers and distributors of new as well as used ICT equipment (Kissling et al., 2012).

Similar to such organisations operating a Social Enterprise model are the ones researched by Ongondo et al. (2013) in the UK as already introduced in the preceding chapter. The results also revealed information regarding their receiving customers: 85.7% stated that their customers are individuals/private consumers whereas 42.9% answered that private businesses make up a part of their receiving customers; 19.0% stated that public administration organisations were among their customers and 4.8% reported that they would also sell to collection points[15] (Ongondo et al., 2013).

Examples of receiving customers of organisations engaged in computer reuse can be found in a set of academic papers although less detailed. These papers have their main focus on other topics and do not in most cases specifically focus on computer reuse organisations but nevertheless, they do reveal bits and pieces of information about receiving customers of such organisations.

In the earlier introduced study of the computer reverse logistics industry in the Canadian region of Québec, Marcotte, Hallé and Montreuil (2008) map the identified reverse logistics network. Thereby, they identified individuals, resellers and brokers as well as generally 'facilities using technological resources' as receiving customers of CROs.

A somewhat older publication by Williams and Kuehr (2003) addresses the market for used computers and describes small and medium-sized enterprises as the typical customers of resellers (which are also stated to be potentially involved in preparation for reuse activities and could thus be considered as ICT/computer reuse organisations). Other types of buyers of used computers are said to be private persons, the government sector as well as educational institutions, specifically schools. Although it is presumed that these groups are buying used computers from computer reuse organisations, this is not clearly stated by Williams and Kuehr (2003). In regard to OEMs being engaged in computer reuse activities, they describe corporate and private customers as their customers (Williams & Kuehr, 2003).

In estimating the transferability of the concept of an ICT Reuse Network from Germany to Austria, Dietrich et al. (2014) assessed the ICT reuse practices in Austria. They found that in the private sector, over 50% of the equipment is leased. After it goes back to the leasing companies, computers are refurbished presumably not by the leasing companies but by external computer reuse organisations. These are described to be located mostly in Eastern Europe, the Netherlands and Germany. After preparation for reuse the equipment is sold for reuse in developing countries. In case the equipment has not been part of a leasing contract, most companies hand the equipment over/sell it to employees for reuse or to the worker's unions for further distribution. Other companies may donate the equipment for charity purposes such as to schools and social projects. It is not clear though if computer reuse organisations are involved in preparation for reuse activities in all of these cases.

Further information is available from Ireland, where O'Connell and Fitzpatrick (2013) issued a report on current reuse practices of EEE giving recommendations for how reuse of EEE in the country could be increased. This has also been assessed by researching the activities of

[15] No further information is provided about the receiving customers, thus it is assumed that the equipment sold/handed over to collection points is seen as (e-)scrap not feasible for reuse and instead deemed to be handled best through recycling.

Rehab Recycle, Ireland's largest non-profit organisation engaged in preparation for reuse of ICT equipment (O'Connell & Fitzpatrick, 2013). In their report the authors mention that Rehab Recycle's receiving customers are private consumers, corporate businesses and non-profit organisations (O'Connell & Fitzpatrick, 2013).

Discussing reverse logistics in the computer industry, Dhanda and Peters (2005) describe schools as receiving customers of non-profit computer reuse organisations. Regarding commercial asset management companies, the authors only state that computers are resold to developing countries where they would be prepared for further reuse.

While it can be seen that the descriptions and typologies or groups of receiving customers of ICT /computer reuse organisations differ, there is also a lot of overlap in the reviewed literature. As for suppliers, four main types of (receiving) customers emerge: private and public (corporate) users, non-commercial users as well as individuals/private persons. These are – together with identified sub-types – shown in *Table A III-1* in Appendix III.

After reviewing the available literature on the types of suppliers and receiving customers of organisations in the reuse of computers, as well as other ICT equipment, the next chapter assesses the barriers that such types of organisations face and which thereby (may) contribute to hampering the practice of computer reuse in general.

2.3.5 Barriers

In order to allow for a better understanding of barriers to computer reuse organisations[16], it seems important to point out that while the focus of the study at hand lies on such barriers in the Swedish context, no academic literature is available in this regard. Nevertheless, several barriers could be identified in grey literature such as a blog and a privately commissioned study on computer reuse in Sweden as well as newspaper articles. While this does not provide an exhaustive list of barriers, other relevant (academic) publications – either with a specific focus on barriers to computer reuse organisations or at least mentioning such barriers in regard to such types of organisations – are presented and discussed to provide a comprehensive overview about the current state of knowledge in the field.

Barriers Identified in the Swedish Context

In a debate article on an online platform of a major Swedish newspaper Fredrik Nilsson (2014), the marketing director of a Swedish computer/ICT refurbishing company describes in regard to schools, that it remains somewhat unclear why not more are purchasing used computers instead of new ones and furthermore would often buy such with high performance which would not be needed to fulfil the educational requirements of pupils. While this can be seen as a barrier in itself, namely potential customers' lack of knowledge about the suitability of used computers for their needs, such behaviour would especially be hard to understand as it usually means that more computers could be purchased for the same amount of money and thus help schools cut the budget.

Trying to explain the reasons behind such behaviour, he sees the biggest barrier in that used computers are seen as inferior in today's society (Nilsson, 2014, para. 10). In the same respect, he denounces people's objections towards used computers as breaking more easily pointing to the societal discussion on the soundness of used computers and the lack of confidence of potential users of such computers (2014).

[16] It seems important to point out that in regard to the barriers, the scope of the thesis at hand only includes barriers that were identified and mentioned as barriers to computer reuse organisations. Thus, barriers to computer reuse in general which were not found to be mentioned as a barrier to computer reuse organisations as such have not been considered in the study at hand in order to do justice to the given space available.

Another barrier he describes is the common argument that used computers would not hold up to the requirements of new(er) software. While this might certainly be true for computers aged 8 years or so, such computers would usually not be dealt on the secondary computer market in Sweden (Nilsson, 2014).
In addition, Nilsson (2014) states that many (public) purchasers seem to think that they may not buy on the secondary markets while the *Lag om offentlig upphandling* (Swedish act on public procurement) (SFS 2007:1091) does not prevent that which suggests that the responsible persons seem to not be fully aware how to apply/interpret these regulations. He furthermore argues that the market for used information technology equipment would in the meantime be as well established as for example the market for used vehicles (Nilsson, 2014).

In the company's official blog, Nilsson (2013a) criticizes that many public authorities ('myndigheter') perceive reselling their used IT equipment as illegal although the *Förordning om överlåtelse av statens lösa egendom* (Swedish regulation on the disposition of the state's loose property) (SFS 1996:1191) allows them to do so. The only requirement is that it happens in a business-like and transparent manner. The fear to sell used equipment and instead sending it to recycling seems to be based on several scandals in the past where nepotism had occurred in relation to selling off used equipment (Nilsson, 2013a).

In another entry of the same blog, Nilsson (2013b) criticizes that most computer OEMs would not really do much in order to prolong the life cycle and support reuse of their products. Based on this criticism, his company conducted an internal evaluation/survey in order to find out about the main factors which could help to increase the reusability, life cycle and value of used IT equipment. The published measures which they deem OEMs should be able to implement or change relatively easy comprises of the following (Nilsson, 2013b):

- Using capacitors and batteries with somewhat higher quality
- Optimizing the cooling, especially for smaller laptops (as heat causes wear and tear)
- Designing products in a way that prevents dust from penetrating (as dust shortens the life time of all electronic products)
- Making it easier to exchange keyboards and memory (RAM)
- Standardize the AC adapters and the interfaces/contact sections of docking stations for laptops in order to allow for easier handling in a second life

While these advices are very detailed, they can be grouped into three different groups of barriers: the design does not consider reuse, the use of low quality components or materials by OEMs and a lack of standards.

Further barriers were revealed by findings from an unpublished commercial study commissioned by Swedish refurbishing company Inrego. One focus of this study was on the reasons why public and private (corporate) organisations do not sell/donate their used IT equipment for refurbishing and reuse/let it be refurbished for deployment but instead choose to recycle the equipment (Inrego, 2014). Interviews were conducted with IT department managers of 200 institutions and companies in the private and public sector with more than 250 employees each (Inrego, 2014). The interview partners representing those organisations that decided to recycle their computers instead of selling them for reuse (despite the fact that a majority of the interviewed organisations knew of the value of the equipment) stated as reasons:

- Fear of data/information leakage from hard drives (40%)
- Avoidance of spending time on selling the used equipment (26%)

- The company policy stipulates that all IT equipment should be scrapped (17%)

While all three reasons limit the supply of computer reuse organisations with used computers as input to their operations, they differ a lot from each other and can all three be seen as single barriers each.

Despite the fact that the barriers found (in grey literature) for the Swedish context already provide a somewhat broader selection, a look at academic publications not specifically addressing Sweden reveals that a substantial number of barriers to computer reuse organisations are still missing.

Barriers Identified in Non-Swedish Contexts

Overall, three comprehensive studies were identified together with three publications mentioning one or several barriers to computer reuse organisations which provided this information more as a by-product. The first three mentioned research works consist of two articles publicized in scientific journals (Kissling et al., 2013; Ongondo et al., 2013) and one master thesis at the International Institute for Industrial Environmental Economics (IIIEE) by Hsieh (2010).

In 2013, Kissling et al. published their research (as part of a StEP-funded project) on the success factors and barriers that for-profit and non-profit reuse organisations perceive regarding the reuse of EEE. The electrical and electronic equipment was in this case defined as comprising of ICT equipment (including computers) and large household appliances while the considered reuse organisations were identified according to the earlier introduced typology of operating models. The geographical scope included organisations form industrialized and developing countries on several continents alike – including Africa, Latin America, North America and Europe (Kissling et al., 2013). Data were collected through semi-structured interviews (Kissling et al., 2013).

Although non-profit and for-profit reuse organisations were included, the authors decided to compile a list of generic success factors and barriers which were found to exist for both types of financial structures. In the following only the barriers will be discussed. Overall, the researchers identified 15 barriers (Kissling et al., 2013) leading to four groups of barriers.

One of the main challenges for the researched organisations was the "access to sufficient volumes of used equipment at good quality and at low costs" (Kissling et al., 2013, p. 23). Basically, all of the other identified barriers from this primary group of barriers are related to or contribute to this first barrier. For example, no regulations were in place which would enforce reuse or provide economic incentives to reuse EEE. The interviewees stated further that the current design of recycling and collection schemes for EEE hampers reuse possibilities, as units are not handled with care and are losing value due to scratches on the surface or being broken during collection. In addition it is stated that retailers which are supporting reuse by supplying the reuse organisations with used EEE are discriminated against as they have for example to organize and finance the related logistics themselves (Kissling et al., 2013, p. 23). Another challenge is posed by recycling organisations which in some cases offer financial compensations for used EEE and thus intensify competition. This competition is also aggravated by OEMs which may mandate reuse organisations to handle the take back of their used products and demand the dismantling of the latter although the reuse organisations deem them to be feasible to be prepared for reuse again. The main reason for such requirements from the manufacturers is the fear that used equipment would compete with new products. All these issues make the supply with (and demand for) used EEE for reuse organisations unpredictable (Kissling et al., 2013).

The second group of barriers emerged mainly from illegal and/or informal practices of actors. One of the main issues is the export of e-waste which is labelled as reusable – a practice known as 'sham reuse' where the e-waste typically ends up in less-developed countries where it is treated/recycled informally leading to adverse effects on humans and the environment. These types of illegal practices are perceived as leading to a critical general perception of EEE reuse, also negatively affecting those reuse organisations that "live up to socially and environmentally sound re-use practices" (Kissling et al., 2013, p. 25).
Secondly, the societal discussion about the integrity and soundness of reusing electrical and electronic equipment is also shaped by OEMs which advocate new products over used ones – one of the reasons leading to this is seen in 'sham reuse' practices (Kissling et al., 2013).
While informal actors are not only seen as nourishing criticism against EEE reuse through practices such as 'sham reuse', formal reuse organisations also experience them as tough competitors in the supply and demand markets. Due to economic advantages gained from non-compliance with environmental and social legislative aspects (Kissling et al., 2013).

In a third group, Kissling et al. (2013) merged identified barriers around the wider areas of regulations, product design and standards. They found that the existence of a multitude of often complex legislation and regulations lead to extra costs related to their administration. This is especially an issue for cross-nationally operating reuse organisations where it would for example (in certain cases) be financially more feasible to transport used equipment to a central facility in another country instead of refurbishing locally. In certain constellations of originating and target countries, domestic and/or international regulations seem to pose barriers to the operations of such reuse organisations. Another barrier relates to standards in the EEE reuse industry. On the one hand, many different standards seem to exist while on the other hand an internationally widely accepted standard is still missing making "it difficult to refer to common definitions of good re-use practices and to enhance transparency and quality control in the re-use sector" (Kissling et al., 2013, p. 25). In regard to the design of EEE products, the researchers found that although reuse organisations manage to efficiently handle the assessment and preparation for reuse processes nowadays, the designs are in most cases not developed with reuse in mind (Kissling et al., 2013).

The overarching theme of the fourth group of barriers is economic and cost-related. Not only were the costs for the logistics and for labour brought up by the interviewed reuse organisations but also the falling prices of new EEE products. These seem from an economic viewpoint to become competitive with items prepared for reuse also leading to a sinking demand for the latter (Kissling et al., 2013).

In the earlier introduced study by Ongondo et al. (2013), the researchers also analysed barriers to the operations of non-profit reuse organisations handling ICT equipment in the UK. The data was collected via an in-depth case study at one reuse organisation which was complemented with questionnaires filled out by 21 other ICT reuse organisations (Ongondo et al., 2013). A list of 29 barriers has been compiled from "qualitative comments" (Ongondo et al., 2013, p. 2603) in the questionnaires and grouped around specific 'issue areas' which are discussed in the following (Ongondo et al., 2013).

The first of the mentioned 'issue areas' is 'marketing' but also comprises barriers related to activities and processes of 'redistribution'[17]. Here, the first barrier is the consumers' lack of trust in the soundness of refurbished equipment. Potentially related to this might be the statement (which has also been listed as a barrier) that "social enterprises [are] seen as tree

[17] Or what has been introduced as ‚remarketing/redistribution' in chapter 2.3.1 describing activities of computer reuse organisations.

huggers rather than professionals" (Ongondo et al., 2013, p. 2603). Another barrier is the promotion of buying new equipment instead of used, once a purchasing decision needs to be made. Also, in regard to selling equipment one or several of the respondents mentioned that they would be missing a shop that could help increase sales of ICT equipment prepared for reuse while on the other hand one identified barrier describes the difficulty in finding buyers for large batches of units ('bulk volume sales'). The last barrier regarding this group of barriers is rather related to acquisition/sourcing and is connected to the societal discussion about and the coverage of cases of identity theft or fraud connected to computer reuse. Due to this publicity potential suppliers/donators of used ICT equipment may act carefully and potentially decide not to donate (Ongondo et al., 2013).

The second area in which the interview partners identified barriers is 'legislation'. The discovered issues are all related to either sourcing or costs. With regard to sourcing, the design of the take back services of manufacturers as regulated for WEEE leads to a situation where collected products are rather recycled or scrapped instead of reused – although potentially feasible for reuse. Another problem related to the acquisition of used products are leasing contracts which prohibit potential suppliers with a high volume of IT equipment from donating it as this would mean a breach of agreement with the leasing company. The third barrier within this area related to sourcing is the fear surrounding data security which seems to keep potential supplying companies from giving equipment away for reuse (Ongondo et al., 2013).
In regard to costs caused by legislation, 'consignment note[18] regulations' are mentioned which would eventually lead to an "extra administration charge to customer[s]" (Ongondo et al., 2013, p. 2603). Other legislation enacted to regulate so-called 'rogue reuse firms' leads also to increased licensing fees for compliant reuse organisations which are perceived as additional costs (Ongondo et al., 2013).

Further difficulties more or less related to sourcing activities have been found and grouped under 'supply issues'. Similar to what has also been mentioned by Kissling et al. (2013), the "lack of access to large quantities of quality equipment" (Ongondo et al., 2013, p. 2603) has been identified as a barrier. The survey respondents also mentioned the growing intervals in which potential supplying organisations exchange their equipment. Also, if/when eventually donated, the equipment seems often to either come without hard drives or is missing other integral parts. Furthermore, the number of received laptops in good condition is considered as too low (Ongondo et al., 2013).

Another area in which several obstacles were recognized is logistics where especially economic aspects play a role. Firstly, some companies which function as suppliers to non-profit ICT reuse organisations are hesitant to remunerate the latter for collecting the used ICT equipment which is perceived as a service provided to the suppliers. This barrier seems to become even more important in the light of expensive fuels which might lead to substantial overall costs for the collection process (Ongondo et al., 2013). Looking at the transportation of collected equipment, the space available in the vehicles seems in some cases to limited and is perceived as a barrier. So are among others (not further discussed) "practical and logistical factors, including [the] distance travelled to collect WEEE" (Ongondo et al., 2013, p. 2603) (Ongondo et al., 2013).

Although two cost-related barriers have been grouped under 'legislation', more obstacles that are not specifically related to any of the other areas were identified and grouped separately as

[18] Consignment notes are forms which have to be filled in whenever hazardous waste is leaving a premise. Once the forms have been filled out correctly, they have to be carried along with the hazardous waste (British Environment Agency, 2014).

'costs' as such (Ongondo et al., 2013). Here, the collected data reveals that potential suppliers often seem not to recognize the value that is in many cases still inherent to certain ICT products once it becomes obsolete (and probably recycle it instead of considering reuse). Another barrier states more or less the opposite, namely that a part of the collected or received used products is not very valuable anymore. The third cost-related barrier is listed as "company's perception of item value" (Ongondo et al., 2013, p. 2603) but it remains unclear if this means that they are not aware of the residual value of the used item or if they overestimate the value of used equipment and try to sell it or demand certain services as a sort of remuneration. A last obstacle within this group is the final price of refurbished items which seems to be perceived as too low when compared with the invested time and financial resources in the refurbishing process[19] (Ongondo et al., 2013). The latter argument is also represented among the barriers related to 'processing' of collected used equipment which is perceived as time demanding. The sourced products and equipment are so diverse that a broad set of technological skills and know-how is required to be able to handle and refurbish those (Ongondo et al., 2013).
The last three identified obstacles are related to storing sourced and/or refurbished products as well as staffing. When equipment has to be stored, this seems in cases not to be done in a responsible enough way so that the equipment gets damaged or broken. This issue might well be realted to small premises which restrict the area that can be used for storing equipment. In regard to staffing, non-profit reuse organisations engaged in ICT reuse in the UK perceive the number of employed people as too little for their operations (Ongondo et al., 2013).

The third publication which comprises specific information about barriers to organisations engaged in computer reuse has been issued by Hsieh in 2010. In her master thesis she assessed the drivers of and barriers to computer reuse in Taiwan. In doing so, she interviewed different stakeholders including government bodies, OEMs of computers as well as for- and non-profit organisations involved in computer reuse totalling in 20 interviews. The barriers identified by the computer/ICT reuse organisations and the OEMs (being partly involved in reuse activities) are presented and discussed in the following.

In regard to non-profit ICT reuse organisations, Hsieh (2010) identified three barriers. Firstly, the decreasing pricing levels of new computers approach the ones of refurbished/used computers which makes customers question why they should decide to purchase a used machine instead of a new one. Another issue was the costs for logistics in the collection as well as the redistribution process due to the centralized structure with only two refurbishing centres located in the South and the North of the country leading to long distances and high transportation costs. A third barrier has been identified in the lack of supply with used computers as non-profit ICT reuse organisations rely solely on donated equipment. Hsieh (2010) reasons that the low supply has to do with a limited willingness of and missing incentives for consumers and commercial actors alike, as donating computers, for example, does not bring any tax reductions. Thus, at least corporate users would rather consider selling used equipment to commercial reuse organisations which pay for it (Hsieh, 2010).

For-profit reuse organisations in Taiwan have been found to face 10 barriers. They were found to face high operational costs mainly stemming from transport and labour costs. While the reason for the cost for transportation seems to be the same as mentioned for the non-profit reuse organisations, the high labour costs are related to the processes of inspecting and

[19] This is the interpretation of the author as Ongondo et al. (2013) list the barrier without further explanation as "time/cost of refurbishment versus final item cost" (Ongondo et al., 2013, p. 2603).

testing the used equipment[20] as well as wiping the hard-drive off old data (Hsieh, 2010).
Another major issue was found in the increasingly lower prices of new computers which seemed able to compete with refurbished products. It has to be pointed out though, that the type of new computers which were seen as competitive price-wise were netbooks being sold for about $300 USD whereas the used machines of brands such as DELL or Lenovo were professional ones coming at an age of 2 to 3 years and at a price of $200 to $250 USD. This development has led to some reuse organisations to also sell new computers (Hsieh, 2010).
As a third problem, the lack of supply (or a 'low collection rate') in general and specifically of "high volumes of used PCs with identical configuration" (Hsieh, 2010, p. 37) was identified as reuse organisations could sell more used computers than they receive. In regard to consumers as suppliers, the reasoning points to a lack of incentives to resell used computers which occasionally leads to stockpiling. When looking at corporate (public and private) actors, Hsieh (2010) states that they would not regularly exchange their computers, so that in some cases computers are 5 to 6 years old when exchanged and then are either broken or have a low residual value (Hsieh, 2010). Another barrier perceived by many of the interview partners are the lack of economies of scale as with lower numbers of units the operating costs (potentially per unit) get comparably high (Hsieh, 2010).
Turning to the refurbishing process of used computers, for-profit reuse organisations stated that the availability of single components or parts and their costs would pose a barrier to their operations. The costs of new parts are considered too high considering that the computers to be refurbished are already several years old. This leads to the use of components from other collected used computers or turning to recyclers or other ICT/computer reuse organisations to check for fitting parts (Hsieh, 2010).
The next barrier which is referred to as 'unreliable sources' can mainly be described as lacking information about the condition of the acquired used computers. This also addresses the age and configurations/specifications of the units. Hsieh (2010) also mentions that often the composition of the mass of sourced computers is diverse leading to higher operational costs for refurbishing compared to big volumes of computers coming with identical configuration. While the author states that "when managing those varying PCs for refurbishment, both yield rate and recovery rate become lower" (Hsieh, 2010, p. 37) it remains unclear why this is the case specifically for a batch of computers with different configurations/specifications (Hsieh, 2010).
Similar to Ongondo et al. (2013) and Kissling et al. (2013), Hsieh (2010) also identifies 'legislation' as a barrier. More specifically, she points to the design of waste management policies which are targeted at recycling but do not consider reuse/refurbishing. Furthermore, collectors often do not consider the reusability of the machines leading to damaged or broken ones. In addition, reuse organisations seem to compete with recyclers for the supply of used computers as the latter seem in cases to pay considerable amounts of money (Hsieh, 2010).

Another mentioned barrier is the perceived decreasing lifetime of components in computers due to increasingly lower prices of new computers. This is also perceived as leading to a potentially lower reliability of used computers in the future. Related to the quality of used/refurbished computers are also the cost-aspect and the financial situation of a for-profit reuse organisation. If receiving customers demand lower prices for used computers (as the prices of new machines would be comparably low) then it might be likely that for-profit reuse organisations will cut down on testing or warranty services in order to lower the operational costs and thus the prices of used computers – potentially leading to lower prices of used computers (Hsieh, 2010).

[20] In the case of some for-profit reuse organisations, the collected computers seem to be dismantled and the single components checked although this does not clearly emanate from the publication (compare Hsieh (2010), p. 36).

Hsieh (2010) also identified issues regarding software. Here, the main barrier is seen in licensing software from Microsoft (perceived as such by about one third of the interviewed reuse organisations) due to the cost at which it comes. When instead considering shipping computers with free operating systems such as Linux, the interview partners stated that end-users would not be capable of operating these as it would not be taught in educational facilities such as elementary schools (Hsieh, 2010).

Hsieh (2010) also conducted interviews with several OEMs consisting of HP Taiwan and Europe, Acer Taiwan as well as Dell Europe in Sweden. The inclusion of the three European branches bases on difficulties to get in touch with Dell's Taiwanese office. The author eventually arrives at a list with seven barriers derived from the interviews with the representatives of the above mentioned companies (Hsieh, 2010). But taking a closer look at the discussions around the single barriers listed for producers, it becomes at least partly unclear on which evidence this list is based. For example, "high quality standard and hard to be profitable" (Hsieh, 2010, p. 40) is listed as a barrier but a related explanation or evidence for this is missing. This is similar for a group of other barriers, too.
Furthermore, statements around the producers seem inconsistent or at least unclear. For example when the author states that "for commercial [sic!] market for secondary PCs, producers have not participated in the operation or sales business actively" (Hsieh, 2010, p. 32) but one paragraph further mentions that at least Dell (Sweden) offers "asset recovery service[s] … to help commercial customers to wipe their hard drive data […] and resell their machines through refurbisher [sic!] partners" (Hsieh, 2010, p. 32). Thus, it was decided to provide a plain list (see *Table 2-2*) of the mentioned barriers for producers but to no further discuss them here nor to consider them for further research.

Table 2-2. List of barriers to computer reuse as mentioned by producers/OEMs and listed by Hsieh (2010)

Barrier	**Barrier**
Brand image	Safety, functionality and quality concerns
High operational cost	Rapid technological development
Higher toxic substances in used ('secondary') computers	Small price differences between new and used computers
High quality standard and hard to be profitable	

Source: Hsieh, 2010.

While the three most comprehesive publications in terms of barriers to computer reuse organisations have been introduced and discussed, a few other publications also mention barriers to computer reuse organisations but are less comprehensive.

In 2014, Dietrich et al. (2014) published an article on a 'Project Zerowin' case study in the ICT sector. Project Zerowin which stands for 'Towards Zero Waste in Industrial Networks' is funded by the European Union and aims to research how resource conservation in primary industries within the EU can be increased (Dietrich et al., 2014). This is attempted to be done by not only involving partners from these industries but also through forming networks between these partners. Besides several other partners (21 in total), the network also comprised of three ICT refurbishing organisations. A platform was developed to allow for the exchange of products that could be reused or recycled between the network members thereby

stimulating ecological and economic gains. As units of research ('indicator products') a desktop computer and a laptop as well as a data logger[21] were set (Dietrich et al., 2014).

Discussing their results as well as opportunities to extend and further develop such (a) network(s), the authors point out several barriers to the network researched in the case study as well as the involved reuse organisations.
Similar to what Kissling et al. (2013) mention, Dietrich et al. (2014) also see one barrier in national and/or international regulations which could negatively influence the financial feasibility of reusing ICT equipment. As an example, Dietrich et al. (2014) mention the changed depreciation rate for ICT equipment in Germany from 60 to 36 months by the national Ministry of Finance. In consequence, this means that in a company's books, the economic value of one ICT appliance would after three years have diminished to 1€ and thus not providing any incentives to consider reuse (Dietrich et al., 2014).

Another barrier described by Dietrich et al. (2014) which has also been described by Kissling et al. (2013) is the public collection system. Firstly because the collection process does not consider reuse in a sense that collected units are handled in such a way that damages are prevented. Secondly, public collection facilities are described as "not willing to hand over material to refurbishers" (Dietrich et al., 2014, p. 133), thus forcing the latter to turn to other sources of supply (Dietrich et al., 2014). While this clearly presents a barrier to computer reuse organisations ('refurbishers'), the authors leave it open if the public collection facilities just do not want to hand over the collected units or if they are prohibited to do so by legislation/regulations.

In regard to the collection of used ICT equipment, Dietrich et al. (2014) point out that in certain countries (e.g. Romania) the quality of such equipment might be too low and therefore could potentially prevent reuse. In such cases the supply should be secured from other countries where an excessive supply is available (e.g. Germany) (Dietrich et al., 2014).

Furthermore, the authors describe the "lack of transparency of product availability" (Dietrich et al., 2014, p. 133) as a barrier. While no specific argumentat for why this is a barrier is given, it is assumed that it is seen to restrict/hamper the access to used ICT equipment (and computers) which could potentially be prepared for reuse and resold. Thus, it would tie in with the findings from Kissling et al. (2013), Ongondo et al. (2013) and Hsieh (2010) which had all identified the supply with sufficient volumes of used IT equipment that could potentially be reused as a barrier. It would also reaffirm that unpredictability in supply poses a barrier to computer reuse organisations as pointed out by Kissling et al. (2013).

As a last barrier to computer reuse organisations, Dietrich et al. (2014) mention missing economic incentives for computer reuse organisations while referring to Becker (2009) (as cited in Dietrich et al., 2014, p. 133). The authors argue that the issue is seen to lie in the high labour costs for preparation for reuse activities ('refurbishment') as compared to the low(er) labour costs applying for the manufacturing/assembly of new ICT equipment making the former economically rather unviable (as cited in Dietrich et al., 2014).
This argumentation is also found in Dietrich et al. (2012) who argue that labour costs for refurbishing and repair activities in Europe would be "indirectly competing with costs for primary resource extraction and assembly of new appliances, which does take place in countries with considerable low wages" (Dietrich et al., 2012, p. 2). Although the last argument by Dietrich et al. (2012) may be somewhat more specific in its geographical area –

[21] A data logger is in the case study described as being used to e.g. measure certain parameters in the environment, e.g. regarding weather or soil and also other areas (Dietrich et al., 2014).

namely Europe – it also ties in with the findings from Kissling et al. (2013) and Hsieh (2010) who had also identified high labour costs as a barrier to computer reuse organisations.
After having presented and discussed the different barriers identified in literature, those have been compiled to a final list which was further used as a basis to develop and fuel the research framework presented in the following methods chapter (3.4). Due to its length it was decided to provide the complete list in Appendix IV.

With this the chapter regarding available literature, presenting and discussing the activities and different types of ogranisations but also their supplying and receiving customers, comes to an end. This makes space now for the research methodology and applied methods for data collection leading to the already mentioned research framework.

3 Methodology

The chapter at hand presents the research methodology as well as the single methods which were used to prepare the research as well as to collect and eventually analyse the data. Furthermore, the research framework which served as a basis for data collection and analysis is introduced.

3.1 Research Approach

Due to the shortage of data on typologies of computer reuse organisations, their suppliers and receiving customers, as well as barriers in general but also specifically in the Swedish context, an exploratory and qualitative research approach was chosen. This type of research approach is suggested to assess research themes where initially no or only little data is available (Bryson, 2012; Hakim, 2000). Furthermore, qualitative research aims at discovering new information and data and at developing typologies or theories (Flick, 2006).
In order to allow for higher validity of researched data, Denzin (1978) suggests a triangulation approach, which can for example consist of using different methods for data collection (Stake, 1995). This was done justice by combining a literature review with interviews and reviewing website information and other documents of the different assessed organisations.

The overall research process consisted of four steps. A thorough initial literature review allowed exploration and gathering of already available theoretical knowledge on the topic and to further refine the research questions. In order to conduct the interviews with experts from the field and to be able to analyse and structure the then collected data at a later stage, a research framework was needed. During the process of reviewing literature, no (fitting) framework could be identified so the need to develop one arose. Thus, based on the findings from the literature review, the framework introduced in Chapter 3.4 was developed constituting the second step of the research process. Thirdly, the research framework was used to develop interview guides. Based on these interview guides the interviews were eventually conducted together with a review of websites and other documents in a fourth step. Finally, the findings from the interviews and the other reviewed documents were analysed and structured.

3.2 Data Collection

As already stated in the preceding chapter, three methods of data collection were combined in the course of the research process. These are further described in the following three sub-chapters.

3.2.1 Literature Review

To approach the topic and to get an overview about existing knowledge and information on computer reuse and computer reuse organisations, an initial literature review was conducted. The reviewed literature covered mainly academic publications such as books, peer-reviewed articles, but also considered grey or non-academic literature such as blog articles, publications, documents and reports from relevant national or international public authorities (e.g. the EPA of Ireland and the U.N.) or non-governmental organisations as well as publications from companies (based on market analyses of private market research companies).

In a second step, literature on computer reuse in the Swedish context was researched and reviewed with the aim to assess the current situation of computer reuse (and the market) and organisations engaged in computer reuse activities, their suppliers and receiving customers as well as the barriers they face. Reviewed literature comprised academic and grey literature

including master theses, peer-reviewed journal articles, reports of relevant national authorities as well as legal texts and blogs.

It became quickly apparent that the biggest part of the academic research related to computer reuse focused on issues and practices related to the end-of-life of computers, life cycle assessments of the environmental impacts of computers and reverse logistics (management) practices related to EoL computers. In contrast, only few publications on computer reuse organisations, their suppliers and receiving customers as well as their barriers could be identified – and almost no information on these themes was found for the Swedish context. Thus, as also stated in the chapter on limitations, the scope regarding the literature was widened and thus also literature with a focus on reuse of ICT equipment was considered.

As mentioned in the preceding chapter, no framework for data collection and analysis could be identified in the course of the literature, so that the need for developing an own framework arose which is presented in Chapter 3.4.

3.2.2 Interviews

Semi-structured interviews were chosen as the means to collect data as part of the qualitative approach. With mainly open-ended questions, this method did not only allow for structuring the interviews to a certain extent but also helped to discover and unveil new information while also leaving space to test for specific aspects identified during literature review, such as barriers or types of suppliers and (receiving) customers. Before the actual interviews were conducted, one pre-test of the interview guide and questions was done. This led to a refinement of some questions and certain parts of the interview guide.

In order to identify suitable interview partners as representatives of computer reuse organisations, the latter had to be identified initially. The criteria making a certain organisation eligible to take part in the study was that it had to be engaged in the activities a computer reuse organisation usually covers as described in Chapter 2.3.1: acquisition, collection, sorting and inspection, preparation for reuse activities and redistribution, while the offering of follow-up services were not considered as a central criteria. This approach guaranteed that the identified organisations were able to contribute with knowledge/information that would help to answer the research questions.

Organisations fitting the criteria were searched for using Google, the official database of the Microsoft Registered and Authorized Refurbisher (MRR/MAR) Programs[22] [23] (Microsoft, n.d. a), websites providing industry-relevant information related to computer reuse such as thebrokersite.com (The Broker Site BV, n.d. a) or websites of related events with a register of attending companies and the country they are located in such as europeanbrokermeeting.com (The Broker Site BV, n.d. b). Other sources of information that were searched comprised official Swedish databases on social enterprises and NGOs as well as newspaper articles and tech- as well as computer-related websites. The contact to two organisations was established via researchers at the International Institute for Industrial Environmental Economics in Lund. After this initial assessment, snowball sampling was applied when conducting interviews with

[22] Two programs that Microsoft offers to computer reuse organisations. In doing so the organisations are allowed to preinstall "genuine Microsoft software" (Microsoft, n.d. b, para. 1) on refurbished computers before selling them. The MAR targets larger computer reuse organisations which deliver on average at least 1,000 computers per month while the MRR focuses on smaller computer reuse organisations which are only allowed to sell "to local consumers and businesses, as well as qualified charitable organisations, academic users, and specially approved recipients" (Microsoft, n.d. b, para 5.).

[23] While searching the MRR database it became obvious that many organisations/companies listed were no longer involved in computer refurbishing processes due to a change in their business offer or having shut down in the meantime.

representatives of initially identified computer reuse organisations – in order to identify further suitable organisations and interview partners.

A total number of 16 organisations met the defined criteria. Interview partners were either managing the overall operations of an organisation (e.g. CEOs/managing director) or holding positions in which they would manage specific single computer reuse activities (e.g. remarketing managers). The initial contact with the person was established via the phone or by sending an email depending on the reachability of the person of interest. Representatives of 12 organisations agreed to take part in the research and received the standardized interview guide with background information about the research and the questions 7 days before the respective interviews to allow for preparation[24]. Eventually, 9 interviews[25] were conducted[26] via the phone lasting between 60 minutes and 2.5 hours between June and October 2015.
During the interviews, the author used the interview guides depicted in Appendices V, VI and VII. All interviews with one exception were recorded and the key points transcribed.

Table 3-1. List of the interviewed partners and for each the respective type of computer reuse organisation.

Position of interview partner	**Type of Organisation**	**Type of Organisation's Operating Model**
Sustainability Manager	Computer/IT Refurbishing Company	IT Asset Management
Head of IT Recovery Sales		
Senior Account Manager	Computer/IT Refurbishing Company	IT Asset Management
Managing Director and Board Member	Computer/IT Refurbishing Company	IT Asset Management
SECC (Safety, Environment, Community, CSR) Manager	Recycling Company also offering Computer/IT refurbishing services	IT Asset Management
Managing Director	Computer/IT Refurbishing Company which also offers recycling services	IT Asset Management
Environmental Manager	Original Equipment Manufacturer (OEM) of computers and related equipment which also offers take back and refurbishing services for its own products but also other brands in Sweden. (Refurbishing does take place outside Sweden though)	IT Asset Management
Head of Administration/ Operations	Social enterprise/Non-profit organisation aiming to bring people with difficulties findings jobs back into the labour market through refurbishing and selling computers & offering cheap refurbished computers to poor/low income individuals and non-profit organisations.	Social Enterprise
Supervisor/Mentor/ Coach	Social enterprise/Non-profit organisation aiming to bring people with difficulties findings jobs back into the	Social Enterprise

[24] The standardized interview guide that was sent out to the interview partners can be found in Appendix V.

[25] After initially agreeing to take part in the interview, two persons representing two different organisations could not be reached at the time of the scheduled interview nor afterwards. In one case the person of interest could after having established a first contact not be reached anymore to book a time and date for an interview. As a result the total number of organisations that could be assessed via interviews shrank to nine.

[26] See Appendix VIII for a more a more detailed list of the assessed organisations and interview partners.

	labour market through refurbishing and selling computers & offering cheap refurbished computers to poor/low income individuals and non-profit organisations.	
Co-Founder & International Director	Non-profit organisation aiming to collect and refurbish used computers and other electronics and sending as well as selling them for reduced prices to humanitarian and non-profit causes/projects in less-developed countries in order to drive and support the technological development	Close the Digital Divide

As the author's knowledge about computer reuse organisations, the barriers they face in a Swedish context and their suppliers and receiving customers emerged with each conducted interview, so did new questions and issues. In order to clarify those and to foster understanding, 'background' interviews with several experts from different organisations and institutions were conducted including the Swedish Waste Management and Recycling Association ('AvfallSverige') as well as two researchers from the International Institute for Industrial Environmental Economics (IIIEE). For these interviews, no standardized interview guides were developed as they were intended to further foster the understanding of specific topics emerging from the research.

3.2.3 Document Analysis/Review

As a third source of data was the websites (and in few cases also documents provided by the interview partners) of the different computer reuse organisations which the interview partners represented. The organisations' websites and (if provided) documents were reviewed for further information regarding the criteria/dimensions that would allow to draw conclusions regarding the type of computer reuse organisations and furthermore for information regarding suppliers, receiving customers and barriers – in order to complement the information gained from the interviews and in order to support triangulation.

3.3 Data Analysis

In a first step the initial notes taken during the semi-structured in-depth interviews were supplemented by the transcription of key points during the rehearing process of the recordings. While no 'word for word' transcription was applied, all key points from the different interviews were duly noted in order to allow for the exploration of new information and to ensure no potentially relevant information would get lost.

In a second step, the identified organisations with whose representatives' interviews had been conducted were categorized according to the four, in the case of non-profit organisations five criteria/dimensions extracted from Kissling et al.'s (2012) typology as introduced in Chapter 2.3.2.

Lastly, the results for the types of suppliers and customers and the geographical location(s) of the market(s) were analysed searching for emerging patterns which would allow for the development of a basic typology as was also done for the identified barriers to computer reuse organisations in the Swedish context.

3.4 Research Framework

Based on the findings from literature in regard to the different research questions, a research framework was developed which has been illustrated in *Figure A IX-1* in Appendix IX. As starting point of the overall reverse logistics process serves the sub-process of acquisition. Here, the different types of suppliers as identified in literature have been added as 'sources of

input'. Likewise, the different types of receiving customers found in the publications discussed in Chapter 2.3.4 have been integrated subsequently to the reverse logistic sub-process of remarketing/redistribution.
Furthermore, the different barriers derived from literature and outlined in Chapter 2.3.5 have been assigned to the different sub-processes along the overall reverse logistics process. Due to several barriers which have been researched specifically in regard to so-called socio-economic enterprises or non-profit organisations, separate lists of barriers for commercial and non-profit actors have been developed where differences occur.

Categories of barriers which could not be allocated to any of the reverse logistics sub-processes, such as legislative or cost-related ones have been illustrated separately from the process scheme.

Based on the findings from literature which suggest a distinction between commercial and non-profit computer reuse organisations as well as based on the developed research framework, two different interview guides emerged. These are found in Appendices VI and VII.

4 Findings

In the following, the findings of the conducted research are presented. While these provide an overview about what answers the research offers to the research questions posed in Chapter 1.3, they are generally not discussed any further. Discussions on the findings that answer the different research questions are provided in Chapter 5. The information presented in the following chapters stems mainly from the conducted interviews but also contains data from the respective assessed organisations' websites and documents (such as information brochures). In order to preserve the anonymity of the interview partners and the organisations they represent, it was decided to abstain from providing these websites and documents as sources.

4.1 Types of Computer Reuse Organisations

In order to categorize/typify the different computer reuse organisations existing in Sweden and thus to be able to answer research question 1a: 'What types of organisations are engaged in reuse activities of desktop computers and notebooks in Sweden?', the following four, respectively five criteria/dimensions suggested by Kissling et al. (2012) and introduced in Chapter 2.3.2 were applied to the nine organisations being part of this study: *finances*, *(business) offerings*, *supply chain*, *(receiving) customers* and *primary aim/purpose* (in the case of the non-profit organisations).

The results suggest that all three types of operating models identified in literature are currently present in the Swedish context. Overall, six of the organisations can be classified as operating under an IT Asset Management model, two as having a Social Enterprise operating model and one operating under a Close the Digital Divide model. Nevertheless, in several cases some overlapping between the different operating models could be observed.

In the following, the general features of the assessed organisations are presented for each type of identified operating model in regard to the four, respectively five criteria mentioned above.

4.1.1 Organisations with IT Asset Management Operating Model

All organisations of this type were found to be for-profit organisations in form of companies. Nevertheless, there are some differences between them. While four were pure computer and ICT reuse companies, one was a recycling company that also offers ICT[27] reuse activities and one was a multinational OEM[28] which also offers computer and ICT reuse activities. In total, three of the organisations were part of international enterprises through which the latter were serving the Swedish market. Furthermore, two companies had the centralized preparation for reuse facilities located outside Sweden. The differences also become obvious looking at general figures and the *finance dimension*. The number of employees[29] varies between 18 and 80 which handle on average between 45,000 and 250,000 units per year leading to a turnover of 40 to 300 million SEK.

The *(business) offerings* of CROs with an ITAM operating model in the Swedish context typically comprise of the collection of used computers (and other ICT equipment) together with inventory tracking from the point of collection, inspection, cleaning and testing as well as data

[27] ICT equipment refers here to servers, displays, tablets, mobiles but also networking equipment such as routers or switches.

[28] The interview partner representing this company did not want to/could not provide any figures for the Swedish market specifically, thus the figures presented in regard to the finance dimension do not include this company.

[29] In the case of the multinational enterprises, only the figures of the Swedish branches were considered.

destruction (either through wiping software, degaussing or mechanical destruction of the complete hard drive leaving it unsuitable for reuse). Furthermore, organisations with an ITAM operating model typically also offer reports and certificates to the suppliers, proving the secure deletion of data/destruction of hard drives. In some cases reports are even provided regarding the further reuse of the supplied used computers or its components/parts in case the computer cannot profitably be prepared for reuse and resold.
Furthermore, the business offer includes the installation of a new operating system (mostly Microsoft Windows 7) and other software as well as remarketing and redistribution of the refurbished computers. In many cases, CROs also sell new software (such as the Microsoft Office package) together with the refurbished computers. One organisation was also found to (re-)sell single parts and components (new and used).

In addition, after-sales services are usually offered in the form of warranties lasting between 1 and 3 years. Regarding the computers and other equipment that are erroneous and/or unprofitable to resell, they also offer recycling services (either by themselves or through external partners).
In regard to the researched OEM, the suppliers of used computers are offered a share of the profit from reselling the refurbished computers or alternatively a discount on new computers/ICT equipment of the same brand.

Other business offers aside of the traditional activities include the pre-configuration and installation of hard- and software to new computers which are then shipped to suppliers and exchanged against the (old) used computers. Often, this seems to happen in cooperation with OEMs which contract the CROs for these services as well as the common refurbishing and remarketing/redistribution activities.
Linked to such activities are also offerings to securely store an extra (over-)stock of the same types of computers for the end-users which can be used in case one of the computers in use fails.
Furthermore, several of the commercial computer reuse organisations in Sweden offer rental services of refurbished computers if a customer is in need of one for a shorter term.
The assessed OEM was also found to provide analyses of the existing infrastructure at (potential) customers' facilities and to develop plans about which used computers, networking equipment, etc. should be deployed.

The *supply* of used computers was found to mainly stem from commercial (corporate) users but also from public ones who either sell the equipment to the computer reuse organisations ('buyback') or contract them for refurbishing and remarketing purposes later sharing the profit from the (re-)sales ('revenue split'/'profit share'). In other cases, the suppliers contract the CROs for preparation for reuse purposes and remarketing/reselling the refurbished computers to their employees ('staff buyout'). Several computer reuse organisations were also contracted by OEMs to offer take back services of used computers from the former's customers. In another case OEMs and retailers functioned as suppliers via selling factory and distribution overstock to one of the CROs.
Furthermore, leasing companies were found to serve as suppliers as well. Cooperations with CROs allow them to offer reduced leasing fees to their customers as they can already factor in the profit from reselling the used computers once refurbished.
One computer reuse organisation also offered a specific donation program where used computers would be handed over to an NGO after having been prepared for reuse. While only one assessed organisation would source from non-commercial organisations, individuals/private persons were not found to contribute to the supply.
The supply chain structure and the different types of suppliers are assessed in more detail in Chapter 4.2.1.

When turning to the *(receiving) customers*, retailers/resellers, redistributors and brokers (mostly located abroad) account for the biggest part. In regard to domestic sales, commercial and public (corporate) organisations, non-commercial organisations as well as individuals/private persons were identified as receiving customers. Schools especially seem to be an important type of customer to Swedish CROs with ITAM operating model. As mentioned earlier, at least in one case, used computers were also donated to eligible recipients as part of a donation program.
A detailed assessment of the (receiving) customer structure can be found in Chapter 4.3.1.

4.1.2 Organisations with Social Enterprise Operating Model

The *purpose* of organisations with a social enterprise model was in the Swedish context found to be two-fold. On the one hand it aims at providing individuals who have been diagnosed with a psychological condition and thus been away from the job market for a longer period of time and find it hard to be re-integrated into it, with meaningful work while helping them with rehabilitation. On the other hand, such organisations also aim to provide training/educational possibilities with the aim to help reintegrate individuals into the job market.

In terms of the *finance* dimension, both assessed organisations were found to be non-profits ('ideella förening') which are run in form of a social enterprise where profit maximization is not the main goal. In fact, they are both financially supported by the respective municipalities which compensate for the salaries of the therapists/work instructors ('arbetstränare'). In one case the municipality also provides the facilities.
Both organisations were found to currently have five employees as part of the therapeutic program plus the work instructor himself. The average number of yearly units handled is 100 to 200 with a turnover of about 20,000 and 25,000 SEK[30]. The total turnover is somewhat higher as both organisations were (besides the computer reuse related branch) also manufacturing and selling handcrafted items such as décor from glass fusing, wooden frames for pictures and other things but also jewellery made out of computer scrap.

Nevertheless, the computer reuse-related *business offer* comprises the collection of used computers (from companies and individuals alike), the cleaning and testing of the same as well as the exchange of faulty parts if necessary. Differences occur in regard to data sanitation – while one organisation conducts data wiping, the other follows an internal policy demanding that all received hard drives need to be scrapped and new hard drives built in. The offerings further include the installation of an operating system (mostly Microsoft Windows 7[31]) as well as remarketing and redistribution of computers prepared for reuse and after-sales services. The latter includes a warranty (usually 6 months) and phone support for three months.
In addition, recycling and disposal services are also offered in partnership with external specialized companies.
Besides preparation of used computers for reuse, one organisation also offered repair services for computers as well as help with installing new operating systems and additional software together with error diagnostics related to faulty components and viruses. In addition, the conduction of hardware upgrades and data recovery services are offered.
The second organisation is planning to also offer study circles for people who are lacking

[30] While this number seems low compared to the overall number of units handled, not all of the computers which are prepared for reuse seem also to be resold or were found to be resold at comparably low prices such as 250 SEK per computer.

[31] Both assessed computer reuse organisations with a social enterprise model were found to either be a Microsoft Accredited Refurbisher (MAR) or Microsoft Registered Refurbisher (MRR). See chapter 3.2.2 for further explanations.

experience in operating computers and furthermore aims to provide website programming services.

In regard to the *supply chain* the public (corporate) users/organisations were identified as the most important suppliers – specifically municipalities and schools. While CROs with a Social Enterprise operating model also receive used computers from commercial (corporate) users/organisation as well as from individuals, these seem to play a comparably small role in the overall supply. The types of suppliers and the structure of the supply chain in general is analysed in detail in Chapter 4.2.2.

As main *(receiving) customers* non-commercial organisations and individuals/private persons were found with the latter outweighing the former. The focus is specifically on persons with restricted access to computers due to certain reasons such as a bad economy or a health condition. A comprehensive and detailed assessment is provided in Chapter 4.3.2.

4.1.3 Organisations with Close the Digital Divide Operating Model

In regard to the organisational form and the *finances* dimension, like the before presented CROs with a Social Enterprise operating model is the one operating under a Close the Digital Divide operating model also organized in form of a non-profit organisation ('ideell förening'). Currently, three people are working for this organisation on average handling about 5,500 units[32] per year with a turnover of up to 200,000 SEK. While one of the three people working for the organisation is doing so in his spare time and is not paid for his work, the remaining two persons are part of the Swedish rehabilitation program which aims at reintegrating people back into the job market and are thus receiving their monthly salary from the Swedish state.

In contrast to CROs with a social enterprise orientation the *purpose* of the assessed CtDD organisation is to prolong the lifetime of obsolete computers (and in doing so reduce the environmental impacts) in helping to drive technological development in less-developed countries and regions of the world – either by providing people with further opportunities for (digital and other) education (for example in schools) or by supporting the development of (administrational) infrastructure, such as in hospitals. Of specific importance is the educational part as people shall be empowered through the reuse of computers.

The *business offer* of the assessed computer reuse organisation with a Close the Digital Divide operating model reaches from the collection of used computers via inventory tracking, cleaning, testing and data wiping as well as the exchange of erroneous parts and components to remarketing and redistribution. Before the computers are resold, usually Linux (Ubuntu) is installed as operating system. In regard to data wiping, the organisation also offers to do this for customers onsite before shipping the acquired computers to the CRO's facilities. While the possibility of providing donating suppliers with certificates and reports regarding the data wiping process exists, this is only done when requested by a supplier and brings an extra fee with it which is paid to the company that developed the data wiping software. Certificates identifying the suppliers as donators are provided by the CRO without reimbursement though. In addition, information about in which locations and projects the donated computers are eventually being reused is also provided by the CRO. Furthermore, recycling of components and/or parts and computers which cannot be reused anymore is also offered in cooperation with an external recycling company.

[32] Besides computers, the organisation also handles other ICT equipment like tablets, mobiles, networking equipment, printers or copiers.

The *supply chain* of the assessed computer reuse organisation with a CtDD operating model consists of commercial and public (corporate) organisations as well as non-commercial ones and individuals/private persons. In regard to the public (corporate) organisations, public administration institutions and educational facilities such as schools play major roles. While the corporate ones together account for more than 90% of the total supply, the roles of individuals/private persons and non-commercial organisations are currently comparably small. While still in trial phase, the assessed organisation was also found to source from a public waste collection point. An in-depth assessment of the supply structure and the types of suppliers is provided in Chapter 4.2.3.

Turning to *(receiving) customers*, these can be differentiated into the ones abroad and the ones within Sweden. Customers from abroad are in all cases non-commercial organisations, such as NGOs usually putting the computers into practice in educational and medical projects such as schools or hospitals or use the acquired used computers themselves internally. In regard to domestic sales, the computers are usually also sold to non-commercial organisations to be found providing either integration classes for immigrants or helping individuals with psychological conditions such as OCD reintegrate into the job market. The domestic market has only recently started to be served. A detailed analysis is conducted in Chapter 4.3.3.

4.2 Types of Suppliers of Computer Reuse Organisations in Sweden

The following two sub-chapters on the types of suppliers (4.2) and receiving customers (4.3) of organisations engaged in computer reuse refer to and try to answer research question 1b and 1c from Chapter 1.3 which had been phrased as: 'What types of actors function as suppliers to and receivers/receiving customers of used computers and computers prepared for reuse of such computer reuse organisations?' and as 'How big is the share of the organisations' sold desktop computers and laptops that is reused in Sweden compared to the share that is exported?'.

In general, the findings suggest a distinction between four different types of suppliers, namely commercial (corporate) organisations, public (corporate) organisations, non-commercial ones as well as individuals/private persons. The composition of these types of suppliers as part of the overall supply structure was found to differ between organisations with a certain type of (main) operating model[33]. Similarly, partly different sub-types of suppliers emerged in the analysis process. Thus it was decided to describe the findings for each type of the three identified (main) operating models applied by organisations engaged in computer reuse in Sweden separately also incorporating the findings to research question 1c in the following.

4.2.1 Types of Suppliers of Computer Reuse Organisations with IT Asset Management Operating Model

Before going into detail about the types of suppliers to computer reuse organisations operating under an IT asset management operating model it seems important to provide two facts about the computers which the mentioned organisations receive from the different types of suppliers.
Firstly, the interview partners stated that the average age of the supplied computers usually lies between two and four years. In certain cases this value can go up to seven or eight years, for example when looking at very specific machines. Secondly, 66.7% of the interview partners estimated the reuse rate of these received computers to lie between 90 and 95%. Only in the

[33] As stated by Kissling et al. (2012), organisations do often not only operate one specific operating model but may run several thus causing overlaps.

case of one organisation, the reuse rate was estimated marginally lower, namely at 80 to 90% while another interview partner did not provide any information.

Looking back to answer the actual research question and thus at the types of suppliers, a first distinction based on the location of the respective suppliers needs to be made. These can be Sweden-based ones and others being located outside Sweden.
In regard to the domestic ones it was found that they account for between 85 and 90% of the total supplied volume of computers for reuse of the respective computer/ICT reuse organisations.
The remaining 10 to 15% of the received supply stem from outside Sweden. Here, the picture becomes somewhat more diverse. Identified countries and regions that play a role outside the domestic Swedish market are especially the three Nordic countries of Denmark, Finland and Norway which were mentioned by three interview partners, while a total of four stated that they would source from within Europe in general. Representatives of two ITAM reuse organisations mentioned that they would not only source within the Nordics or Europe but worldwide.

After this first geo-based distinction has been made, the types of suppliers of computers for reuse can now be differentiated in more detail. In regard to the domestic suppliers, three main groups could be identified, namely commercial (corporate) organisations, public (corporate) organisations as well as non-commercial ones.

Commercial (Corporate) Organisations

All interview partners stated to source from commercial (corporate) organisations. While the research also aimed at identifying specific sub-types/-groups within the main groups of suppliers, no clear sub-groups emerged from the collected data in the case of the supplying commercial (corporate) organisations. Instead the data covers a broad range of organisations spanning from IT (service) (and) leasing companies over private schools (so-called 'friskolor') to OEMs and companies in general operating in a variety of industries such as food or human resources making it hard to provide a detailed overview. Thus, *Figure 4-1* provides instead an overview about the different sub-types of commercial (corporate) organisations acting as suppliers to computer/ICT reuse organisations and the respective number of mentions as stated by the interview partners and/or found on the organisations' respective websites and/or official company documents (such as brochures or case studies).

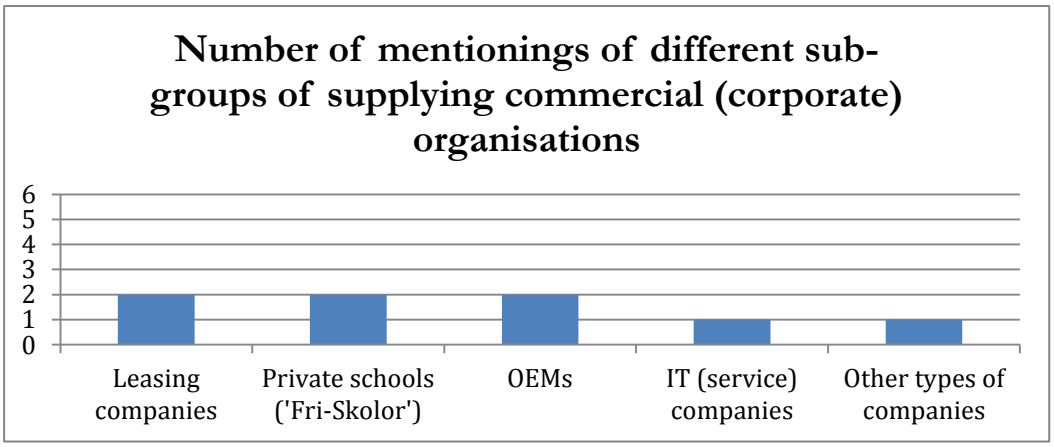

Figure 4-1. Number of mentionings of different sub-groups of supplying commercial (corporate) organisations

Source: Own illustration of the results from websites and documents as well as interviews with representatives of the assessed organisations engaged in computer reuse in Sweden.

The only comprehensive feature of such supplying commercial organisations seems to be their size as 83.3% of the interview partners stated that they would receive their input of used computers from mainly large commercial organisations.

Public (Corporate) Organisations

Similar to the commercial (corporate) organisations, the interview partners from all organisations with an ITAM operating model mentioned public (corporate) organisations as suppliers. In contrast to the commercial (corporate) organisations as suppliers, several sub-types of public (corporate) organisations emerged from the data retrieved through interviews, websites and documents of the reuse organisations with an IT asset management operating model.

As the biggest single sub-group of suppliers, public administration institutions from all levels could be identified, spanning from municipalities/cities via *Lanstings* and *Regions* to government agencies and state organisations such as the Swedish International Development Cooperation Agency (SIDA). This sub-type/-group was found to function as supplier for 83.3% of the assessed computer/ICT reuse organisations with an ITAM operating model.

Furthermore, educational facilities consisting of universities and public schools were found to be an important source of used computers for reuse organisations with this type of operating model as it was mentioned by or found on the website/in documents in 66.7% of the relevant six cases.

Another identified sub-group/-type within the general supplier type of public (corporate) organisations were medical institutions (hospitals) for which 50% of the reuse organisations with an ITAM operating model were found to receive supply from.

Non-Commercial Organisations

While the interviewed representatives of all organisations with an ITAM operating model said that their respective organisation would source from commercial and public (corporate) organisations such as a companies or public authorities, only one interview partner stated that his organisation would also receive computers from non-commercial organisations. Nevertheless, no specific information was provided that would allow for identifying specific sub-groups[34].

Non-Domestic Suppliers

When sourcing from abroad, the Swedish computer/ICT reuse organisations get their supply from two different sub-groups of commercial (corporate) organisations, namely from so-called brokers or distributors/resellers. While brokers mainly conciliate between different parties interested in selling and/or buying, the resellers seem typically to be computer/ICT reuse organisations themselves based in countries outside Sweden which sell computers prepared for reuse (partly also for refurbishing) to end-customers (such as commercial (corporate) organisations or individuals) or other computer/ICT reuse organisations (see e.g. Williams & Kuehr, 2003; Kissling et al., 2013). Both sub-groups have been confirmed for 83.3% (or 5 out of 6) of the researched reuse organisations with an operational focus on the IT asset management operating model.

[34] Besides this fact, the generalizability of the findings based on only one out of 6 assessed organisations would be questionable.

Share between Main Types of Suppliers

In order to get a better picture of the structure of the supply market, it was attempted to assess the shares between the different general/main types of suppliers. Unfortunately, only three of six interview partners could/did provide information on this. Nevertheless, all three distinguished between commercial and public (corporate) organisations pointing out the importance of these two main types of suppliers. The answers from the three interviewees stagger into three stages from 80% of the supply stemming from the commercial sector and 20% from the public one via 70% versus 30% to 60% versus 40%.
Thus, despite the figures having to be seen as educated guesses (as some of the interview partners pointed out themselves) they do show a tendency towards the private sector.

4.2.2 Types of Suppliers of Computer Reuse Organisations with Social Enterprise Operating Model

Turning from commercial (profit-oriented) computer reuse organisations to non-profit ones, and specifically those with a social enterprise operating model the first differences become apparent when assessing the average age of the sourced computers. With between four and six years, it is approximately two years higher than that of computers sourced by for-profit organisations. A less clear cut picture emerges regarding the reuse rates of the computers. While one interview partner estimated it at about 90%, the second one estimated his guess at 75% (thus being significantly lower as the figures for for-profit organisations).

Another difference to the organisations performing computer reuse activities commercially, are the sources of supply. While the former source beyond the borders of Sweden, both computer reuse organisations with a social enterprise model were found to source solely domestically. In this context, commercial (corporate) organisations, public (corporate) organisations as well as individuals/private persons were identified as types of suppliers with the latter two seeming to be the main sources of supply.

Commercial (Corporate) Organisations

While both assessed organisations were found to receive supply from companies, no specific sub-types emerged but this main type of suppliers was just described as companies in general by both interview partners. The only specification made by one interview partner was private schools ('friskolor').

Public (Corporate) Organisations

In contrast, public (corporate) organisations seem to substantially contribute to the overall volume of used computers received by social reuse enterprises. For one organisation it constitutes the biggest single category of suppliers. In regard to sub-types, both interview partners mentioned public administration institutions, specifically *municipalities*. Institutions on other administrational levels or state agencies or organisations seem not to play a role for both assessed reuse organisations.
50% of the interview partners stated that they would also receive used computers from public schools while – in contrast to organisations with an ITAM operating model – medical institutions seem not to play a role in terms of supply.

Individuals / Private Persons

As another main type of suppliers, individuals/private persons could be identified from whom both interview partners stated to receive used computers for refurbishment. Here, differences between both organisations occurred only regarding the collection process. While in the case of one organisation, individuals usually drop off the computers at the social enterprise's office, the second organisation stated to partly also pick used computers up from private persons'.

Share between Main Types of Suppliers

While public (corporate) organisations and individuals/private persons seem to account for the biggest part of the supply with used computers, significant differences occur between both assessed organisations.

One interview partner did/could not provide any detailed information nor did want to provide an educated guess regarding the share for which the different main types of suppliers would account but did state that the organisation he is working for receives the majority of its supply from individuals/private persons while public and private (corporate) organisations (specifically municipalities) would account for the rest.

The second interviewed person did provide an estimated guess as no precise figures were available either which points out the importance of the public sector as source of supply for this specific social enterprise: accordingly, 40% of the supply stems from municipalities and another 40% from public schools while the remaining 20% are received from companies on the one hand and individuals/private persons on the other hand.

Based on this information, it can be stated that the supply situation seems to differ between different computer reuse organisations with a social enterprise model. Nevertheless, the findings suggest that the importance of the private sector seems currently negligible.

4.2.3 Types of Suppliers of Computer Reuse Organisations with Close the Digital Divide Operating Model

When assessing the supply situation for the second type of non-profit reuse organisations, the average age of the received computers approximates between 2.5 and 3 years with a reuse rate of 95-98%.

In regard to the geographical aspect of sourcing, an estimated 98 to 99% of the received computers are donated from suppliers located within Sweden. The remaining 1 to 2% usually stem from the Nordics as well as other Central- and Western-European countries including but not exclusively Austria, Belgium, France, Germany, the Netherlands, Luxemburg and Switzerland. Here, basically all received computers stem from commercial companies.
When turning to the main types of suppliers of reuse organisations with a Close the Digital Divide operating model, commercial and private (corporate) organisations as well as non-commercial organisations and individuals/private people could be identified with the private sector playing a central role.

Commercial (Corporate) Organisations

While these types of organisations were found to account for the majority of the volume of donated computers for reuse, no specific sub-groups/-types could be identified. Instead, the suppliers represent a broad variety of industries and organisational sizes. Only *leasing companies* were specifically mentioned by the interviewee – to not act as suppliers yet.

Public (Corporate) Organisations

Public (corporate) organisations were also found to account for a substantial amount of the overall supply with used computers. Identified sub-types comprise public administration institutions from all levels from municipalities via so-called *Läns*, *Lanstings* and *Regions* up to state agencies and organisations. Furthermore, educational facilities, specifically schools and universities were identified as a second sub-type of public (corporate) organisations. Thirdly,

the assessed reuse organisation was also found to cooperate with a so-called *kretsloppspark*[35] in a major Swedish city as part of an on-going pilot project.

Non-Commercial Organisations

While the interview partner mentioned church-related organisations as donating non-commercial organisations, they play only a marginal role in the supply of the assessed computer reuse organisation. This also becomes obvious when looking at the shares between the different types of suppliers as part of the overall volume of received computers for reuse where non-commercial organisations are not being mentioned as a single entity by the interviewee.

Individuals / Private Persons

Another identified type of suppliers are individuals/private persons donating their used computers but which seem to account for only a comparably small amount of the total volume of computers received by the assessed CtDD reuse organisation as the figures in the following chapter suggests.

Share between Main Types of Suppliers

Based on the interview with the representative of the assessed computer reuse organisation with a Close the Digital Divide operating model, private sector organisations emerge as the single biggest type of suppliers accounting for about 60% of the total amount received. Although still responsible for roughly one-third (32-35%) of the donated used computers, the contribution of the public (corporate) sector with its administrational institutions and state agencies is rather small when compared to the private sector. While individuals/private persons account for the other 5-8%, the share of non-commercial organisations has to be seen as negligible as the interview partner did not provide specific figures for this supplier type. Similarly, no figures are provided for supply stemming from circularity parks/(e-)waste collection points as the mentioned trials had started only about 1 to 2 months before the interview was conducted.

What these findings regarding the supply structure and the different types of suppliers mean for the praxis as well as hitherto knowledge and future research is discussed in Chapter 5. But before, the next two main chapters present the results in regard to the identified types of receiving customers of the different types of computer reuse organisations as well as the barriers which such reuse organisations in Sweden were found to face in their operations.

4.3 Types of Receiving Customers of Computer Reuse Organisations in Sweden

Similar to the findings regarding the types of suppliers of CROs, it also became obvious during the analysis process that the types of receiving customers varied for the different (main) operating models of computer reuse organisations. Thus, the findings are in the following also presented separately for each type of operating model as defined by Kissling et al. (2012) and introduced in Chapter 2.3.2.

[35] A kretsloppspark (Swedish for 'circularity park') in the Swedish context consists usually of a regular waste collection and recycling station but futhrmore offers people the possibility to donate things for reuse if they want to do so and consider them to still be reusable (Ljunggren Söderman, Palm & Rydberg, 2011).

4.3.1 Types of Receiving Customers of Computer Reuse Organisations with IT Asset Management Operating Model

Before presenting the findings regarding the types of receiving customers of reuse organisations with an ITAM operating model it needs to be pointed out that those findings base on the data from five of the six assessed and interviewed organisations. In the case of the sixth one, the interview partner could not provide any data as the computers, once refurbished, are shipped to another company-owned facility outside Sweden which takes care of the remarketing/redistribution.

Receiving customers of CROs with an IT Asset Management operating model can generally be divided into those located outside Sweden and those based within. Four of the interview partners were able and did want to provide educated guesses or specific figures regarding the sales shares within Sweden and abroad. While in three cases the majority of the used computers are sold to customers abroad (respectively 90%, 85%, 70%), only one interview partner stated that his company would sell about 90% of the computers sourced within Sweden again domestically after having them prepared for reuse.
Looking at the destination regions, Eastern, Western and Central Europe seem to be the most important ones. While the majority of the single mentioned countries are located in the Western part of Europe such as the UK (mentioned by 3 interview partners), the Netherlands (2) and Germany (2) which indeed seem to be big markets for used computers (and ICT equipment) – the biggest volume of used computers seems to be sold to Eastern European states (including the Baltics). Besides the three mentioned countries above, interview partners also referred to Poland (1), Norway (1) and Finland (1) although the two Nordics seem to account for only a small amount of the total sales. As the only country outside of Europe, Dubai got mentioned once.

Non-Domestic Receiving Customers

Three different types of receiving customers emerged when computers were sold abroad. Four of the interview partners stated that they would sell to resellers/redistributors in other countries which would then usually resell the used computers to end-customers. Two mentioned that they would also sell the used computers to/via brokers which would buy and resell them to other resellers/redistributors/retailers or computer reuse organisations or to end-customers. In addition, one of the assessed commercial computer reuse organisations was found to also sell to another refurbishing company abroad.

While one interview partner mentioned that his company would sometimes also sell directly to end-customers in other countries such as schools or government organisations, this seems to be a very rare exception – even in the praxis of his company. Thus, it remains almost impossible to say which end-users redeploy the refurbished computers.

In contrast to this, four main types of receiving customers could be identified for the Swedish domestic market, namely: commercial and public (corporate) organisations, non-commercial organisations and individuals/private persons.

Commercial (Corporate) Organisations

Five of the six assessed companies were found to sell used computers to commercial (corporate) organisations within Sweden. Two specific sub-types of such private sector organisations could be identified, namely private schools ('friskolor') as well as resellers/retailers selling the used computers further to end-customers. Both categories were mentioned by 60% of the interview partners that did provide data. In regard to the resellers it should be mentioned though that the representative of one assessed situation stated that his

company would not sell to such resellers/retailers within Sweden as this would lead to increased competition within the home market.
Otherwise, although about 65% of the interviewees stated that they would sell to companies, no specific industry or company category emerged (besides the retailers). Surprisingly IT-companies were mentioned as customers by only one interview partner.

Public (Corporate) Organisations

In regard to the public sector 83.3% of the researched computer reuse organisations with an ITAM operating model were found to serve it with used computers. Furthermore, two sub-types emerged: on the one hand, public administration institutions on all levels (from municipalities to *landsting* (regional public administration organisation in Sweden) as well as state agencies and organisations (80% of the ITAM organisations that provided data). Especially municipalities seem to play an important role as they were mentioned by three of the five commercial computer reuse organisations with detailed data. On the other hand did 60% of the same pool of interview partners mention that their company would sell to educational facilities, specifically to public schools.

Non-Commercial Organisations

Representatives of only two commercial computer reuse organisations stated that they had non-profit organisations among their receiving customers. With one of the organisations, this is part of an offered donation program, where commercial and other types of organisations can donate obsolete computers and other ICT equipment. After the former is refurbished it is eventually handed over to partnering non-profit/non-commercial organisations for reuse.

Individuals/Private Persons

Three of the five computer reuse organisations with an ITAM model that could provide more data on their receiving customer structure were found to sell to individuals/private persons. This usually happens by means of online shops run by the respective computer reuse organisations. Interestingly, one of the interviewees pointed out that his organisation would not sell to individuals/private persons in order to avoid entering in competition with some of their receiving customers who act as resellers to individuals/private persons within Sweden.

Share between Main Types of Receiving Customers

In terms of shares between the different identified main types of receiving customers located in Sweden, combined data was only provided by two of the assessed organisations.
In both cases, schools (private and public combined) made up 50, respectively 75% of the total sales of used computers in Sweden. One of the two organisations stated to currently serve around 600 schools country-wide. Unfortunately no details were provided regarding the shares between private and public schools. Nevertheless do the statements of several interview partners point into the direction of private schools currently contributing with a bigger share.

Although specific figures were available for schools, data become less comparable when turning to and trying to distinguish the private and public sector in general. While one of both commercial organisations stated that companies would account for about 20% of their domestic sales, the representative of the second computer reuse organisation could only provide a figure for both sectors (private & public) combined – namely to account for about 50% of the sales in Sweden.

Turning to individuals/private people only one of the two mentioned organisations that provided somewhat differentiated data provided a figure about their sales to private people, which would account for 5%. Therefore did a third of the organisations with an ITAM

operating model provide data only for individuals but not for any other type of receiving customers, stating that roughly 20% of the used computers resold in Sweden would go to private people.

While the collected data regarding the shares between different types of receiving customers in Sweden is unfortunately not very uniform, one trend is visible: schools seem to currently be an or even the most important group of customers that stands out potentially leading the way to increased reuse of computers in other organisations of the commercial and public sector.

4.3.2 Types of Receiving Customers of Computer Reuse Organisations with Social Enterprise Operating Model

In contrast to the commercially operating computer reuse organisations, both assessed non-profit ones with a social enterprise operating model were found to solely sell the refurbished computers within Sweden but not abroad.

In this context, non-commercial organisations and individuals/private persons emerged as the two main types of receiving customers whereas commercial and public (corporate) organisations were not found to be receiving customers of computer reuse organisations with a Social Enterprise operating model.

Non-Commercial Organisations

Both interview partners representing the two respective assessed computer reuse organisations stated that they would sell the computers to non-profit organisations once refurbished. In regard to sub-types of non-commercial organisations, no specific work areas could be identified but seem to comprise almost all sorts of non-profit organisations.

Individuals/Private Persons

Individuals or private persons seem to form the bigger of the two groups of receiving customers and were mentioned to be receiving customers by 100% of the interviewees representing social computer reuse enterprises. Such social enterprises are not in all cases (allowed to) selling refurbished computers to all types of individuals/private persons. The latter are only eligible when fulfilling certain premises such as restricted access to computers due to certain circumstances or situations. – For example due to a bad economic situation or health condition as might be the case with some pensioners, people relying on social welfare, long-term sick or disabled people as well as students.

Share between Main Types of Receiving Customers

Unfortunately, only one of the two assessed social enterprises did provide data – and only in form of an educated guess as detailed data was not available. The results suggest though, that individuals/private persons are the most important customer group accounting for 75% of the total sales volume while non-commercial organisations make up for the remaining 25%.

4.3.3 Types of Receiving Customers of Computer Reuse Organisations with Close the Digital Divide Operating Model

The assessed organisation with a Digital Divide operating model was found to sell its refurbished computers not only to customers abroad (roughly 99.5%) but also to such based in Sweden (around 0.5%). The main world regions served comprise the African continent, the Middle East region as well as Central Asia. The interview partner pointed out though, that the sales program for domestic customers had only been launched about 3 to 4 months prior to the interview but would already have succeeded the expectations with circa 150 computers

having been ordered in the same period of time. He expects this figure and the share of domestic sales to increase significantly in the future.

During research, only one main type of receiving customer emerged in regard to the sales abroad but also to the domestic ones: non-commercial organisations. Neither commercial and public (corporate) organisations nor individuals/private persons were found to be receiving customers in either of the cases.

Non-Domestic Non-Commercial Organisations

When sold abroad, used computers are typically sold to non-commercial organisations such as NGOs or NPOs. These include the purchased machines then in their projects which they might implement either themselves or in cooperation with public (corporate) organisations in the destined (typically less-developed) country.

The projects can be grouped into two sub-categories, namely educational (about 60%) and health care-related (roughly 40%) ones. While the former usually stands for plain schools, it also included one project where the basics of entrepreneurship were taught (also by means of computers) and the participants could acquire the computers after having finished the courses. The other projects focusing on health-care were in most cases said to be hospitals where the used computers typically serve administrational purposes.

In order to prevent misuse of the comparably cheap used computers, the assessed computer reuse organisation demands in the case of a request for used computers always a project description.

In most cases the assessed CtDD organisation partnered only with organisations based in Sweden or wider Europe in order to be able to check if these requesting organisations are actually legal and to further reduce chances for misuse of delivered computers – but also to follow up on the further development of the actual project in which the computers are used. Additionally, the reuse organisation always demands a project description when a request for purchasing used computers from them is posed.

Domestic Non-Commercial Organisations

The same organisations which are implementing the before mentioned projects abroad might in cases also purchase used computers from the CtDD organisation for their own use (then in Sweden (or respectively their office(s) within wider Europe).

Besides this type of organisations, three other non-commercial organisations based in Sweden were identified. According to their focus of work, they can be distinguished into two sub-categories: one of the organisations works with individuals with psychological issues including such as OCD with the aim to help them integrate into the regular job market. The remaining two organisations were both stated to work in the immigration sector where they try to help people with integration into the Swedish society – not only via language courses but also in terms of understanding the culture.

Taking the on-going migration to Europe/into the EU into account, the demand for used computers in the work of these non-commercial organisations might likely further increase in the near future.

4.4 Barriers to Computer Reuse Organisations

Turning from types of suppliers and receivers to the second research questions asking about the barriers, organisations involved in reuse activities of desktop computers and notebooks in Sweden are facing, the former can be divided into two main groups.
While some barriers seem to be general and occur across organisations with all respective types of operating models, certain barriers seem specific to organisations with a certain type of operating model. These are only very briefly mentioned separately in the following and will be described and discussed comprisingly in Chapters 5.1.1, 5.2.1, 5.3.1 and 5.4.1.

In order to consider a barrier (as found in the literature or discovered newly) as confirmed or negated for the Swedish context it was decided that a 2/3 (or 66.7%) majority of the assessed organisations would be needed. Regarding the general barriers, this figure was applied to the overall number of 9 assessed organisations while for the barriers related to a specific type of operating model, the respective number of assessed organisations (6 ITAM; 2 SE; 1 CtDD) was used as starting point.

In the case of new barriers (not found in literature) that were only mentioned by single interview partners, the former were grouped around the different identified types of operating models of the CROs and are presented in Chaper 4.4.5. They may serve as a basis for future studies in the Swedish or other context(s). Disconfirmed barriers are presented in Appendix XI split into generic ones spanning across all three types of operating models as well as specific ones inherent to respective single operating models.

4.4.1 General Barriers in the Swedish Context

In addition to the overall 66.7% majority as introduced above, it was decided that furthermore at least one organisation from each respective group of organisations attributed to one specific operating model had to confirm the barrier. If the same barriers were also found confirmed or negated as specific ones to organisations with one specific type of operating model, the barriers will in the respective chapter be mentioned as confirmed or negated but not further discussed as this has already been done in the chapter at hand.

(Lack of) Access to Sufficient Volumes of Used Equipment

The biggest general identified barrier in terms of agreement by the number of confirmations through interview partners (88.9%) was found to be the *(lack of) access to sufficient volumes of used equipment*. Only the assessed OEM also offering refurbishing services was not found to face this issue.

Suppliers' Concerns about Data Security

This barrier comprises several related single barriers found in literature, namely the *fear of unsecure data handling/deletion*, *the publicity regarding fraud and identity theft leading to a circumspect approach to the donation of (used) equipment* and that *companies are reluctant to pass products on for reuse because of concerns about data security*.
This was seen as a barrier by 77.8% of the assessed organisations. Only one representative of an ITAM and a SE computer reuse organisation each did not see this as a barrier.

Lack of Knowledge about Suitability of Used Computers for Needs of (Potential) Buyers

Overall, six of the nine organisations taking part in the study declared that potential buyers and especially consumers would not be able to judge or consider the suitability of used computers prepared for reuse when considering purchasing a computer. Only two

organisations with an ITAM and one with a SE operating model did either not find this as a barrier, respectively provide specific information.

4.4.2 Barriers to Computer Reuse Organisations with IT Asset Management Operating Model

The *lack of access to sufficient volumes of used equipment* and *customers' concerns about data security* were stated to be barriers by 83.3% of the assessed organisations with an ITAM operating model. While they have already been presented and described in the previous chapter, these shall not be looked at further in the current one. This also applies to *software licensing* which was not found to be a barrier for 4 of the 6 commercial reuse organisations. Further confirmed and abnegated barriers found for commercial reuse organisations in a Swedish context are presented in the following.

Lack of Legislation That Sets Financial Incentives for Reuse and Enforces Reuse

Similarly, five of the interview partners representing six commercial reuse organisations confirmed that the lack of legislation setting financial incentives for reuse and the enforcement of reuse are perceived as barriers to their organisations' operations.

Unpredictability in Supply / Lack of Transparency about Product Availability

Five of six interview partners confirmed that the *unpredictability in supply* and the *lack of transparency about the availability of used computers and equipment* would pose a barrier.

Market Demand for Used Computers

Two thirds of the assessed commercial organisations found the (lower) *market demand of used computers* to be a barrier. This was found to have several reasons.

Labour Costs

Overall, 66.7% of the assessed organisations were found to see labour costs as a barrier.
While several interview partners stated that computer and ICT-equipment reuse-related recovery activities would be work intensive, one interview partner pointed out that these activities could only be automated to a certain degree and would always require a certain amount of labour.

Variety of Different Standards and Lack of Global Reuse Standard with Clear Definitions

Representatives from four of the six assessed reuse organisations with an IT Asset Management operating model confirmed the variety of different standards and the lack of a global reuse standard with clear definitions as a barrier.

4.4.3 Barriers to Computer Reuse Organisations with Social Enterprise Operating Model

In regard to CROs identified to mainly operate under Social Enterprise model, five specific barriers could be confirmed and four negated for the Swedish context.

While the *(lack of) access to sufficient volumes of used equipment* was found to be a barrier, it has already been discussed in Chapter 4.4.1 and shall thus not be repeated here. The other barriers are *limited storage space for equipment*, the *cost and availability of spare parts*, *market availability/demand for products* and that *social enterprises are seen as tree huggers rather than professionals*.

Furthermore, besides the already presented *software licensing*, also *logistics costs*, *low staffing* and *competition for supply of used equipment with (licensed) recyclers* can were not found to be barriers to computer reuse organisations with social enterprise operating models in Sweden.

Limited Storage Space for Equipment

Both interview partners representing social enterprises saw the limited space for storing used computers for refurbishing and remarketing as a barrier to their operations. While they did have storage space, this was set to be too little at times, especially when receiving a high number of computers at once.

Cost and Availability of Spare Parts

In regard to the cost and the availability of spare parts, the two assessed organisations' focus in terms of barriers lay on the 'cost' part. While both were found to keep a stock of components and parts such as memory (RAM) or hard drives from otherwise scrapped computers, one of the organisations needed to regularly buy new hard drives increasing the costs.

Market Availability/Demand for Products

Furthermore, both interviewees agreed that the availability of (a) market(s) and the demand for used computers is increasingly becoming a barrier.

Social Enterprises seen as Treehuggers Rather than Professionals

The representatives of both assessed social enterprises had the perception that their organisation was rather seen as 'semi-professional' by potential (corporate) suppliers.

4.4.4 Barriers to Computer Reuse Organisations with Close the Digital Divide Operating Model

As already mentioned earlier, only one computer reuse organisation with a Close the Digital Divide operating model could be identified in the Swedish context and thus the only one of this type being part of the study. While this means, that the findings are not generalizable, they nevertheless provide a first glimpse on the barriers that such types of CROs are facing in the Swedish context. It furthermore means that no real ranking of single (non-)barriers by means of the number of organisations confirming or abnegating them is possible. Thus, the author did instead decide to group them according to the different processes/activities computer reuse organisations were found to conduct in literature and presented in Chapter 2.3.1. If more than 66.7% of the barriers attributed to a process or overarching activity (e.g. collection/logistics) were confirmed or negated, the respective process or activity was seen as being of high relevance in terms of being hampered by barriers or mostly free of barriers.

The relevant processes or activities found to be mainly hampered are *collection/logistics*, *inspection* as well as *legislation*. In the contrary were only *recovery*-related activities identified as seemingly mostly free of barriers. No conclusions could be drawn regarding *sourcing*, *costs* or *remarketing* as the percentage of (de-)confirmed or identified barriers was lower than 66.7% but higher than 33.3% of the respective overall number of barriers in these respective categories.

Logistics

80% of the assessed barriers in this category were confirmed by the interview partner. Furthermore, one new, related barrier could be identified, namely *police checks* leading to an increased expenditure of time and a decreasing moral of volunteers.

Inspection/Selection/Sorting/Disposition

Three quarters of the barriers related to the *inspection, selection and disposition* of used computers were found to pose problems for the assessed CRO with a Close the Digital Divide operating model.

Legislation

While regarding legislation, only about one third of the originally related barriers could be confirmed for the researched CtDD organisation, also two new barriers were found.

Thus it was decided to nevertheless include legislation as a relevant category in terms of barriers.

Namely that Swedish customs and the tax office consider the refurbished computers by the assessed CRO as scrap and prohibit the shipping to the receiving customers and the projects mostly located outside the EU. The other newly revealed barrier concerns *regulations regarding the export and import of specific products* (among them computers) (from Sweden/the EU) into certain target countries. In several (mostly less-developed) countries it is forbidden to import computers below a certain age as for example the local market shall be strengthened. In other cases, embargos either completely restrict the export of computers to specific countries or also demand them to have a certain age.

4.4.5 Newly Identified Barriers in the Swedish context

During the course of the research, several new barriers which seem to be specific for single operating models emerged. Because these were in all cases only mentioned by single interview partners and could thus neither be confirmed nor disconfirmed it was decided to briefly describe them in the following. They are also briefly listed in tables *A XII-1* to *A XII-3* in Appendix XII.

These barriers may be of interest and provide an extended basis for future research regarding barriers to ICT or computer reuse organisations. – Not only to verify or falsify them on a broad basis in the Swedish context but also in other national ones or internationally.

4.4.5.1 Computer Reuse Organisations with IT Asset Management Operating Model

In regard to the sourcing of and supply with used computers, one interview partner stated that the presence and involvement of ***too many middlemen*** would increase the cost of the used computers as such organisations, as for example leasing companies, would typically try to auction the computers or in other cases just recycle or throw them away instead of considering reuse as an EoL.

When turning to the logistics and collection process, one interview partner mentioned that in some cames the suppliers of used computers would ***not have the used computers prepared for transport and ready for hand over*** to a third party carrier leading to increased costs and timely issues. A second mentioned barrier related to collection was described with the necessity to test and certify used computers as still functioning in order to comply with the ***strict EU-regulations regarding the cross-border shipment of e-waste*** allowing for the transportation from other countries to Sweden where the refurbishing facilities of the company are located. Furthermore, one interviewee stated that the ***absence of a collection channel for used computers (and other ICT equipment) from households and private***

persons would be missing so far and potentially prevents from higher reuse rates. This seems interesting as the findings from Chapter 5.2.3 suggest that the quality is usually seen as too low to be prepared and remarketed for reuse profitably.

Table 4-1. Newlsy identified barriers to computer reuse organisations with IT Asset Management operating model

Related Process / Activity	Barrier
Sourcing	Too many middlemen between supplying organisations and CROs
Logistics/ Collection	Suppliers not being prepared for collection/hand over of used computers
	Used computers cannot be shipped across borders without being tested and certified for functionality due to EU-regulations
	Logistics infrastructure/collection channel for used equipment of individuals/private people is missing
Remarketing/ Redistribution	Low market demand for used appurtenances (e.g. keyboards and mice) of computers
	Market destruction due to low quality items from foreign brokers/retailers
	OEMs offer too low rates in (public) tendering processes
	(Perceived) Lack of willingness of public institutions/organisations to buy used computers
	Fraud risk through (potential) business partners
Legislation	Country-specific regulations restricting/hindering the import of computers (e.g. above a certain age)

In the area of remarketing/redistribution the interviews revealed five new barriers which were each mentioned by a single interview partner. Fistly, there was said to be only a ***low market demand for used appurtenances such as mice or keyboards*** often coming with sourced used computers so that they are usually sold on to recyclers but are in most cases not reused. In the case of keyboards this also has to do with the different signs, letters and keyboard layouts in different countries and markets. Secondly, one interview partner mentioned that ***foreign brokers or retailers selling low quality units on the Swedish market have led to unsatisified (potential) customers*** who also have lost trust in refurbished computers causing a setback of the Swedish market in general. Another issue is seen in ***OEMs offering (too) low-priced bids in public tendering processes*** making it hard to compete for specialized computer reuse companies. This seems to have to do with the pricing strategy of OEMs which can offer lower initial prices for their new computers as they were said to generate the profits through follow-up sales of additional equipment such as monitors or services. A fourth barrier is seen in the ***(perceived) lack of willingness of public***

institutions and organisations to buy refurbished/used computers and other IT equipment. On the other hand are exactly those organisations expected to act as frontrunners by the interview partner mentioning this barrier. In addition, one interview partner also stated that in regard to selling refurbished computers to (potential) business partners such as brokers or retailers in foreign markets, there would be a ***high risk of fraud*** which could lead to financial losses.

When turning to the area of legislation, one interviewee mentioned that the ***import regulations of certain countries*** (e.g. the restriction to not sell computers older than three years) would hinder in selling used computers to (potential) customers in these countries.

4.4.5.2 Computer Reuse Organisations with Social Enterprise Operating Model

The following barriers were mentioned by single representatives of computer reuse organisations with a Social Enterprise operating model during the interviews and identified as new.

In regard to the sourcing process, one interviewee stated that ***about half of the used computers donated by individuals/private people would partly not be reusable as they would be too old*** to be prepared for reuse and are thus recycled instead.

When turning to the actual process of preparing computers for reuse (recovery), a major mentioned issue seems to be the (in most cases) ***remaining low capacities of laptop batteries*** making them less attractive to potential buyers. Furthermore, charging cables are missing sometimes making it necessary to purchase new ones and thus leading to extra costs.

Table 4-2. Newlsy identified barriers to computer reuse organisations with Social Enterprise operating model

Related Process / Activity	Barrier
Sourcing	Received used computers from individuals/private people can partly not be reused because they are too old
Recovery	Low battery capacity of used laptops and/or chargers missing
Remarketing/ Redistribution	Dependency on Microsoft to be approved as MAR/MRR
Costs	Dependency on municipal support to cover costs / Operations are not (yet) self-sustaining

In terms of remarketing and redistribution of used computers, one interview partner pointed out that the ***dependency on being approved as a Microsoft Accredited Refurbisher or Microsoft Registered Refurbisher by Microsoft*** could threaten the survival of his organisation. If no permission is granted, the licenses for the Microsoft Windows software (the operating system) would become too expensive. Using the free alternative operating system 'Linux' with the refurbished computers is seen as making them less attractive to potential buyers.

Regarding the costs of the organisations' operations, one interview partner pointed out that the latter is currently not able to sustain itself financially and would thus be ***dependent on the municipality's support***. If the annually conducted assessment by the municipality would suggest to cease support, the computer reuse organisation would not be able to continue its operations.

4.4.5.3 Computer Reuse Organisations with Close the Digital Divide Operating Model

From the interview with the only representative of a computer reuse organisation with a Close the Digital Divide operating model, 12 new barriers which had previously not been found in literature, emerged for the Swedish context.

During the collection process of transporting used computers from suppliers, the interviewee reported that in some cases ***police would control the truck(s)/vehicles used for transportation causing long delays***, partly in fact tripling the originally estimated time. Stickers still remaining on the computers' cases suggesting they would still belong to the donating company/organisation contribute to misunderstandings. Such incidents were stated to negatively affect the moral of the volunteers also involved in the collection process. Another mentioned barrier associated with logistics and transportation is the ***lack of own vehicles for transportation/collection purposes*** causing a dependency on befriended truck drivers and other volunteers willing to support the CRO.

In terms of the recovery process, an occurring issue is that ***donated computers are partly protected with a BIOS password*** which makes it hard(er) to wipe the hard drive and reinstall a new operating system and thus to be prepared for reuse unless the password protection is removed.

When turning to the remarketing and redistribution of used computers, the interviewed representative mentioned five barriers. Firstly would ***wars/crises or armed conflicts in certain parts of the world hinder them from shipping computers to (partner) projects*** in these specific (world) regions or countries. – Either because the projects have been suspended for the time being due to the crisis/war or because the computers would never arrive at the projects. Secondly, the ***absence of proper recycling systems for (e-)waste in many of the destined countries*** makes it hard to ensure that provided computers are treated in a proper way once reaching their final EoL and to prevent them from getting dumped into the environment. A third issue is the ***present corruption in many countries of destination and/or transit countries***, for example causing month- or even year-long delays at the customs or ports. This can lead to situations where computers might only arrive at the partner projects after those have already ceased due to the lack of computers. Another barrier in this regard are ***varying regulations regarding the shipment of used computers to certain countries*** because they differ (partly a lot) between different countries and do not always seem to follow logical reasoning. For example stated the interview partner that when sending used computers to Burundi they would have to be labelled as education material although they would be used within a hospital project whereas when sending them to Kenya, the explanation could be stated as for use in a hospital directly. A fifth barrier regarding remarketing/redistribution were found to be ***changing contact persons at the Swedish customs and lack of information***. Some of them were reported to be not aware that the

computers were refurbished and exported for reuse purposes for technological development in less-developed countries and would thus forbid the export considering the computers prepared for reuse as scrap. Clarification was reported to usually cost a lot of time and effort.

Table 4-3. Newlsy identified barriers to computer reuse organisations with Close the Digital Divide operating model

Related Process / Activity	Barrier
Logistics/ Collection	(Time-intensive) Police controls due to fraud/theft suspicions
	No own/only restricted possibilities (vehicles) to collect donated computers
Recovery	Computers come partly with BIOS password
Remarketing/ Redistribution	Crisis/wars/armed conflicts prevent shipping of computers to projects
	No recycling systems for e-waste in most countries where partner projects are located
	Corruption in destination or transit countries
	Varying regulations and processes regarding paper work between countries of destination/transit
	Different contact persons with different level of insights/background knowledge at Swedish customs when shipping out computers to projects
Legislation	Restrictions regarding the selling of donated new computers
	Taxes on donations prevents willing companies from donating money
Costs	Lack of (financial means to be able to afford) a bank account approved and monitored by the Swedish Fundraising Control ('Svensk Insamlings Kontroll')
	Relying on voluntary work due to lack of constant income stream

Legislation and/or regulation-related barriers were two-fold. On the one hand ***demand some organisations donating brandnew computers to ship them to partnering projects of the assessed Close the Digital Divide organisation while the latter would rather have them sold on the local computer reuse market to sustain its own operations financially***. Instead computers would in such cases have to be placed into stock (often for several years) as the import or custom fees for new computers would be too high in some of the destined countries where partner projects are located. On the other hand did the interviewee state that ***taxes on monetary donations*** (or at least above a certain amount) would prevent companies from financially supporting the CtDD organisation thus hindering the latter in its operations and work.

In regard to costs, a first stated barrier is the ***lack of financial means to be able to afford a bank account approved and monitored by the Swedish Fundraising Control ('Svensk Insamlings Kontroll')*** which was perceived by the interviwee as keeping some potential donors from financially supporting his CtDD organisation. A further reported barrier is the ***lack of a constant stream of income meaning that the CtDD organisation would have to rely on and is dependent on volunteers and voluntary work*** making it necessary to sell the computers to partner projects at low prices instead of donating them for free – as the CtDDs organisation's operations could otherwise not be financed.

It shall be pointed out again, that these barriers may be of interest and provide an extended basis for future research regarding barriers to ICT or computer reuse (organisations). – At the same time it is necessary to test the latter on a broader scale involving numerous interview partners and organisations in order to verify or falsify them and thus being able to provide the appropriate target audiences with proper information and recommendations.

After the findings to the research questions one and two have been answered, the results are discussed and a comprising analysis is conducted in the following Chapter 5.

5 Discussion and Analysis

The chapter at hand aims at providing a synthesis and discussion of the findings presented in the preceding chapters 4.1 to 4.4 by means of analysing them according to the developed research framework and interpreting them but also evaluating them against to what was already known by hitherto existing literature as outlined in Chapter 2.

During the analysis it became clear that while several types of (main) suppliers to, (receiving) customers of as well as barriers to computer reuse organisation were found to be more or less generic in the Swedish context, many were identified as specific to the respective operating models. Thus, it was decided to first provide a brief discussion of the generic findings regarding all researched areas before having a deeper look at those which were identified as being tied to the operating models.
The structure was somewhat changed compared to Chapter 4 as barriers will be discussed first before turning to the operating model as such as well as types of suppliers and (receiving) customers. This allowed for synthesising findings in regard to many barriers with those for suppliers and (receiving) customers which will be discussed later. Eventually, Chapter 5 closes with a discussion of the methodological and analytical choices.

5.1 General Discussion

In the following, the more general findings such as the generic barriers to organisations of all types of identified operating models, their main suppliers and receiving (customers) are briefly discussed.

5.1.1 Barriers

As already outlined in Chapter 4.4.1, three barriers identified in literature could be confirmed for the Swedish context. The reasons for why they were perceived as barriers by a majority of the interview partners are described in the following.

(Lack of) Access to Sufficient Volumes of Used Equipment

For CROs with an ITAM operating model the main issue is that the demand for used computers has been and continues to be higher than the supply with used computers, meaning that potential economic revenues are lost while the available number of computers fir for refurbishing is reduced. This is backed up by the earlier introduced private study commissioned and published by refurbishing company Inrego (2012) which shows that about 277,000 computers which could potentially be refurbished and reused were instead recycled in 2012. Furthermore, the competition between commercial organisations turned out to be quite tough as the market has been consolidated during the last ten years leading to a situation with several major players and only few smaller ones left. Another reason seems to be the development that original equipment manufacturers as well as leasing companies are increasingly trying to get the computers back in order to refurbish and remarket them themselves offering complete solutions 'under one roof'.

Social Enterprises face the same issue in terms of getting fewer computers in, than they could actually (re-)sell - specifically laptops. Another reason for them seem to be leasing contracts of (potential) supplying donors which prohibit the latter from donating the computers and instead demanding to hand them back to the leasing companies. In addition, one interview partner stated that it seems too much of a hassle for some of the potential or earlier (donators) to deal with donating their used computers to his reuse organisation as that would mean to have several people at the offices/facilities picking up computers and other equipment.

In case of Close the Digital Divide organisations, the lack of access to used computers leads also to an unsteady supply which forces them to build up a stock of refurbished computers in order to be able to serve customers' requests also in times of low supply. Furthermore, it does not allow them to plan ahead very well how many projects/customers they will be able to serve throughout a year.

(Potential) Suppliers' Concerns about Data Security

Commercial reuse organisations with an IT Asset Management operating model see the concerns of (potential) customers about data security to be less of an issue than it has been in the past. At the same time they are still experience several companies and other organisations as very sensitive towards this issue and are thus not willing to refurbish their computers for a second life. This has also been shown by a study commissioned by Inrego (2014) and introduced in Chapter 2.3.5 where interviews with IT department managers of 200 institutions and companies in the private and public sector with more than 250 employees each were conducted. The results show that 40% of those organisations that decided to recycle their computers instead of letting them refurbish saw the data/information leakage from hard drives as the main issue.

While this statement also holds for social enterprises and CtDD reuse organisations, organisations from all three categories of operating models expressed that once a (potential) supplier has been informed about and knows how refurbishing/preparation for reuse of computers look like within a reuse organisation, the concerns about data security can usually be smoothed. This suggests a lack of information or communication between the CROs and (potential) suppliers.

This is somewhat contradictory when taking other information collected during the interviews into consideration. While differences existed between the computer reuse organisations, especially commercial ones were found to have comprising measures for data security in place. These range from the obligatory registration of collected computers within the inventory system allowing for tracking their status and throughout the whole refurbishing process. Further measures included transportation in lockable boxes, fenced and CCTV monitored facilities, fences, burglar alarms, security teams on site as well as partly also containers made out of concrete to allow for a safe storing of hard drives which have not yet been data wiped. In addition, all assessed organisations except for one with a Social Enterprise model (which were in one case found to have a policy in place that demanded the exchange and recycling of all incoming hard drives), were found to provide certifications/reports proving that the data have been deleted of a certain hard drive/computer. In almost all cases a software called 'Blancco' which complies for example with the standards of the Swedish Armed Forces and has been recommended by the NATO (North Atlantic Treaty Organisation) regarding data wiping or information/data security, was used for this process (Blancco, n.d.). Some organisations also offer data deletion by means of physically destructing hard drives via degaussing (via specific magnets) or shredding making the hard drives unusable.
What actually is contradictory is that in comparison, recycling has (at least currently) to be considered less secure as no inventory tracking is taking place and it is assumed that the way of a recycled product is not monitored all along the way between the recycling station/collection site and the recycling facility. It is furthermore assumed that this would potentially allow for unauthorised persons to get access to used computers which are frequently found with installed hard drives in the incoming recycling streams of recycling facilities as the representative of the assessed recycling company stated. Especially against the background that civic amenity sites, for example in Stockholm, have in recent years become deliberately victims of slumps of break-ins by criminal gangs/organisations who stole big materials allotted to recycling on a large scale as the interview partner from the Swedish Waste

Management and Recycling Association stated during one of the background interviews (personal communication, August 21, 2015). Similar incidents have also been reported from other parts of Sweden (see e.g. Markannen (2015); Gabrielsson (2015); Jägemar (2015)).

Lack of Knowledge about Suitability of Used Computers for Needs of (Potential) Buyers

A general reason why this has been reported as a barrier by organisations attributed to the different categories of operating models is that people usually seem to think of their old used computer(s) at home when thinking about 'used computers'. These are generally considered as too old, too slow and not properly working. While computers sold on secondary markets (in Sweden) do typically not fit any of the formerly mentioned attributes, people seem not aware of these differences. It was especially pointed out that customers would see used computers to not be as good as new ones in terms of performance and/or warranty. While this might certainly hold for some computers and some offers, in many cases the warranty period of used computers is just a bit shorter or almost similar to that of new ones. In terms of performance the issue is rather seen in customers and especially private consumers demanding new, high performing machines while in most cases the performance is not needed for their purposes. This in turn means that money is lost as financial resources are spent on additional performance which seems in most cases almost never to be fully made use of.

Another issue related to this is the economical aspect. While several (new) computer models in the consumer market segment can in the meantime compete with prices of used computers, especially private consumers considering buying a new one are said to not be aware of the quality differences between the former and the professional machines usually sold on (the) secondary market(s) in Sweden.

In terms of external markets, especially the CtDD organisation reported that people in charge of planning and implementing the projects of partnering/receiving organisations use their own reference base when deciding on the performance and configuration of computers to be ordered. But usually, they would not consider that these computers would be over dimensioned for the needs within the actual project where only general office applications might be used.

5.1.2 Types of Computer Reuse Organisations

When comparing the results presented in Chapter 4.1 with the findings from literature outlined in Chapter 2.3.2 it can generally be stated that all three types of operating models of EEE/ICT reuse organisations identified by Kissling et al. (2012) deemed relevant for the scope of the thesis at hand, can be confirmed for computer reuse organisations in the Swedish context.

Interestingly, a majority of the found (not only of the assessed) computer reuse organisations had its focus on an IT Asset Management operating model (11) whereas organisations with a Social Enterprise (3) and Close the Digital Divide (1) one occurred as a minority each.[36] The reasons for this remain somewhat unclear but based on the findings, the author assumes that this can be attributed to the fact that all three non-profit organisations were as of yet not economically sustainable let alone profitable. They were either reliant on financial support or goods/facilities covered/provided from the municipalities (Social Enterprises) or reliant on volunteer work or depending on having a part of the employees' salaries paid by the state (Close the Digital Divide).

[36] See Appendix VIII for more information.

The underlying reasons for this can presumably be explained by the identified general barriers perceived by CROs from all different groups of operating models. On the one hand seems the lack of supply with used computers play a role as computer reuse organisations would be able to sell more computers than available. This seems to be an issue especially for organisations with a Social Enterprise or a Close the Digital Divide operating model as the yearly handled number of machines are with between 100/200 (SE organisations) and 5,500 (CtDD organisations) much lower than the 45,000 to 250,000 units handled by commercial CROs. The perceived barrier (by CROs) that (potential) suppliers of used computers are unwilling to do so because of a fear of unsecure data handling or data leakage certainly contributes to this situation. Especially considering that this is the biggest issue related to supplying computers for refurbishing from the perspective of companies or public corporate users/organisations as found by the study commissioned by Inrego which has already been discussed above.

In regard to the differing numbers of organisations with different types of operating models, it is also assumed that the rather small, and in the case of organisations with a Social Enterprise operating model also rather specific domestic market (only non-commercial organisations and specific eligible individuals due to the specific MAR/MRR license) and the claim to offer used computers at low prices (in the case of organisations with a CtDD operating model) lead to the conclusion that these operating models are currently less attractive than the IT Asset Management operating model which seems to also face some challenges but is economically profitable.

5.1.3 Types of Suppliers

When turning to the different types of suppliers of CROs, literature revealed four main types together with several sub-types among them. These four main types, namely commercial and public (corporate) users/organisations, non-commercial ones and individuals/private persons, can be confirmed for Sweden. In regard to the sub-types, all identified in literature were found in the Swedish context except for Close the Digital Divide organisations which Kissling et al. (2012) had in one extreme case found to act as supplier to another CRO.
Nevertheless, the supply structure as well as the sub-types of suppliers were found to differ between organisations – depending on their respective operating model which confirms the findings from Kissling et al. (2012) for EEE/ICT reuse organisations in general. However, this limited the applicability of the framework developed from literature as literature (except for Kissling et al. (2012)) did not (allow to) distinguish between different types of operating models. Thus, while the main types of suppliers can be assessed via the framework, this is not possible on the operating model level. Here, the only usable source for further assessment is Kissling et al. (2012) as introduced in Chapter 2.3.2. This also applies to the types of (receiving) customers in Chapters 5.2.4, 5.3.4 and 5.4.4.

The practice of sourcing abroad which was found for organisations with an ITAM and CtDD operating model seems to be connected to the lack of supply with used computers on the domestic market. The reasons are discussed in more detail later in the chapters related to the different operating models.

Overall, the private and the public sector users/organisations could be identified as the main suppliers or sources of used computers for CROs in Sweden. Especially for organisations with an ITAM and CtDD operating model, the private and public sector play a major role. This looks somewhat different for organisations with a SE operating model but here the numbers of handled computers per year are very low. The reasons for the importance of these two types of suppliers seem twofold: on the one hand organisations from these sectors are seen as able to provide big numbers of used computers – often also the same type/model of computers with the same or similar specifications. This does not only allow for economies of

scale in the refurbishing/recovery process but also allows for exchanging parts within the same batch of computers. For example in case one computer is considered as not resalable and another computer needs a specific component or part. In addition it might be easier to resell computers in a rather big volume of the same type/model when selling to private companies or public institutions as having the same model will potentially allow for lower IT administrational efforts on the customer side.
A second reason for the importance of those two sectors/types of suppliers seems to be, that computers are often leased and/or exchanged after two to three years making them attractive to refurbish as they will still be profitable to sell on secondary markets.

Nevertheless, the supply structure differs severely between organisations with different (main) operating models. Thus, further details in regard to suppliers are discussed in the respective Chapters 5.2.3, 5.3.3 and 5.4.3.

5.1.4 Types of (Receiving) Customers

Similar to the types of suppliers can also the four main types of (receiving) customers, which have been identified during the literature review, confirmed. These are the same as for suppliers, namely commercial and public (corporate) users/organisations, non-commercial users/organisations as well as private users/individuals. In regard to the sub-types only 'worker's unions' and '(public (e-)waste) collection points' were not found among the (receiving) customers. But also similar to the types of suppliers, the (receiving) customer structure depends on the operating model of a computer reuse organisation.

The high shares of exported used computers in the case of organisations with an ITAM operating model (70-90%) suggest that the domestic demand and market(s) for these machines are comparably small – probably related to the earlier described barrier of potential buyers lacking knowledge about the suitability of used computers for their needs.
At the same time it is interesting to observe that the assessed CRO with a CtDD operating model, which traditionally exports computer for reuse in projects in less developed countries, had recently started to also sell refurbished computers to non-commercial organisation on the domestic market (0.5%) – and even expects this figure to rise in the future. This suggests that there might (at least in the case of non-commercial organisations) be potential for increased reuse in the future.

In contrast to the types of suppliers, no main type(s) of receiving customers could be identified as the most important one(s). Instead the types of (receiving) customers vary very much between organisations with different operating models. Thus, the types of (receiving) customers are discussed further in the respective chapters in the following.

5.2 Organisations with IT Asset Management Operating Model

The chapter at hand synthesises the findings in regard to the ITAM operating model, its identified types of suppliers, receiving customers as well as the barriers it faces.

5.2.1 Barriers

This chapter presents a discussion of the five barriers which were found and confirmed for organisations with an ITAM operating model in the Swedish context. It furthermore provides the reasons for why the interview partners saw the respective barriers as such.

Lack of Legislation That Sets Financial Incentives for Reuse and Enforces Reuse

In four specific areas, interview partners demanded new or at least a change in legislation.
Firstly, in regard to taxes, the main request was directed at lowering them for companies working in the reuse sector as this would allow for higher profitability and also lead to increased numbers of refurbished computers and other equipment. The latter statement seems related to the cost of labour in the recovery processes which leads to recycling (or selling computers labelled as 'broken') of computers which are not easily repairable in order to keep down the work-related costs. A further demand is to lower the value-added tax (VAT) of refurbished computers for individuals making them more competitive to newly manufactured, low-priced consumer machines. At the same time the taxes for new computers and other equipment as well as virgin/raw materials should be increased.
Secondly, stricter requirements for (potential) suppliers of used computers should be introduced to increase the overall supply with used computers and to prevent them from being recycled although still suitable for (preparation for) reuse.[37] In this, the third policy area at which demands are directed ties in: policies should be developed which aim at providing a better logistical infrastructure (e.g. for the collection of used equipment) aiming at supporting computer and ICT equipment reuse. In single cases, kretsloppsparks offer this possibility already to consumers which want to dispose of their 'old' computers.
The last area of new policies concerns the public procurement regulations which should be adjusted to preferring used computers and ICT equipment wherever possible (and not just stating that it is not forbidden to buy used equipment as it is currently formulated). Several interviewees stated that for example municipalities in most cases still buy new computers and IT equipment although used ones would allow for financial savings and serve the purposes they are used for.

Unpredictability in Supply / Lack of Transparency about Product Availability

According to the companies' representatives it is hard to predict when, what types of and how many computers and other ICT equipment is coming in which makes it hard to plan the operations as well as remarketing and reselling of the computers and the other equipment ahead. Interviewees report that while in some months several thousand units are sourced it might be none in the subsequent one.
In this regard, the lack of transparency of product availability seems also to play a special role. Some of the (potential) suppliers such as companies or organisations seem to stockpile their computers once becoming obsolete instead of selling them to commercial CROs. While this contributes to a lack of knowledge regarding the available numbers of used computers and other equipment, it also means a loss of money – not only for the owners but also for the computer reuse organisations due to the rapid value loss of computers. Some commercial CROs were found to calculate with a monthly value loss/depreciation rate of 5%.

Market Demand for Used Computers

With the formerly described decreasing prices of new computers which are becoming more and more competitive with refurbished professional machines it would become more and more attractive for customers to buy new units instead. While the price is seen as the biggest reason, some of the interviewees stated that customers seem not to have trust in used equipment and would consider it as being of lower quality than new items. In addition and similarly to what has been described for the general barrier labelled as (*lack of) knowledge about*

[37] Several interview partners stated that in some cases (potential) suppliers denied to sell off their used equipment but instead demanded that all products were shredded due to data security reasons. While this also included screens, keyboards and other equipment which did not contain any data storage it was nevertheless recycled and eventually destroyed.

suitability of used computers for the needs of (potential) buyers, some (types of) customers might demand machines from the newest generation although the performance and abilities may often not be needed for the intended purposes. These issues seem mainly to apply to the segment of private consumers though as new professional machines are still comparably expensive and can in most cases price-wise currently not compete with refurbished ones.

Another reason seems to be changes in the general economic situation in some foreign countries where former (receiving) customers can now afford to buy new computers and equipment instead of used ones.

Labour Costs

While several interview partners stated that computer and ICT-equipment reuse-related recovery activities would be work intensive, one interview partner pointed out that these activities could only be automated to a certain degree and would always require a certain amount of labour.

Due to this fact, labour seems to account for a big part of a commercial CRO's spendings and to be a major factor influencing its profitability. Thus, recovery-related activities are somewhat restrained by labour(-related) costs in the sense that in the case of some reuse companies, computers which turn out to not work properly during the testing phase, are usually recycled or sold on the market 'as broken'. Other companies seem to decide on a case by case basis if a not working computer is repaired or not. One company was found to conduct the recovery/refurbishing process in a central facility in another Central European country. One of the reasons for this seemed to be the lower labour-related costs. It could be speculated if further increasing labour-related costs in combination with decreasing prices of new computers could drive companies to relocate the refurbishing processes abroad meaning potential job losses in Sweden. Furthermore, lower labour-related costs could allow for spending somewhat more time on repairing computers in need instead of recycling them thus contributing to an overall increased reuse rate (not purely domestic).

Variety of Different Standards and Lack of Global Reuse Standard with Clear Definitions

Due to the absence of a general reuse standard with clear definitions, reuse companies in the Swedish context were found to each have developed an own grading scale regarding the quality of the refurbished computers ranging from 'A' to 'D'[38] with 'A' representing the highest quality. Additionally, plus (+) and minus (-) signs allow for a more detailed description of the status the computer is in.
The problem is that these gradings are highly individual and subjective varying between the different companies. This makes it hard especially for new (receiving) customers of computer reuse organisations to estimate the quality of the offered machines before actually receiving them. Nevertheless, almost all assessed commercial CROs were found to only sell computers of the highest quality ('A'-graded) on the domestic market whereas lower-graded ones would only be resold to other countries.

At the same time, the lack of clear definitions seems to partly also have led to some 'semi-professional' reuse organisations not acting in line with good business practices and selling computers without data wiping or serious testing in the past which could potentially have led to failure of electronics parts causing fires.

[38] Almost all of the researched commercial reuse organisations in Sweden were found to only sell computers labeled with the highest grade 'A' in Sweden. Computers with an estimated lower quality seem to usually only be sold abroad.

5.2.2 Operating Model

When comparing the results in regard to commercial or for-profit CROs to the findings by Kissling et al. (2012), the differences emerge in the types of suppliers/supply chain, the business offer, the types of receiving customers and the finance dimension.

When looking at the *supply chain*, the main difference to the findings from Kissling et al. (2012) is that CROs with an IT Asset Management Operating Model engaged in Sweden do not source used computers from individuals/private persons. The reasons for this are further explained in Chapter 5.2.3. Furthermore, while 'distributors and retailers' were not found as specific types of suppliers in Sweden, other types identified in literature (specifically by Kissling et al. (2012)) could be confirmed and were categorized as sub-types of suppliers including IT Service companies, OEMs and IT leasing companies. Interestingly and going beyond the results from the original study, is that private schools were also mentioned as suppliers which is further discussed in the respective Chapter 5.2.3.

In regard to *business offers*, the ones provided by commercial computer reuse organisations in the Swedish context exceed what had been found by Kissling et al. (2012) on an international level. While also covering the traditional services spanning from collection, preparation for reuse, data wiping, recycling (in cooperation with an external service provider) and remarketing as well as provision of certifications for data destruction, the Swedish companies were found to also offer the following ones: storage of (new) equipment for customers (as back up) until needed for exchange, renting out computers, setting up of new computers (installing images/software; modifications of hardware) for customers in cooperation with OEMs in order to allow for the provision of tailor-made installations and machines.
The reasons for the development of the business offers beyond the 'traditional' core business are seen as related to the lack of supply of used computers. The cooperations with OEMs and leasing companies seem to be a way to secure the supply with used computers. This is further supported by the statement of one interview partner which pointed out the importance of leasing companies in the Swedish context as the latter would serve about 25% of the domestic computer and IT equipment market. Other offerings such as renting out refurbished computers seem to be an attempt to capitalize on used machines beyond the traditional core business and increase profitability in addressing a niche market.
In contrast to that was only one of the assessed organisations found to remarket/resell parts and components (as stated by Kissling et al., 2012). The reason for this seems to be that such components and spare parts are usually collected from non-repairable machines and reused in others that need to be fixed – although not all CROs were found to repair machines as has already been stated above. This helps the organisations to avoid extra costs of buying such components and parts anew.

Looking at the main types of *(receiving) customers*, the findings for Sweden generally match the results from Kissling et al. (2012) who distinguished between distributors and retailers, (corporate) commercial and public users/organisations, individual users and eligible recipients. Taking in consideration that 'donate for refurbish' programs typically also include non-commercial organisations which receive refurbished computers as donations or at low prices, this was also found for the Swedish context – although only for one of the assessed companies. Interestingly, schools emerged as an important sub-type of public (corporate) organisations/users accounting for a major share of the domestic Swedish market for refurbished computers while other public (corporate) organisations such as public administration institutions and commercial (corporate) users do not seem to play a major role so far. The underlying reasons for these differences and issues are discussed in detail in Chapter 5.2.4.

In regard to the *finance* dimension/criterion, all assessed organisations with an IT Asset Management operating model were found to have a for-profit purpose and are thus in line with the results from Kissling et al. (2012). The figures for the average yearly turnover ranging from 40 to 300 million SEK (equalling roughly $500,000 to $37 million USD) are somewhat above the lower and upper thresholds ($200,000 - $30 million USD) provided by Kissling et al. (2012). Here, it should be taken into account though, that Kissling et al. (2012) did not specifically assess the numbers of computers handled but of ICT equipment in general.

5.2.3 Types of Suppliers

When discussing the types of suppliers of CROs with an ITAM operating model in a Swedish context the geographical locations of suppliers have to be considered. As has already been stated in Chapter 4.2.1 such organisations source between 85 and 90% of the used computers from within Sweden while the remaining 10-15% stem from abroad. Although several organisations stated that they would source Europe- and worldwide, the Nordics (Denmark, Norway, Finland) seem to play a somewhat special role. Although not entirely clear, it is assumed that this is on the one hand due to the location and being close(r) to the facilities of CROs in Sweden but may also have to do with the overall good economic situation in these countries presumably leading to shorter first lifecycles (in leasing contracts or otherwise) thus making them attractive for refurbishing and remarketing. Another reason for sourcing abroad is seen in the lack of access to sufficient volumes of used computers (within Sweden) thus trying to increase supply via sourcing from abroad. While several interview partners stated that their organisations would also source worldwide, this seems to rather apply to smaller batches of or single computers as another interview partner outlined that the transport via ships would take too long and having them flown in (e.g. from the U.S.) would be too expensive and not be in line with the environmental/sustainable orientation of the company.

Turning to the domestic suppliers, it has already been mentioned that one of the main findings in this respect is, that computer reuse organisations with an ITAM operating model are generally[39] not sourcing from individuals or private persons thus opposing the findings from Kissling et al. (2012). The reason is that this group is seen to generally buy low-priced computers/laptops from within the consumer segments (meaning no professional machines as usually used in e.g. office environments) which are considered to be of too low quality in order to prepare them for reuse and remarket/resell them profitably. The cost for the exchange of parts or components and the related amount of work is seen as too high for an estimated total lifecycle of five years. Furthermore, components obstructed in such machines are often perceived to be of low quality posing an economic risk as warranties on refurbished computers can be as long as three years – and could in the worst case also lead to a lack of trust of customers.

Public administration institutions and government/state organisations, universities, OEMs, leasing and IT companies as well as companies from other sectors were all found to serve as suppliers to commercial CROs in Sweden. The (usually) large batches of computers of the same or similar models allow for economies of scale in the refurbishing process leading to high efficiencies and thus making these types of organisations interesting suppliers. These results confirm the findings from Kissling et al. (2012) in regard to commercial (corporate) users/organisations.
An interesting point was that leasing companies were only mentioned to act as suppliers by two interview partners although they were stated to have a market share of roughly 25%

[39] Only one company was found to accept computers from private persons and decide on a case-by-case basis if they may be refurbished and brought to use again or if they are recycled. Nevertheless, the individuals would not receive any financial reward for handing in the computer.

regarding computers and ICT equipment in Sweden. It remains unclear why this is the case though – especially when considering that the lack of supply of used computers is seen as a general barrier in the Swedish market. But also because leasing companies would be able to offer more attractive lease contracts when considering that computers and other ICT equipment is refurbished and resold afterwards[40]. One explanation could be that some leasing companies conduct the refurbishing of computers themselves and thus offer so-called 'all-under-one-roof' solutions spanning the whole lifecycle of computers to their customers.

While potentially having somewhat large batches, private and public schools seem on first sight to not really fit into the supplier category – at least if the supplied computers were used by pupils who might not always handle the machines with care. Nevertheless, such machines may – even if no longer in the best shape – still be attractive on certain foreign markets where for example scratches might not play a role and price is the deciding criterion.

In regard to the fact that only one interviewee stated that his organisation would source from non-commercial organisations, this is assumed to have to do with the often tight budget of such organisations which might lead to a somewhat longer use of computers and ICT equipment before exchanging them. In such cases and after a long(er) first lifecycle compared to e.g. leased machines, such units may no longer be attractive for remarketing on secondary markets – although this is purely speculative.

Turning to the non-domestic suppliers, the three identified sub-types comprising of distributors, retailers/resellers and brokers emerged did not pose any surprises and confirm the findings from Kissling et al. (2012) and Dietrich et al. (2014). An interesting point is that Swedish CROs did not source directly from end-users. This seems to have to do with the fact that sourcing from abroad is in many cases used to address quite specific orders from customers which want to have a certain amount of a very specific model or when a Swedish CRO sold a batch of a specific type of computer but is still lacking one or few machines which they do not have in stock or cannot be found on the Swedish market. It seems that in such cases brokers, retailers and resellers provide a contact point with centralized information about where and at which prices the requested computers may be/are available.

5.2.4 Types of (Receiving) Customers

The findings regarding the types of (receiving) customers show that a vast majority of refurbished/used computers (between 70 and 90%) are sold to customers abroad.
The reason seems to be the low demand for refurbished computers on the domestic market(s) due to different reasons as described in Chapter 5.2.1 and the lack of knowledge about the suitability of used computers for their needs discussed in Chapter 5.1.1. A role might also play the lack/variety of (a) reuse standard(s) which may keep potential (new) customers from buying as they may not be entirely sure what quality a computer will come at as described in Chapter 5.2.1.

The look at the main types of (receiving) customers in the domestic market brings at least one surprise. Private and public schools were found to account for a very high share of resold computers in Sweden with between 50 and 75% of the assessed organisations sales. Taking a closer look it makes much sense as kids/pupils may not always take care of their computers in the best possible way so that new computers would certainly be damaged as well and thus buying refurbished ones allows for cutting costs too. At the same time the performance of

[40] The respective interviewee stated that they could tell the leasing companies how much they would get from reselling a certain type/model of computer after the end of the leasing contract, already before the leasing contract even starts.

used computers will still be good enough for school purposes. This has to be considered as a new finding or something specifically inherent to the Swedish context, as Kissling et al. (2012) did not identify private/public schools as major types of customers.

In contrast, the shares of sales to public organisations and institutions as well as private companies are comparably low. In regard to companies it assumed that they prefer to buy new computers, can afford to do this (due to the overall good economic situation in Sweden) and thus do so.
It becomes less clear in regard to public institutions and organisations which were by several interview partners seen to act as laggards and not as frontrunner, although they were expected to take this role. A possible reason for this was revealed by three interview partners who stated that the often high numbers of computers demanded by public institutions would allow OEMs to offer low prices with only small differences to those of refurbished computers. At the same time they would try to not capitalise on the computers itself but on the sales of additional IT equipment. Nevertheless, good examples of municipalities/cities such as the municipality/city of Eskilstuna exist, which initiated a frame contract with refurbishing company Inrego for used IT equipment and computers allowing the former to cut its related costs by 50-60% (Eriksson, 2015).

Turning to the generally lower shares individuals/private consumers have in the overall domestic sales vary quite a bit (between 5 and 20%), the reasons for this seem to be the cultural attitude towards and the image of used computers and having access to new computers at only marginally higher prices as described in Chapter 5.1.1 and 5.2.1.

For end-customers located abroad, quality or visual issues (such as scratches on the surface) seem not to pose a problem but the price to be the deciding criteria. While the end-customers are not served directly but via resellers/redistributors, brokers and commercial CROs located abroad, these types of direct customers of commercial CROs in Sweden are in line with the findings by Kissling et al. (2012). The reason is assumed to lie in the fact that those organisations have better knowledge about the respective national markets and may already have established relations with local customers. It can also be speculated that the risk of fraud might play a role to choose selling only to such middle-men.

After having discussed and synthesised the findings in regard to organisations with an IT Asset Management operating model, the next chapter focuses on CROs with a Social Enterprise operating model.

5.3 Organisations with Social Enterprise Operating Model

The chapter at hand synthesises the findings in regard to the Social Enterprise operating model, its identified types of suppliers, receiving customers as well as the barriers it faces.

5.3.1 Barriers

This chapter discusses the barriers which the interview partners representing organisations with a Social Enterprise perceived as such together with the underlying reasons leading to this.

Limited Storage Space for Equipment

Both interview partners stated that while they did have storage space, this was set to be too little at times, especially when receiving a high number of computers at once. In addition, it was found that sharing the space with other workshops/departments of the respective same enterprise (as described in Chapter 4.1.2) also manufacturing handcrafted objects further contributed to limit the available space.

Cost and Availability of Spare Parts

In regard to the cost and the availability of spare parts, the two assessed organisations' focus in terms of barriers lay on the 'cost' part. While both were found to keep a stock of components and parts such as memory (RAM) or hard drives from otherwise scrapped computers, one of the organisations needed to regularly buy new hard drives increasing the costs. This is related to the organisation's internal policy that the HDDs of incoming computers need to be taken out and recycled and in any case be replaced with new ones – in order to avoid any issues in terms of data safety.
In the case of the other organisation, new hard drives have to be bought sometimes as suppliers may take them out for to data security reasons before donating the computers.

As has already been discussed in Chapter 5.1.1 in regard to the barrier 'Suppliers' concerns about Data Security' taking out hard drives and recycling them may not be safer (or even less safe) than having them refurbished and data wiped with specific software.

Market Availability/Demand for Products

Furthermore, both interviewees agreed that the availability of (a) market(s) and the demand for used computers is increasingly becoming a barrier. The reason is two-fold with ever decreasing prices of new computers in the consumer segment (no professional machines) slowly approaching the level costs related to refurbishing. The price differences are becoming more and more marginal so that consumers as one of the main customer groups are seen to rather buy new computers instead of refurbished used ones – especially due to longer warranty periods of new machines.

Social Enterprises seen as Treehuggers Rather than Professionals

The representatives of both assessed social enterprises had the perception that their organisation was seen as rather 'semi-professional' by potential (corporate) suppliers. While the first interviewee remained somewhat vague and just stated that for example companies might not see it as a good idea to donate their used computers to his organisation and rather consider recycling it. It is assumed that this has to do with potential suppliers' fears regarding data security. The second interview partner became more concrete and pointed for example out, that some of the municipalities from which his organisation would receive used equipment would probably not trust them with wiping off sensitive data from the HDDs as they would either consider to recycle computers or otherwise donate them only without hard drives, leading to extra costs for the organisations as described above.

It remains unclear though if there is a difference in the level of trust regarding safe data handling/wiping between organisations with different types of operating models. Something that future research should consider in order to find out why certain types of CROs are trusted more than others and allow the respective less-trusted organisations to adjust.

5.3.2 Operating Model

Similar to organisations with an ITAM operating model, several differences in regard to types of suppliers, receiving customers, the business offers and finances were found when comparing the results with the ones identified in literature.

In regard to the *supply chain* and the (main) types of suppliers, private and public (corporate) organisations/users and individuals/private persons could be confirmed whereas non-commercial organisations do not play a role in the case of the assessed organisations with Social Enterprise operating model. Furthermore, while acting as suppliers, private sector organisations seem to only play a marginal role whereas municipalities and public as well as

private schools emerged as sub-types and seem (besides individuals/private persons) to be the most important suppliers to Social Enterprises engaged in computer reuse. Other sub-types of suppliers were not identified – thus posing another difference in regard to the findings by Kissling et al. (2012) who had found distributors, OEMs and in one case even a CRO with a CtDD operating model to act as suppliers. The reasoning and interpretation related to those findings are further discussed in the following Chapter 5.3.3.

When comparing the findings regarding the *business offer* of organisations with a SE operating model to the ones from Kissling et al. (2012), only few but nevertheless interesting differences emerged. The one deemed most important is that while data wiping took place in the case of one of the two assessed organisations[41], no certifications for this were offered/provided to the suppliers. While not entirely clear, this may be the or one of the main reasons leading to a situation where (potential) suppliers may rather recycle their used computers, remove their hard drives before donating and thus help create the perceived barrier of such CROs of being perceived as treehuggers rather than professionals and being considered as less trustworthy.
It is furthermore unclear why no certifications are offered – especially as for example the assessed organisation with a CtDD operating model stated that it had a co-operation with one of the data wiping software companies where suppliers can receive a certification against paying a small fee to the software company whose software was used.
Such a practice could not only lead to a more professional or more trust-worthy perception of such organisations in the public but in turn also lead to increased supplies with used computers and eventually to an economically sustainable enterprise. In case of the second assessed organisation, such practices could help prevent exchanging every hard drive and thus bring cost reductions in regard to buying spare parts/new HDDs which was experienced as a barrier.

The second interesting and new aspect (compared to the findings by Kissling et al., 2012) in regard to the business offer was that one of the representative of one of the assessed organisations mentioned that they would be planning to extend their business model to also offer study circles for individuals without or only little computer knowledge and the programming of websites to customers.

When turning to the types of *(receiving) customers* only two of the ones identified in literature can be confirmed for organisations with a SE operating model in the Swedish context, namely non-commercial organisation/users as well as eligible individuals/private persons for example when relying on state support. In regard to non-commercial organisations no specific sub-types could be identified and thus the findings from Kissling et al. (2012) who more specifically mentions NGOs as well as health and educational institutions, could not be confirmed. Furthermore, Swedish CROs with a Social Enterprise operating model were not found to sell to distributors or retailers as stated by Kissling et al. (2012) although this seemed to be an exception in the previous study.

The reasons for this customer structure and the sub-types of customers are discussed in more detail in Chapter 5.3.4.

When turning to the *finance* dimension/criterion, several differences occurred when comparing the results with the ones from Kissling et al. (2012). While in the case of the latter, all researched organisations had to be economically sustainable or self-sustaining in order to be considered, none of the assessed organisations in the Swedish context could match this

[41] The second one had an internal policy, that the hard drives of all incoming computers would have to be removed and exchanged against new ones as described in Chapter 4.1.2.

criterion and were found to be (at least partly) dependent on funding from the municipality as part of its social engagement/plan.
One reason for this seems to have to do with the fact that the main purpose of the organisations is to provide long-term sick, people with diagnosed psychological condition, etc. a way back into the job market and/or a meaningful work instead of being profitable in the first place.
At the same time: both organisations were found to only have started their work recently and thus are still in the development/start-up phase still allowing to become economically sustainable in the future.
Reasons for why this is not the case at the moment may include the lack of supply with used computers where the fact that potential suppliers are concerned about their data safety while not perceiving SE organisations as professionals might contribute to the dilemma of lack of supply.

Thus, the yearly revenues with a converted $2,500 to $3,000 USD are only a small fraction of the revenues found for organisations with an SE operating model researched by Kissling et al. (2012) with $500,000 to $38.5 million USD.
It is assumed that this has to do with the lack of supply on the one hand but also the low market demand for used computers in Sweden together with the small price differences between refurbished and new computers in the consumer segment. Especially as private people/consumers seem to make up a big part of the receiving customers. Operating under a specific MAR/MRR license only allowing for selling to non-commercial organisations and specific eligible individuals narrows the number of potential customers further down.

Other differences that occurred were that the organisations in Sweden did not sell off components and spare parts but kept them in storage for reuse in their own operations. Neither were collected waste materials sold to recyclers. It is assumed that the volume is too low to allow for creating revenues from selling it.

After the differences and interesting findings in regard to the operating model of organisations with a Social Enterprise operating model have been discussed, the next two chapters provide more specific discussions about the types of suppliers and (receiving) customers before turning to the last type of operating model, namely the Close the Digital Divide one.

5.3.3 Types of Suppliers

The first interesting finding in regard to suppliers is the location of the suppliers which were in the case of organisations with a SE operating model found to be solely located domestically. It is assumed that this has to do with the rather small number of units which were found to be handled per year by these organisations and the rather small and rather local markets which they are serving so that the need to increase the supply with used computers did not arise as the demand on the rather local/regional market(s) can still be met.

When turning to the identified main types of suppliers, it is somewhat unclear why non-commercial organisations were not found to act as suppliers. It is assumed that these are often using the computers for longer periods of time before exchanging them and thus making them less attractive for refurbishing and reuse. At the same time this explanation may also be doubted as computers from individuals may be even older and nevertheless are in many cases refurbished.

While the remaining three main types of suppliers confirm the findings from Kissling et al. (2012) in regard to the Social Enterprise operating model, the findings also suggest that commercial (corporate) customers only play a minor role in the overall volume of supply.

Furthermore, the sub-types of commercial (corporate) organisations comprising of distributors/retailers and OEMs which Kissling et al. (2012) identified in single cases could not be confirmed for Sweden.

In contrast, were especially municipalities and schools identified as sub-types of public (corporate) organisations/users contributing a major share to the overall supply.

The main reasons for this division is seen to lie in the fear of many private and public organisations regarding unsecure data handling as described in Chapter 5.1.1 together with the perception of CROs with a SE operating model as treehuggers rather than professionals. In the case of municipalities and schools, less or no sensitive data might be available which would potentially keep them from donating used computers for reuse.
At the same time, this perception of being seen as rather unprofessional again contributes to a continued lack of supply as has already been described in regard to the operating model in the last chapter.

Another interesting finding is that while the assessed organisation with a Close the Digital Divide operating model was found to currently have a trial regarding sourcing from the earlier introduced and described kretsloppsparks in order to test and potentially open up a new source of used computers, none of the two assessed SE organisations was found to have such a cooperation. Nevertheless, one of the interviewed representatives of an organisation with a Social Enterprise operating model stated that this would be very interesting for them and could have potential for the future while needing further investigation. Such cooperations could provide or at least be part of a solution in regard to the issue of lack of supply with used computers.

In regard to the one assessed SE organisation stating that it would receive the major part of its used computers from individuals, it is interesting that while such computers are considered as of too low quality by organisations with an ITAM operating model, they seem to still be able to serve the purpose and needs of the specific clientele of organisations with a Social Enterprise operating model. At the same time did the interview partners point out that also a substantial amount of these computers has to be sorted out and recycled as it is not seen as feasible for reuse.
Nevertheless, the cooperation between such organisations and kretsloppparks could also be an interesting approach for municipalities with a waste collection facility/station and which are also interested in increasing the reuse of EEE/ICT equipment where a higher number of inhabitants which could potentially provide a steady supply of used computers (and other ICT/EEE equipment).

5.3.4 Types of (Receiving) Customers

When turning to the types of (receiving) customers of organisations with SE operating model, the first finding confirms what had been described by Kissling et al. (2012) in their international study published four years ago also for the Swedish market: that Social Enterprises are solely selling to domestic markets but not abroad. The main reason for this seems to lie in the license. Microsoft's refurbishing license for "small and medium-sized partners" (Microsoft, 2014, p. 2) only allows for serving *local* customers.

The license seems also to be the restricting factor in regard to the types of (receiving) customers. The interview partners (and additional information on the website) stated that they would thus only be allowed to sell the refurbished computers to specific eligible individuals (comprising of pensioners, unemployed or disabled people as well as non-commercial organisations and similar).

This mainly confirms the findings from Kissling et al. (2012) in regard to the types of (receiving) customers who identified (corporate) non-commercial and individual users. The single case of having a Social Enterprise selling refurbished computers to distributors and retailers was not found in the Swedish context.

While it is assumed that such a specific license for the use/installation software products of Microsoft helps keeping the costs for the licenses low, it remains unclear how much more computers, the assessed organisations with a social enterprise operating model would have to sell in order to make up for expected higher expenses connected to switching to another license which would also allow them to sell to other customer groups/market segments. It is speculated that the generally low market demand for used/refurbished computers in Sweden together with the low prices of new computers from the consumer segment contribute to this situation.
The representative of one organisation also stated that it would not be an option to sell the computers with a Linux derivate instead of Microsoft operating systems as this would be expected by their customers as they would usually only have experience in using Microsoft Windows operating systems. Thus, turning away from this would very likely results in lower sales figures.

After the different assessed aspects in regard to organisations with a Social Enterprise operating model, the following Chapter 5.4 shifts the focus on analysing and discussing these aspects in regard to organisations with a Close the Digital Divide operating model. Chapter 5 closes then with a discussion of the methodological and analytical choices in the course of the research at hand.

5.4 Organisations with Close the Digital Divide Operating Model

The chapter at hand synthesises the findings in regard to the Close the Digital Divide operating model, its identified types of suppliers, receiving customers as well as the barriers it faces.

5.4.1 Barriers

This chapter presents a discussion of the barriers which were found and confirmed for organisations with a Close the Digital Divide operating model in the Swedish context. This was done by grouping them according to the different processes/activities computer reuse organisations were found to conduct in literature and presented in Chapter 2.3.1 as the number of barriers which would have to be discussed separately each would have been too high for the available space.

Logistics

The main reason why the researched organisation did consider *practical and logistical factors, including the distance travelled to collect used computers* as a barrier is the fact that they do not own any spacious vehicles such as trucks which could be used for the transportation of the computers. Instead it is relying on external services such as DHL which leads to high costs or on the help of befriended truck drivers helping out in their spare time.
The alternative is to use a car with a trailer which does not offer as much space and requires several rides between the supplier and the facilities of the CRO which also confirms *limited collection capacity* as a barrier.

This leads in either way to *high logistics costs* (constituting the third barrier) – either for the fuel of the truck/car with trailer or for the services of DHL. Furthermore, the employees and volunteers need to commute between (currently) two storage spaces as it is cheaper for the

CRO than renting one big one only – further contributing to the fuel consumption and increased time. This in turn backs up the barrier described as 'practical and logistical factors' above.

While in some cases companies offer to compensate the computer reuse organisation by paying for the fuel needed for transportation, this seems to be an exception. In most cases, *companies seem not wanting to pay or compensate the CRO for the collection services offered* (4th barrier). The reasoning seems according to the interview partner to lie in the fact that companies would have to pay extra taxes for such a payments or donations keeping many eventually from doing so. Instead the issue is in cases avoided by paying for the re-filling of the vehicles used for collection by means of fuel cards.

A fifth and newly identified barrier are police controls on the route back between the suppliers of used computers and the facilities of the assessed computer reuse organisation. As many computers have not been cleared from labels and tags stating them as property to the supplying company/organisation, the police seem usually to suspect thievery. The clarification process between the police and respective donating suppliers was reported to be quite time-intensive and would often lower the moral of the involved volunteers as they're suspected to have committed a crime. The practice of having suppliers sign a contract and providing contact details to the person in charge only turned out to help only in few cases.

Inspection/Selection/Sorting/Disposition

Although having two facilities in use (as mentioned before), the representative of the respective organisation stated that this means *limited storage space for the computers and equipment* and would be restricting their operations. Organisations and companies willing to supply their computers seem often to want them being picked up almost immediately or within a relatively short amount of time. – Otherwise the used computers would instead be recycled.

Due to the limited space, computers and equipment are not only stashed upon each other when stored before or after refurbishing but also during the recovery activities. While this does not only restrict the space for work such as cleaning the computers or re-installing them, in some cases it also leads to damages or broken equipment due to moving it around several times or to stashing practices negatively influencing the quality and commercial value.

Another barrier related to inspection, selection, sorting, disposing and other recovery-related activities are the *low staff numbers*. The interview partner stated that his organisation would need more people/volunteers) helping with the inspection as well as other recovery processes such as cleaning and repairing.

Legislation

While regarding legislation, only about one third of the originally related barriers could be confirmed for the researched CtDD organisation, also two new barriers were found. Thus it was decided to nevertheless include legislation as a relevant category in terms of barriers.

In the eyes of the interviewee, the *lack of legislation that sets financial incentives for reuse and enforces it*, is insofar a problem that it does not restrict the discarding or recycling of items, that are still working and could be reused. Thus, it should be too expensive to throw such items like working computers away. He reported that this would for example sometimes happen with retailers when items cannot be resold anymore.
Furthermore, current relevant policies would not have its focus on reuse (of ICT equipment) but on recycling instead.

A newly identified and very specific barrier seems to be that Swedish customs and the tax office ('Skatteverket') consider the refurbished computers as scrap and prohibit the shipping to the receiving customers and the projects mostly located outside the EU. The CtDD organisation stated that usually, they would eventually be permitted to export the computers but only after severe efforts to be granted an exemption also costing a lot of time. Contacts within the Swedish customs and being in touch with the foreign ministry providing specific details about the served projects have helped to be granted exemptions and to tackle this issue in many cases. Nevertheless, this may not always work straight away and still lead to issues and a delay in shipping the computers.

Another barrier that only became obvious during the course of research is *regulations regarding the export and import of specific products* (among them computers) (from Sweden/the EU) into certain target countries. In several (mostly less-developed) countries it is forbidden to import computers below a certain age as for example the local market shall be strengthened. In other cases, embargos either completely restrict the export of computers to specific countries or also demand them to have a certain age.
Furthermore, exporting (relatively) new computers also means higher taxes compared to refurbished ones.
All this leads to problems when no such old computers are available and potentially prevents the computer reuse organisation from serving projects in certain countries and regions. In addition do some suppliers of brand-new computers demand that those may not be sold on secondary markets to finance the organisations operations but instead of giving them to projects – which leads to a situation in which these computers have to sit in stock for several years in order to be able to be exported.

After having presented the findings related to the research questions, the following chapter aims at discussing these in the light of what had originally been found in the literature as well as what these results mean. *Table A XIII-1* in Appendix XIII presents a condensed overview about the presented findings.

5.4.2 Operating Model

When turning to the analysis and discussion of the operating model it emerged, that while most findings from literature could be confirmed, several differences occurred.

In regard to the *supply chain*, all of the four main types of suppliers, namely public and private (corporate) organisations/users, non-commercial organisations/users and individuals identified in literature could be confirmed in the case of the assessed organisations with a CtDD operating model in the Swedish context. In comparison to the findings from Kissling et al. (2012), the identified sub-types which emerged in the case of public (corporate) users are more specific. These comprise public administration institutions from all levels such as municipalities and state agencies but also educational and health-related facilities. One of the main differences to Kissling et al. (2012) but in line with the publication from Ongondo et al. (2013) for the UK, public waste collection points were also found to serve as a source of supply. These differences and findings are discussed more specifically in the following chapter 5.4.3.

When comparing the *business offer* of the assessed CtDD organisation the findings from Kissling et al. (2012), only marginal differences could be identified. While the refurbishment of the received used computers was performed by the Close the Digital Divide organisation itself, the collection was found to be outsourced in few cases to logistics providers such as DHL or comparable. In most cases this seems to be performed by the organisation itself though. In this context has also the perceived barrier of high logistics costs to be seen which

stem partly from compensating such logistics providers for providing the collection/transport services.
In regard to the refurbishing process itself, two interesting facts emerged. One the one hand were not all of the workers performing their tasks on a voluntary basis but in two of three cases paid (comparably low) salaries with a partial financing from the state as part of re-integration programs into the job market. Only one employee was found to work without receiving a financial compensation. The creation of positions as part of state-sponsored/supported programs could also be an opportunity to tackle the low staff numbers which were perceived as a barrier by the assessed CtDD organisation while making working for the latter (potentially) more attractive than working as a volunteer.
Similarly, other barriers such as the limited storage space or the limited collection capacity and being (at least partly) reliant on external service providers have all to do with the financial situation and comparably low budget of the CtDD organisation stemming from the goal to offer refurbished computers at low prices to eligible types of customers.

Another difference which emerged in regard to refurbishing was that the CtDD organisation did not sell single parts or components but usually kept them in stock for reuse in other computers.
As for the redistribution process, the findings from Kissling et al. (2012) can be confirmed insofar that the CtDD organisation was found to usually ship computers to partners (usually with an office in Sweden or Europe) but not to projects directly as this would complicate the follow up. The praxis of having partner organisations in the target countries also allows for better recycling and preventing dumping of used computers. This is usually done via offering a reward for each computer found dumped and at the same time penalising the original receiving project (partner). At the same time the main responsibility for ensuring proper recycling lies with the local project partners though.

Looking at the next dimension/criterion of analysis, namely *receiving customers*, non-commercial organisations/users could be confirmed as the only main type of (receiving) customers which is in line with the findings from Kissling et al. (2012). The identified sub-types also correspond with results from the mentioned study insofar that the non-commercial organisations were usually working in health- or education-related areas and/or were non-profit and/or non-governmental organisations.

Nevertheless, two big differences in regard to the study by Kissling et al. (2012) emerged. On the one hand was the assessed organisation with a CtDD operating model found to not sell to individuals while on the other hand also selling to non-commercial organisations within Sweden and thus widening the traditional market(s).
The reasons for these as well as a more detailed discussion are provided in Chapter 5.4.4.

When looking at the *finance* dimension/criterion, it was found that the yearly revenue of (converted) $25,000 USD of the assessed CtDD organisation was only a fraction compared to the $800,000 to 2.3 million USD of the ones assessed by Kissling et al. (2012). The reasons for this big difference are unclear but may lie in the fact that only small part of the revenues come from fundraising whereas the sale of products seems to account for the biggest part. Furthermore, the rather small amounts of computers handled yearly may just not allow for higher revenues. This would also be in line with the main goal of the assessed organisation to provide cheap computers to project partners in order to close the digital divide. The fact that neither used components/parts nor recycled material are sold but is either reused internally (in the first case) or picked up for free by a partnering recycling company also means less incoming money but still cannot explain the big monetary difference regarding the revenues.

Another interesting finding is that two of the three workers at the organisation are financially compensated with the help of state-support as part of reintegration programs for the job market(s). As has been mentioned before, this could be a way to also foster reuse of computers while at the same time helping in tackling the perceived barrier of low staff numbers.

After the main findings in regard to the operating model of the assessed CtDD reuse organisation have been discussed are the following two chapters providing a deeper discussion and analysis in regard to the types of suppliers and (receiving) customers before Chapter 5.4 closes.

5.4.3 Types of Suppliers

When taking a closer look at the results in regard to the types of suppliers of the assessed organisation with a Close the Digital Divide operating model, the findings state that about 1 to 2% of the received used computers stem from abroad. While this may occur as somewhat surprising in the first place, it can be explained quite easily with the supply stemming from foreign offices of Swedish companies or foreign companies which have their IT department located in Sweden where used computers are sent to once reaching their first EoL – which would then donate it to the CtDD organisation.

In regard to the big share of supply from private (corporate) organisations/users (60%) and public ones (32-35%) it remains unclear why they donate their used computers to the CtDD organisation – even though this is in line with the findings from Kissling et al. (2012) who had also identified the private and public sector as main source of supply.
This is especially interesting when taking into consideration that in the case of the assessed CROs with a Social Enterprise operating model (as the second type of non-profit reuse operating model), computers would either be donated without hard drives or not at all (potentially) due to the fear of unsecure data handling.

While unclear it could be explained by the fact that either the cause of bridging the digital divide is seen as more valuable by the suppliers or by the fact that the CtDD organisation did use Blancco as data wiping software and offered (even though against an extra fee and via Blancco as company) certifications that the data has been wiped off the hard drives of donated computers.
Other reasons may include that it is seen as more valuable to a donating company's renomee when computers are reused for the cause of closing the digital divide.

Nevertheless it remains interesting, that leasing companies did not act as suppliers to the assessed CtDD organisation. Information from the interview revealed that this may change soon as negotiations between the CtDD organisation and several leasing companies were stated to already have come a long way. In the future lessees shall be offered the possibility to pay a marginally higher leasing fee per month and thus be given the opportunity to donate the computers to the CtDD organisation at the end of the leasing contract instead of handing them back to the leasing company. This model could also be of interest to computer reuse organisations with a Social Enterprise operating model.

The most interesting finding in relation to the public sector is certainly the discovery that the assessed organisation with a Close the Digital Divide operating model had established a co-operation with a *kretsloppspark* of one of Sweden's more populous cities on a trial basis. Here individuals/private persons could hand in used computers which would be locked away by employees of the kretsloppspark and access was only granted to a representative of the co-operating CtDD organisation which would then collect the computers on a monthly basis and

check them for suitability for reuse. While still on trial, the interview partner stated that about 10-12 computers were collected within this one kretslopppark during the first two to three months and the reuse rate would thus far have been at about 50%.
While this sounds promising it also can explain the interview partner's demand for legislation which should create incentives to prevent recycling and foster reuse instead – also by means of providing better infrastructure for reuse over recycling.
This finding does not only confirm the results from a study by Ongondo et al. (2013) for the UK which also found that social enterprises/non-profit organisations would source from public waste collection points but also suggests that the results of an unpublished study regarding the reuse potential of computers from waste collection points commissioned by IT company Hewlett Packard conducted for Denmark should be reassessed/be seen in a new light (Anthesis, 2015). The research had assessed the reusability of business-to-consumer IT products (based on criteria from the British standard PAS 141[42]) disposed at public waste collection points and found that none of 52 laptops and only one of 27 desktop computers were reusable (Anthesis, 2015). Thus, a future study for the Swedish context could provide new insights if the praxis of the CtDD organisation would allow for increased reuse of laptops and desktop computers (even though potentially not or only to a small extent within Sweden).

In regard to non-commercial organisations, it remains unclear why they basically do not play a role as suppliers to the assessed CtDD organisation. Especially as the goal of the CtDD organisation to close the digital divide may be supported or be align with the goals of many non-commercial organisations to improve the situation of less-privileged individuals. It is assumed that this has nothing to do with the age or condition the computers of such non-commercial organisations are in as the representative of the CtDD organisation stated that they would even partly use computers from kretsloppsparks and individuals/private persons.

When having a closer look at the latter ones as type of supplier, the reason for the small share of used computers from individuals seems according to the interviewee to mainly lie in their age, performance or their incompability with operating system Linux Ubuntu installed by the CtDD organisation before shipping the computers to the partner projects.

Thus, while the number of used computers handled per year is in the case of the assessed CRO with a Close the Digital Divide operating model higher than for both assessed computer reuse organisations with a Social Enterprise operating model, opportunities to increase the supply with used computers (which is seen as a main barrier) do exist.

After the different types of suppliers have been discussed against the barriers and what had been found in literature, the following chapter turns its focus onto the types of (receiving) customers.

5.4.4 Types of (Receiving) Customers

The main finding in regard to the types of receiving customers is, that those are not only located in developing countries but also within Sweden. This is in contrast to the results from Kissling et al. (2012) who had stated that ICT reuse organisations with a Close the Digital Divide operating model would only export the refurbished equipment including computers to developing countries. This is insofar important as it was also partly used by the authors to distinguish between the Social Enterprise and Close the Digital Divide operating model and might thus have implications for future research.
While the share of the domestic sales in the Swedish context is with 0.5% comparably low, the

[42] Please see WRAP (n.d. a) for further information.

interview partner stated that domestic sales had only started recently and expectations been outperformed. He furthermore expects the numbers to increase further in the future.

It is not clear why the domestic sales of computers have only been started recently. One possible explanation is seen in the magnitude of several crises on a global level restrict the opportunity of the assessed CtDD organisation to ship refurbished computers to projects (for example in the Middle East region). Thus, the CtDD organisation has limited opportunities to create income in order to finance its operations and thus might see selling domestically as a new way of generating income.

In regard to the customers located abroad, the results from the study at hand are in line with the findings from Kissling et al. (2012) who had identified non-commercial organisations (corporate users) and especially education- and health-related institutions as well as NPOs and NGOs.
A main difference to the study from Kissling et al. (2012) which has already been mentioned in Chapter 5.4.2 is that the assessed organisation with a Close the Digital Divide operating model in the Swedish context is not selling refurbished computers to (low income nor general) individuals/private persons. The reason for this is according to the interview partner that it is not possible for them to follow up what happens with the computers. For example, if they would actually be used by eligible persons (e.g. individuals with a low income) or if someone would resell those computers in order to earn money. Furthermore, it would not be possible for them to check if the computers would be recycled once reaching their end-of-life.
This also explains the requests of the assessed Swedish CtDD organisation that potential customers (organisations) hand in a project description and that they would have an office or their headquarters in Sweden or Europe allowing them to not only follow up on the shipped computers but also to prevent fraud and misuse of the same by checking if they are registered/legal organisations.

Thus, while the types of customers confirm the findings from Kissling et al. (2012) to a certain extent, some things seem to be different in the Swedish context, which partly also have implications in regard to distinguishing between the Social Enterprise and Close the Digital Divide operating model.

After the different operating models, their related barriers and the inherent types of suppliers and (receiving) customers have been analysed and discussed, Chapter 5 closes with an analysis and discussion regarding the methodological and analytical choices as presented in the following chapter.

5.5 Methodological and Analytical Choices

After the findings of the study at hand have been discussed and analysed in regard to the main topics of interest, the current chapter aims to discuss the choice of methods, to evaluate the research/analytical framework as well as how the research aims and objectives have been met and how generalizable the findings are.

5.5.1 Methods

Regarding the methods used to collect the data, the application of the chosen exploratory and qualitative approach of conducting interview with experts representing organisations from within the computer reuse sector can be seen as successful. Not only did it allow for gaining in-depth insights about the operations of computer reuse organisations and the industry as such in a Swedish context. It also enabled to confirm (and partly also disconfirm) types of CROs, suppliers, (receiving) customers as well as barriers but was also useful in identifying

new entities regarding the formerly described groups – especially in regard to sub-types of suppliers, receiving customers and barriers.

The review of websites and additional documents of the assessed organisations for the purpose of triangulation was useful and revealed in some cases additional and/or interesting information also contributing to a better understanding regarding the overall topic as well as specific ones such as the sub-types of suppliers and (receiving) customers.

The background interviews with a representative of the Swedish Waste Management and Recycling Association (Avfall Sverige) and two researchers from the IIIEE provided useful insights about current practices and approaches towards recycling and reuse of EEE in Sweden as part of the official collection systems run by El Kretsen and Elektronikåtervinning i Sverige. These insights were especially useful for a better understanding of the current situation but also for the analysis and discussion of the current situation of and barriers towards reuse of EEE and computers in Sweden.

In regard to the practice of identifying fitting organisations and thus interview partners, the approach of using the official MAR/MRR databases for Sweden, relevant industry websites and such of related events as well as Google as search engine turned out as successful. Nevertheless were in the case of Microsoft's databases also several organisations listed which could not be verified as being (still) active in computer reuse thus drastically reducing the number of potential interview partners. This holds especially for non-profit CROs which were rather identified using Google and Swedish websites listing social enterprises.
Furthermore, snowball sampling, used to identify further fitting organisations and interview partners, did only proof successful in the case of non-profit computer reuse organisations[43]. In the case of commercial CROs, only one interview partner pointed to one other organisation. – This might have to do with the tough competition in the Swedish market which also lead to one company refusing to take part in the study due to fear of sharing information with potential competitors.

When turning to the interviews with representatives of computer reuse organisations, it turned out to be of great value to send the interview questions before hand. While this allowed the interviewees for some preparations, the results and the quality of the collected data were in all cases much better than in the pre-test where the interview guide had not been sent before.

Nevertheless, the limited time of some interviewees posed an issue which partly led to some shortcomings regarding the barriers in the last part of the interview guide. Here, it was in some cases not possible to ask for deeper explanations of certain mentioned barriers.
In retrospect, a mixed methods approach could have made sense insofar that the questions regarding the facts about the organisations, the types and shares of suppliers, customers as well as the shares of how much of the supply is sourced and resold domestically, could have been posed via a questionnaire as these are mainly numbers. In that case, descriptions of for example suppliers could also have been filled into a form allowing for additional comments. This could have saved a lot of time which would have been useful to have for assessing the barriers in the case of some interviews. In addition, the use of a questionnaire would probably have streamlined the provided data, for example about shares between different types of (receiving) customers, and thus allowed for better comparability between different types of CROs. Instead, several interview partners provided combined data in answering certain

[43] Eventually it did not lead to an increased number of cases as it turned out that the organisations mentioned by the interview partners had either already been identified before and were part of the study – or were currently inactive/had shut their operations down.

questions while others provided strictly separated data making it hard(er) to evaluate and analyse.

So, while in regard to the chosen methods few changes and adjustments are recommended, it can be stated the overall approach and the majority of the chosen methods is seen as fitting to meet the research objectives described in Chapter 1.3.

5.5.2 Research/Analytical Framework

As it has already been described in Chapter 3.1 no fitting framework for the purpose of this this research could be identified during the literature review process so that the need to develop a tailor-made framework (see Chapter 3.4 and Appendix IX) emerged.

The self-developed framework was found to overall work well for the purpose of the research at hand. Basing on an adjusted[44] typology of EEE/ICT reuse organisations by Kissling et al. (2012), this also offered four, in some cases five, criteria/dimensions as described in Chapter 2.3.2 which allowed to distinguish between different computer reuse organisations based on their (main) operating models. While the criteria were not specifically developed in hindsight of computer reuse organisations, they turned out to work well to distinguish between the different relevant operating models and when analysing and discussing the findings. It should be pointed out though, that the criteria did in most cases not match to 100% (as for example the business offers of CROs in Sweden differ from the ones identified in an international context in the original study) and have thus to rather be seen as guiding in the differentiation process.

This was somewhat different in the case of types of suppliers and (receiving) customers. While the different main- and sub-types of suppliers and (receiving) customers identified in literature helped in grasping the spectrum of actors and provide a good starting point, they could not really be used for analysis and discussion. This had to do with the realization that the (sub-)types of suppliers and (receiving) customers seem to depend on the operating model. Thus, while for example shares between the main types of suppliers and receiving customers could be analysed using the compiled lists shown in Appendix II and Appendix III, the latter two did not allow for specifically analysing the sub-types of suppliers and (receiving) customers. In this regard, only one publication by Kissling et al. (2012) could be used as it was the only one that was found to provide information about the supplier and (receiving) customer structure broken down per operating model.

In regard to the assessment of barriers, the list compiled from literature and illustrated in Appendix IV worked – overall – well. Only the distinction of barriers into such to non-profit and for-profit organisations could be reconsidered as few barriers which had originally been ascribed to non-profit organisations by publications were during the research also mentioned by interview partners of for-profit organisation – and the other way around. Thus, potential barriers may in some cases not be identified during research. Using one (the same) list for assessing for- and non-profit CROs would help avoiding this.

When turning to the overall structure of the framework, it can be stated that it worked very well in helping to structure the data collection process. Especially the subdivision of the barriers along the different process steps in the reverse supply chain turned out to be useful for structuring the interview guides and related questions.

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[44] Two operating models contained in the original typology were taken out as they were irrelevant for the focus of the study at hand. They focused mainly on networking equipment such as servers and switches, respectively large household appliances. Please see Chapter 2.3.2 for further information.

Thus, while the analysis framework brings some limitations, it can serve very well for the purposes of researching shares and types of suppliers, receiving customers as well as barriers which computer reuse organisations face when taking the limitations into account and adjusting the framework accordingly.

5.5.3 Research Aim and Objectives

The aim of the study at hand was to close the information gap regarding the computer reuse market(s) and their main actors in the Swedish context as well as the barriers they face and to provide recommendations how these barriers could be met in order to increase computer reuse in Sweden. The results have been presented in Chapter 4.1 to 4.4 while the recommendations for the main target audiences will be given in Chapter 6.1.1 and 6.1.2.

While the results regarding some of the research questions have to be seen as somewhat fuzzy – for example in regard of the shares between different types of (receiving) customers of CROs with a Social Enterprise operating model, they provide the first comprising assessment of types of computer reuse organisations, types of suppliers, (receiving) customers and barriers differentiated after operating models not only in the Swedish but also in a national context. Thus, while the research results draw a first complete picture of the computer reuse landscape and market(s) in the Swedish context, further research is needed for which the results of the study at hand may serve as a basis.
Recommendations about what future research should focus on are provided in Chapter 6.2.

5.5.4 Generalisability

When trying to estimate the generalizability of the findings, a separation should be made. While the ones from the literature review reflect the current state of the research regarding the different types of EEE/ICT/computer reuse organisations, their suppliers and (receiving) customers as well as barriers and thus should be seen as generalizable, this does not apply for the newly revealed information from the conducted interviews.

This is due to several reasons. On the one hand is the reliability of the data at least in the case of organisations with a Social Enterprise and Close the Digital Divide operating model due to the low numbers of interviewees, namely 2, respectively 1, very restricted. Further research should thus try to identify and include more of these types of organisations to allow for higher data validity and thus better generalizability.
On the other hand (and taking a more general perspective), the results only reflect the current situation in the Swedish context as this was the sole focus of the study. They suggest that cultural (e.g. the critical attitude towards reuse; concerns about data security), socio-economic (e.g. most people/organisations can afford to buy new computers; low prices of some new computers), as well as legislative (e.g. need for better legislation supporting reuse; regulations hindering CtDD organisations in exporting used computers) aspects play all a role and influence how the secondary (domestic) market(s) for used computers look, which types of CROs can be found at which numbers and which barriers they face. Due to these factors, it is expected that the results will not hold for other national or international contexts restricting the generalizability.

Nevertheless, the four *main* types of suppliers and (receiving) customers (private and public (corporate users/organisations, non-commercial users/organisations, individuals/private consumers) found in literature have been confirmed and thus suggest that those will also be present in other national contexts.

Furthermore, while this study has been the first one to assess the types of computer organisations, their respective types of suppliers, (receiving) customers and barriers in a

national context, it has been shown that the barriers as well as the sub-types of suppliers and (receiving) customers are in a national context depending on the operating model of a CRO – thus confirming the results from an international study by Kissling et al. (2012). This finding should be (con)tested in further research in other national contexts but certainly be considered when research computer reuse organisations in the future.

6 Conclusion

Current Western lifestyles and an emerging global middle class contribute to an ever-growing volume of e-waste of which desktop computers and laptops are also a part of. One solution to reduce the contribution of the latter to the overall amount of WEEE is seen in reuse which potentially allows for the prolonging of lifetime and thus (potentially) reducing the demand for manufacturing new computers.
While this is clear, only little information about the reuse market(s) in regard to (W)EEE and specifically computers is available in the case of Sweden somewhat preventing policy-makers and other actors from developing strategies and policies in order to increase computer (and (W)EEE) reuse and reducing the total amount of e-waste in the Swedish context.

The objective of the research at hand was to provide (further) information about the computer reuse market in the Swedish context including the main actors, participants and barriers. Thus, the following research questions were posed:

- ***How do the reuse market(s) for desktop computers and laptops in the Swedish context look like?***
  - ***What types of organisations are engaged in reuse activities of desktop computers and notebooks in Sweden?***
  - ***What types of actors function as suppliers to and receivers/receiving customers of used computers respectively computers prepared for reuse of such computer reuse organisations?***
  - ***How big is the share of the organisations' sold desktop computers and laptops that is reused in Sweden compared to the share that is exported?***

- ***What are the barriers organisations involved in reuse activities of desktop computers and notebooks in Sweden are facing?***

- ***How can the identified barriers be overcome and reuse of desktop computers and notebooks in Sweden fostered?***

In order to collect data and answer these questions, literature analysis, in-depth interviews and document analysis were used as means of data collection. The combination of these different methods allowed for triangulation and better accuracy of the retrieved data.

Three different types of organisations were found to be engaged in computer reuse functioning as the central actors in the Swedish computer reuse market(s). These can be distinguished based on their main operating model into such with a profit-focused orientation (IT Asset Management operating model) and such with a non-profit orientation focusing on a social cause. Such non-profits with a social cause can be further divided. Firstly, into the ones which try to provide a meaningful work for people with a psychological condition or to offer reintegration opportunities for long-term unemployed to the job market while at the same time offering low-income individuals access to computers (Social Enterprise operating model). The main aim of the second type of non-profit organisations (and third overall type of organisations engaged in computer reuse) can be described as trying to close the digital divide between industrialized/developed and less-developed countries by refurbishing and exporting used computers to specific projects in such countries and regions. Interestingly they have (against what has been suggested by previous literature) also started to sell used computers to non-profit organisations within Sweden.

Furthermore, the operating model was identified as the decisive criterion in regard to the types of suppliers, (receiving) customers, barriers and the share of used computers sold domestically and abroad. While organisations with a Social Enterprise operating model were found to only sell domestically, organisations with a Close the Digital Divide operating model were found to almost exclusively export the refurbished computers (99.5%) similarly to organisations with an IT Asset Management operating model which currently also sell between 70 and 90% of their received computers abroad.
Also considering the overall numbers of computers handled per year, the organisations with an IT Asset Management operating model are by far the most important with figures between 45,000 and 250,000 followed by organisations with a Close the Digital Divide operating model (ca. 5,500 per year) whereas the 100 to 200 used computers resold by organisations with a Social Enterprise operating model seem in comparison almost negligible.

Turning to the general types of suppliers providing such organisations engaged in computer reuse with used computers, four were identified, namely commercial (corporate) users/organisations, public (corporate) users/organisations, non-commercial users/organisations and private consumers/individuals. While also several sub-types emerged, these together with the supply structure vary (partly a lot) depending on the operating model of a computer reuse organisation. Nevertheless it can be stated that organisations from the private as well as public sector currently account (by far) for the major part of the CRO's input whereas non-commercial organisations and individuals only play a role in specific single cases of organisations with a SE operating model. When turning to the sub-types, public administration institutions and educational facilities such as schools emerged as specific important ones within the public sector.

In regard to the main types of (receiving) customers, the same ones as for suppliers were identified, namely commercial (corporate) users/organisations, public (corporate) users/organisations, non-commercial users/organisations and private consumers/individuals.
Furthermore, private and public schools (located within Sweden) as well as brokers and resellers/redistributors emerged as the most important (sub-)types of (receiving) customers of organisations with an ITAM operating model. In regard to the ones with a Social Enterprise orientation, non-commercial organisations and eligible individuals (e.g. relying on state support) were found as the only types of (receiving) customers. As for the CRO with a CtDD operating model, non-commercial organisations mainly located abroad but also domestically were identified as the main types of (receiving) customers.

When looking at the barriers which computer reuse organisations in Sweden perceive as such, it was found that these vary partly a lot - depending on the operating model of a CRO. Nevertheless, the (lack of) access to sufficient volumes of used equipment, the suppliers' concerns about data security and the lack of knowledge about the suitability of used computers for needs of (potential) buyers were found as barriers which organisations across all three types of operating models perceived.

In regard to CROs with an IT Asset Management operating model, the identified barriers consisted of a lack of legislation that sets financial incentives for reuse and which also enforces reuse, a low demand for refurbished computers in the Swedish (domestic) market, too high labour costs related to the refurbishing process(es), a variety of different reuse standards instead of a central one. They furthermore perceived the unpredictability regarding the supply and the lack of transparency about the availability of computers for refurbishing as a barrier.
Computer reuse organisations with a Social Enterprise operating model feel themselves hindered by the limited space available for storing of equipment, the too high costs of spare parts such as hard drives, but also by the low market demand for refurbished computers by

their main customer groups. In addition, they feel that they are rather seen as treehuggers instead of being professional(s) by potential supplying customers also restricting access to computers for refurbishment.
The assessed CRO with a Close the Digital Divide operating model perceived practical and logistical factors such as the distance travelled in order to collect used computers, the limited collection capacity of their own vehicle(s) as well as high logistics costs in regard to fuel prices or the payment of external service providers as main barriers related to the logistics process. Furthermore seem companies which act as suppliers in many cases not wanting to pay for the collection service(s) offered by the CRO. In addition, police controls on the way from a supplier to the organisation's facilities were perceived as barriers as they would negatively affect the motivation of the volunteers. In terms of the inspection/selection/sorting and disposition process, the low staff numbers and the limited storage space for the computers and related equipment were seen as the issues hampering the organisation's activities the most. In regard to legislation, the lack of such which provides financial incentives for reuse instead of recycling potentially refurbishable computers and enforcing such behaviour was seen as a main barrier. Besides, the assessed CtDD organisations perceived the sometimes occurring restrictions regarding the export (outside the EU) of refurbished computers by the tax office (Skatteverket) as issues as the latter would declare the computers as scrap although function. The restrictions of some target countries to not allow the import of refurbished/used computers for several reasons was also seen as a problem by the assessed organisation with a CtDD operating model.

The findings of the research at hand suggest, that – while there is a reuse market and industry already existent in Sweden – the reuse does currently mainly take place abroad as domestic market demand is too low but still has a lot of potential. This seems to mainly have to do with potential buyers' lack of knowledge about the suitability of the used computers for their needs and information about its status as they seem to often attribute lower performance and reliability to refurbished/used machines. In addition, low/decreasing prices of new computers in the consumer segment allow them to compete with refurbished professional machines (which seem usually to be of higher quality).

In the perspective of CROs with an ITAM operating model as accounting for the major share of handling used computers, especially the public sector and specifically municipalities should take the lead and act as frontrunners in order to show that refurbished computers are performing well while not only being more sustainable in comparison to buying a new computer but also potentially helping in cutting the budget of a municipality or another public administration organisation. For example could the city of Eskilstuna cut its IT budget by 50 to 60% in switching to refurbished IT equipment including computers (Eriksson, 2015).

The results of the study furthermore suggest, that strategies and policies aiming at increasing the domestic reuse of computers should focus on such organisations with an ITAM or SE operating model as CtDD organisations almost exclusively export computers.

When taking a more general perspective, the perceived barrier of (lack of) access to sufficient volumes of used equipment suggests that the CROs could actually sell more computers than they receive for refurbishment. This seems mainly to have to do with the (potential) suppliers' concerns about data security leading to their decision to rather recycle the computer or remove the hard drive before donating it. Although the refurbishing of used computers has to be considered safe when done with a serious refurbishing partner, it seems that there is an information gap between potential suppliers and the offering CROs regarding the safety of the process.

Several recommendations how to tackle this and the before mentioned issues regarding computer reuse in the Swedish context are presented in the following Chapter 6.1 in regard to how the target audiences of this study could potentially anticipate.

Besides these practical implications, the study at hand contributed to the literature by providing first insights regarding the types of suppliers and (receiving) customers as well as barriers of computer reuse organisations in a national context applying operating models as mode of distinction. The results suggest that barriers and (sub-)types of suppliers and (receiving) customers and their respective (supplier and customer) structure are mainly dependent on the operating model of a computer reuse organisation (even if some similarities may occur). Thus, future research regarding computer reuse organisations should consider taking operating model(s) into account when assessing them. While it has been shown for barriers as well as types of suppliers and (receiving) customers, other parameters may also be dependent on a CRO's operating model.
Furthermore, the findings from the thesis at hand support Kissling et al.'s (2012) statement that "the EEE re-use sector […] is not homogeneous and should not look for "one size fits all" approaches when aiming to promote re-use" (Kissling et al., 2012, p. 86). The results of the research in the Swedish context show that national and regional contexts and circumstances, for example legislation and cultural attitudes, play a crucial role – but in regard to computer reuse, also the operating models of engaged organisations play a crucial role. Thus, it can be expected that in regard to deal with and eliminate barriers to computer reuse (organisations), no generally applicable solutions are available, but the specific national and regional contexts as well as the operating models of CROs will have to be understood and considered in order to design successful strategies aiming at fostering reuse of computers and other ICT equipment.

6.1 Recommendations for Target Audiences

Based on the findings regarding the barriers as perceived by the assessed computer reuse organisations, the chapter at hand aims to provide recommendations how the barriers could be overcome and thus computer reuse in a Swedish context be fostered.
The recommendations will be presented separately for the two main audiences which have been defined in Chapter 1.6, namely policy-makers as well as computer reuse organisations active in Sweden themselves. These do mainly address the identified general barriers for CROs in the Swedish context but also provide suggestions how to tackle the challenges of organisations with an ITAM operating model as these have currently to be seen as the most important actors because of the high numbers of used computers. In contrast, the numbers of computers handled by organisations with an SE or CtDD operating model are much lower and the targeted customer segments are very specific as of yet. Nevertheless were recommendations in regard to some of the issues of organisations with either of the two types of operating models included.

6.1.1 Policy-Makers

In regard to the lack of supply which organisations across all types of identified operating models reported to face, policy-makers in Sweden should focus on adjusting current legislation in such a way that its primary focus is shifted from recycling towards reuse in order to change the current situation - something that has already been described by Lee and Sundin (2012).
This means that the respective legislation should for example focus on providing the infrastructure fostering the reuse of computers. Kretsloppsparks as identified in the case of the assessed CRO with a CtDD operating model provide a first step into this direction from which also Social Enterprises could profit. Regulations regarding El Kretsen and the handling

of (W)EEE in Sweden could also allow for reuse opportunities regarding the non-consumer stream of used computers – for example via the cooperation with CROs with IT Asset Management operating models.

In order to increase the supply with used computers for CROs, legislation should furthermore create incentives (for example financial ones) or impose requirements, in order to ensure and enforce businesses and public sector organisations/institutions to donate or sell their used computers instead of recycling them. In order to allow for concrete suggestions in this regard, further studies with a focus on the reasons for potential suppliers of used computers to not sell/donate their computers for reuse should be conducted as further described in Chapter 6.2.

In order to stimulate the demand for refurbished computers, policy-makers should/could act in two ways. On the one hand could the value-added tax (VAT) on refurbished computers in Sweden be reduced from the standard rate of 25% to one of the two lower rates currently set at 12 and 6% (Skatteverket, 2016). This practice is currently prevented by EU legislation though which allows reduced taxes in its member countries only on certain goods of which computers and other electrical household appliances are currently not a part of (Directive 2006/112/EC). Thus, policy-makers should aim at a change of legislation at the EU-level allowing for reduced VAT on computers (and other (R)EEE items) as has also been suggested by Bauer, Gylling, Trzepacz, Sander Poulsen, & Tojo, 2013).
On the other hand could tax reductions on labour or reduced social contributions such as the payroll tax ('arbetsgivaravgift') (at least) in the case of organisations with an ITAM operating model very likely lead to reduced overall operating costs as computer refurbishing processes can according to several interview partners only be automated to a certain extent. Thus, in turn would likely allow for lower prices of refurbished computers and make them more competitive against new, low-priced computers for the consumer segments.
Such a regulation has for example already been introduced for employees who dedicate at least 75% or 15 hours per month for commercial research. In such cases employers are allowed to deduct up to 10% of the employee's salary from the total arbetsgivaravgift for the employee (31.42% of the salary) as long as it is still higher than 10.21% of the salary and the total monthly amount for all such employees does not exceed $230,000 SEK (Skatteverket, n.d.). Similar regulations also already exist regarding employees being born in 1992 or later where the arbetsgivaravgift for the employer is set at 10.21% instead of the regular rate of 31.42% in order to foster the employment of younger people (Skatteverket, 2015).

Another potential measure for increased demand for used computers is the introduction of a reuse standard for computers and ICT equipment as it could help built trust in refurbished machines by (potential) customers. These may consists of a given list of check-points which used computers need to be assessed and tested against. Comparable standards such as PAS 141 in the UK exist already which already provides specific recommendations and requirements regarding the refurbishing of desktop computers and laptops (see e.g. WRAP, 2013; n.d. a; n.d. b; n. d. c). Such a standard could also provide criteria regarding the assessment of and provision of certifications for organisations exporting refurbished computers for reuse (such as CROs with a CtDD operating model) allowing them to "demonstrate to […] regulators that you are only exporting legitimate REEE and not WEEE" (WRAP, n.d. c, Compliance Schemes) which "will give you the confidence that the equipment you export has been treated by independently verified legitimate re-use companies" (WRAP, n.d. c, Exporters).

Furthermore could the current public procurement laws be adjusted/reformulated in such a way that it does not only not prevent public organisations and institutions from buying and

selling used equipment and computers but instead encourages them to do so via stricter requirements. This is seen as a central point in order to turn public organisations into front-runners and showcases showing that refurbished computers are reliable and performing well and thus may help in convincing the private sector as well as consumers in also purchasing refurbished machines instead of buying new ones.

Nevertheless can also computer reuse organisations themselves get active and at least partly solve some of the identified barriers. Recommendations on how this could be done are provided in the following chapter.

6.1.2 Computer Reuse Organisations

With regard to computer reuse organisations in general, the foundation of some kind of industry association is suggested which could not only serve as a central point of contact and information for policy-makers or as lobby institution but also plan and conduct joint campaigns offering information about the operations and processes in refurbishing computers.
This could on the one hand help in increasing the supply with used computers as (potential) suppliers may become (more) aware how secure/safe the refurbishing processes regarding data protection are (especially in comparison to recycling as outlined in Chapter 5.1.1) with among others CCTV monitoring, inventory tracking and certifications for data wiping. On the other hand could information campaigns also aim at changing people's image of used computers as old, broken and slow and instead show how well-performing and reliable used refurbished computers are and thus help growing the domestic demand and market(s) – but also that they might usually be of better quality than new, low-priced computers from the consumer segment.
An issue might be the tough competition between commercial CROs which might make it hard to find a common agreement for founding such an organisation.

Computer reuse organisations with a Social Enterprise and Close the Digital Divide operating model should consider cooperations with kretsloppsparks or (e-)waste collection stations in order to increase their supply with used computers. This would not only contribute in (at least partly) solving the issue of lack of supply but also lead to increased levels of reuse. Nevertheless, more information about the suitability of computers sourced via this streams and the volume is needed in order to develop further strategies in this regard.

Social Enterprises should also look into potential cooperations with CROs with an IT Asset Management operating model. Some of the latter were (due to the high labour-related costs) found to scrap already broken and not very quickly repairable computers instead of preparing them for reuse. This could pose an opportunity to collect such computers and donate them to organisations with a Social Enterprise model as this would not only help them to increase their supply with used computers while not increasing their costs as the individuals working with preparing the computers for reuse are currently working for free. At the same time, such a practice would not bring any competition between both types of organisations as they serve different customer segments/types of customers as the findings suggest.
It remains unclear though how big the supply from commercial CROs would be or if they are willing to engage in such cooperations.

Computer reuse organisations with a Social Enterprise operating model should also investigate if it would be useful for them to employ a similar system in regard to data wiping as done by the assessed CtDD organisation. – Establishing a co-operation with the developer of the certified and popular data wiping software 'Blancco' where the software could be used for free but suppliers requesting a certification for the data wiping would have to pay a small fee

directly to the developing company of the Blancco software wiped computer. This could help in lifting the image from being seen as treehuggers to being perceived as (more) professional(s) and in cutting costs for buying new hard drives which in the case of one organisation with a SE operating model were usually taken out and replaced by such new ones. At the same time this could also help to increase the trust from (potential) suppliers and thus also lead to increased supply and higher related turnovers and help in developing economically sustainable operations in the middle or long run. Here, the widening of the targeted customer segments beyond the current ones of non-commercial organisations and specific eligible individuals/private persons could also be considered. Successful examples for bridging financially sustainable computer (and ICT) reuse operations with social goals are the AfB Group active in Germany and Austria or the earlier introduced social enterprise Rehab Recycle in Ireland (AfB Group, n.d.; Rehab Recycle, n.d.).

6.2 Recommendations for Further Research

While several issues to computer reuse and the operations of computer reuse organisations in the Swedish context have been revealed and addressed with practical recommendations in the last Chapter 6.1, several have not been addressed – mainly due to a lack of information.
Thus, future research should address the aspects which emerged during the course of the research and which are presented in the following.

After the main and sub-types of suppliers and (receiving) customers of CROs in Sweden have been identified for the respective operating models, future research should focus on studying what keeps (potential) suppliers from supplying their used computers to CROs. Furthermore, it should be researched what keeps (potential) buyers from buying refurbished computers. Here, especially public organisations and institutions which are expected to act as frontrunners should be in the focus. While the earlier introduced study by computer reuse company Inrego (2014) already revealed some insights, it only considered private and public sector organisations with more than 250 employees.
This would allow for addressing the respective issues more specifically via policy measures and/or actions from the side of CROs in Sweden.

Research should also be carried out about how the currently existing recycling (collection) system in Sweden can be adapted to offer broader and better opportunities for the reuse of computers but also other ICT and electrical and electronics equipment and how computer/ICT reuse organisations could for example be integrated in or co-operate with the currently existing system run by El Kretsen and Elektronikåtervinning i Sverige.

In regard to possible co-operations between kretsloppsparks and computer reuse organisations with a SE or CtDD operating model, it should be researched how feasible computers and other ICT equipment collected via this channel are for refurbishing and reuse purposes of both types of organisations. An unpublished study for the situation in Denmark from 2015 commissioned by a multinational ICT manufacturing company found that laptops and desktop computers collected via public (e-)waste collection stations were not deemed feasible for reuse – but the first results provided by the assessed CtDD organisation in Sweden show something different (Anthesis, 2015).

New studies with a focus on the Swedish context should also aim at including a bigger sample of organisations with a CtDD and SE operating model as the numbers within the study at hand are with one, respectively two organisations small. Bigger samples might reveal more accurate data on those.

Future research should also include the newly discovered barriers summarized in Appendix XII to see if these were only perceived by single assessed organisations or play a role as general barriers or just in the case of (a) certain operating model(s).

Research regarding the types of computer reuse organisations, their supply and (receiving) customer structures as well as their barriers should also be carried out in other national contexts to gain a better understanding of the impacts and influences of certain cultural, legislative and other circumstances on the former aspects and computer reuse in the respective countries in general. As so far no other comprising studies differentiating between operating models in regard to barriers, types of suppliers and (receiving) customers have been conducted.

Bibliography

AfB Group. (n.d.). AfB social & green IT. Retrieved May 14, 2016 from http://www.afb-group.de/en/company

Agamuthu, P., Cooper, J., & Herat, S. (2012). Dilemma in re-use and recycling of waste electrical and electronic equipment. *Waste Management & Research*, *30*(11), 1111-1112. http://dx.doi.org/10.1177/0734242x12451406

Andrae, A., & Andersen, O. (2010). Life cycle assessments of consumer electronics - are they consistent?. *International Journal of Life Cycle Assessment*, *15*(8), 827-836. http://dx.doi.org/10.1007/s11367-010-0206-1

Anthesis. (2015). The suitability of household end-of-life IT for reuse in Denmark – EXTERNAL. [Received via email].

Ashayeri, J., Heuts, R., Jansen, A., & Szczerba, B. (1996). Inventory management of repairable service parts for personal computers. *International Journal of Operations & Production Management*, *16*(12), 74-97. http://dx.doi.org/10.1108/01443579610151760

Assadourian, E. (2010). The Rise and Fall of Consumer Cultures. In L. Starke & L. Mastny (Eds.), *State of the world 2010. Transforming cultures. From consumerism to sustainability* (pp. 3-20). New York: W.W. Norton.

Babbitt, C., Kahhat, R., Williams, E., & Babbitt, G. (2009). Evolution of Product Lifespan and Implications for Environmental Assessment and Management: A Case Study of Personal Computers in Higher Education. *Environmental Science & Technology*, *43*(13), 5106-5112. http://dx.doi.org/10.1021/es803568p

Babbitt, C., Williams, E., & Kahhat, R. (2011). Institutional Disposition and Management of End-of-Life Electronics. *Environmental Science & Technology*, *45*(12), 5366-5372. http://dx.doi.org/10.1021/es1028469

Baldé, C., Wang, F., Kuehr, R., & Huisman, J. (2015). *The global e-waste monitor 2014. Quantities, flows and resources*. Bonn, Germany: United Nations University, IAS – SCYCLE. Retrieved from http://i.unu.edu/media/unu.edu/news/52624/Global-E-waste-Monitor-2014-small2.pdf

Bauer, B., Gylling, A. C., Trzepacz, S., Sander Poulsen, T., & Tojo, N. (2013). Prevention of WEEE Generation - An Idea Catalogue. Nordic WEEE Ideas and projection. Unpublished manuscript, Nordic Council of Ministers.

Becker, F. (2009). Reuse-networks - a contribution to a zero waste strategy. In P. Lechner (Ed.), *Prosperity waste and waste resources. 3rd BOKU Waste Conference 2009* (pp. 161-170). Vienna, Austria: OKU-University of Natural Resources and Applied Life Sciences.

Blancco. (n.d.). Certifications guarantee safety and compliance. Retrieved April 13, 2016 from http://www.blancco.com/sites/default/files/product_sheets/certifications_fact_sheet_uk.pdf

Brandtzæg, P., Heim, J., & Karahasanović, A. (2011). Understanding the new digital divide—A typology of Internet users in Europe. *International Journal Of Human-Computer Studies*, *69*(3), 123-138. http://dx.doi.org/10.1016/j.ijhcs.2010.11.004

British Environment Agency. (2014). Hazardous waste: consignment note - supplementary guidance. Retrieved June 10, 2015 from https://www.gov.uk/guidance/hazardous-waste-consignment-note-supplementary-guidance

Bryson, A. (2012). *Social research methods* (4th ed.). Oxford, UK: Oxford University Press.

Chi, X., Streicher-Porte, M., Wang, M., & Reuter, M. (2011). Informal electronic waste recycling: A sector review with special focus on China. *Waste Management*, *31*(4), 731-742. http://dx.doi.org/10.1016/j.wasman.2010.11.006

Cumps, B., Van den Eynde, O., & Viaene, S. (2013, January 7). Impact of e-waste on the operating model of a "close the digital divide" organisation. Retrieved from:

http://aisel.aisnet.org/cgi/viewcontent.cgi?article=1294&context=ecis2013_cr

Dagan, R., Dubey, B., Bitton, G., & Townsend, T. (2007). Aquatic Toxicity of Leachates Generated from Electronic Devices. *Arch Environ Contam Toxicol*, *53*(2), 168-173. http://dx.doi.org/10.1007/s00244-006-0205-1

Dalrymple, I., Wright, N., Kellner, R., Bains, N., Geraghty, K., Goosey, M., & Lightfoot, L. (2007). An integrated approach to electronic waste (WEEE) recycling. *Circuit World*, *33*(2), 52-58. http://dx.doi.org/10.1108/03056120710750256

De Brito, M. P., & Dekker, R. (2004). A framework for reverse logistics. In R. Dekker, M. Fleischmann, K. Inderfurth & van Wassenhove, L.N. (Eds.), *Reverse logistics. Quantitative models for closed- loop supply chains* (pp. 3-27). Berlin/Heidelberg, Germany: Springer.

Dell (n.d.). *Dell refurbished computers & electronics. Official dell store*. Retrieved October 20th 2015 from https://dellrefurbished.com/

Deng, W., Louie, P., Liu, W., Bi, X., Fu, J., & Wong, M. (2006). Atmospheric levels and cytotoxicity of PAHs and heavy metals in TSP and PM2.5 at an electronic waste recycling site in southeast China. *Atmospheric Environment*, *40*(36), 6945-6955. http://dx.doi.org/10.1016/j.atmosenv.2006.06.032

Denzin, N. K. (1978). *Sociological Methods: A Sourcebook* (2nd ed.). New York, NY: McGraw-Hill.

Dhanda, K., & Peters, A. (2005). Reverse logistics in the computer industry. *International Journal of Computers, Systems and Signals*, *6*(2), 57-67.

Dietrich, J., Curran, T., Schadlbauer, S., Modoran, D., Musterle, J., Kast, G., … Aionesei, C. (2014). Extending product lifetimes: a reuse network for ICT hardware. *Proceedings of the ICE - Waste and Resource Management*, *167*(3), 123-135. http://dx.doi.org/10.1680/warm.13.00024

Dietrich, J., Becker, F., Kast, G., Nittka, T., Kopacek, B., Schadlbauer, S., … Regenfelder, M. (2012). Practical demonstrator "ReUse ICT Network". In K.-D. Lang, N. F. Nissen, A. Middendorf, & P. Chancerel (Eds.), *Electronics Goes Green 2012+ (EGG) Proceedings*. Retrieved from http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6360505

Directive 2006/112/EC of the European Council of 28 November 2006 on the common system of value added tax [2006] OJ L347/1. Retrieved June 1, 2016, from http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32006L0112&from=EN

Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives [2008] OJ L312/3. Retrieved June 8, 2015, from http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0098&from=EN

Directive 2012/19/EU of the European Parliament and of the Council of 4 July 2012 on waste electrical and electronic equipment (WEEE) (recast) [2012] OJ L197/38. Retrieved June 8, 2015, from http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32012L0019&from=EN

Dowlatshahi, S. (2000). Developing a Theory of Reverse Logistics. *Interfaces*, *30*(3), 143-155. http://dx.doi.org/10.1287/inte.30.3.143.11670

Eriksson, P. (2015). Begagnat – för pris och miljö [Used - for the price and the environment]. Retrieved April 13, 2016 from http://upphandling24.se/begagnat-for-pris-och-miljo/

European Commission [EC]. (2012). Guidance on the interpretation of key provisions of Directive 2008/98/EC on waste. Retrieved June 3, 2015, from http://ec.europa.eu/environment/waste/framework/pdf/guidance_doc.pdf

European Commission [EC]. (2015a). Waste Prevention. Retrieved May 27, 2015 from http://ec.europa.eu/environment/waste/prevention/legislation.htm

European Commission [EC]. (2015b). Directive 2008/98/EC on waste (Waste Framework Directive). Retrieved June 2, 2015 from http://ec.europa.eu/environment/waste/framework/

Fernández Quesada, I. (2013). The concept of reverse logistics. A review of literature. *Reverse Logistics Magazine*, *7*(12), 40-47. Retrieved June 8, 2015, from http://rlmagazine.com/RLMagazine_Edition_58.pdf

Fitzpatrick, C., Hickey, S., O'Connell, M., Cronin, É., Paddy, F., & Grout, I. (2012). A bridge from unsustainable e-waste to sustainable e-resources. In R. Kahhat, K. Hieronymi & E. Williams, *E-waste management: from waste to resource* (pp. 209-235). London, UK: Earthscan.

Flick, U. (2006). An introduction to qualitative research (3rd ed.). London, UK: Sage.

Förordning om överlåtelse av statens lösa egendom [Regulation on the disposition of the state's loose property] (SFS 1996:1191). Retrieved June 29, 2015, from http://www.riksdagen.se/sv/Dokument-Lagar/Lagar/Svenskforfattningssamling/Forordning-19961191-om-over_sfs-1996-1191/

Forge, S. (2007). Powering down: remedies for unsustainable ICT. *Foresight*, *9*(4), 3-21. http://dx.doi.org/10.1108/14636680710773795

Gabrielsson, A. (2015, July 15). Stora problem med inbrott på återvinningen – trots kameraövervakning. [Big problems with burglaries at civic amenity sites – despite CCTV]. *Allehanda*. Retrieved from http://www.allehanda.se/angermanland/solleftea/stora-problem-med-inbrott-pa-atervinningen-trots-kameraovervakning

Garlapati, V. K. (2016). E-waste in India and developed countries: Management, recycling, business and biotechnological initiatives. Renewable and Sustainable Energy Reviews, 54, 874-881. http://dx.doi.org/10.1016/j.rser.2015.10.106

Gartner (2016, January, 12). Gartner says worldwide pc shipments declined 8.3 percent in fourth quarter of 2015. Holiday sales provided little cheer to pc vendors in 2015. Retrieved 20th January 2016 from http://www.gartner.com/newsroom/id/3185224

Gharfalkar, M., Ali, Z., & Hillier, G. (2015, July). *Clarifying the definitions of various reuse options for effective recovery of resources from waste streams*. Paper presented at the 3rd International Conference on Sustainable Solid Waste Management, Pyrgos/Tinos Island, Greece.

Goosey, M. & Kellner, R. (2002, n.d.). A scoping study end-of-life printed circuit boards. Retrieved June 18th 2015 from http://www.cfsd.org.uk/seeba/TD/reports/PCB_Study.pdf

Hakim, C. (2000). *Research Design: Successful designs for social and economic research* (2nd ed.). London, UK: Routledge.

Hall, W., & Williams, P. (2007). Separation and recovery of materials from scrap printed circuit boards. *Resources, Conservation and Recycling*, *51*(3), 691-709. http://dx.doi.org/10.1016/j.resconrec.2006.11.010

Hickey, S., & Fitzpatrick, C. (2008). Combating Adverse Selection in Secondary PC Markets. *Environmental Science & Technology*, *42*(8), 3047-3052. http://dx.doi.org/10.1021/es071706x

Hickey, S. (2009). *Use phase signals to promote lifetime extension for desktop PCs*. (Doctoral dissertation, University of Limerick, Limerick, Republic of Ireland). Retrieved from

http://research.microsoft.com/pubs/79385/Stewart%20Hickey%20-%20Thesis%20-%20Use%20Phase%20Signals%20to%20Promote%20Lifetime%20Extension%20for%20Desktop%20PCs.pdf

Höhn, R., & Brinkley, A. (2003). IBM's environmental management of product aspects. In R. Kuehr, & E. Williams (Eds.), *Computers and the environment: Understanding and managing their impacts* (pp. 87-98). Dordrecht: Kluwer.

HP. (n.d.). HPE Renew – Americas. Retrieved June 19, 2015, from http://www.hp.com/united-states/hpe-renew/

Hsieh, A. (2010). *Analysis of drivers and barriers for personal computer re-use. A case study of secondary PCs in Taiwan* (Master's thesis, Lund University). Retrieved from LUP Student Papers database. (UMI No. IIIEE Theses 2010: 06)

Huisman, J. (2012). Eco-efficiency evaluation of WEEE take-back systems. In V. Goodship & A. Stevels, *Waste Electrical and Electronic Equipment (WEEE) Handbook* (pp. 93-119). Cambridge, UK: Woodhead.

Humphries, M. (2012). *Rare earth elements: The global supply chain* (CSR Report No. 7-5700, R41347). Retrieved June 3, 2015, from http://fpc.state.gov/documents/organisation/193701.pdf

Ijomah, W. L. (2002). *A model-based definition of the generic remanufacturing business process* (Doctoral dissertation, Plymouth University, Plymouth, UK). Retrieved from https://pearl.plymouth.ac.uk/bitstream/handle/10026.1/601/434296.pdf

Ijomah, W. L., & Danis, M. (2012). Refurbishment and reuse of WEEE. In V. Goodship & A. Stevels, *Waste Electrical and Electronic Equipment (WEEE) Handbook* (pp. 145-162). Cambridge, UK: Woodhead.

Ijomah, W. L., Hammond, G. P., Childe, S. J., & McMahon, C. A. (2005). A robust description and tool for remanufacturing: A resource and energy recovery strategy. In R. Yamamoto, Y. Furukawa, H. Koshibu, P. Eagan, H. Griese, Y. Umeda, & K. Aoyama (Eds.), *EcoDesign 2005. Fourth international symposium on environmentally conscious design and inverse manufacturing. Proceedings* (pp. 472-479). Retrieved from http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=1619269

Inrego. (2012). Företagen skrotar datorer för en halv miljard kronor i år [Companies scrap computers for half a billion SEK this year]. Retrieved May 25, 2015, from http://www.inrego.se/pressrum#/pressreleases/foeretagen-skrotar-datorer-foer-en-halv-miljard-kronor-i-aar-820282

Inrego. (2014). Företag och myndigheter skrotar datorer för över 600 miljoner kronor [Businesses and public authorities scrap computers worth more than 600 million SEK]. Retrieved June 27, 2015, from http://www.inrego.se/pressrum#/pressreleases/foeretag-och-myndigheter-skrotar-datorer-foer-oever-600-miljoner-kronor-1082550

Intlekofer, K., Bras, B., & Ferguson, M. (2010). Energy implications of product leasing. *Environmental Science & Technology*, *44*(12), 4409-4415. http://dx.doi.org/10.1021/es9036836

Jägemar, R. O. (2015, July 29). Stöldvåg på återvinningscentral. [Spate of thefts at civic amenity site]. *SVT Nyheter Uppsala*. Retrieved from http://www.svt.se/nyheter/lokalt/uppsala/stoldvag-pa-atervinningscentral

Jönbrink, A. K. (2007). *European Commission DG TREN Preparatory studies for eco-design requirements of EuPs (Contract TREN/D1/40-2005/LOT3/S07.56313). Lot 3 personal computers (desktops and laptops) and computer monitors. Final report (Task 1-8)*. Mölndal, Sweden: IVF Industrial Research and Development Corporation.

Johnson, M. R., & Wang, M. H. (1995). Planning product disassembly for material recovery opportunities. *International Journal of Production Research*, *33*(11), 3119-3142. http://dx.doi.org/10.1080/00207549508904864

Jun, H.-B., Cusin, M., Kiritsis, D., & Xirouchakis, P. (2007). A multi-objective evolutionary algorithm for EOL product recovery optimization: turbocharger case study. *International Journal of Production Research*, *45*(18-19), 4573-4594. http://dx.doi.org/10.1080/00207540701440071

Kahhat, R., & Williams, E. (2009). Product or waste? Importation and end-of-life processing of computers in Peru. *Environmental Science & Technology*, *43*(15), 6010-6016. http://dx.doi.org/10.1021/es8035835

Kharas, H., & Gertz, G. (2010). The new global middle class: A cross-over from West to East. In C. Li (Ed.), *China's emerging middle class: Beyond economic transformation* (pp. 32-51). Washington, D.C.: Brookings Institution Press.

King, A. M., Burgess, S. C., Ijomah, W., & McMahon, C. A. (2006). Reducing waste: repair, recondition, remanufacture or recycle? *Sustainable Development*, *14*(4), 257-267. http://dx.doi.org/10.1002/sd.271

Kissling, R., Coughlan, D., Fitzpatrick, C., Boeni, H., Luepschen, C., Andrew, S., & Dickenson, J. (2013). Success factors and barriers in re-use of electrical and electronic equipment. *Resources, Conservation and Recycling*, *80*, 21-31. http://dx.doi.org/10.1016/j.resconrec.2013.07.009

Kissling, R., Fitzpatrick, C., Boeni, H., Luepschen, C., Andrew, S., & Dickenson, J. (2012). Definition of generic re-use operating models for electrical and electronic equipment. *Resources, Conservation and Recycling*, *65*, 85-99. http://dx.doi.org/10.1016/j.resconrec.2012.04.003

Knemeyer, A. M., Ponzurick, T. G., & Logar, C. M. (2002). A qualitative examination of factors affecting reverse logistics systems for end-of-life computers. *International Journal of Physical Distribution & Logistics Management*, *32*(6), 455-479. http://dx.doi.org/10.1108/09600030210437979

Krikke, H. R., van Harten, A., & Schuur, P. C. (1999). Business case Roteb: recovery strategies for monitors. *Computers & Industrial Engineering*, *36*(4), 739-757. http://dx.doi.org/10.1016/s0360-8352(99)00163-1

Lag om offentlig upphandling [Act on public procurement] (SFS 2007:1091). Retrieved June 29, 2015, from https://www.riksdagen.se/sv/Dokument-Lagar/Lagar/Svenskforfattningssamling/_sfs-2007-1091/

Lee, H. M., & Sundin, E. (2012). The Swedish WEEE system - Challenges and recommendations. In *Proceedings of the 2012 IEEE International Symposium on Sustainable Systems and Technology (ISSST)*. Retrieved from http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6228012

Leung, A., Luksemburg, W., Wong, A., & Wong, M. (2007). Spatial Distribution of Polybrominated Diphenyl Ethers and Polychlorinated Dibenzo- p -dioxins and Dibenzofurans in Soil and Combusted Residue at Guiyu, an Electronic Waste Recycling Site in Southeast China. *Environmental Science & Technology*, *41*(8), 2730-2737. http://dx.doi.org/10.1021/es0625935

Leung, A., Duzgoren-Aydin, N., Cheung, K., & Wong, M. (2008). Heavy Metals Concentrations of Surface Dust from e-Waste Recycling and Its Human Health Implications in Southeast China. *Environmental Science & Technology*, *42*(7), 2674-2680. http://dx.doi.org/10.1021/es071873x

Li, H., Yu, L., Sheng, G., Fu, J., & Peng, P. (2007). Severe PCDD/F and PBDD/F Pollution in Air around an Electronic Waste Dismantling Area in China. *Environmental Science & Technology*, *41*(16), 5641-5646. http://dx.doi.org/10.1021/es0702925

Li, Y., Huo, X., Liu, J., Peng, L., Li, W., & Xu, X. (2010). Assessment of cadmium exposure for neonates in Guiyu, an electronic waste pollution site of China. *Environmental Monitoring and Assessment*, *177*(1-4), 343-351. http://dx.doi.org/10.1007/s10661-010-1638-6

Lind, J. (2014, November 12). Datorer för 650 miljoner kronor skrotas varje år [Computers worth 650 million SEK scrapped each year]. *Dagens Nyheter*. Retrieved June 1, 2015 from http://www.dn.se/ekonomi/datorer-for-650-miljoner-kronor-skrotas-varje-ar/

Ljunggren Söderman, M., Palm, D., & Rydberg, T. (2011). Förebygga avfall med kretsloppsparker. Analys av miljöpåverkan [Prevent waste with circularity parks. An analysis of the environmental effects]. Retrieved March 4, 2016, from http://www3.ivl.se/rapporter/pdf/B1958.pdf

Marcotte, S., Hallé, M.-E., & Montreuil, B. (2008). Computer hardware reverse logistics: A field study of Canadian facilities. Retrieved June 5, 2015, from https://www.cirrelt.ca/DocumentsTravail/CIRRELT-2008-41.pdf

Markannen, J. (2015, May 13). Ständiga inbrott på återvinningen. [Permanent burglaries at civic amenity sites]. *Skånska Dagbladet*. Retrieved from http://www.skd.se/2015/05/13/standiga-inbrott-pa-atervinningen/

Mayers, K., France, C., Cleverly, A., Kabouris, E., & Planas, S. (2002). The use and disposal of IT products within commercial markets. *Jnl Of Bus & Indus Marketing, 17*(5), 357-378. http://dx.doi.org/10.1108/08858620210439040

Meadows, D. H., Randers, J., & Meadows, D. L. (2004). *Limits to growth. The 30-year update*. White River Junction, VT: Chelsea Green.

Melissen, F. W., & De Ron, A. J. (1999). Defining recovery practices - definitions and terminology. *International Journal on Environmentally Conscious Manufacturing and Design, 8*(2), 1-18.

Microsoft. (2014). Microsoft Windows Operating System Licensing Guide. Guide for Refurbished Personal Computers (PC). Retrieved May 10, 2016 from http://download.microsoft.com/download/F/5/5/F5549310-DBCE-4762-AA1A-A2012A65F2DB/Microsoft_Refurbished_PC_Licensing_Guidelines_FY14Q2.pdf

Microsoft. (n.d. a). Refurbished PCs. Contact a Microsoft Refurbisher Today. Retrieved May 30, 2015 from https://www.microsoft.com/refurbishedpcs/Directory.aspx

Microsoft. (n.d. b). Get affordable and reliable refurbished PCs with Microsoft Windows software! Retrieved May 30, 2015 from https://www.microsoft.com/OEM/en/licensing/sblicensing/Pages/refurbisher_programs.aspx#fbid=ottqZ09gO9k

Ming, K.L., Williams, D.J., & Dixon, C. (1997). The economics of end of life management strategy choice: Route to revenue generation from mature products. In *Proceedings of the 1997 IEEE International Symposium on Electronics and the Environment ISEE – 1997* (pp. 291–296). Rerieved from http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=605343

Naturvårdsverket. (2015a). *Tillsammans vinner vi på ett giftfritt och resurseffektivt samhälle. Sveriges program för att förebygga avfall 2014–2017* [Together we reach a non-toxic and resource-efficient society. Sweden's programme for preventing waste 2014-2017]. Stockholm, Sweden: Naturvårdsverket. Retrieved from: https://www.naturvardsverket.se/Documents/publikationer6400/978-91-620-6654-3.pdf

Naturvårdsverket. (2015b). *Tillsammans vinner vi på ett giftfritt och resurseffektivt samhälle. Bilagor. Sveriges program för att förebygga avfall 2014–2017* [Together we reach a non-toxic and resource-efficient society. Appendices. Sweden's programme for preventing waste 2014-2017]. Stockholm, Sweden: Naturvårdsverket. Retrieved from: https://www.naturvardsverket.se/Documents/publikationer6400/978-91-620-6654-3_Bilagor.pdf

F. Nilsson. (2013a, May 20). Visst får myndigheter sälja egendom [Certainly authorities may sell property]. [Web log comment]. Retrieved June 10, 2015 from http://blogg.inrego.se/miljo/2013/visst-far-myndigheter-salja-egendom/

F. Nilsson. (2013b, May 29). Så kan tillverkarna bädda för återanvändning! [So can manufacturers embed reuse!]. [Web log comment]. Retrieved June 10, 2015 from http://blogg.inrego.se/miljo/2013/sa-kan-tillverkarna-badda-for-ateranvandning/

Nilsson, F. (2014, May 9). Begagnade datorer duger åt eleverna! [Used computers are good enough for students!]. *Dagens Samhälle*. Retrieved June 10, 2015 from http://www.dagenssamhalle.se/debatt/stelbent-upphandling-skapar-datorbrist-i-skolan-8946

O'Connell, M., & Fitzpatrick, C. (2013). *Re-evaluate re-use of electrical and electronic equipment (evaluation and mainstreaming)*. Wexford, Republic of Ireland: Environmental Protection Agency. Retrieved from https://www.epa.ie/pubs/reports/research/waste/STRIVE_110_RE-Evaluate%20-%20Re-use%20of%20Electrical%20and%20Electronic%20Equipment%20%28Evaluation%20and%20Mainstreaming%29.pdf

O'Connell, M., Fitzpatrick, C., & Hickey, S. (2010). Investigating reuse of B2C WEEE in Ireland. *In Proceedings of the 2010 IEEE International Symposium on Sustainable Systems & Technology (ISSST)*. Retrieved from: http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=5507675

O'Connell, M., Fitzpatrick, C., & Hickey, S. (2011). WEEE reuse trials in Ireland. In *Proceedings of the 2011 IEEE International Symposium on Sustainable Systems & Technology (ISSST)*. Retrieved from http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=5936910

O'Connell, M., Hickey, S., & Fitzpatrick, C. (2012). Evaluating the sustainability potential of a white goods refurbishment program. *Sustainability Science*, *8*(4), 529-541. http://dx.doi.org/10.1007/s11625-012-0194-0

Ongondo, F. O., Williams, I. D., & Cherrett, T. J. (2011). How are WEEE doing? A global review of the management of electrical and electronic wastes. *Waste Management*, *31*(4), 714-730. http://dx.doi.org/10.1016/j.wasman.2010.10.023

Ongondo, F. O., Williams, I. D., Dietrich, J., & Carroll, C. (2013). ICT reuse in socio-economic enterprises. *Waste Management*, *33*(12), 2600-2606. http://dx.doi.org/10.1016/j.wasman.2013.08.020

Osibanjo, O., & Nnorom, I. (2007). The challenge of electronic waste (e-waste) management in developing countries. *Waste Management & Research*, *25*(6), 489-501. http://dx.doi.org/10.1177/0734242x07082028

Parkinson, H. J., & Thompson, G. (2003). Analysis and taxonomy of remanufacturing industry practice. *Proceedings Of The Institution Of Mechanical Engineers, Part E: Journal Of Process Mechanical Engineering*, *217*(3), 243-256. http://dx.doi.org/10.1243/095440803322328890

Perez-Belis, V., Bovea, M., & Ibanez-Fores, V. (2014). An in-depth literature review of the waste electrical and electronic equipment context: Trends and evolution. *Waste Management & Research*, *33*(1), 3-29. http://dx.doi.org/10.1177/0734242x14557382

Perkins, D., Brune Drisse, M., Nxele, T., & Sly, P. (2014). E-Waste: A Global Hazard. *Annals of Global Health*, *80*(4), 286-295. http://dx.doi.org/10.1016/j.aogh.2014.10.001

Quariguasi Frota Neto, J., & Bloemhof, J. (2011). An analysis of the eco-efficiency of remanufactured personal computers and mobile phones. *Production and Operations Management*, *21*(1), 101-114. http://dx.doi.org/10.1111/j.1937-5956.2011.01234.x

Rahman, S., & Subramanian, N. (2012). Factors for implementing end-of-life computer recycling operations in reverse supply chains. *International Journal of Production Economics*, *140*(1), 239-248. http://dx.doi.org/10.1016/j.ijpe.2011.07.019

Randers, J. (2012). *2052: A global forecast for the next forty years*. White River Junction, VT: Chelsea Green.

Ravi, V., Shankar, R., & Tiwari, M. (2005). Analyzing alternatives in reverse logistics for end-of-life computers: ANP and balanced scorecard approach. *Computers & Industrial Engineering*, *48*(2), 327-356. http://dx.doi.org/10.1016/j.cie.2005.01.017

Rehab Recycle. (n.d.). About Rehab Recycle. Retrieved May 14, 2016 from http://www.afb-group.de/en/company

Richter, F. (2016). Global PC Sales Fall to Eight-Year Low. Retrieved January, 20, 2015 from http://www.statista.com/chart/4231/global-pc-shipments/

Robinson, B. (2009). E-waste: An assessment of global production and environmental impacts. *Science of the Total Environment*, *408*(2), 183-191. http://dx.doi.org/10.1016/j.scitotenv.2009.09.044

Rogers, D. S., & Tibben-Lembke, R. S. (1999). *Going backwards*. Reno, NV: University of Nevada, Reno, Center for Logistics Management.

Rubinstein, L. (2004, May). Economic sustainability of reuse as an end-of-life management tool for computers and televisions. In D. Dickinson, H. S. Matthews, P. Muscanelli (Co-Chairs), *2004 IEEE International Symposium on Electronics & the Environment*. Conducted in Scottsdale, AZ. Retrieved June 20, 2015, from http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=1299678

Schischke, K., Kohlmeyer, R., Griese, H., & Reichl, H. (2003, December). Life cycle energy analysis of PCs - environmental consequences of lifetime extension through reuse. In *11th LCA Casse Studies Symposium*. Conducted in Lausanne, Switzerland. Retrieved May 29, 2015, from https://www.researchgate.net/profile/Karsten_Schischke/publication/268435652_LIFE_CYCLE_ENERGY_ANALYSIS_OF_PCS__ENVIRONMENTAL_CONSEQUENCES_OF_LIFETIME_EXTENSION_THROUGH_REUSE/links/54bd1f800cf218d4a16a05c7.pdf

Sepúlveda, A., Schluep, M., Renaud, F., Streicher, M., Kuehr, R., Hagelüken, C., & Gerecke, A. (2010). A review of the environmental fate and effects of hazardous substances released from electrical and electronic equipments during recycling: Examples from China and India. *Environmental Impact Assessment Review*, *30*(1), 28-41. http://dx.doi.org/10.1016/j.eiar.2009.04.001

Shih, L. (2001). Reverse logistics system planning for recycling electrical appliances and computers in Taiwan. *Resources, Conservation and Recycling*, *32*(1), 55-72. http://dx.doi.org/10.1016/s0921-3449(00)00098-7

Skatteverket. (2015). Nya arbetsgivaravgifter för unga. [New employer contributions for young people.] Retrieved June 2, 2016 from: https://www.skatteverket.se/omoss/nyheter/2015/nyheter/nyaarbetsgivaravgifterforunga.5.7be5268414bea06469447ee.html

Skatteverket. (2016). *The VAT Brochure*. Online: Swedish Tax Agency. Retrieved from: https://www.skatteverket.se/download/18.361dc8c15312eff6fd117b1/1462185115587/the-vat-brochure-skv552b-utgava15.pdf

Skatteverket. (n.d.). Sänkt arbetsgivaravgift för forskning i kommersiellt syfte. [Reduced payroll for research for commercial purposes]. Retrieved June 2, 2016 from: https://www.skatteverket.se/foretagorganisationer/arbetsgivare/socialavgifter/forskningsavdrag.4.8dcbbe4142d38302d7cb4.html

Skjøtt-Larsen, T., Schary, P. B., Mikkola, J. H., & Kotzab, H. (2007). *Managing the global supply chain* (3rd ed.). Copenhagen, Denmark: Copenhagen Business School Press.

Stake, R. E. (1995). *The Art of Case Study Research*. Thousand Oaks, CA; London, UK: Sage.

StEP Initiative [StEP]. (2009). *Solving the e-waste problem (StEP) white paper. One global understanding of re-use - common definitions*. Bonn, Germany: StEP Initiative/United Nations University. Retrieved from: http://www.step-initiative.org/files/step/_documents/StEP_TF3_WPCommonDefinitions.pdf

StEP Initiative [StEP]. (n.d. a). Our organisation. Retrieved June 5, 2015 from http://www.step-initiative.org/our-organisation.html

StEP Initiative [StEP]. (n.d. b). Our objectives. Retrieved June 5, 2015from http://www.step-initiative.org/our-objectives.html

StEP Initiative [StEP]. (n.d. c). Our role. Retrieved June 5, 2015 from http://www.step-initiative.org/our-role.html

StEP Initiative [StEP]. (n.d. d). Our work. Retrieved June 5, 2015 from http://www.step-initiative.org/our-work.html

Sthiannopkao, S., & Wong, M. (2013). Handling e-waste in developed and developing countries: Initiatives, practices, and consequences. *Science Of The Total Environment*, *463-464*, 1147-1153. http://dx.doi.org/10.1016/j.scitotenv.2012.06.088

Stock, J.R. (2001). Reverse logistics in the supply chain. In E. Cooper (Ed.), *Business briefing: Global Purchasing & Supply Chain Strategies* (pp. 44 – 48). London, UK: Business Briefings. Retrieved from http://www.lomag-man.org/reverselogistique/ReverseLogisticsintheSupplyChain7_J-stock.pdf

Svensk Insamlings Kontroll [SIK]. (n.d.). About us. Retrieved March 25, 2016 from http://www.insamlingskontroll.se/en/pages/about-us

Svenska MiljöEmissionsData [SMED]. (2012). *SMED Rapport Nr 105 2012. Kartläggning av flöden och upplagrade mängder av elektriska och elektroniska produkter i Sverige 2010* [SMED Report Nr. 105 2012. Mapping of flows and volume of stored electrical and electronic products in Sweden in 2010]. Norrköping, Sweden: Sveriges Meteorologiska och Hydrologiska Institut. Retrieved from http://www.smed.se/wp-content/uploads/2012/02/SMED-Rapport-2012-1051.pdf

Tan, A., Yu, W., & Arun, K. (2003). Improving the performance of a computer company in supporting its reverse logistics operations in the Asia-Pacific region. *International Journal of Physical Distribution & Logistics Management*, *33*(1), 59-74. http://dx.doi.org/10.1108/09600030310461007

Tan, A., & Kumar, A. (2008). A decision making model to maximise the value of reverse logistics in the computer industry. *International Journal of Logistics Systems and Management*, *4*(3), 297. http://dx.doi.org/10.1504/ijlsm.2008.017478

Teehan, P., & Kandlikar, M. (2012). Sources of variation in life cycle assessments of desktop computers. *Journal of Industrial Ecology*, *16*, 182-194. http://dx.doi.org/10.1111/j.1530-9290.2011.00431.x

The Broker Site BV. (n.d. a). Companies. Search Results. Retrieved August 21, 2015, from http://www.thebrokersite.com/companies.php?kw=sweden&a=1

The Broker Site BV. (n.d. b). Attendees of the EBM Athens 2015. Retrieved August 21, 2015, from http://www.europeanbrokermeeting.com/attendees.php

Thierry, M., Salomon, M., Van Nunen, J., & Van Wassenhove, L. (1995). Strategy issues in product recovery management. *California Management Review*, *37*(2), 114-135. http://dx.doi.org/10.2307/41165792

Townsend, T. (2011). Environmental issues and management strategies for waste electronic and electrical equipment. *Journal of the Air & Waste Management Association*, *61*(6), 587-610. http://dx.doi.org/10.3155/1047-3289.61.6.587

Truttmann, N., & Rechberger, H. (2006). Contribution to resource conservation by reuse of electrical and electronic household appliances. *Resources, Conservation and Recycling*, *48*(3), 249-262. http://dx.doi.org/10.1016/j.resconrec.2006.02.003

United Nations Industrial Development Organisation [UNIDO] & Microsoft. (2009). Reuse & Recycle: Growing Green Business. Retrieved May 26, 2015, from https://www.unido.org/fileadmin/user_media/Services/PSD/ICT/0_Green_busines.PDF

Van Dijk, J. A. G. M. (2009). One Europe, digitally divided. In A. Chadwick & P. N. Howard, *Routledge handbook of internet politics* (pp. 288-304). London, UK: Routledge.

Wadhwa, S., Madaan, J., & Chan, F. (2009). Flexible decision modeling of reverse logistics system: A value adding MCDM approach for alternative selection. *Robotics and Computer-Integrated Manufacturing*, *25*(2), 460-469. http://dx.doi.org/10.1016/j.rcim.2008.01.006

Wang, Y., Luo, C., Li, J., Yin, H., Li, X., & Zhang, G. (2011). Characterization of PBDEs in soils and vegetations near an e-waste recycling site in South China. *Environmental Pollution*, *159*(10), 2443-2448. http://dx.doi.org/10.1016/j.envpol.2011.06.030

Wang, W., & Pecht, M. (2011, May). *Impact analysis of electronics reuse using system dynamics*. Paper presented at the 2011 Prognostics and System Health Management Conference, Shenzen, China. Retrieved June 3, 2015 from http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=5939545

Waste & Resources Action Programme [WRAP]. (2011). *A methodology for quantifying the environmental and economic impacts of reuse*. Banbury, UK: WRAP. Retrieved from http://www.wrap.org.uk/sites/files/wrap/Final%20Reuse%20Method.pdf

Waste & Resources Action Programme [WRAP]. (2013). *PAS 141 Protocol: Product Guide. Desktop and laptop computers*. Banbury, UK: WRAP. Retrieved from http://www.wrap.org.uk/sites/files/wrap/PAS%20141%20Product%20Guide%20-%20Desktop%20and%20laptop%20computers.pdf

Waste & Resources Action Programme [WRAP]. (n.d. a). PAS 141 Re-use Standard. Retrieved April 25, 2016, from http://www.wrap.org.uk/content/pas-141-re-use-standard

Waste & Resources Action Programme [WRAP]. (n.d. b). Re-use protocols for electrical products. Retrieved April 25, 2016, from http://www.wrap.org.uk/content/re-use-protocols-electrical-products

Waste & Resources Action Programme [WRAP]. (n.d. c). The benefits of PAS 141. Retrieved April 25, 2016, from http://www.wrap.org.uk/content/benefits-pas-141

White, C., Masanet, E., Rosen, C., & Beckman, S. (2003). Product recovery with some byte: an overview of management challenges and environmental consequences in reverse manufacturing for the computer industry. *Journal Of Cleaner Production*, *11*(4), 445-458. http://dx.doi.org/10.1016/s0959-6526(02)00066-5

Widmer, R., Oswald-Krapf, H., Sinha-Khetriwal, D., Schnellmann, M., & Böni, H. (2005). Global perspectives on e-waste. *Environmental Impact Assessment Review*, *25*(5), 436-458. http://dx.doi.org/10.1016/j.eiar.2005.04.001

Williams, E. (2003). Environmental impacts in the production of personal computers. In R. Kuehr, & E. Williams (Eds.), *Computers and the environment: Understanding and managing their impacts* (pp. 41-72). Dordrecht: Kluwer.

Williams, E., Kahhat, R., Allenby, B., Kavazanjian, E., Kim, J., & Xu, M. (2008). Environmental, social, and economic implications of global reuse and recycling of personal computers. *Environmental Science & Technology*, *42*(17), 6446-6454. http://dx.doi.org/10.1021/es702255z

Williams, E., & Kuehr, R. (2003). Today's markets for used PCs - and ways to enhance them. In R. Kuehr, & E. Williams (Eds.), *Computers and the environment: Understanding and managing their impacts* (pp. 197-209). Dordrecht: Kluwer.

Williams, E., & Sasaki, Y. (2003). Strategizing the end-of-life handling of personal computers: resell, upgrade, recycle. In R. Kuehr, & E. Williams (Eds.), *Computers and the environment: Understanding and managing their impacts* (pp. 183-196). Dordrecht: Kluwer.

Wong, M., Wu, S., Deng, W., Yu, X., Luo, Q., & Leung, A. et al. (2007). Export of toxic chemicals – A review of the case of uncontrolled electronic-waste recycling. *Environmental Pollution*, *149*(2), 131-140. http://dx.doi.org/10.1016/j.envpol.2007.01.044

Wong, C., Wu, S., Duzgoren-Aydin, N., Aydin, A., & Wong, M. (2007). Trace metal contamination of sediments in an e-waste processing village in China. *Environmental Pollution*, *145*(2), 434-442. http://dx.doi.org/10.1016/j.envpol.2006.05.017

World Commission on Environment and Development [WCED]. (1987). *Report of the World Commission on Environment and Development: Our common future*. Oxford, UK: Oxford University Press.

Xing, G., Chan, J., Leung, A., Wu, S., & Wong, M. (2009). Environmental impact and human exposure to PCBs in Guiyu, an electronic waste recycling site in China. *Environment International*, *35*(1), 76-82. http://dx.doi.org/10.1016/j.envint.2008.07.025

Xu, X., Yang, H., Chen, A., Zhou, Y., Wu, K., & Liu, J. et al. (2012). Birth outcomes related to informal e-waste recycling in Guiyu, China. *Reproductive Toxicology*, *33*(1), 94-98. http://dx.doi.org/10.1016/j.reprotox.2011.12.006

Yu, J., Williams, E., Ju, M., & Yang, Y. (2010). Forecasting Global Generation of Obsolete Personal Computers. *Environmental Science & Technology*, *44*(9), 3232-3237. http://dx.doi.org/10.1021/es903350q

Ziout, A., Azab, A., & Atwan, M. (2014). A holistic approach for decision on selection of end-of-life products recovery options. *Journal of Cleaner Production*, *65*, 497-516. http://dx.doi.org/10.1016/j.jclepro.2013.10.001

Appendix I – List of Assessment Dimensions for Operating Models of ICT/EEE Reuse Organisations

In order to develop a typology of generic reuse operating models of organisations engaged in the reuse of electrical and electronic equipment, Kissling et al. (2012) used several dimensions in order to assess and differentiate between several operating models. While the operating models are labelled as related to the reuse of EEE, the main focus is on information and telecommunication technology equipment.

The different dimensions/criteria have already been described and laid out in Chapter 2.3.2. The following *Table A I-1* provides a summary of the relations between the level of depth of analysis, the dimensions and how they differ for each of the respective operating models.

Table A I-0-1. The vertices of Kissling et al.'s (2012) typology of ICT reuse organisations

Level of depth	**Operating Model**		**Dimension /Criterion**	**Operating Model**
1st	Non-profit		***Finance***	For profit
	Close the Digital Divide	**Social Enterprise**		**IT Asset Recovery Management**
2nd	Collection, cleaning & testing, data deletion/wiping, providing certifications for compliant reuse & data deletion, recycling services in cooperation with external partners; ensuring reuse in compliant manner	Preparation of ICT equipment for reuse & resale through charity outlets or directly	***Offerings***	Collection, cleaning & testing, data deletion/wiping, providing certifications for compliant reuse & data deletion, recycling services in cooperation with external partners
	Donations mainly from corporate public & commercial users but also individuals /private persons; in few cases also NPOs and/or NGOs	Donations mainly from large corporate public & commercial organisations (incl. OEMs and distributors; also from individuals/private persons	***Supply Chain***	Mainly corporate commercial & public users (either owning the equipment themselves or taking part in a take back program offered by a contracted OEM or leasing company); in few cases also from retailers, individual users, computers from OEM's in-house use or IT service companies
	Non-commercial organisations in developing countries (mainly educational or medical); individuals/private persons	Non-commercial organisations (e.g. medical & education-related organisations); individuals with low incomes; in exceptions also: commercial retailers/distributors	***(Receiving) Customer segments***	Different corporate users (incl. retailers/distributors), individuals, recipients of donation programmes
3rd	Provide marginalized people w/ access to ICT equipment & related services	Create employment and opportunities for education	***Primary aim***	n.a.

Source: Own graphical illustration of Kissling et al. (2012).

Appendix II – List of Types of Suppliers to Computer Reuse Organisations

The following *Table A II-1* depicts a summary of the general types of suppliers and respective more specific sub-groups as identified in literature and discussed in Chapter 2.3.3. In case of further limitations or additional information regarding specific sub-groups, the comments column provides further details as found in the listed sources.

Table A II-0-1. Types of suppliers of organisations engaged in computer/ICT reuse

General Types of Suppliers	Identified Sub-Groups	Source(s)	Comments
Non-commercial users		Kissling et al. (2012)	
	- Close the Digital Divide organisations	Kissling et al. (2012)	
Commercial (corporate) users		Cumps, Vanden Eynde and Viaene (2013), Kahhat & Williams (2009), Kissling et al. (2012), Kuehr & Williams (2003), Ongondo et al. (2013)	
	- Leasing companies	Dietrich et al. (2014), Kuehr & Williams (2003), Ongondo et al. (2013),	
	- Distributors & Retailers	Dietrich et al. (2014), Kissling et al. (2012)	
	- IT Service Companies	Kissling et al. (2012)	
	- OEMs	Höhn & Brinkley (2003), Kissling et al. (2012), White et al. (2003)	Computers from in-house use
	- Large commercial corporations	Dietrich et al. (2014)	Given examples are insurance companies and public enterprises
Public (corporate) users		Cumps, Van den Eynde and Viaene (2013), Höhn & Brinkley (2003), Kissling et al. (2012), Kuehr & Williams (2003), Ongondo et al. (2013)	
	- Governmental/State institutions & organisations / Public administration	Dietrich et al. (2014), Kahhat & Williams (2009), Kuehr & Williams (2003), Ongondo et al. (2013)	
	- Academic & educational institutions	Babbitt, Williams & Kahhat (2011), Kahhat & Williams (2009), Kuehr & Williams (2003)	Babbitt, Williams and Kahhat (2011) specifically point out universities
	- Collection points	Ongondo et al. (2013)	No specific information provided about what is

			meant with 'collection points'[45]
Private Consumers/Individuals		Höhn & Brinkley (2003), Kissling et al. (2012), Kuehr & Williams (2003), Ongondo et al. (2013), White et al. (2003)	

Source: Own categorization based on identified sources as stated in the table.

[45] The author assumes that the researchers refer to public collection points for (e-)waste.

Appendix III – List of Types of (Receiving) Customers of Computer Reuse Organisations

The following *Table A III-1* provides an overview about the general types of (receiving) customers of computer reuse organisations as found in literature and discussed in Chapter 2.3.4. The second column's ('Identified Sub-Groups') aim is to merely depict the different sub-types of non-commercial users and occasions to which used computers that have been prepared for reuse by computer reuse organisations are sold or donated to. These might partly overlap or interlace. For example may a medical institution exist in the form of a non-profit or non-governmental organisation or as a social project. It could also be a local partner organisation to a CtDD organisation

If specific limitations or information were existent, these have been considered and noted in the column named 'comments'.

Table A III-0-1. Types of receiving customers/recipients of organisations engaged in computer/ICT reuse

General Type(s) of Receiving Customers	Identified Sub-Groups[46]	Source(s)	Comment(s)
Non-commercial users		Kissling et al. (2012), Marcotte, Hallé & Montreuil (2008), O'Connell & Fitzpatrick (2013)	
	- Health/Medical institutions	Kissling et al. (2012)	In partner projects of computer reuse organisations with a 'Close the Digital Divide' operating model
	- Non-profit organisations (NPO)	Kissling et al. (2012), O'Connell & Fitzpatrick (2013)	
	- Non-governmental organisations (NGO)	Kissling et al. (2012)	
	- Local partner organisations of CtDD organisations	Kissling et al. (2012)	
	- Social projects	Dietrich et al. (2014)	Not further specified; here seen as projects for a social cause which are conducted outside a formally registered institution such as a NPO or NGO
	- Workers' unions	Dietrich et al. (2014)	
Commercial (corporate) users		Kissling et al. (2012), Marcotte, Hallé	Redeployment in other units/departments of the

[46] In regard to educational institutions, health/medical institutions, non-profit organisations, non-governmental organisations, as well as to private consumers/individuals, the recipients may either be located in the same country as the supplier of the used ICT equipment/computers to the reuse organisations (Social Enterprise model or as donations within the IT Asset Management model) or be located in less-developed countries when served by CtDD organisations and their partners. This depends on the operating model and the reuse organisation in each specific case.

		&Montreuil (2008), O'Connell & Fitzpatrick (2013), Ongondo et al. (2013), Williams & Kuehr (2003)	supplying organisation (Kissling et al., 2012)
	- Retailers/Resellers, distributors& brokers	Kissling et al. (2012), Marcotte, Hallé & Montreuil (2008)	
	- Small and medium-sized enterprises	Williams & Kuehr (2003)	
Public (corporate) users		Kissling et al. (2012), Marcotte, Hallé & Montreuil (2008), Williams & Kuehr (2003)	
	- Governmental institutions & organisations / Public administration organisations	Ongondo et al. (2013), Williams & Kuehr (2003)	
	- Educational institutions	Dhanda & Peters (2005), Dietrich et al. (2014), Kissling et al. (2012), Williams & Kuehr (2003)	Dhanda and Peters (2005), Dietrich et al. (2014) and Williams and Kuehr (2003) refer specifically to 'schools'
	- Collection points	Ongondo et al. (2013)	No specific information provided about what is meant with 'collection points'[47]
Private Consumers/ Individuals		Kissling et al. (2012), Marcotte, Hallé & Montreuil (2008), O'Connell & Fitzpatrick (2013), Ongondo et al. (2013), Williams & Kuehr (2003)	
	- Employees of commercial companies which refurbish for redeployment	Dietrich et al. (2014), Kissling et al. (2012)	Employees may either get computers prepared for reuse as a donation or be able to buy it from the commercial company letting the computers refurbish by an external computer reuse organisation
	- Low income/poor individuals	Kissling et al. (2012)	Specifically served by organisations with a Social Enterprise operating model

Source: Own categorization based on identified sources as stated in the table.

[47] The author assumes that the researchers refer to public collection points for (e-)waste. It is further assumed that due to the low percentage of equipment that this type of customer(s) receive, that it is about equipment which either cannot be refurbished or is seen as economically unfeasible to be prepared for reuse.

Appendix IV – List of Barriers to Computer/ICT Reuse Organisations

The following *Table A IV-1* provides a comprising list of the identified barriers which ICT/computer reuse organisations face based on the reviewed literature. The respective barriers are presented and discussed in chapter 2.3.5. The second column sheds light on if a barrier has been identified as a generic one or to only apply for ICT/computer reuse organisations with specific types of operating models or financial structures such as for- or non-profit ones. The 'comments' column provides further details about the respective barriers if available and needed.

Table A IV-0-1. List of barriers to computer reuse organisations as identified in literature

Barrier	Specific Financial Structure or Operating Model of Type of ICT / Computer Reuse Organisation	Source(s)	Comment(s) – partly also as stated in the original sources
Lack of legislation that sets financial incentives for reuse and enforces reuse & Regulations leading to economic unfeasibility of computer reuse operations	Generic	Dietrich et al. (2014), Kissling et al. (2013)	In Dietrich et al. (2014) the authors mention the changed depreciation rate for used ICT devices in Germany which was lowered from 60 to 36 months as an example
Lack of access to sufficient volumes of used equipment at good quality and at low costs	Generic, For-profit & Non-profit reuse organisations	Dietrich et al. (2014), Hsieh (2010), Kissling et al. (2013), Ongondo et al. (2013)	Hsieh (2010) mentions in regard to non-profit reuse organisations only the lack of supply with used equipment as a barrier, but neither quality nor costs; the same is stated for for-profit reuse organisations but the lack of supply is refined to 'high volumes of used PCs with identical configurations'; Ongondo et al. (2013) only refer to large quantities at good quality and also address specifically laptops but do not mention costs; Dietrich et al. (2014) refer to computers in general but point to certain countries (e.g. Romania) instead of proclaiming it as a general barrier
Bad reuse practices ('shame reuse') lead to reluctance towards reuse	Generic	Kissling et al. (2013)	
Competition from informal sector and from unlicensed recyclers	Generic	Kissling et al. (2013)	Some of these actors pay for used equipment, which also increases procurement costs for

			compliant institutions'
Public and industry organized collection and recycling schemes do not consider reuse in their design	Generic, For-profit & Non-profit reuse organisations	Dietrich et al. (2014), Hsieh (2010), Kissling et al. (2013), Ongondo et al. (2013)	Kissling et al. (2013) provide as further explanation: No value conserving collection; logistical and financial discrimination of retailers who contribute to EEE for reuse; Manufacturers' obligated WEEE take back services channelling potentially reusable WEEE to disposal/recycling; Hsieh (2010) states in the case of Taiwan that waste management policies are mainly targeted at recycling but do not consider (preparation for) reuse; Ongondo et al. (2013) point to the obligated WEEE take back services that would channel potentially reusable WEEE to disposal/recycling; Dietrich et al. (2014) also mentions the lack of value conserving collection but furthermore the facilities' unwillingness 'to hand over material to refurbishers'
Some OEMs do not approve of the sale of used products because they fear that these products compete with OEM branded new products	Generic	Kissling et al. (2013)	
Unpredictability in supply and demand / Lack of transparency of product availability	Generic	Dietrich et al. (2014), Kissling et al. (2013)	
Societal discussion on the soundness of reuse of appliances / Consumer non-confidence in refurbished equipment	Generic, For-profit & Non-profit reuse organisations	Kissling et al. (2013), Nilsson (2014), Ongondo et al. (2013)	Kissling et al. (2013) mention that producers promote the selling of new appliances, not reuse; Ongondo et al. (2013) identify consumer non-confidence in refurbished equipment as a barrier to non-profit reuse organisations; Nilsson (2014) mentions people's perception of used computers (and other goods) as inferior
Complex legal and	Generic	Kissling et al. (2013)	Especially for trans

regulatory situation leads to administrative effort and costs for collection, preparation for reuse and redistribution of used products			boundary movements from Non-OECD to OECD countries
Competition with (licensed) recyclers for supply of used equipment	Generic & For-profit reuse organisations	Hsieh (2010), Kissling et al. (2013)	Some recyclers pay for used equipment; Hsieh (2010) specifies this as a barrier to for-profit reuse organisations
No consideration of reuse in product designs	Generic, For-profit organisations	Kissling et al. (2013), Nilsson (2013b)	
Variety of different standards and lack of global reuse standard with clear definitions	Generic	Kissling et al. (2013)	
Market for products: prices of new EEE decrease, approaching the level of refurbishing costs; demand for used EEE decreases	Generic, For-profit & Non-profit reuse organisations	Hsieh (2010), Kissling et al. (2013), Ongondo et al. (2013)	Hsieh (2010) mentions the difference in market prices between used and new equipment as a barrier to for-profit as well as for non-profit reuse organisations; Ongondo et al. (2013) express this through mentioning 'time/cost of refurbishment versus final item cost
(High) Logistics costs	Generic & Non-profit reuse organisations	Hsieh (2010), Kissling et al. (2013), Ongondo et al. (2013)	Hsieh (2010) mentions logistics costs as a barrier to for-profit as well as to non-profit reuse organisations; Ongondo et al. (2013) stresses high fuel and (potentially) high collection costs in the case of non-profit reuse organisations
(High) Labour costs	Generic & For-profit reuse organisations	Dietrich et al. (2012), Dietrich et al. (2014), Hsieh (2010), Kissling et al. (2013)	Hsieh (2010) mentions high labour costs specifically as a barrier to for-profit reuse organisations; Dietrich et al. (2012) mention the high labour costs specifically for Europe
Lack of shop premises to increase sales	Non-profit reuse organisations	Ongondo et al. (2013)	
Publicity regarding fraud and identity theft leading to a circumspect approach to the donation of (used) equipment & Companies are reluctant to pass products on for reuse because of	Generic For-profit & Non-profit reuse organisations	Inrego (2014), Kissling et al. (2013), Ongondo et al. (2013)	

concerns about data security			
Social enterprises seen as 'tree huggers' rather than professionals	Non-profit reuse organisations	Ongondo et al. (2013)	
Finding customers for bulk volume sales	Non-profit reuse organisations	Ongondo et al. (2013)	
IT equipment held in lease agreements with large suppliers means companies cannot donate without breaching contracts	Non-profit reuse organisations	Ongondo et al. (2013)	
Legislation aimed at curtailing rogue reuse firms drives up licensing fees meaning extra expenses for legitimate reuse organisations	Non-profit reuse organisations	Ongondo et al. (2013)	
Consignment note regulations	Non-profit reuse organisations	Ongondo et al. (2013)	(extra administration charge to customer); seems a regulation specific to England/the UK, thus not further considered in the study at hand
Practical and logistical factors, including distance travelled to collect WEEE	Non-profit reuse organisations	Hsieh (2010), Ongondo et al. (2013)	
Limited collection capacity	Non-profit reuse organisations	Ongondo et al. (2013)	
Companies not wanting to pay for collection services offered	Non-profit reuse organisations	Ongondo et al. (2013)	
Organisations upgrading equipment less regularly	For-profit & Non-profit reuse organisations	Hsieh (2010), Ongondo et al. (2013)	Hsieh (2010) reports this regarding corporate (public and private) actors for Taiwan
Equipment stripped of vital components before donation & Difficulties in obtaining operating system disks to go with computers	Non-profit reuse organisations	Ongondo et al. (2013)	
Low value of some used equipment	For-profit & Non-profit reuse organisations	Hsieh (2010), Ongondo et al. (2013)	Hsieh (2010) states this for for-profit reuse organisations while Ongondo et al. (2013) report this as a barrier to non-profit reuse organisations
Company's perception of item value / Lack of awareness of residual value	Non-profit reuse organisations	Ongondo et al. (2013)	
Time intensive processing time	Non-profit reuse organisations	Ongondo et al. (2013)	

Vast range of technical knowledge required in order to process the variety of appliances received	Non-profit reuse organisations	Ongondo et al. (2013)	
Limited storage space for equipment	Non-profit reuse organisations	Ongondo et al. (2013)	
Poor storage practices can lead to damage and breakage of equipment	Non-profit reuse organisations	Ongondo et al. (2013)	
Low staff numbers	Non-profit reuse organisations	Ongondo et al. (2013)	
Software licenses too expensive / (potential) customers do not know how to operate alternative free software	For-profit reuse organisations	Hsieh (2010)	Specifically mentioned are licenses for Microsoft software which about 1/3rd of the interviewed for-profit reuse organisations perceived as too expensive
Damage of equipment during transportation/ collection processes	Generic & for-profit reuse organisations	Dietrich et al. (2014), Hsieh (2010)	Hsieh (2010) mentions this as a barrier specifically to for-profit reuse organisations
Lack of information about product condition results in uncertainty of quality of acquired products	Generic	Hsieh (2010)	Refers to information such as age and specifications of computers/systems
Cost & availability of spare parts	Generic	Hsieh (2010)	
Use of low quality components or materials by OEMs leading to shorter lifetimes of computers	For-profit reuse organisations	Hsieh (2010), Nilsson (2013b)	
Lack of economies of scale leading to increased operational costs	For-profit reuse organisations	Hsieh (2010)	For example due to the inspection, testing and data wiping processes
Marketing reuse as the preferred option when considering purchasing	Non-profit reuse organisations	Ongondo et al. (2013)	
Potential customers' lack of knowledge about the suitability of used computers for their needs	For-profit reuse organisations	Nilsson (2014)	Nilsson (2014) mentions specifically the objections of potential customers towards used computers in terms of a lack of power to run newer/the newest software but states that this does in most cases not apply
Potential purchasers' misunderstanding of respective regulations and laws	For-profit reuse organisations	Nilsson (2014)	The author points out that many people working in the procurement for public institutions/ organisations seem to think that they are not allowed to buy used

			equipment although the respective law (lagen om offentlig upphandling) does not prevent that
Potential suppliers' misunderstanding of respective regulations and laws	For-profit reuse organisations	Nilsson (2013a)	The author points out that many people working in the sales department for public institutions/ organisations seem to think that they are not allowed to sell used equipment on secondary markets although the respective law (Förordning (1996:1191) om överlåtelse av statens lösa egendom) does not prevent that
Lack of layout/design standards for computers	For-profit reuse organisations	Nilsson et al. (2013b)	Nilsson (2013b) refers rather to design/layout standards for laptops and related equipment (e.g. charging cable and docking station adapters) to allow for an easier reuse
Avoidance of spending time on selling the used equipment by potential suppliers	For-profit reuse organisations	Inrego (2014)	
Company policy stipulates that all IT equipment should be scrapped at EoL	For-profit reuse organisations	Inrego (2014)	

Source: Own compilation of barriers based on the ones identified in the respective sources stated in the table.

Appendix V – Interview Guide (Hand-out Version)

Part 1: Interview opening

Greeting

Introducing myself

M.Sc. student 'Environmental Management & Policy', 4th term, IIIEE/Lund University

Content and purpose of the interview

Naturvårdsverket, the Swedish EPA has only recently published the first waste prevention program for Sweden (June 2015). In it, the EPA defines four focus areas on which waste prevention and reduction should focus within the upcoming years, among them electronics via the extension of products' lifetimes as well as increased reuse. The defined strategies to reach these goals comprise among others: developing policies to support reuse, (further) developing existing and establishing new markets and business models as well as better provision of information regarding the overall matter. At the same time, Naturvårdsverket acknowledges that too little information is available regarding barriers and drivers in these markets to develop consistent policies.

Especially computers as a product group have been stated to be feasible for the extension of their life cycles (via direct or preparation for reuse) while at the same time (potentially) leading to reduced environmental burdens and socio-economic benefits. While organisations involved in activities aiming at computer reuse and lifetime extension are found in Sweden, relatively little is known about the market, the actors and their drivers as well as the barriers they are facing. Thus, this research aims to find out more about the involved actors, the drivers and barriers they are facing in order to provide a first insight into the field and allow for further, more detailed research respectively providing policy-makers with information.

Course of the interview

Duration: ca. 60-75 minutes

Recording/Anonymity

The interview will be recorded so that we can focus on the conversation. Anonymity will be preserved (if this is wished for). – Do you agree that the interview is recorded? Do you wish for anonymisation as a person and/or of the company?

Part 2: Introductory questions

1. Please tell me your position within the organisation/company?

2. Can you please tell me in which year the organisation/company was founded?

3. Please tell me the size of your organisation/company in terms of:
    a. Employees?
    b. Annual revenues (in SEK)?

4. Can you please tell me how big the annual volume of desktop computers and laptops is that your organisation/company handles?
    a. How big is the annual supply of items (in units)?
    b. How big are the annual sales of items (in units)?

5. Regarding the computers, could you please tell me the percentage of sourced products that can be reused/be prepared for reuse?
    a. Furthermore, I would like to know what is the average age of the sourced used computers?
    b. Also, can you please tell me what is the current average reuse lifespan (potential life time after having been prepared for reuse) of the computers?

Part 3: Company operations, suppliers & customers

6. Companies/Organisations being involved in the reuse of computers seem to cover a range of activities from collection to remarketing. Can you please describe what range of services your organisation/company offers to its supplying and receiving customers and what the related processes are?
    a. What do the operations look like?
    b. How does the typical process of refurbishing (e.g. from sourcing to remarketing) look like through which used computers typically pass at your organisation/company?

7. Literature suggests that organisations/companies involved in computer reuse can have different sources of supply such as companies, state agencies, municipalities or educational institutions such as universities. Can you please tell me from whom your organisation/company typically receives its supply of computers?

    a. Can you please also tell me the respective shares the different mentioned types of suppliers have in the overall supply with computers regarding your organisation/company?

    b. Furthermore, some organisations/companies involved in the reuse of computers seem to get their supply from abroad. Can you please tell me if your organisation/company sources from abroad and if so, from which regions?

    c. Can you please also tell me the share of used computers your organisation/company sources domestically and from abroad?

8. Not only the sources for used computers seem to vary but also the types of customers buying used computers. Can you please describe to what types of customers does your organisation/company usually sell computers prepared for reuse?

    a. Can you please also tell me the respective shares the different mentioned types of customers have of the overall donations/sales of your organisation/company?

    b. Furthermore, computers prepared for reuse seem often to be sold abroad. Can you please tell me if you sell computers to foreign markets and if so to which regions?

    c. Can you please also tell me the share of used computers your organisation/company sells in Sweden and the share it sells to other countries?

Part 4: Barriers

9. Generally, the supply/sourcing of used computers is perceived as an issue by organisations/companies involved in reuse/preparation for reuse activities. Can you please tell me what you perceive as the main barriers related to sourcing of used computers?

10. Another area related to sourcing is usually collection/logistics and the shipping of used computers to the refurbishing facility. I wonder whether you experienced any issues related to collection/logistics?

11. After the sourced products arrive at the refurbishing facility, literature suggests that they usually go through an inspection and are sorted according to certain criteria. Could you please tell me if you see any barriers related to these activities and if so, describe them specifically?

12. When looking at the recovery/refurbishing (process) of computers once they arrived at the refurbishing facilities, what are in your opinion the hindering factors for conducting such recovery processes for used computers?

13. Once computers have been prepared for reuse they are usually remarketed/redistributed. Can you please tell me, what would you see as the main barriers to remarketing/ redistributing used computers?

14. Generally, legislation and regulation is seen as a barrier hampering reuse of computers in different ways. Do you agree with this view? Could you please specify in what way you see legislation and regulation as a barrier to computer reuse? Are there any specific ones?

15. Costs related to the preparation of computers for reuse are also often seen as a barrier. Could you please specify what in your perspective the main cost-related barriers are?

16. ***Would you like to add something? Or would you like to ask me something or do you have any comments?***

Thank you very much for your time!

Appendix VI – Interview Guide for For-Profit Computer Reuse Organisations (Interviewer Version)

Part 1: Interview opening

Greeting

Introducing myself

M.Sc. student 'Environmental Management & Policy', 4th term, IIIEE/Lund University

Content and purpose of the interview

Naturvårdsverket, the Swedish EPA has only recently published the first waste prevention program for Sweden (June 2015). In it, the EPA defines four focus areas on which waste prevention and reduction should focus within the upcoming years, among them electronics via the extension of products' lifetimes as well as increased reuse. The defined strategies to reach these goals comprise among others: developing policies to support reuse, (further) developing existing and establishing new markets and business models as well as better provision of information regarding the overall matter. At the same time, Naturvårdsverket acknowledges that too little information is available regarding barriers and drivers in these markets to develop consistent policies.

Especially computers as a product group have been stated to be feasible for the extension of their life cycles (via direct or preparation for reuse) while at the same time (potentially) leading to reduced environmental burdens and socio-economic benefits. While organisations involved in activities aiming at computer reuse and lifetime extension are found in Sweden, relatively little is known about the market, the actors and their drivers as well as the barriers they are facing. Thus, this research aims to find out more about the involved actors, the drivers and barriers they are facing in order to provide a first insight into the field and allow for further, more detailed research respectively providing policy-makers with information.

Course of the interview

Duration: ca. 60-75 minutes

Recording/Anonymity

The interview will be recorded so that we can focus on the conversation. Anonymity will be preserved (if this is wished for). – Do you agree that the interview is recorded? Do you wish for anonymisation as a person and/or of the company?

Part 2: Introductory questions

1. Please tell me your position within the organisation/company?

2. Can you please tell me in which year the organisation/company was founded?

3. Please tell me the size of your organisation/company in terms of:
    a. Employees?
    b. Annual revenues (in SEK)?

4. Can you please tell me how big the annual volume of desktop computers and laptops is that your organisation/company handles?
    a. How big is the annual supply of items (in units)?
    b. How big are the annual sales of items (in units)?

5. Regarding the computers, could you please tell me the percentage of sourced products that can be reused/be prepared for reuse?
    a. Furthermore, I would like to know what is the average age of the sourced used computers?
    b. Also, can you please tell me what is the current average reuse lifespan (potential life time after having been prepared for reuse) of the computers?

Part 3: Company operations, suppliers & customers

6. Companies/Organisations being involved in the reuse of computers seem to cover a range of activities from collection to remarketing. Can you please describe what range of services your organisation/company offers to its supplying and receiving customers and what the related processes are?
    a. What do the operations look like?
    b. How does the typical process of refurbishing (e.g. from sourcing to remarketing) look like through which used computers typically pass at your organisation/company?

7. Literature suggests that organisations/companies involved in computer reuse can have different sources of supply such as companies, state agencies, municipalities or educational institutions such as universities. Can you please tell me from whom your organisation/company typically receives its supply of computers?

Type of suppliers identified in literature	**Sub-Type of suppliers identified in literature**	**Organisation of interview partner receiving from this type of supplier?**	**If not, why not?**	**Own comment(s)**
Non-commercial users				
	Close the Digital Divide Organisations			
Commercial (corporate) users				
	Leasing companies			
	Distributors & retailers			
	IT service companies			
	OEMs			
	Large commercial corporations in general			
Public (corporate) users				
	Governmental institutions & organisations			
	Public administration			
	Collection points			

Private consumers / Individuals				

a. Can you please also tell me the respective shares the different mentioned types of suppliers have in the overall supply with computers regarding your organisation/company?

b. Furthermore, some organisations/companies involved in the reuse of computers seem to get their supply from abroad. Can you please tell me if your organisation/company sources from abroad and if so, from which regions?

c. Can you please also tell me the share of used computers your organisation/company sources domestically and from abroad?

8. Not only the sources for used computers seem to vary but also the types of customers buying used computers. Can you please describe to what types of customers does your organisation/company usually sell computers prepared for reuse?

Type of receiving customers identified in literature	**Sub-Type of receiving customers identified in literature**	**Organisation of interview partner receiving from this type of**	**If not, why not?**	**Own comment(s)**

		supplier?		
Non-commercial users				
	Health/medical institutions (partner projects of Close the Digital Divide (CtDD) organis.			
	Non-profit organisations			
	Non-governmental org.			
	Local partner org. of Close the Digital Divide organisations			
	Social projects			
	Workers' unions			
Commercial (corporate) users				
	Retailers/Resellers, distributors & brokers			
	Commercial corporate users that redeploy the equipment in other departments/units			
	Small and medium-sized enterprises			
Public (corporate) users				
	Governmental institutions & organisations			
	Public administration org.			
	Educational institutions			
	Collection points			

Private consumers / Individuals				
	Low income/poor individuals			
	Employees of commercial companies which receive refurbished computers			

a. Can you please also tell me the respective shares the different mentioned types of customers have of the overall donations/sales of your organisation/company?

b. Furthermore, computers prepared for reuse seem often to be sold abroad. Can you please tell me if you sell computers to foreign markets and if so to which regions?

c. Can you please also tell me the share of used computers your organisation/company sells in Sweden and the share it sells to other countries?

Part 4: Barriers

9. Generally, the supply with/sourcing of used computers is perceived as an issue by organisations/companies involved in reuse/preparation for reuse activities. Can you please tell me what you perceive as the main barriers related to sourcing of used computers?

Barrier identified in literature	**Perceived as such?**	**Why? / What is/ are the reasons?**	**Own comment(s)**
Lack of access to sufficient volumes of used equipment at good quality and at low costs			
Competition from informal sector and from unlicensed recyclers			
Public and industry organized collection and recycling schemes do not consider reuse in their design			
Some OEMs do not approve of the sale of used products because they fear that either these products compete with OEM branded new products			
Unpredictability in supply and demand / Lack of transparency of product availability			
Competition with recyclers for supply of used equipment			
Publicity regarding fraud and identity theft leading to a circumspect approach to the donation of (used) equipment & Companies are reluctant to pass products on for reuse because of concerns about data security			
Organisations upgrading equipment less regularly			
Low value of some used equipment			
Avoidance of spending time on selling the used equipment by potential suppliers			
Company policy stipulates that all IT equipment should be scrapped at EoL			

Potential suppliers' misunderstanding of respective regulations			

10. Another area related to sourcing is usually collection/logistics and the shipping of used computers to the refurbishing facility. I wonder whether you experienced any issues related to collection/logistics?

Barrier identified in lit.	**Perceived as such?**	**Why? / What is/ are the reasons?**	**Own comment(s)**
(High) Logistics costs			
Damage of equipment during transportation/ collection processes			

11. After the sourced products arrive at the refurbishing facility, literature suggests that they usually go through an inspection process and are sorted according to certain criteria. Could you please tell me if you see any barriers related to these activities and if so, describe them specifically?

Barrier identified in lit.	**Perceived as such?**	**Why? / What is/ are the reasons?**	**Own comment(s)**
Lack of information about product condition results in uncertainty of quality of acquired products			

12. When looking at the recovery/refurbishing (process) of computers once they arrived at the refurbishing facilities, what are in your opinion the hindering factors for conducting such recovery processes for used computers?

Barrier identified in lit.	**Perceived as such?**	**Why? / What is/ are the reasons?**	**Own comment(s)**
No consideration of reuse in product designs			
(High) Labour costs			
Cost & availability of spare parts			

13. Once computers have been prepared for reuse they are usually remarketed/redistributed. Can you please tell me, what would you see as the main barriers to remarketing/ redistributing used computers?

Barrier identified in lit.	**Perceived as such?**	**Why? / What is/ are the reasons?**	**Own comment(s)**
Bad reuse practices ('shame reuse') lead to reluctance towards reuse			
Societal discussion on the soundness of reuse of appliances / Consumer non-confidence in refurbished equipment			
Variety of different standards and lack of global reuse standard with clear definitions			
Market for products: prices of new EEE decrease, approaching the level of refurbishing costs; demand for used EEE decreases			
Use of low quality components or materials by OEMs leading to shorter			

lifetimes of computers			
Potential customers' lack of knowledge about the suitability of used computers for their needs			
Potential purchasers' misunderstanding of respective regulations			
Software licenses too expensive / (potential) customers do not know how to operate alternative free software			

14. Generally, legislation and regulation is seen as a barrier hampering reuse of computers in different ways. Do you agree with this view? Could you please specify in what way you see legislation and regulation as a barrier to computer reuse? Are there any specific ones?

Barrier identified in lit.	**Perceived as such?**	**Why? / What is/ are the reasons?**	**Own comment(s)**
Lack of legislation that sets financial incentives for reuse and enforces reuse & Regulations leading to economic unfeasibility of computer reuse operations			
Complex legal and regulatory situation leads to			

administrative effort and costs for collection, preparation for reuse and redistribution of used products			
Lack of layout/design standards for computers			

15. Costs related to the preparation of computers for reuse are also often seen as a barrier. Could you please specify what in your perspective the main cost-related barriers are?

Barrier identified in lit.	**Perceived as such?**	**Why? / What is/ are the reasons?**	**Own comment(s)**
Lack of economies of scale leading to increased operational costs			

16. ***Would you like to add something? Or would you like to ask me something or do you have any comments?***

Thank you very much for your time!

Appendix VII – Interview Guide for Non-Profit Computer Reuse Organisations (Interviewer Version)

Part 1: Interview opening

Greeting

Introducing myself

M.Sc. student 'Environmental Management & Policy', 4th term, IIIEE/Lund University

Content and purpose of the interview

Naturvårdsverket, the Swedish EPA has only recently published the first waste prevention program for Sweden (June 2015). In it, the EPA defines four focus areas on which waste prevention and reduction should focus within the upcoming years, among them electronics via the extension of products' lifetimes as well as increased reuse. The defined strategies to reach these goals comprise among others: developing policies to support reuse, (further) developing existing and establishing new markets and business models as well as better provision of information regarding the overall matter. At the same time, Naturvårdsverket acknowledges that too little information is available regarding barriers and drivers in these markets to develop consistent policies.

Especially computers as a product group have been stated to be feasible for the extension of their life cycles (via direct or preparation for reuse) while at the same time (potentially) leading to reduced environmental burdens and socio-economic benefits. While organisations involved in activities aiming at computer reuse and lifetime extension are found in Sweden, relatively little is known about the market, the actors and their drivers as well as the barriers they are facing. Thus, this research aims to find out more about the involved actors, the drivers and barriers they are facing in order to provide a first insight into the field and allow for further, more detailed research respectively providing policy-makers with information.

Course of the interview

Duration: ca. 60-75 minutes

Recording/Anonymity

The interview will be recorded so that we can focus on the conversation. Anonymity will be preserved (if this is wished for). – Do you agree that the interview is recorded? Do you wish for anonymisation as a person and/or of the organisation?

Part 2: Introductory questions

1. Please tell me your position within the organisation/company?

2. Can you please tell me in which year the organisation/company was founded?

3. Please tell me the size of your organisation/company in terms of:
    a. Employees?
    b. Annual revenues (in SEK)?

4. Can you please tell me how big the annual volume of desktop computers and laptops is that your organisation/company handles?
    c. How big is the annual supply of items (in units)?
    d. How big are the annual sales of items (in units)?

5. Regarding the computers, could you please tell me the percentage of sourced products that can be reused/be prepared for reuse?
    e. Furthermore, I would like to know what is the average age of the sourced used computers?
    f. Also, can you please tell me what is the current average reuse lifespan (potential life time after having been prepared for reuse) of the computers?

Part 3: Company operations, suppliers & customers

6. Companies/Organisations being involved in the reuse of computers seem to cover a range of activities from collection to remarketing. Can you please describe what range of services your organisation/company offers to its supplying and receiving customers and what the related processes are?
    g. What do the operations look like?
    h. How does the typical process of refurbishing (e.g. from sourcing to remarketing) look like through which used computers typically pass at your organisation/company?

7. Literature suggests that organisations/companies involved in computer reuse can have different sources of supply such as companies, state agencies, municipalities or educational institutions such as universities. Can you please tell me from whom your organisation/company typically receives its supply of computers?

Type of suppliers identified in literature	**Sub-Type of suppliers identified in literature**	**Organisation of interview partner receiving from this type of supplier?**	**If not, why not?**	**Own comment(s)**
Non-commercial users				
	Close the Digital Divide Organisations			
Commercial (corporate) users				
	Leasing companies			
	Distributors & retailers			
	IT service companies			
	OEMs			
	Large commercial corporations in general			
Public (corporate) users				
	Governmental institutions & organisations			
	Public administration			
	Collection points			

Private consumers / Individuals				

i. Can you please also tell me the respective shares the different mentioned types of suppliers have in the overall supply with computers regarding your organisation/company?

j. Furthermore, some organisations/companies involved in the reuse of computers seem to get their supply from abroad. Can you please tell me if your organisation/company sources from abroad and if so, from which regions?

k. Can you please also tell me the share of used computers your organisation/company sources domestically and from abroad?

8. Not only the sources for used computers seem to vary but also the types of customers buying used computers. Can you please describe to what types of customers does your organisation/company usually sell computers prepared for reuse?

Type of receiving customers identified in literature	**Sub-Type of receiving customers identified in literature**	**Organisation of interview partner receiving from this type of**	**If not, why not?**	**Own comment(s)**

		supplier?		
Non-commercial users				
	Health/medical institutions (partner projects of Close the Digital Divide (CtDD) organis.			
	Non-profit organisations			
	Non-governmental org.			
	Local partner org. of Close the Digital Divide organisations			
	Social projects			
	Workers' unions			
Commercial (corporate) users				
	Retailers/Resellers, distributors & brokers			
	Commercial corporate users that redeploy the equipment in other departments/units			
	Small and medium-sized enterprises			
Public (corporate) users				
	Governmental institutions & organisations			
	Public administration org.			
	Educational institutions			
	Collection points			

Private consumers / Individuals				
	Low income/poor individuals			
	Employees of commercial companies which receive refurbished computers			
	Stone			

l. Can you please also tell me the respective shares the different mentioned types of customers have of the overall donations/sales of your organisation/company?

m. Furthermore, computers prepared for reuse seem often to be sold abroad. Can you please tell me if you sell computers to foreign markets and if so to which regions?

n. Can you please also tell me the share of used computers your organisation/company sells in Sweden and the share it sells to other countries?

Part 4: Barriers

9. Generally, the supply with/sourcing of used computers is perceived as an issue by organisations/companies involved in reuse/preparation for reuse activities. Can you please tell me what you perceive as the main barriers related to sourcing of used

computers?

Barrier identified in lit.	**Perceived as such?**	**Why? / What is/ are the reasons?**	**Own comment(s)**
Lack of access to sufficient volumes of used equipment at good quality and at low costs			
Competition from informal sector and from unlicensed recyclers			
Public and industry organized collection and recycling schemes do not consider reuse in their design			
Some OEMs do not approve of the sale of used products because they fear that either these products compete with OEM branded new products			
Unpredictability in supply and demand / Lack of transparency of product availability			
Competition with recyclers for supply of used equipment			
Publicity regarding fraud and identity theft leading to a circumspect approach to the donation of (used) equipment & Companies are reluctant to pass products on for reuse because of concerns about data security			
Organisations upgrading equipment less regularly			
Low value of some used equipment			
Social enterprises seen as 'tree huggers' rather than professionals			
IT equipment held in lease agreements with large suppliers means companies			

cannot donate without breaching contracts			
Equipment stripped of vital components before donation & Difficulties in obtaining operating system disks to go with computers			
Company's perception of item value / Lack of awareness of residual value			

10. Another area related to sourcing is usually collection/logistics and the shipping of used computers to the refurbishing facility. I wonder whether you experienced any issues related to collection/logistics?

Barrier identified in lit.	**Perceived as such?**	**Why? / What is/ are the reasons?**	**Own comment(s)**
(High) Logistics costs			
Damage of equipment during transportation/ collection processes			
Practical and logistical factors, including distance travelled to collect WEEE			
Companies not wanting to pay for collection services offered			

Limited collection capacity			

11. After the sourced products arrive at the refurbishing facility, literature suggests that they usually go through an inspection process and are sorted according to certain criteria. Could you please tell me if you see any barriers related to these activities and if so, describe them specifically?

Barrier identified in lit.	**Perceived as such?**	**Why? / What is/ are the reasons?**	**Own comment(s)**
Lack of information about product condition results in uncertainty of quality of acquired products			
(Limited storage space for equipment)			
(Poor storage practices can lead to damage and breakage of equipment)			

12. When looking at the recovery/refurbishing (process) of computers once they arrived at the refurbishing facilities, what are in your opinion the hindering factors for conducting such recovery processes for used computers?

Barrier identified in lit.	**Perceived as such?**	**Why? / What is/ are the reasons?**	**Own comment(s)**
No consideration of reuse in product designs			
(High) Labour costs			
Cost & availability of spare parts			
Vast range of technical knowledge required in order to process the variety of appliances received			
Low staff numbers			
Time intensive processing time			

13. Once computers have been prepared for reuse they are usually remarketed/redistributed. Can you please tell me, what would you see as the main barriers to remarketing/ redistributing used computers?

Barrier identified in lit.	**Perceived as such?**	**Why? / What is/ are the reasons?**	**Own comment(s)**
Bad reuse practices ('shame reuse') lead to reluctance towards reuse			
Societal discussion on the soundness of reuse of appliances / Consumer non-confidence in refurbished equipment			
Variety of different standards and lack of global reuse standard with clear definitions			
Market for products: prices of new EEE decrease, approaching the level of refurbishing costs; demand for used EEE decreases			
Marketing reuse as the preferred option when considering purchasing			
Poor storage practices can lead to damage and breakage of equipment			
Limited storage space for equipment			
Lack of shop premises to increase sales			
Finding customers for bulk volume sales			

14. Generally, legislation and regulation is seen as a barrier hampering reuse of computers in different ways. Do you agree with this view? Could you please specify in what way you see legislation and regulation as a barrier to computer reuse? Are there any specific ones?

Barrier identified in lit.	**Perceived as such?**	**Why? / What is/ are the reasons?**	**Own comment(s)**
Lack of legislation that sets financial incentives for reuse and enforces reuse & Regulations leading to economic unfeasibility of computer reuse operations			
Complex legal and regulatory situation leads to administrative effort and costs for collection, preparation for reuse and redistribution of used products			
Legislation aimed at curtailing rogue reuse firms drives up licensing fees meaning extra expenses for legitimate reuse organisations			

15. Costs related to the preparation of computers for reuse are also often seen as a barrier. Could you please specify what in your perspective the main cost-related barriers are?

Barrier identified in lit.	**Perceived as such?**	**Why? / What is/ are the reasons?**	**Own comment(s)**
((High) Logistics costs)			
(Companies not wanting to pay for collection services offered)			

16. Would you like to add something? Or would you like to ask me something or do you have any comments?

Thank you very much for your time!

Appendix VIII – List of Interview Partners

The following *Table A VIII-1* provides an overview about the positions the interview partners held within the respective computer reuse organisation they were presenting. The second column provides information about the type of organisation while the third one shows the identified type of operating model based on the typology developed by Kissling et al. (2012). Furthermore, the dates on which the interviews took place are provided along with comments for clarification purposes or additional information.

Table A VIII-0-1. List of interview partners

Position	Type of Organisation	Type of Organisation's Operating Model	Date of Interview	Comment(s)
Sustainability Manager	Computer/IT Refurbishing Company	IT Asset Management	16.06.2015	The interview partner had held several other positions within the same company: production manager, logistics manager, quality manager, project manager.
Head of IT Recovery Sales			08.09.2015	
Senior Account Manager	Computer/IT Refurbishing Company	IT Asset Management	14.08.2015	
Managing Director and Board Member	Computer/IT Refurbishing Company	IT Asset Management	20.08.2015	
SECC (Safety, Environment, Community, CSR) Manager	Recycling Company also offering Computer/IT refurbishing services	IT Asset Management	31.08.2015	Equipment is only collected and pre-sorted in Sweden but refurbished at facilities/premises of the company in other countries.
Managing Director	Computer/IT Refurbishing Company which also offers recycling services	IT Asset Management	10.09.2015	
Environmental Manager	Original Equipment Manufacturer (OEM) of computers and related equipment which also offers take back and refurbishing services for its own products but also other brands in Sweden. (Refurbishing does take place outside Sweden though)	IT Asset Management	08.10.2015	The original interview partner could not be reached due to a major internal restructuring of the company, so that I was referred to this contact with which the interview was eventually conducted.
Head of Administration/Ope	Social enterprise/Non-profit organisation aiming	Social Enterprise	18.08.2015	

rations	to bring people with difficulties findings jobs back into the labour market through refurbishing and selling computers & offering cheap refurbished computers to poor/low income individuals and non-profit organisations.			
Supervisor/Mentor/ Coach	Social enterprise/Non-profit organisation aiming to bring people with difficulties findings jobs back into the labour market through refurbishing and selling computers & offering cheap refurbished computers to poor/low income individuals and non-profit organisations.	Social Enterprise	19.08.2015	
Co-Founder & International Director	Non-profit organisation aiming to collect and refurbish used computers and other electronics and sending as well as selling them for reduced prices to humanitarian and non-profit causes/projects in less-developed countries in order to drive and support the technological development	Close the Digital Divide	07.09.2015	
Remarketing Manager	Company specialized in supplying IT Infrastructure	IT Asset Management	-	
Managing Director		Social Enterprise	-	
Take back Portfolio Manager EMEA	Original Equipment Manufacturer (OEM)	IT Asset Management	-	The interview partner hoped for did not have time for an interview nor filling out the questionnaire sent via email; did not refer to anyone else instead.
Managing Director	Computer/IT Equipment Refurbishing Company	IT Asset Management	-	Did not want to take part.
Business Manager for the Reuse Program	IT Equipment Provider	IT Asset Management	-	Could not be reached via phone or email.
Managing Director	IT Retailer/Distributor also offering take back and remarketing services	IT Asset Management	-	Could not be reached via phone or email.
Procurement/Order Manager			-	Could not be reached via phone or email.

Source: Own compilation based on data collected during interviews and document analysis.

Scheduled interviews which could not be conducted due to short-notice cancellation or unheralded unattainability of interview partners are marked in light red. Identified computer reuse organisations whose representatives did either reject to be interviewed or could not be reached (via phone) or did not reply to interview requests (via email) to book an interview are marked in dark red. This information seemed useful to integrate to get a better feeling for the total number and different types of identified actors in the computer reuse industry in Sweden.

Appendix IX – Research Framework

The following page provides a comprehensive illustration of the research framework as it has been described in Chapter 3.4 which joins the findings from Chapters 2.3.1 to 2.3.5 together. It merges the different identified types (and sub-types) of suppliers to computer reuse organisations with the different types of the latter's (receiving) customers by joining them together via the typical processes served and activities conducted by computer reuse organisations as presented in Chapter 2.3.1. Furthermore, the barriers to computer reuse organisations discussed in Chapter 2.3.5 have been attributed to the respective identified processes/activities of CROs. In addition, they have been differentiated based on if they were identified as generic barriers or specifically for non-profit or for-profit computer reuse organisations.

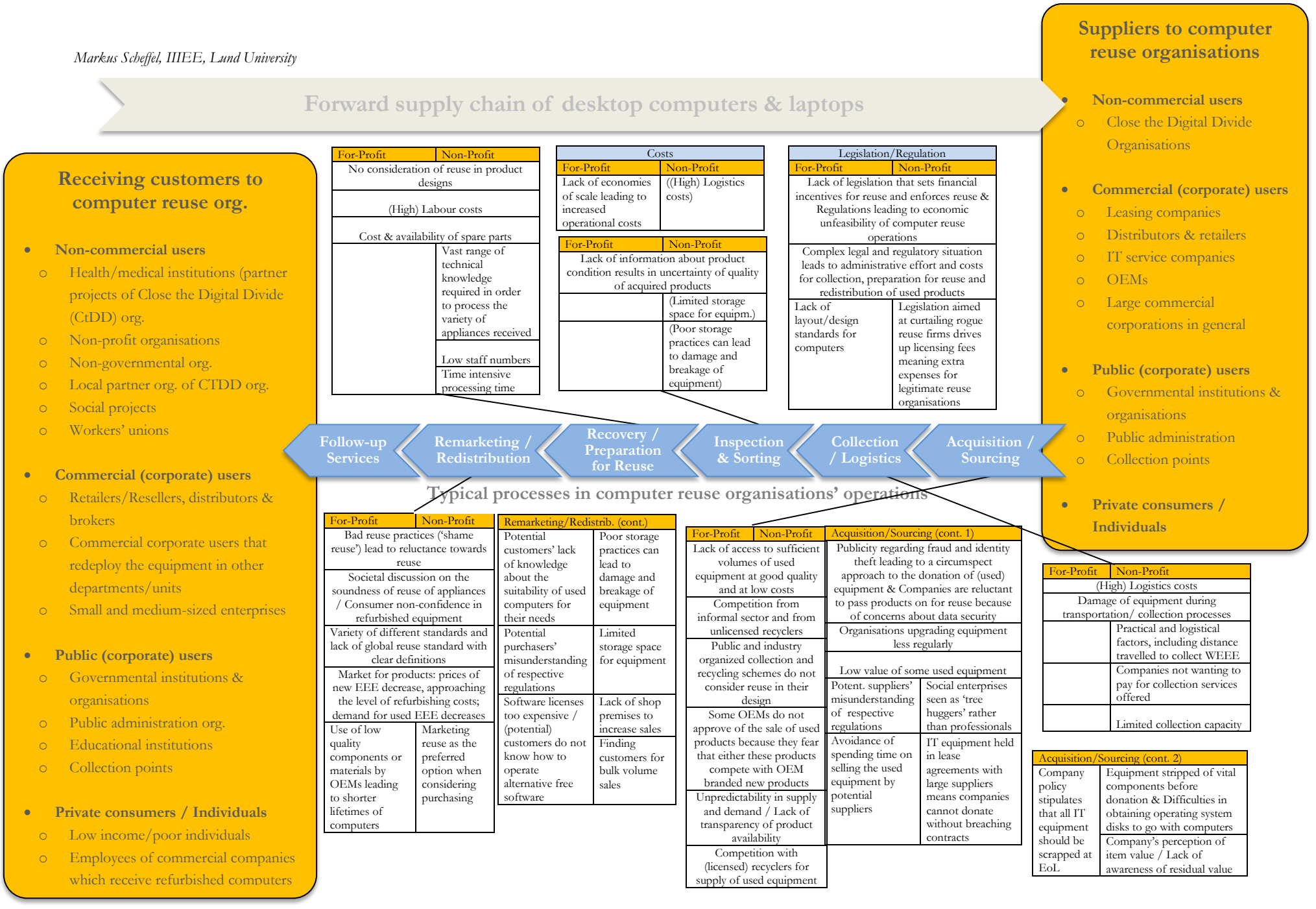

Figure A IX-1. Research framework.
Source: Own framework developed based on the findings presented in the chapters 2.3.1 to 2.3.5.

Appendix X – Overview about Confirmed, Falsified and Inconclusive Barriers in the Swedish Context

The following *Table A X-1* provides an overview about which barriers that have been found during the literature review and presented in chapter 2.3.5 could be confirmed (marked green), falsified (marked red) for the respective organisations with a certain (main) type of operating model. If 66.7% equalling two thirds or more of the organisations allocated to one of the three operating models of computer/ICT reuse organisations stated for a certain barrier, that they would perceive it as a barrier, it was seen to be confirmed for the Swedish context. If the value for a certain barrier was below 33.3% (or 1/3) it was seen as falsified. In several cases, the interview partners had differing opinions about if a certain barrier was actually a barrier for their organisation or not so that the values lay between 66.7% and 33.3%. In such cases they were marked orange.

Regarding some barriers and for certain types of operating models, few interview partners did not provide (any or enough) information to allow for verification or falsification. In order to accommodate this fact, these cases are marked with 'n.a.' (for *not available*) to allow for distinction from such cases where information was available but no clear tendency for verification of falsification of a barrier was available.

Barriers that were not assessed for a certain type of operating model (e.g. because literature suggested that it would only be a barrier for organisations with a non-profit operating model) are in the table marked with a '–' for those types of operating models for which it has not been assessed (based on the literature review and the research framework).

Table A X-0-1. Overview about confirmed, falsified and inconclusive barriers

	Type of Computer Reuse Organisation Operating Model	**For-Profit**	**Non-Profit**	
		IT Asset Management	Social Enterprise	Close The Digital Divide
Reverse Supply Chain Processes	**Barriers**			
Acquaintance / Sourcing				
	Lack of access to sufficient volumes of used equipment at good quality and low costs			
	Competition from informal sector and from unlicensed recyclers			
	Public and industry organized collection and recycling schemes do not consider reuse in their design			
	Some OEMs do not approve of the sale of used products because they fear that these products compete with OEM branded new products		n.a.	
	Unpredictability in supply and demand / Lack of transparency of product availability			

	Competition with (licensed) recyclers for supply of used equipment			
	Publicity regarding fraud and identity theft leading to a circumspect approach to the donation of (used) equipment & Companies are reluctant to pass products on for reuse because of concerns about data security			
	Organisations upgrading equipment less regularly	n.a.	n.a.	
	Low value of some used equipment	n.a.		
	Potential suppliers' misunderstanding of respective regulations and laws	n.a.	-	-
	Avoidance of spending time on selling the used equipment by potential suppliers		-	-
	Company policy stipulates that all IT equipment should be scrapped at EoL		-	-
	Social enterprises seen as 'tree huggers' rather than professionals	-		n.a.
	IT equipment held in lease agreements with large suppliers means companies cannot donate without breaching contracts	-		
	Equipment stripped of vital components before donation & Difficulties in obtaining operating system disks to go with computers	-		
	Company's perception of item value / Lack of awareness of residual value	-		
Collection / Logistics	(High) Logistics costs			
	Damage of equipment during transportation/ collection processes		n.a.	
	Practical and logistical factors, including distance travelled to collect WEEE	-		
	Companies not wanting to pay for collection services offered	-	n.a.	
	Limited collection capacity	-		
Inspection & Sorting	Lack of information about product condition results in uncertainty of quality of acquired products			
	(Limited storage space for equipm.)	-		
	(Poor storage practices can lead to damage and breakage of equipment)	-	n.a.	

Recovery / Preparation for Reuse	No consideration of reuse in product designs			
	(High) Labour costs			
	Cost & availability of spare parts			
	Vast range of technical knowledge required in order to process the variety of appliances received	-		
	Low staff numbers	-		
	Time intensive processing time	-		
Remarketing / Redistribution	Bad reuse practices ('shame reuse') lead to reluctance towards reuse			
	Societal discussion on the soundness of reuse of appliances / Consumer non-confidence in refurbished equipment			
	Variety of different standards and lack of global reuse standard with clear definitions			
	Market for products: prices of new EEE decrease, approaching the level of refurbishing costs; demand for used EEE decreases			
	Use of low quality components or materials by OEMs leading to shorter lifetimes of computers		-	-
	Potential customers' lack of knowledge about the suitability of used computers for their needs		-	-
	Potential purchasers' misunderstanding of respective regulations		-	-
	Software licenses too expensive / (potential) customers do not know how to operate alternative free software		-	-
	Marketing reuse as the preferred option when considering purchasing	-	n.a.	n.a.
	Poor storage practices can lead to damage and breakage of equipment	-	n.a.	
	Limited storage space for equipment	-		
	Lack of shop premises to increase sales	-		
	Finding customers for bulk volume sales	-	n.a.	
Legislation				
	Lack of legislation that sets financial incentives for reuse and enforces reuse & Regulations leading to economic unfeasibility of computer reuse operations		n.a.	

	Complex legal and regulatory situation leads to administrative effort and costs for collection, preparation for reuse and redistribution of used products		n.a.	n.a.
	Lack of layout/design standards for computers		-	-
	Legislation aimed at curtailing rogue reuse firms drives up licensing fees meaning extra expenses for legitimate reuse organisations	-	n.a.	n.a.
Costs	Lack of economies of scale leading to increased operational costs	n.a.	-	-
	((High) Logistics costs)	-		

Source: Own compilation based on analysis of collected data during interviews.

Appendix XI – Negated Barriers in the Swedish Context

As part of the study it was also assessed which barriers identified in literature did not turn out to be barriers in the Swedish context as already stated in Chapter 4.4.

These negated barriers are presented in the following split into general ones which were found for organisations across all three types of operating models and specific ones which were only identified for the single respective operating models.

General Negated Barriers

In the following the barriers which could be negated for all three types of operating models are described together with the reasons for why the interview partners did not perceive them as a barrier.

No Consideration of Reuse in Product Design

Seven of nine computer reuse organisations (among them five with ITAM, one with SE and one with CtDD operating models) abnegated that the non-consideration of reuse in the product design of computers would be a barrier. The latter also inherits two several barriers identified during the literature review, namely that *processing of used computers would be time-intensive* and that a *vast range of knowledge and information would be needed to prepare (disassemble) computers for reuse*.

The respective organisations representing all identified types of operating models stated that it is not seen as a barrier as computers have become somewhat of a standard product and thus would generally (at least in regard of the big brands) all look more or less the same in terms of the product design/layout.
Furthermore, many OEMs seem to have introduced a modular design and 'click-mechanisms' allowing to open the shell of a computer/laptop and for a quick exchange of components. In other cases at least the number of screws used seems to have been reduced also allowing for speeding up recovery-related processes.
In addition (and especially in the case of commercial organisations) the technicians involved in the recovery processes are seen as very skilled, experienced and knowledgeable in terms of repairing the machines. Thus, processes can become quite efficient. For example was one commercial CRO found to process around 140 computers within 30 minutes.

Only in few cases[48] computers seem not repairable in an easy or efficient way due to a complicated product design which demands to tear for example complete laptops apart only to change a standard component such as a memory (RAM) bar. These seem to either be resold as broken or nevertheless tried to be repaired for reuse. Especially Apple products seem to pose a problem in this regard as it was specifically mentioned by several of the interviewees as they would use glue rather than screws or comparably easy to open systems.

Software Licensing

The barrier regarding software licensing combines actually two different barriers identified during literature review. On the one hand that software licenses can usually be passed on with computers and be reused but that this practice seems usually not followed as the first users of computers seem not aware of this. On the other hand it was found that if used computers come without software, for example an operating system, they are less attractive to customers,

[48] One interview partner stated that about 2% of the total incoming volume of computers could not be dismantled and repaired in an easy and efficient manner.

especially consumers.
In total, 7 of 9 of the representatives of the researched organisations did find neither to be a barrier while two interview partners from commercial reuse organisations either found it to be an issue or did not provide any specific information.

One reason for not seeing the practice of not passing on licenses with computers as a barrier seems to lie in the fact that this is in most cases considered an illegal practice as licenses (especially for Microsoft's Windows operating system) are in most cases personalized licenses. These can in most cases not be passed on together with a computer.

Computer reuse organisations with an ITAM and an SE operating model were in most cases found to be Microsoft Accredited or Microsoft Registered Refurbishers allowing them to install operating systems and other software from Microsoft. These contracts allow the respective CROs to get comparably cheap software licenses and to offer the computers prepared for reuse with professional operating systems and/or other software at lower prices. Depending on the license, a CRO can either serve any type of customer (commercial license) or only sell to specific customer groups, such as non-commercial (non-corporate) organisations, specific types of private consumers such as disabled people or educational institutions (citizenship license). The latter was found for both assessed social enterprises. One of the researched (commercial) reuse organisations was found to sell its computers without any operating system leaving it to the customers.

While the only organisation with a Close the Digital Divide operating model was found to only install Linux (Ubuntu) on its computers for reuse, one of the SE reuse organisations stated that Linux would not be an alternative for them as their customer would usually be used to Microsoft Windows and demand this OS as they already know how to operate/can relate to it.

Lack of Information about Condition of Used Computers

The lack of information about the condition of used computers partly depending on the intensity of use and the environment it was used in was de-confirmed by the representatives of 6 out of 9 computer reuse organisations, thereof three commercial ones.

The reasons for this seem manifold. Customers (at least in the case of (corporate) organisations seem to usually be able to provide quite good information about the condition of the computers allowing commercial CROs to estimate a price. This seems often to be accompanied by extra contracts determining that the CROs will only pay for computers that are actually found to work or are allowed to demand a price deduction in case computers have visible impairments on the outside.

Furthermore, during the testing process, software tools seem to provide a big set of data about former usage length and intensity allowing for a quite good estimation of the status and health of single parts and components as well as the overall machine. Especially in combination with opening the computer shells to clean the inside, also providing the opportunity to take a look at the inner life and components. The latter can allow for recognizing visible signs of how careful a computer has been dealt with by its former user.[49]

[49] One interview partner mentioned for example that if users often use a 'hard reset/power down' instead of shutting the computer down via software commands, this can lead to visible spikes and a dark ring on the mainboard near the power connector.

Negated Barriers to Computer Reuse Organisations with IT Asset Management Operating Model

This sub-chapter presents the barriers which were not perceived as such by representatives of organisations with an ITAM operating model in the Swedish context.

Costs and Availability of Spare Parts

In regard to the *costs and the availability of spare parts* for repairing not working computers, five of the six assessed commercial reuse organisations abnegated this to be a barrier.

The reasons are two-fold. Some organisations are not exchanging faulty parts at all as it is seen as too inefficient and/or expensive, mainly due to the related labour costs being seen as too high and thus recycled the respective machines instead. Other organisations decide on a case by case basis if a computer is repaired or not. If this is the case, then components or parts are usually not bought but taken from stock where they are collected as spare parts from formerly discarded computers. Only in very few cases, organisations seem to buy new parts as they are partly seen as expensive and might in some cases lead to situations where the market price of such a refurbished computer would be higher than that of new (consumer-targeted) ones and thus losing its competitiveness.

Logistics costs

Another barrier identified in literature that turned out to not be applicable to computer reuse companies in a Swedish context are *costs related to logistics*. Representatives of four of the six assessed commercial organisations agreed on this.
On the one hand when passing on the costs to single units these were stated to low while on the other hand the costs for the transportation would be passed on to the supplying customers anyway – in the case of a profit/revenue share contract. Thus, logistics does de facto not cause any extra costs for commercial computer reuse organisations.
In the case of other business models/contract such as a buyout where the CRO buys all the computers from a supplier and then keeps the revenues from remarketing/reselling the refurbished computers, logistics cost are only seen as an issue if the bought computers are very old and hard to sell profitable.

Thus, logistics costs were by some interview partners rather seen as a driver to develop more efficient or 'smart' logistics in order to drive down the overall costs – depending on the type of business model/contract – for themselves or for their suppliers.

Some OEMs do not Approve of the Sale of Used Products

During literature review, it was found that the *non-approval of some OEMs to refurbish and remarket their products* seems to have posed a barrier to some computer reuse organisations. Two thirds of the interview partners from commercial reuse organisations did state they have not experienced this yet. On the contrary, some of the assessed organisations were found to be partners or supply each other with used computers as several of the main computer manufacturers have in the last few years also entered the refurbishing industry and reuse markets with own services and facilities.
Furthermore, while competition in the market is certainly tough, few interview partners even mentioned that their organisation would sometimes contact OEMs to request help regarding issues (e.g. dismantling/replacing of components) in the recovery process of certain products.

Negated Barriers to Computer Reuse Organisations with Social Enterprise Operating Model

The following barriers identified in literature were not perceived as such by the interview partners representing organisations with a Social Enterprise operating model and thus disconfirmed for the Swedish context due to the reasons described for each of the barriers respectively.

Logistics Costs

In regard to *logistics costs*, these were not found as a barrier for CROs with a social enterprise model in the Swedish context as all of the interviewed representatives did not see this as a barrier.
In the case of one organisation which got the majority of its supply from individuals/private people, the latter would usually drop their used computers of at the organisation's facilities/office so that usually no need for collecting the machines occurs.
In contrast to that operates the second assessed organisation a bus to collect used computers. Nevertheless are the costs arising from maintaining the vehicle and the fuel covered by the revenue from the sales of used computers prepared for reuse. If both cases are a speciality in regard to not having logistics costs or not perceiving them as a barrier – as the people involved in the preparation processes are usually not paid any wages – remains to be seen depending on results of future research.

Low Staff Numbers

During literature review, *too few staff* had been identified as a barrier. In contrast to that were neither of the two assessed organisations found to face it and instead stated that they would have just the right number of staffing for the moment. While one organisation was still in its start-up phase and had not such a big volume of used computers coming in yet thus not being in need of more staff than they had employed at the time, it looked somewhat similar for the second organisation. Although somewhat more established, the interviewee found that they had just the right amount of people as the facilities were not too spacious and otherwise they would have too many people working there. Furthermore, he deemed that their current size and numbers of employees would just be right for serving the local market as otherwise there might be a risk of growing too fast and becoming unsustainable.

Competition with (Licensed) Recyclers for Supply of Used Equipment

Although the competition for used computers and equipment in Sweden seems to be quite tough and the (lack of) access to used equipment is perceived as a barrier, neither of the two social enterprises had experienced *competition with licensed recyclers for the supply of used equipment*. Thus, this barrier earlier identified in literature does not seem to exist in the case of CROs with a social enterprise operating model in the Swedish context and can thus be seen as falsified.

Negated Barriers to Computer Reuse Organisations with Close the Digital Divide Operating Model

In regard to the single assessed organisation with a CtDD operating model, the following barriers related to the recovery process/activities were found as not being perceived as such by the interview partner. The reasons for this are described below for each of the single barriers respectively.

Recovery

The only process-/activities-related category for which a clear majority of barriers could be falsified (about four fifth or 83.3%) is *recovery*. This also includes the one named *no consideration of reuse in product designs* which has already been discussed in Chapter 4.4.1 on general barriers to CROs in the Swedish context and will thus not be further outlined in the following.

The interview partner could not confirm that *a vast range of knowledge would be required in order to process the variety of different computers and ICT appliances* they would receive. Generally, computers would have easy and quick to open solutions either without or only few screws. Only in few cases, especially for Apple computers, a lot of knowledge and time is needed to prepare such computers for reuse if such are in need of repair. While true in certain cases as just described, the solutions allowing for a quick and easy opening as well as exchange of components due to often modular designs make the *recovery processes* also less *time-consuming*. Thus, this barrier was also seen as abnegated.

The *costs and availability of spare parts* was not considered as a barrier by the interviewee. He stated that his organisation would usually keep a stock of components and parts such as memory (RAM), graphic and sound cards, hard drives and others. These are taken from computers which can for different reasons not be refurbished, reused or resold anymore (e.g. too old). In some cases, the organisation was also found to be provided with parts and components by manufacturers.
Nevertheless occur sometimes situations that demand the procurement of new parts in which they are often considered as too expensive – especially when the same part is needed for a batch of around 100 computers.

(High) Labour costs were neither seen as a barrier as one of the three people working at the assessed organisation with an Close the Digital Divide operating model stated to work as a volunteer whereas one would be part of a 'guaranteed employed' program and the third person taking part in a 'new start' program. In the case of the latter two, the state seems to cover a major part of the salary or provide a refund for the work-related taxes. The interviewee stated though that the reselling prices of the refurbished computers would rise if the CRO would have to cover the employees' full salaries.

Appendix XII – List of Newly Discovered Barriers per Reuse Operating Model in the Swedish Context

During the course of the research, several barriers which had previously been identified in the literature could be verified or falsified based on the findings from the interviews – in general but also regarding certain types of operating models. In addition, new barriers which seem to be specific for single operating models emerged. Because these were in all cases only mentioned by single interview partners and could thus neither be confirmed nor disconfirmed it was decided to list them in the following. It was further chosen to present them in form of tables (*Table A XII-1* to *A XII-3*) with the respective reasoning why the interview partners perceive it as a barrier, in form of bullet points.

These listed barriers may be of interest and provide an extended basis for future research regarding barriers to ICT or computer reuse organisations. Not only to verify or falsify them on a broad basis in the Swedish context but also internationally or in other national contexts.

Organisations with IT Asset Management Operating Model

The following barriers were mentioned by single representatives of computer reuse organisations with an IT Asset Management operating model during the interviews and identified as new.

Table A XII-0-1. List of newly identified barriers to computer reuse organisations with IT Asset Management operating model

Related Process / Activity	Barrier	Why is it seen as barrier?
Sourcing	Too many middlemen between supplying organisations and CROs	Especially leasing companies are seen as unnecessary middlemen between the end-users (e.g. companies) and computer refurbishing companies. Because the former would typically try to auction the used computers to computer reuse companies in order to make profit from them, the prices of the computers would increase. In other cases the leasing companies were said to just throw the used computers away instead of selling/auctioning them.
Logistics / Collection	Suppliers not being prepared for collection of used computers	One interview partner mentioned that his company would usually commission an external logistics company to collect the used computers and other equipment from the customers and shipping it to the reuse company's facilities. In many cases the used computers are not ready for transport or hand over to the carrier leading to time issues and increased costs.
	Used computers cannot be shipped across borders without being tested and certified for functionality	The strict regulations regarding the shipment of e-waste and used EEE between EU member states import from outside the EU and export from within the EU to non-EU countries demand the testing and certification of used computers as still functioning before such shipments. This poses a barrier especially in such cases when used computers shall be shipped

		from a neighbouring EU country. One interview partner stated as an example that in the case of sourcing used computers in Denmark, those would first have to be tested and certified as still functional (by a local refurbishing organisation) in order to be allowed to ship them to Sweden where the sourcing computer reuse company would have their headquarters. The related increased costs are seen as the main issue.
	Logistics infrastructure/ collection channel for used equipment of individuals/private people is missing	One of the representatives of a commercial computer reuse organisation mentioned that logistics infrastructure /a collection channel for used computers and other ICT equipment of individuals/private people would be missing so far. It remains unclear though, if computers and other equipment sourced through this channel would actually be prepared for reuse by computer reuse companies as the findings from Chapter 5.2.3 suggest that the quality is usually seen as too low to be prepared and remarketed for reuse profitably.
Remarketing / Redistribution	Low market demand for used appurtenances (e.g. keyboards and mice)	It is hard to find demand and secondary markets for appurtenances and accessories such as external keyboards or mice often coming with used computers. Especially keyboards are in many cases hard to match between computers as the letters and signs may not fit for the market in which they might be sold (if sold abroad). Thus, such appurtenances are often sold to recyclers.
	Market destruction due to low quality items from foreign brokers/retailers	One interview partner saw the destruction/setback of the secondary computer market in Sweden due to the selling of low quality units from foreign brokers/retailers as a barrier. This had led to unsatisfied customers and the loss of trust of (potential) customers in Sweden in used computers taking quite some time to rebuild.
	OEMs offer too low rates in (public) tendering processes	The pricing strategy of OEMs regarding public tenders for computers and IT equipment was also seen as a barrier by one interviewee. OEMs would often lower their prices to a level where their margins would be very small or non-existent and also making it hard for computer reuse companies to compete with, while the OEMs eventually make their returns via selling additional equipment or accessories for the computers in the following.
	(Perceived) Lack of willingness of public institutions/organisations	Two interviewees stated that public administrations in general would – except for some exemptions – not be keen on/willing to buy(ing) used computers or IT equipment. At the same time, exactly those

	to buy new computers	organisations and institutions were by the interview partners expected to take a lead and become forerunners in buying used computers and other IT equipment and in doing so to serve as a good example. While the *Lag om offentlig upphandling* (Swedish act on public procurement) (SFS 2007:1091) does not forbid to buy used computers or other equipment, the interviewees said that the regulations to issue tenders for sourcing would give OEMs an advantage as those would be able to sell to lower prices making their returns through the selling of additional equipment. Thus, they would like to see regulations aiming to push harder for such public organisations and institutions to buy used equipment and regulations allowing computer reuse companies to become more competitive regarding the prices in public tenders.
	Fraud risk through (potential) business partners	Two of the interview partners stated that there would be many untrustworthy (potential) business partners (brokers/retailers) when selling to foreign markets which think that there is quick and dirty business to be made. Thus, one company representative stated that one would need to be very careful when doing business and to only start deliveries once the money has arrived in the bank account.
Legislation	Country-specific regulations restricting the import of computers above a certain age	One issue that was brought up and stated to be seen as a barrier were some countries' regulations which would not allow the import of computers above a certain age (e.g. 3 or 5 years) which makes it hard to resell used computers to business partners located in such countries.

Source: Own compilation based on data collected during interviews with representatives of computer reuse organisations with an IT Asset Management operating model.

Organisations with Social Enterprise Operating Model

The following barriers were mentioned by single representatives of computer reuse organisations with a Social Enterprise operating model during the interviews and identified as new.

Table A XII-0-2. List of newly identified barriers to computer reuse organisations with Social Enterprise operating model

Related Process / Activity	Barrier	Why is it seen as barrier?
Sourcing	Received used computers from individuals/private people can partly not be reused	About half of the computers and laptops donated by individuals/private people are too old to prepare and resell them for reuse. Such computers are usually recycled instead.

Recovery	Low battery capacity of used laptops and/or chargers missing	In case of donated laptops, the batteries have in most cases been extensively used and won't last very long making the laptop less attractive to potential buyers. In other cases charging cables are missing which means that they will in most cases have to be bought anew before reselling the laptop.
Remarketing / Redistribution	Dependency on Microsoft to be approved as MAR/MRR	Computer reuse organisations have to fulfil certain criteria to stay a MAR or MRR which are regularly assessed. If no permission is granted, the operations of the CRO are seen in danger by the interviewee as the licenses for Microsoft software would either become too expensive or Linux would have to be installed and resold with the refurbished computers as a free alternative – although it is seen as making refurbished computers less attractive to potential buyers.
Costs	Dependency on municipal support to cover costs / Operations not (yet) self-sustaining	While both assessed CROs with a social enterprise operating model were found to be financially supported by the municipality (work trainer's salary and costs for facilities), one of the representatives stated that this decision is reassessed every year. If it should not be renewed it would be hard to keep the work up as the organisation is currently not able to financially sustain itself – despite the fact that the individuals preparing the computers for reuse have so far no contract through which they would receive a regular salary.

Source: Own compilation based on data collected during interviews with representatives of computer reuse organisations with a Social Enterprise operating model.

Organisations with Close the Digital Divide Operating Model

In case of the single assessed computer reuse organisation with a Close the Digital Divide operating model, many newly identified barriers have already been included in the presentation of the findings in Chapter 4.4.4 as those were not discussed one by one but rather along the different processes and related activities. Thus, in the following some overlapping might occur.

Table A XII-0-3. List of newly identified barriers to computer reuse organisations with Close the Digital Divide operating model

Related Process / Activity	Barrier	Why is it seen as barrier?
Logistics /Collection	(Time-intensive) Police controls due to fraud/theft suspicions	In some cases, the police control the truck or other vehicles used for collecting the used computers from the donating organisations and transporting them to the CtDD organisation's own facilities. Because usually there are still stickers on the computers suggesting that they would still belong to the donating company, it is hard to prove for the volunteers that they did not steal

		the computers. Due to the police controlling if the computers were actually donated, the time needed to bring the computers back to the CtDD organisation's facilities partly triples. Besides it was stated to often lower the moral of the volunteers as they see themselves in the first place confronted with being accused of fraud.
	No own/only restricted possibilities to collect donated computers	The representative of the assessed CtDD reuse organisation stated that they would not possess their own truck or other spacious vehicles to collect used computers from donating organisations. Thus, they depend on (the availability of) volunteers such as befriended truck drivers who can collect and transport used computers from the donators to the organisation's facilities. Otherwise, a car and a trailer have to be used which mostly requires several rides between the donating organisation and the CtDD organisation's facilities leading to increased costs and making the process time-intensive.
Recovery	Computers come partly with BIOS password	The interviewee reported that in some cases donated computers come protected by a BIOS password making it harder to wipe the hard drive and reinstall a new operating system and thus to be reused unless the password protection is removed. It seems that the OEMs are in the meantime willing and able to support in case of such issues.
Remarketing / Redistribution	Crisis/wars/armed conflicts prevent shipping of computers to projects	Wars/crisis or armed conflicts in certain parts of the world hinder the assessed CtDD organisation from shipping computers to (partner) projects in these specific (world) regions or countries. Either because the projects have been suspended for the time being due to the crisis/war or because the computers would never arrive at the projects.
	No recycling systems for e-waste in most countries where partner projects are located	The missing recycling systems for (e-)waste in many of the countries where project partners are located pose another barrier to computer reuse organisations with a Close the Digital Divide operating model as it is often hard to ensure that the computers are treated/recycled properly once they reach their final EoL and to prevent them from being dumped into the environment.
	Corruption in destination or transit countries	The corruption in the countries of destination of shipments of used computers or in transit countries is also perceived as a barrier. The interview partner stated for example that in some cases containers with used computers destined for partner projects were held back (partly for very long periods of time, e.g. one year) at the customs in ports in order to press bribes from the CtDD organisation. This can lead to

		situations where computers might only arrive at the partner projects after those have already ceased due to the lack of computers.
	Varying regulations and processes regarding paper work between countries of destination/transit	The varying regulations regarding the shipment of used computers to certain countries are seen as a barrier because they differ (partly a lot) between different countries and do not always seem to follow logical reasoning. For example stated the interview partner that when sending used computers to Burundi they would have to be labelled as education material although they would be used within a hospital project whereas when sending them to Kenya, the explanation could be stated as for use in a hospital directly. Thus, in order to be able to fill out the required paperwork in the correct way and to meet the regulations, much time and efforts are required in order to be able to check the current customs regulations or if embargos, etc. are currently in place for specific countries.
	Different contact persons with different level of insights/background knowledge at Swedish customs when shipping out computers to projects	The interview partner stated that the Swedish customs would generally see the used computers as scrap and not as used and tested for reuse and thus forbid the export of the same. While he also stated that it is usually hard for them to proof this, contacts at the customs and the Swedish Tax Agency ('Skatteverket') could in the meantime be established which know about the computers being destined for certain projects in less-developed countries. Furthermore, this usually allows the CtDD organisation to also pay lower taxes for the shipped computers as it would otherwise be too expensive to export them at all. While usually shipping the containers with the computers via the port in Gothenburg, it also happens that the customs in other cities, such as Malmö might answer the phone, which do not have the same insights as the people that the CtDD organisation usually works together. This seems often to lead to situations where a lot of explanation is needed costing a lot of time and efforts.
Legislation	Restrictions regarding the selling of donated new computers	Some organisations (especially companies) sometimes donate (brand)new computers for certain reasons. While the CtDD organisation would generally sell them in order to financially sustain its operations, some donating organisations forbid them to do so and instead request that the computers are shipped to partner projects. In such cases, the computers can often not be sent out to the projects until they reach a certain age because otherwise the taxes/customs fees for the export/import of new computers from Sweden

		to certain countries would be too high. Furthermore, some countries restrict the import of computers below a certain age (e.g. in order to strengthen local markets) leading to a situation where computers need to 'sit' with the CtDD organisation in Sweden for one or several years before they can be shipped to partner projects abroad.
	Taxes on donations prevents willing companies from donating money	Companies that want to support the assessed CtDD organisation seem usually to have to pay taxes on their donations (or at least if those donations are above a certain threshold). The interview partner perceived this regulation as a barrier as it would (in his eyes) keep companies which would be willing to financially support his computer reuse organisation from doing so. At the same time it would hinder his organisation in its operations and work.
	Lack of (financial means to be able to afford) a bank account approved and monitored by the Swedish Fundraising Control ('Svensk Insamlings Kontroll')	Another barrier for the CtDD organisation is seen in not having a so-called '90'-account. Such bank accounts beginning with the numbers 90 are approved and monitored by the Swedish Fundraising Control organisation ('Svensk Insamlings Kontroll') in order to ensure that the respective organisations' "fundraising activities among the public for humanitarian, charitable and culture purposes, environmental protection, conservation of nature and other public benefit aims is safely monitored, that collections are not burdened with excessive costs, that sound marketing techniques are used in fundraising activities and appropriate methods for fundraising control is developed" (Svensk Insamlings Kontroll [SIK], n.d.). While the big non-profit organisations in Sweden usually possess such an account, the assessed CtDD organisation does not as this would require them to employ/commission a bookkeeper to meet the requested standards and requirements of SIK leading to increased costs. This leads to a situation where potential (financial) supporters become hesitant to donate money as they doubt the seriousness of the assessed CtDD organisation as it does not possess a '90' account.
Costs	Relying on voluntary work due to lack of constant income stream	The representative of the CtDD organisation also sees the dependence on volunteers/voluntary work as a barrier to the organisation's operations. Due to the lack of a constant income stream the computers prepared for reuse cannot be donated but have to currently be sold at low prices as the organisation's operations could otherwise not be financed.

Source: Own compilation based on data collected during interviews with the representative of a computer reuse organisations with a Close the Digital Divide operating model.

Appendix XIII – Summary of the Findings per Operating Model

The following *Table A XIII-1* presents the findings in regard to the research questions discussed in Chapter 4 in a more condensed manner. The results are shown for each operating model and in regard to each (sub-)research question separately to allow for a better and quick overview but are thus also less detailed than what has been shown in Chapter 4.

Table A XIII-0-1. Overview about the different identified operating models of computer reuse organisations in Sweden, their respective types of suppliers and receiving customers as well as barriers

Identified types of operating models of computer reuse organisations in the Swedish context	**IT Asset Management**		**Social Enterprise**	**Close the Digital Divide**	
Identified types of suppliers	***Domestic***	***Abroad***	***Domestic only***	***Domestic***	***Abroad***

	- Commercial (corporate) org.
	  o Different types from several industries
	
	- Public (corporate) org.
	  o Public administration institutions
	  o Educational facilities (public schools & universities)
	  o Medical institutions (e.g. hospitals)
	
	- Non-commercial organisations
		- Commercial (corporate) org.
		  o Brokers
		  o Distributors/ Resellers
			- Commercial (corporate) org.
			- Public (corporate) organisations
			  o Public administration institutions, e.g. municipalities
			  o Schools
			
			- Individuals/Private persons
				- Commercial (corporate) org.
				- Public (corporate) org.
				  o Public administration institutions (on all levels)
				  o Educational facilities (schools & universities)
				  o Public waste collection/ recycling stations, especially *kretsloppsparks*
				
				- Non-commercial org.
				- Individuals/Private persons
					- Commercial (corporate) organisations

Identified types of (receiving) customers	***Domestic***	***Abroad***	***Domestic only***	***Domestic***	***Abroad***

	- Commercial (corporate) org.
	  o Private schools ('friskolor')
	  o Resellers
	
	- Public (corporate) organisations
	  o Public administration institutions & state agencies
	  o Educational facilities
		- Commercial (corporate) org.
		  o Resellers/ Redistributors
		  o Brokers
		  o Refurbishing companies
			- Non-commercial org.
			- Individuals/Private persons (only when fulfilling certain criteria)
				- Non-commercial organisations
				  o Working with individuals with psychological issues
				  o Providing language and cultural courses for immigrants
					- Non-commercial organisations (e.g. NGOs, NPOs) implementing different projects
					  o Educational
					  o Health-care

	- Non-commercial org. - Individuals/ Private persons				related
Falsified/Disconfirmed barriers to computer reuse organisations with a specific operating model	- Costs and availability of spare parts - Logistics costs - Some OEMs do not approve of the sale of used products		- Logistics costs - Low staff numbers - Competition with (licensed) recyclers for supply of used equipment	- Recovery: o A vast range of knowledge required in order to process the variety of different computers and ICT appliances o Costs and availability of spare parts o (High) Labour costs	
Barriers to computer reuse organisations with a specific operating model	- Lack of legislation that sets financial incentives for reuse and enforces reuse - Unpredictability in supply / Lack of transparency about product availability - Market demand for used computers - Labour costs - Variety of different standards and lack of global reuse standard with clear definitions		- Limited storage space for equipment - Cost and availability of spare parts - Market availability for products - Social enterprises are seen as treehuggers rather than professionals	- Logistics: o Police checks/controls making transport time-intensive & lowers volunteers' moral o Practical and logistical factors, including the distance travelled to collect used computers o Limited collection capacity o High logistics costs o Companies not wanting to pay or compensate CRO for the collection services offered - Inspection/Selection/Sorting/Disposition: o Limited storage space for the computers and equipment o Low staff numbers - Legislation: o Lack of legislation that sets financial incentives for reuse and enforces it o Customs/Tax office consider refurbished computers as scrap and prohibit export to foreign (receiving) customers o Regulations regarding the export and import of specific products	
Falsified/Disconfirmed general barriers to	- No consideration of reuse in product design - Software licensing				

computer reuse organisations in the Swedish context	- Lack of information about condition of used computers
General barriers to computer reuse organisations in the Swedish context	- (Lack of) access to sufficient volumes of used computers/equipment - (Potential) Suppliers' concerns about data security - Potential buyers' lack of knowledge about suitability of used computers for their needs

Source: Own illustration of the results from websites and documents as well as interviews with representatives of the assessed organisations engaged in computer reuse in Sweden.