Waste prevention of ICT products towards circular economy

– a study about how municipalities are, and can work towards waste minimizing of ICT products in Sweden

HANNA WADSTEN 2018

MVEK02 EXAMENSARBETE FÖR KANDIDATEXAMEN 15 HP
MILJÖVETENSKAP | LUNDS UNIVERSITET

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MVEK02 Examensarbete för Kandidatexamen 15 hp, Lunds universitet

Intern handledare: Jessika Luth Richter, IIIEE, Lunds universitet

CEC - Centrum för miljö- och klimatforskning
Lunds universitet
Lund 2018

Abstract

Information and Communications Technology (ICT) is something that drives our society forward, but how we are consuming these products is rather something that harm our environment rather than pushing our society forward. This thesis investigates our unstainable consumption of ICT products and takes a look at waste prevention solutions in order to reach circular economy with a focus on Swedish municipalities. The thesis aims to investigate how Swedish municipalities work and can work towards waste prevention within this product category. The thesis is conducted by a literature review and an interview survey with respondents from several municipalities in Scania, Sweden.

During the literature review the two main barriers within waste prevention of ICT products were found; lack of appropriate take-back schemes and consumers' preferences for new products. These two main barriers were also confirmed by the interview respondents.

Since both the literature and the interview respondents agreed on these two main berries, the thesis presents two potential solutions which are an implementation of a deposit-refund system for ICT products and more information about the importance of collecting ICT in order to increase repair, refurbishment and reuse.

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Introduction

The consumption habits of todays' society have led to a development of a "wear and tear" or "take-make-dispose" society where older and broken products often are replaced instead of being updated or repaired. This in turn has led to an unsustainable extraction of virgin materials that tear down the valuable resources of our earth (SOU 2017:22, 18). Due to the demand for new raw materials in order to produce new products, we have put an enormous pressure on Earth's resources and, if we continue at this rate, we will in a near future exceed the planetary boundaries which will have devastating consequences for us and future generations (Rockström et al. 2009, 2-3). It is clear the current levels of electronics consumption is unsustainable but even un Sweden today electronic waste is the fastest growing waste category (Naturvårdsverket 2017b). In order to reduce this waste category and decrease the embodied[1] resources that Information and Communication Technology (ICT) products have, we must start to reuse and repair instead of replace.

The more our society develop the demand of electronic products will increase (Pickren 2014, 111-112). In order to ensure the future of the planet, there must be a change in our consumption pattern and habits and the change must come from several different sectors. Today's consumptions society is often explained and blamed on the type of economy that governs and has ruled historically, the linear economy. In the linear economy profit is based on extraction and abolition of resources, which tears the planet and will not ensure its future. By switching to a circular economy based in a more efficient resource use, where products are not replaced but repaired, updated and reused, we can take a step further towards ensuring the future of the planet.

[1] Embodied resources will be explained further in the background.

Purpose and research questions

The purpose of the thesis is to investigate waste prevention solutions among ICT products in order to reach circular economy with a focus on Swedish municipalities. By increasing the understanding of the barriers within reuse of ICT products and understand how municipalities are working today in order to prevent the development of ICT waste, strategies of how to work against these can be addressed. The general aim of this thesis is to contribute to the development of waste prevention of ICT products.

Research questions:

1. In general what are the main barriers within the reuse of ICT products in Sweden today?
2. How are municipalities working towards waste prevention of ICT products today?
3. What can municipalities do to increase reuse, repair and refurbish of ICT product?

Delimitations:

This thesis aims to investigate Swedish municipalities work towards waste prevention of ICT products, therefore will no other actors be involved. The municipalities interviewed in this study are located in Scania.

Method

The thesis is based on two different types of data, partly a literature review and partly an interview survey. The literature review constitutes the background of the thesis, as Bell (2011) writes in her book "Introduktion till forskningsmetodik" it is important to have a literature review which will act and present as the background for the thesis because it gives the reader "the state of the art" and why the research is important for the field (Bell 2011, 99). The literature that was reviewed during the literature review were compiled through some different strategies. Some part of the literature were provided by the thesis supervisor Jessika Luth Richter, she is very well-grounded within the subject and could offer many valuable references within the subject. Other strategies used during the literature research were the use of different search engine, for example LUBsearch and web of science were used. These two search engines were chosen because these two were recommended during the library exercise that was mandatory in the beginning of the bachelor thesis course. Key terms such as "circular economy AND electronics" were used. By having AND as a Boolean operator articles that both discussed circular economy and electronics were found, which was of interest for this thesis. A requirement for all the articles used within the thesis is that they are peer-reviewed.

In addition to the help of my supervisor and through search engines, further articles for the thesis were found through the snowball method.

Data for this thesis was also collected through interviews, which were semi-structured. This type of interviews was chosen because semi structured interviews are easier to summarize and analyze, unlike unstructured interviews (Bell 2011, 159-163; Häger 2007, 57). However, it was important within this thesis to collect comprehensive answers therefor yes / no questions were avoided as far as possible. After the interviews, an open question was asked to the interview respondent to see if there was something they would like to add, and to encourage interesting thoughts and aspects regarding CE and waste reduction. I chose to keep the interview respondents anonymous and will therefore throughout the thesis they will be referred as "interview respondent A-E" with an explanation about their professional role at the municipality (see Table 1 at page 29). The interviews were not be transcribed, transcribing is a very time-consuming process

which can better be spent on other parts of the research, this is also motivated according to Bell's (2011) arguments in her book, where she believes that in shorter projects, it is doubtful whether one should transcribe because transcribing is a very time-consuming process. By this decision, I did not quote any of the interviewers, but provided a short summary of answers in Appendix 3. All interviews that gave their permission were recorded, which means that if someone wants to check something that an interviewer has said, the recordings have been retained (Bell 2011, 165-167).

During the interview survey persons within the waste prevention field were interviewed as representatives from different municipalities and they were questioned about their work towards circular economy and how they can increase their waste prevention work. The focus was on ICT products, and on who will be responsible and how a more simple and favorable take-back scheme could be implemented. An interview guide with all interview questions can be found in Appendix 1 (Swedish) and 2 (English). 40 municipalities located in Scania and Halland County were contacted via e-mail where the purpose of the survey and questions was presented. The e-mail provided two options, either to answer the questions via a telephone interview or if there was no time for such, the option was given to answer the questions via e-mail. 5 municipalities of 40 choose to participate in the interview survey and the interviews lasted between 15-40 minutes. The ones who choose to participate in the interview survey was Malmö Stad, Åstorp municipality, Vellinge municipality, Lund Renhållningeverk and Ystad municipality. A table presenting who and what professional role the interview respondent can be seen in Table 1.

Table 1
Table of the interview respondents.

INTERVIEW RESPONDENT	MUNICIPALITY	PROFSSIONAL ROLE
A	Malmö Stad	Employee at Environmental management[2] Malmö city
B	Åstorp municipality	Environmental manager at Åstorp municipality
C	Vellinge municipality	Waste coordinator at Vellinge municipality
D	Lund Renhållningsverk	Communicator Lund Renhållningsverk
E	Ystad municipality	Environmental strategist at Ystad waste unit

[2] Miljöförvaltningen at Malmö Stad

Outline of thesis:

Below is a figure of how the process behind this thesis is structured.

Figure 1 Process of thesis
Figure that shows the porcess behind the thesis.

Background

The general background to this Bachelor thesis is on the one hand to understand the importance of implementing circular economy into our society and on the other to understand current barriers within the refurbish and repair sector. Why is it important to implement a circular economy to our society? Today we have a very resource-intensive economy which is unsustainable, this kind of economy is often referred to Linear Economy (LE) (Mont, Plepys, Whalen & Nussholz 2017, 6). LE is based on unsustainable throughput of resources, where new virgin materials constantly are extracted. This leads to the fact that we are exhausting our valuable natural resources. Circular Economy (CE) on the other hand is based in a way that are mimics the circular flow of resources in nature and by closing material loops and minimizing the extraction of virgin materials (Mont, Plepys, Whalen & Nussholz 2017, 6,7). The concept of circular economy is about making the usage of natural resources more effective and it is about making the flow of actual resources more circular (Bocken, Olivetti, Cullen, Potting & Lifset 2017, 477-478; SOU 2017:22, 82). In the industry sector this can be achieved through long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing and recycling (Mont, Plepys, Whalen & Nussholz 2017, 7).

This particular thesis focusses on Sweden and their work towards CE and waste prevention. It also has a focus on ICT products.

Waste prevention and why?

Sweden is one of the 28 members in European Union (EU) and as a part of the EU every member state shall have a waste prevention management program; this is mandatory by the ordinance 2008/98/EG (Waste Framework Directive). In the Waste Framework Directive, which sets up the basic concept and definition related to waste management for all EU Member States there is a waste hierarchy that should be followed. The waste hierarchy has a priority order in how the member states should be handling

their waste, this priority order should be taken into considerations within all the member states waste prevention program (Gentil, Gallo & Christiensen 2011, 2371; Naturvårdsverket 2017c). The directive and the hierarchy lays down some basic waste management principles which are ensuring that waste is managed in such way that it is not endangering human health and harming the environment. The following figure illustrates the EU waste hierarchy:

Figure 2 EU waste hierarchy
Illustration of EU waste hierarchy (2008/98/EG).

Figure 2 shows that highest step on the waste hierarchy is prevention of waste, by prevention waste there will be no unsustainable usage of materials because everything is within a material loop that uses the same resources and nothing is becoming waste (2008/98/EG, article 4). This kind of view of "waste" or in a better word resource is the same view as the CE has, where nothing goes to waste and all materials are in a loop, where they can be reused. The second step of the hierarchy is to prepare for re-use, where a product can be refurbished or repaired. The third step is recycling, fourth is recovery and fifth is disposal (SOU 2017:22, 169; Naturvårdsverket 2017c). The waste management program, as referred to earlier, is mandatory by the Waste Framework Directive and shall involve goals, intern goals/targets and actions that are needed in order to decrease the environmental impacts that the waste are causing, it also should decrease the amount of waste and the usage of toxic substances in materials and products (Naturvårdsverket 2017a). But why do we need waste prevention? As mentioned above, our

society needs to be more careful about our valuable natural resources than we are today. By working with waste prevention both resources and money can be saved. Waste prevention actions are thing that we do before something is classified as waste, it can be done already in the first stages of a products lifespan. By doing changes in design virgin materials can be saved and toxic substances can be excluded from products. Other ways of working with waste prevention are to stimulate people, organizations and companies to reuse ICT products, furniture and clothes. By doing these kind of waste prevention actions and by decreasing the amount of waste and the amount of toxic substances in products Sweden can save billions of Swedish crowns from a socio-economic perspective (Geissdoerfer, Savaget, Bocken & Hultink 2017, 759; Naturvårdsverket 2017a).

Sweden's electronic waste management strategies today

As explained earlier waste prevention actions are things that we do before something is classified as waste, by Swedish law waste is "all items or substances that the owner want to get rid of, or are responsible to get rid of[3] (2008/98/EG). With this definition waste within the Swedish law isn't something that is broken or nonfunctioning, waste is only something that is unwanted by the owner. Within the Waste Electrical and Electronic Equipment (WEEE), which ICT products are a part of, Sweden is often perceived as a front-runner within this kind of waste management (Ylä-Mella, Pojkela, Lehtinen, Tanskanen, Román, Keiski & Pongrácz 2014, 9-10). But WEEE management doesn't mean that it is waste prevention. Sweden has today a high WEEE recycling rate, which means that when a WEEE product in the owners eyes is waste it is transported to a recycling station for disassembly and material recycling (Naturvårdsverket 2013, 63, 64). These kind of waste management strategies are done after a product have been classified as waste, by connecting this to the definition of waste prevention we can understand that the majority of the actions done within the WEEE sector in Sweden today isn't waste prevention actions, they are rather waste management actions. So what can be done in order to work with more waste prevention within the WEEE sector? Sweden's

[3] The Swedish definition: "Alla föremål som innehavaren vill göra sig av med eller är skyldig att göra sig av med"

environmental protections agency have developed some strategies in order to prevent the occurrence of WEEE, these strategies are:

1. Increase the information about the content[4] within EEE (Electrical and Electronic Equipment).
2. Increase the lifespan, both the actual lifespan and the usage time.
3. Increase reuse.

(Naturvårdsverket 2013, 66-67).

The ICT repair and refurbishment sector in Sweden

As one of the strategies from Sweden's Environmental Protection Agency is to increase reuse within the EEE (Naturvårdsverket 2013, 66-67), this paragraph are investigation reuse, repair and refurbish sector in Sweden with focus of only ICT products. There are many "gap exploiters" or "independent reuse business companies" in Sweden, a gap exploiter is a third-party firm who exploits the residual value of other companies' products by slowing down the throughput of new products in society (Whalen, Milios & Nussholz 2017, 2).

Problems with short usage time compared to potential lifetime

As mentioned before, Naturvårdsverket (the Swedish Environmental Protection Agency), argues that how we are consuming has a big role to play within the waste prevention work, big environmental gains can be achieved if the product isn't even produced in the first place, which requires that before a product is bought consumers need to rethink the need for and importance of a new product. Increasing a products lifespan and usage time through reuse and repair is important for the decrease of the environmental impact of ICT product (Naturvårdsverket 2017b). This because of all the embodied resources within ICT products, embodied resources is all natural

[4] Content in the meaning is both the toxic substances and embodied resources used in the production and the abolishment of the product.

resources needed in the production, usage and disposal/recycling of a product (Scott, Roelich, Owen & Barrett 2017, 629). Examples of these kind of natural resources are materials, GHG, toxic substances and water (Göteborgs stad, kretslopp och vatten 2018, 3). The Swedish Environmental Protection Agency argues that we need to increase the lifespan and the usage time on our ICT products, does that mean that we are not using our ICT products through their whole lifespan and why? In an article written by Ylä-Mella, Keiski and Pongrácz (2015) they explain that phones often are replaced before their lifetime is expired, supporting the fact that we are consuming phones in a unsustainable way. They mean that because phones are an "up-to-date" product consumers find it important to upgrade, they blame this on fact that consumers thinks that the "old" phone works but just not "as proper" as it did before (Ylä-Mella, Keiski & Pongrácz 2015, 383).

What are the main barriers?

One of the strategies from the Swedish Environmental Protection Agency is to increase the reuse of EEE products (Naturvårdsverket 2013, 66-67). In order to understand how we can increase the reuse we must study the repair, reuse and refurbishment sector in Sweden and get some knowledge about their barriers and drivers to better understand how the municipalities can work towards gaining the reuse of ICT products. In the article "Briding the gap: Barriers and potential for scaling reuse practices in the Swedish ICT sector" Whalen, Milios and Nussholtz (2017) write that the biggest barriers for gap exploiters today is the lack of appropriate take-back schemes for used ICT equipment; they explain that the waste management and the collection management that we have in Sweden today not are favoring the ability to collect the used products in a proper way. With "proper way" means that many of the products that can be repair and refurbish and prepared for reuse often ends up at a recycling station where they will "only" be recycled for material reuse and not product and function reuse (Whalen, Milios & Nussholz 2017, 6). Another barrier within the reuse sector is consumer's attitudes towards reused ICT products and their preferences for new things, this can be explained by the lack of thrill of newness with reused products (Whalen, Milios & Nussholz 2017, 6; van Weelden, Mugge & Bakker 2016, 746-747).

How can we deal with these barriers?

We now know that two of the main barriers within reuse of ICT products from the gap exploiters point of view is the lack of take-back schemes and consumers preferences of new products (Whalen et al. 2017, p.6; van Weelden, Mugge & Bakker 2016, 746-747). In the Ylä-Mella et al. article (2015) the authors explains that the high recycling rates in households can be a barriers for proper recycling of ICT products; they mean that there is high knowledge about the importance of recycling EEE but this is not transferred into behavior (Ylä-Mella, keiski & Pongrácz 2015, 383; Watson, Gylling, Tojo, Thorne-Holst, Bauer & Milios 2017, 176). But the problem does not stop there, as you recycle your electronic waste at one of the many recycling stations in Sweden, it will be classified as waste immediately, and as soon as a product is classified as waste it will also be treated as waste, which means that gap exploiters can't get any access to these products and can't repair and refurbish these for resale (Watson, Gylling, Tojo, Thorne-Holst, Bauer & Milios 2017, 13). In order to work around this problem so products can be repaired and refurbished for reuse instead of just material recycling some articles present the solution of having a deposit-refund system, were a buyer pays a fee when purchasing a new product and when the product are refund at a special collection station they get this fee will be paid back to the customer (Whalen, Milios & Nussholz 2017, 6; Ylä-Mella, Keiski & Pongrácz 2015, 177, 383). With this kind of deposit-refund system the consumer will have an economic incentive to return the used product instead of just throwing it away as "regular" electronic waste. A deposit-refund system depends on the producers assuming responsibility for collecting used product (Walls 2011, 5).

The other main barrier presented in the publications, studied in this literature review, is consumers' preferences of new products (Whalen, Milios& Nussholz 2017, 6), the thrill of newness compared to old products (van Weelden, Mugge & Bakker 2016, 746-747), and misunderstandings or perceived unreliability of refurbished products are some of the main factors and drivers for consumers to purchase a new products (Whalen, Milios & Nussholz 2017, 2-3). In the Whalen et al. (2017) article they write that a consumers' willingness to seek a gap exploiter instead of purchasing a new product are depending on four things, which are offer, cosumer, supply chain and finance (Whalen, Milios & Nussholz 2017, 2). Compared to a deposit-refund system the solution of consumers' willingness of purchasing a used product are depending on consumer participation.

Today consumers' response towards refurbished products is focused on consumers' willingness to pay, but there is an attitude-behavior gap within the consumers' between saying that they will do something an

actually doing something (Csutora 2012, 147; van Weelden, Mugge & Bakker 2016, 744). Consumers' decision-making process can be a problem in the actually purchase of a refurbished and reused product because of the lack of reliability (van Weelden, Mugge & Bakker 2016, 745). In order to work around this problem once again an economic incentive can be the solution. In an article written by Watson, Gylling, Tojo, Thorne-Holst, Bauer and Milios from 2017 they write that consumers' often engage in repair and second hand sales because of cost saving and not for the environment. By knowing this it can be concluded that in order to increase the reuse and resell of ICT product there needs to be an economic incentive that pushes the consumer (Watson, Gylling, Tojo, Thorne-Holst, Bauer & Milios 2017, 11). In an investigation done by Statens Offentliga Utredningar (SOU 2017:22) (2017) on behalf of the Swedish government looking at possible market based instruments (MBI) in order to increase reuse and resale as well as decrease waste and decrease purchase of new products. In this investigation they concluded that the price difference between purchasing a new product in order to repair a product is one of the biggest barriers for consumers. In order to overcome this barrier a proposal about a tax reduction was presented, this tax reduction is called hyberavdrag5 and will include a tax reduction up to 50% when a consumer are doing something that are decreasing waste development. Among other things will the tax reduction include reparations, service, updating and refurbishing of products and also purchasing of reused products (SOU 2017:22, 241). As written in Watson et al. (2017) article often consumers that are engaging in reuse and resell are doing this in order to save money so a tax reduction can be a solution because this will increase the price of repair and refurbish of products which will conclude in a more attractive reuse lifestyle because it will save money.

The Role of Municipalities

So far, the report has presented the two main barriers to the reuse of ICT products, as well as potential solutions to these. The question now is how to get there? Can the municipalities do something? In the same proposal as described above (SOU 2017:22) they explain that the municipalities have an important role in the work of collecting products that can be reused before

[5] Hyberavdrag is a fictional word that are based on a mix of several Swedish words, such as, renting, second-hand and reparation in order to develop a word which are covering all of these waste reduction methods into one word that is explaining the tax reduction.

it will be classified as waste, since it is more convenient and more effective to have a separate collecting system for those things that can be reused than throwing everything in the same container and later scanning through containers and collecting things that can be reused (this is also illegal). Here municipalities can both be working with infrastructure at recycling stations and also in cooperation with reuse companies. By making it easier for consumers to collect products that can be reused instead of disposing them in the regular recycling container, products can be picked up and redistributed to retail. Municipalities must work with waste management that are aiming for the highest step on the EU waste hierarchy compared to the second highest (SOU 2017:22, 299). As seen previously in the paragraph municipalities have an important role to play but it is the producers that are responsible to create the link between the production phase and the waste phase of a product. Because of this the producers are responsible for the operators of waste treatment plants, which are the municipalities, therefore municipalities have no responsibility to offer a well-functioning collecting system of ICT products (2002/96/EC; Sander, Schilling, Tojo, van Rossern, Vemon & George 2007, 1).

Results

The question asked during the interviews can be found in Appendix 1 (Swedish) and Appendix 2 (English), these questions are based on the barriers identified in the literature review.

A table showing all the interview respondents answer in short is presented in Appendix 3 at page 49, a table showing every interviewee professional role in their municipality is provided in the Method section (Table 1, page 15).

The following section will present a summary of each interview question individually based on the respondents' response.

1. *How does your municipality work with waste and circular economy?*

All the interview respondents confirmed that their municipalities were working with CE and waste, but the responses indicated that they were working with it in different ways. Interview respondent A, B and E answered that their responsible waste disposal station are the ones with the responsibility for developing a waste management system that are working towards CE and waste prevention. Interview respondent C answered that within their municipalizes waste plan they are working toward the highest steps in EUs waste hierarchy but the respondent also says that it is not necessarily that waste minimizing is just a question for the waste unit, it is important to work with waste prevention in all sectors within the municipality. Respondent C confirms that the municipality has as a goal to work more circular within all sectors, but has a hard time explaining how. Interview respondent D answered that their part within the work with waste and CE is to be an active part in different projects that are working with waste prevention.

2. *Is that something that you are actively working with?*

All of the interview respondents claims that they are working actively with CE and waste. Both respondent A, C and D explained that they are working

actively with CE in different ways. Interview respondent A answered that Malmö municipality have many projects within CE, which includes both official contracts and private projects. Respondent C explains that their municipality is working actively with CE and waste in different ways in different sectors. The respondent gave an example of how they are working with sharing furniture between different offices within the municipality. In such way they are preventing waste development when a office is redesigned. Respondent D explained that they are working with the private sector by encouraging households, through information, to increase the lifetime of products and in that way preventing waste development.

3. *Would you like to develop your work with circular economy and waste within your municipality, in that case how?*

Three of the five respondents answered that they wanted to develop their work with circular economy. Interview respondent A was answering that SYSAV, their waste disposal station, was the responsible actor in their municipality. Interview respondent C answered that their municipality was working with many small projects but also responded that it could do more in the work towards CE. Interview respondent E responded that they wanted to develop their work with CE but wasn't sure in what kind of way. Respondent E who was the representative for Ystad municipality answered that their municipality was a part of many waste prevention projects that they wanted to implement in their municipality but that implementation hadn't started yet. Interview respondent B didn't really answer the question but are explaining that the municipality has several collection stations at all of the disposal stations within the municipality and that they are reselling these products. In contrast to all of the other interview respondents respondent D answered that the work within circular economy and waste is a producer question. In order to work more waste preventing and aiming towards a CE the producers need to rethink and redo the design of products. Design for repair is a solution according to respondent D.

4. *Gap exploiters that are working with repair and refurbish of products find it a problem that people have a very positive view of regular recycling although repairs, reprocessing and resell of products are better for the environment than*

recycling. How can municipalities work to influence and change people's positive attitudes towards recycling?[6]

Three of five interview respondents answered that municipalities can influence and change people's positive attitude towards recycling throughout information. Interview respondent B, C and E argues that more and more transparent information to the citizens about the importance of reuse and resell of products is the way to go if peoples' attitudes should be influenced. Respondent E also explains the importance of not only inform but also give the concrete opportunity to act more sustainable in everyday life. Respondent E also questioned the municipality's role within attitude change, and questioned what municipalities can or should do?

Interview respondent A explains that Malmö city doesn't have any policies about increasing reuse which could be something that have a negative effect on peoples' attitudes towards reuse. The respondent, however, answered that the municipality has a lot of initiatives that are showing the importance of reuse and second-hand. Further, the respondent also presented an idea about sharing economy could be something that could open up peoples' eyes towards reuse of products.

When interviewing Lund Renhållningsverk, respondent D, once again responded that CE is and will be a design question. CE and the work towards it is all about the producers and they need to take their responsibility. The respondent also explains that the work towards CE is about the consumers' behavior and attitudes. Our society need to change our consumptions habits and we need to rethink what can be reused, resold and kept. The interviewee finished off with the importance of consumers questioning themselves if they really need the latest model.

[6] The problem with peoples' positive view of recycling is that many products that could be repaired and refurbished are thrown away in the regular recycling container and goes only to material and energy reuse instead of product reuse, the question is about how municipalities can change the positive attitude towards regular recycling and influence people to collect ICT products for reuse instead of recycling.

5. *A lot of products goes to waste today by regular recycling, which could be repaired and reused. How can you work with this, such as to redistribute products from waste to other "waste" streams?*

All of the respondents answered that they are, and could even more, working with infrastructure at the waste disposal stations to increase the collection and reuse of functioning products. With infrastructure they mean that in the beginning of the disposal stations there is a possibility to leave products that can be reused, this kind of infrastructure are supposed to influence people to not throw away products that can be reused. Interview respondent A are actively working with infrastructure but are seeing a barrier with the fact that when a product are classified as waste they can't do anything about it.

Interviewee C answered that they were working actively with infrastructure at their waste disposal station but the station was old and the infrastructure needed to be worked with a lot more to influence citizens to collect products that could be reused instead of recycling them.

Respondent D, as all of the other respondents, were talking about infrastructure but also explaining that a change in consumers behavior is needed. Also a change in consumers' preferences towards new products are needed. The respondent answered that a way to change peoples' attitudes could be a development of sharing economy, which will provide the consumers knowledge to use products collectively without the need of owning things.

Respondent E was also talking about infrastructure, and that this is something that they could work with even more and developed with the responsible waste management company SYSAV. The interviewee also presented the idea that the work with redistributing products from waste to other waste streams could be to work with property owners and connecting these to business that are working with reselling to redistribute products. The respondent finished by commenting that this is something that they needed to think about how to manage.

6. *Would you be able to develop your cooperation with companies that work with re-manufacturing and repairs? Can you develop your cooperation with second hand stores? What drives and barriers do you see within this?*

Only one of the respondents answered that they would be able to develop their cooperation with remanufacturing companies. This was respondent D, which answered that they definitely could develop their cooperation and explained that the infrastructure at the recycling stations has an important role to play and also the cooperation between municipalities and second-hand markets. The interviewee also responded positively about the future, explaining that at the moment in our society we are in the stage where we are searching for solutions about how we can implement CE in our society. The respondent also explained the positive vibes that the furniture industry is sending out at the moment where they have started to develop a system that is working towards waste prevention and sustainable consumption. Interview respondent C was explaining that cooperation between municipalities and reuse and repair shops are difficult, which the respondent not further explains.

All of the respondent explains that their municipality have cooperation's with second-hand markets at their waste deposit stations, were the citizens have the possibility to deposit product at a special place for reuse and resell at a second-hand shop. Respondent B answered that their municipality provides opportunities for companies to increase collection of products by submitting places for this. But the interviewee explains that a problem within the reselling sector is that many companies that are collecting products doesn't have the recall of products that are needed to receive all of the submitted products at the disposal stations.

What kind of barriers does the municipalities see within the collection and reuse sector? Interview respondent A answered that the two biggest barriers are that waste is waste, and when a product have been thrown away and classified as waste there is nothing that can be done. The second barrier are the consumers preferences of new product, the respondent further explains that they as a municipality have the responsibility to influence people into a behavior change and make it easier to do right. The interviewee further explains that it is hard for municipalities to promote reuse and resell because of the strong commercial forces that are driving our society forward and that todays' economy are built on the purchase of new product. Interview respondent C explains that the biggest barrier in their municipality is that Vellinge is a rich municipality with a high average

income which leads to low interest in reused products. This, in turn, leads to a low collection rate as they do not realize the importance of re-usage. Interview respondent C are also explaining another barrier within their municipality which are stockholding possibilities, and further explains that there is no room for the municipality to store used products in order to resell them and instead the products will end up in the usual recycling bin. The interviewee finished of with explaining that the biggest barrier in order to increase re-usage and decrease waste development is the structural defects in the production market, where the respondent expresses their frustration about that there is no one that takes responsibility of developing a functional reuse market. The respondent means that it is the producers that have the responsibility for a sustainable consumption within all product categories and that they need to develop a system were products easier can be collected and further repaired, refurbished and reused. Interview respondent D answers that the biggest barrier today in order to increase reuse of products is our society's consumption hysteria and explains that the solution to this is to change our values and attitudes towards consumption.

What kind of drivers does the municipalities see within the collection and reuse sector? Interview respondent A, C and D have similar answers about the drivers within the collection and reuse sector and that is to work with role-models, which that can provide a good example. By showing "the right way" to reuse, repair, recycle can these role-models encouraging citizens not to throw away used products and encourage reuse are these three respondents positive that such initiatives can create ripples. Interview respondent D explains the gains of local democracy as citizens tend to listen to their friends rather than to "higher" powers. By commencing projects that work with waste prevention within housing associations where the project combines environmental benefits with social contexts changes can be accomplished. Interview respondent A are giving a successful example of this kind of local democracy project within their municipality, which was a clothing swapping day. This kind of initiative are working towards waste prevention and at the same time are creating a social context, which can create ripples, interview respondent A also believes that this kind of initiative could be done with other product categories as well.

Discussion

Answering the research questions

1. *In general what are the main barriers within the reuse of ICT products in Sweden today?*

Both the literature study and the interview survey are showing that there are two main barriers within the reuse of ICT products in Sweden today, these two are:

- Lack of appropriate take-back schemes.
- Consumers' preferences for new products.

(Whalen, Milios & Nussholz 2017, 6; van Weelden, Mugge & Bakker 2016, 746-747; Appendix 3).

The reuse and repair sector in Sweden are seeing big problems with consumers' positive attitudes towards recycling and explains that many products that can be repaired and reused are ending up in a lower step on EUs waste hierarchy, when it could end up at the highest one (Whalen, Milios & Nussholz 2017, 6). The interviewed municipalities are agreeing with this problem and answers that they could work more with the infrastructure at their waste deposit stations in order to increase the collection of reusable products. Both the literature and one respondent in the interview survey are seeing a big barrier in the reign classification of waste, when a product are collected in the "regular" WEEE bin at the waste deposit station it is immediately classified as waste and either the companies that are working towards reuse and repair or the municipalities can do anything about it (Watson, Gylling, Tojo, Thorne-Holst, Bauer & Milios 2017, 13; Appendix 3).

The reuse and repair sector in Sweden and some of the interviewed municipalities also agrees on the problem of consumers' preferences of new products (Whalen et al. 2017, p.6; Appendix 3), where the literature are

explaining that the lack of thrill of newness and unreliability on refurbished and repaired products are some of the main factors that prevent consumers to purchase a reused product (van Weelden, Mugge & Bakker 2016, 746-747; Whalen, Milios & Nussholz 2017, 2-3). Interview respondent C from Vellinge municipality explains that because of the high income rate in their municipality have caused a low interest in purchasing reused products, which also are showing in low collection rate. Interview respondent D is agreeing with the literature and are blaming the low purchase rate of reused products can be explained by our society's consumption hysteria where new products are highly valued (Appendix 3).

2. *How are municipalities working towards waste prevention of ICT products today?*

All of the interview respondents during the interview survey answered that they were working with infrastructure at their waste disposal stations in order to prevent waste development, all of the interviewed also answered that this is something that they could work even more with in order to increase the collection of functioning products and redistribute these to other "waste" streams (Appendix 3). During the interviews a question was asked to the municipalities about how they could work to influence and change people's positive attitudes towards recycling, which is, as explained above, one of the barriers that was decreasing the proper way of collecting functioning products. During this question three of five interview respondent answered that municipalities can influence and change people's positive attitudes towards recycling throughout information, this is something that they already do but they also argues that more and more transparent information to the citizens about the importance of re-usage and resell of products can be a potential solution (Appendix 3). As a conclusion about how municipalities are working towards waste prevention within the ICT sector today is that the interviewed municipalities are working with infrastructure in order to increase the collection of reusable product and that they are working with information about the importance of collection and reuse of products. All of the interviewed also agreed that they could work more within this two ways of preventing waste development within the ICT sector.

3. *What can municipalities do to increase reuse, repair and refurbish of ICT products?*

In the investigation which are presented in the background of this thesis done by Statens Offentliga Utredningar (SOU 2017:22) were they were looking at possible market based instruments in order to increase reuse and resell of products in our society they are explaining that the municipalities have an important role in the work of collecting products before they are classified as waste. The authors of the investigation writes that priority should be given to products that can be reused, and explains the importance that this kind of products never should be classified as waste. It further explains the importance of developing a well-functioning market for re-usage and repairs (SOU 2017:22, 299). As confirmed during the interviews all the interviewed municipalities was actively working CE and waste prevention. But as a conclusion it can be established that enough isn't done, because the problem still exist and we don't have a functioning reuse, repair and refurbish market in Sweden today. During the literature research and the interviews I've come to an understanding that a big problem is that no one really knows whose responsibility it is to create and drive a well-functioning collecting system within ICT products today. Interview respondent D, from Lund Renhållningsverk, claims that both CE and a well-functioning collection system is a producer questions since they are the ones putting the product on the market in the first place and they should be the responsible ones to develop and drive this kind of collecting system. Which also is the case since in one way, as explained above in the text, it is the producers that are the responsible ones to create a link between production phase and waste phase (Sander, Schilling, Tojo, van Rossem, Vernon & George 2007, 1). As it is today the producers have taken their responsibility and developed a way to collect used ICT products but today the system isn't favorable in order to reach circular economy since the products that are collected today often ends up at a material or energy reuse and not at the highest step on EU waste hierarchy which is product reuse (2008/98/EG). Interview respondent E from Ystad municipality was multiple times questioning the municipalities role within the whole question of a well-functioning collection system that should benefit a reuse and repair market for used products. The respondent explained that the frustrations about what can and should the municipality do and what kind of relationship should the municipality have with business and non-profit actors. All the municipalities that were a part of the interview survey are in agreement on one part and that is the fact that our society is facing a higher problem than just a well-functioning collection system and that it is our consumption

habits which are in need of a change if we will secure our planets future (Appendix 3).

The question about what municipalities can do to increase a sustainable reuse, repair and refurbish market within ICT products in Sweden today still isn't answered and that could be the reason why we still don't have a functioning system for it yet.

General discussion

As confirmed in the literature study and the interview survey what is done in our society today isn't enough since we don't have a well-functioning reuse and repair market in Sweden today. But what is the problem and what could a potential solution be? All the interviewed municipalities confirmed during the interviews that they were working with CE and waste, but the answers were indicating that they were working with it in different ways and that they was seeing different on who and what sector within the municipality who actually was the responsible one. Some interview respondents answered that the responsible part is the waste disposal station, another respondent answered that waste minimizing isn't just a question for the waste unit and further explained the importance of working with waste prevention within all sectors of the municipality. Further one respondent explained that CE is and will be a producers question and that it is the producers of products that are the one in charge for developing a circular system for products. As seen from this answer it is unclear about who and what part of the municipality who is responsible and if it even is on the municipality's table. As interview respondent E from Ystad municipality is several times during the interview questioning the municipality's role and what a municipality can or can't do or should or shouldn't do in order to develop the work towards CE.

It is very clear after the literature review and the interview survey that there is confusions about who is the one in charge of developing a circular product flow in our society. Some argues that the work towards CE is a producers question, some argues that it is our society's consumptions habits that are putting spanners in the work and some argues that it is the municipalities' role to inform and educate people to understand the importance of reuse and repair.

Possible solutions

This section will present the most discussed solution in the literature for the problem that well-functioning products are thrown away without being able to be repaired or resold, that solution is a deposit-refund system. A deposit-refund system is a market-based instrument that addresses the externalities. Externalities is the cost or benefit that third party are being affected by, externalities in this case is the cost of the environment that are caused by unsustain extraction of new virgin materials that are needed in order to produce new ICT products (Mont, Plepys, Whalen & Nussholz 2017, 6,7). By implementing a deposit-refund system the polluter, the one that not are returning the used product, are paying a fee, not getting back the refund that the consumer paid when purchasing the product. In this case it will be a kind of Polluter Pays Principle because the consumer that are causing that more virgin materials are extracted because the consumer didn't return the product for reuse are paying a fee for doing something unsustainable (1998:808, kap 2 §8). In Whalen et al. article (2017) they argue that the lack of appropriate take-back schemes for used ICT products hinders a higher supply of good quality ICT equipment for reuse (Whalen, Milios & Nussholz 2017, 6). In the same article they argues that a implementation of a well-designed deposit-refund system similarly to the one for PET- and aluminum bottles we have in Sweden today can be a solution. In the article written by Ylä-Mella, Keiski and Pongrácz (2015) they also argues for an implementation of a deposit-refund system for ICT products. They argues for the deposit-refund system by explaining that this kind of system is more profitable than other economic instruments such as taxes on virgin materials, waste disposal fees and recycling subsidies (Ylä-Mella, Keiski & Pongrácz, 2015, 377). They also explains, by their own survey, that consumers are more motivated for return of used products if an economic incentive such as a deposit-refund system is implemented (Ylä-Mella, Keiski & Pongrác, 2015, 382). A deposit-refund system is also known as extended producer responsibility, which means that it is the producers that are the one in charge of implementing a well-functioning system (Walls 2011, 5). A deposit-refund system is also known as extended producer responsibility, which means that it is the producers that are the one in charge of implementing a well-functioning system (Walls 2011, 5). As it is today, producers are bound by the WEEE Directive to provide a collections system for take-back of ICT products (Ylä-Mella, Poikela, Lehtinen, Tanskanen, Román, Keiski & Pongrácz 2014, 12). Today the possibility for collection of used ICT products are offered at waste deposit stations and in some retail stores. As we can see these kind of solutions for collection of used ICT products is not well functioning since big quantities still are

ending up in the regular WEEE container. A deposit-refund, as written before, will give the consumer an economic incentive for collecting ICT products in a more sustainable way since it can be redistributed to gap-exploiters more easily this way. We can now conclude that it is the producers' responsibility, by law, to implement a well-functioning take-back system the only thing municipalities can do is to inform people about the importance recycle their ICT products in the best way possible, this by not throwing them away but to collecting them in order to redistribute them to repair and resell business.

While municipalities should motivate residents to return their used products, municipalities also have to work with attitude changes within our consumption habits in order to make them more sustainable. Possible solutions to this that emerged during the interviews where implementing "clothes swapping days" for other products, role-models which precedes a good example, labeling of products and local democracy and sharing economy where environmental benefits combines with a social context which in turn can motivate a waste preventing lifestyle.

Discussion about the thesis process

It is important to take into considerations throughout the thesis that only 5 municipalities participated in the interview survey. Of course, it would have been advantageous with more municipalities to participate, but I think that the municipalities that chose to participate gave a diverse perspective of the problems within waste prevention of ICT products.

If I had the possibility to do my thesis again I would definitely try to have more respondents to my interview survey, another interesting thing to involve in this type of study would be to involve other actors within waste prevention of ICT products. Such as gap exploiters, consumers and producers in order to get a deeper understanding about the problems within the whole lifecycle of an ICT product.

My recommendations to future studies within the filed would be to investigate the potentials of an introduction of a deposit-refund system for ICT products, who should be responsible one and what amount of money would be a enough to create an economic incentive for people to collect and deposit their used ICT products. Other studies that could be done in this filed would also be further investigation about producer responsibility and how producers are working towards a circular way of treating used products.

Conclusion

As a conclusion to this thesis it was clear that the municipalities have the same view of the main barriers with waste prevention within the ICT sector as the literature shows, these two main barriers are lack of a well-functioning take-back scheme and consumers' preferences of new products. The barriers are known but the solutions are still not figured out; this could be because of lack of clear responsibilities. The solution of a well-functioning take-back scheme could be an implementation of a deposit-refund system where the producers are responsible for a proper collection of used ICT products. But as long as we don't have that kind of system the municipalities need to work with infrastructure at their waste deposit stations in order to guide consumers to collect instead of discharging products so that they do not become part of the waste stream and can be redistributed for resale. Finally, and perhaps most importantly, is that our society must review our consumption habits, which both the literature and the interviewed municipalities explains as a big reason for our waste streams today. And here municipalities can work with information about the importance of sustainable consumption and proper collection of products in order to increase reuse (appendix 3).

Thanks

I would like to thank my supervisor Jessika Luth Richter and my group supervisor Carl Dalhammar. I would also like to thank interview respondents from Malmö, Åstorp, Vellinge, Lund and Ystad municipality for participating in my interview survey.

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Appendix

Appendix 1

Interview questions, in Swedish.

1. Hur tänker/ arbetar er kommun med avfall och cirkulär ekonomi?
2. Är det något ni arbetar aktivt med?
3. Skulle ni vilja utveckla ert arbete inom den cirkulära ekonomin och avfall inom er kommun, i sådana fall hur?
4. Företag som arbetar med återtillverkning och reparationer tycker att det är ett problem att folk ser positivt på återvinning, eftersom reparationer och återtillverkning är bättre än återvinning ur miljösynpunkt. Hur kan ni kommuner arbeta för att påverka folks attityder?
5. Mycket avfall idag hamnar på återvinning, som skulle kunna gå till återanvändning och reparationer. Hur kan ni arbeta med detta, t.ex. vad gäller att omfördela produkter från avfall till andra avfallsströmmar?
6. Skulle ni kunna utveckla ert samarbeta med företag som arbetar med återtillverkning och reparationer? Kan ni utveckla ert samarbeta med second hand-affärer? Vilka drivkrafter och barriärer upplever ni angående detta?

Appendix 2

Interview questions, translated to English.

1. How does your municipality work with waste and circular economy?
2. Is that something that you are actively working with?
3. Would you like to develop your work with circular economy and waste within your municipality, in that case how?
4. Gap exploiters that are working with repair and refurbish of products find it a problem that people have a very positive view of regular recycling although repairs, reprocessing and resell of products are better for the environment than recycling. How can municipalities work to influence and change people's positive attitudes towards recycling?
5. A lot of products goes to waste today by regular recycling, which could be repaired and reused. How can you work with this, such as to redistribute products from waste to other "waste" streams?
6. Would you be able to develop your cooperation with companies that work with re-manufacturing and repairs? Can you develop your cooperation with second hand stores? What drives and barriers do you see within this?

Appendix 3

Interview answers, translated to English.

Q	A, MALMÖ	B, ÅSTORP	C, VELLINGE	D, LUNDE RENHÅLLNINGSVERK	E, YSTAD
1.	Our waste disposal station, SYSAV, are working with this.	Together with NSR we are developing a new waste managing plan which will have clear goals of decreasing the municipality's waste amount and increase reuse.	In our waste management plan we have goals that are built on EU waste hierarchy where we are working for waste prevention. But it is not necessary that waste minimizing is just at the waste unit but in all of the sectors in the municipality. But our goal is to work more circular.	We can be a part and drive projects.	In our municipality our work is always to aim towards the upper parts of EU waste hierarchy, but unfortunate it is hard to work towards the 2 upper parts, prevent and reuse. Our waste unit, SYSAV, are always working with educating and information about the importance of reuse and waste prevention. Together with SYSAV and the 13 other owner municipalities we are having a dialogue about how we can work with this in the future. I think that a lot will happen within this field in the near future.
2.	Yes, we have many projects within CE, both within official contracts and private projects such as "delad energi dubbel energi".	Yes.	Yes, but different ways in different sectors. For example are we working with charring furniture's between different offices in the municipality.	Yes, we are working with the private sector and encourages households to increase the lifetime of products.	Yes, we are trying.

3.	Yes, SYSAV is working with it.	The municipality has a section that are collecting collected stuff at all of the waste disposal stations within the municipality and have a reselling of these products.	Yes, we have small projects but it could be more.	It is a producer question, it is about design, such as design for repair.	Yes, but how is the question. We are a part of many waste prevention projects that we want to implement in our municipality but we haven't started yet.
4.	There is no policies in our municipality about decreasing reuse, which could be something that could affect peoples' attitudes towards reuse. Also sharing economy could be something that could open up peoples' eyes towards reuse. But we have a lot of initiatives that are showing the importance of reuse and second-hand.	More and more transparent information about the importance of reuse.	Information, although I feel that that is one thing a have put a lot of resources on. More information about the importance of reselling and reuse.	CE is and will be a design question, it is all about the producers and they need to take their responsibility. It is also about behavior and attitudes, we need to change these in our society, what can be reused, sold and what can be kept. Do I really need to latest model?	Information is one way we as a municipality can work with. It would be fun to do more, but it will be difficult. I think it's important to not only inform but also give the concrete opportunity to act sustainably in everyday life. But here we immediately encounter the question about what is the municipality's role - what can and should the municipality do?
5.	SYSAV is working with infrastructure at the recycling station, which influences people to not throw away products that can be reused. The problem is when a product are classified as waste because then we can't do anything.	Within our waste disposal stations there is a possibility to leave products that can be reused, this container is placed in the front of the station which makes it easier to collect those things that can be reused. We are working with infrastructure.	Infrastructure, our waste disposal station is old and have an old infrastructure, the collecting stations is in the beginning of the station but we need to work with the infrastructure.	Infrastructure, and change the consumer behavior. Do we really need to own stuff? And change the attitudes towards the preferences for new products. Charring economy can be one thing that will show that we can use products collectively.	We have the possibility at the recycling center to leave waste for reuse instead of disposing. This is something that can and should be further developed in cooperation with Sysav and something Sysav is looking to do in Malmö. Another way can also be to work with property owners and business to help them. This is something we should think about how to do.

6.	Two of the biggest barriers are the fact that waste are waste and we can't really do anything after that, the second barriers are the consumers' preferences of new products. We as a municipality need to influence people into a behavior change. As a municipality we need to make it easier to do right and SYSAV needs to work more with the infrastructure, but it is hard for municipalities because it is very strong commercial forces and todays' economy are built on the purchase of new products. Successful waste minimizing initiatives we have done is clothing swapping days and I believe that that could be done with other products as well.	The municipality has a department for this. The municipality provides opportunities for companies to increase collection opportunities by indicating places for this. One problem is that many reselling companies do not have the recall of things that are needed to receive all submitted at the waste disposal stations.	It is fun with mote cooperation's' between municipalities and reuse and repair shops but it is contradictory between private and official sectors. But we have some, for example stores that have the possibility to collect used ICT products. Barriers in our municipality are stockholding possibilities, there is no room for us to store used products that can be reused, and instead they will end up in the usual recycling and the upper steps of EU waste hierarchy is not accomplished. However, I believe that the main barrier in our municipality is that it is a rich municipality where interest in used products is low. In order for consumers to change their perception of refurbishment, I think that it requires role models that create ripples and perhaps help with nudging projects that can pave the way for a more sustainable society. But above all, I think the biggest barrier is the structural defects in the market where it feels that today there is no one in charge. I think it's the one who puts the product on the market that has the responsibility to develop a functioning refurbishment market. The government in Sweden today	Yes, we could. I think that the infrastructure has an important role to paly, also that municipalities can work, even more, with second-hand markets. Right now I think that we are in a stadium of searching of solutions about how we can implement CE in our society and what I can see I feel that the furniture industry are starting to send good signals about a system within waste prevention and consumption that are working. The biggest barriers today I think is the consumption hysteria and I think that the solution to that is to change our values and attitudes towards consumption. I think that driving forces can be initiatives and in this case initiatives that are encouraging a lifestyle which generates less waste. Local democracy is important as citizens tend to rather listen to their friends than to "higher" powers. By commencing projects that work with waste prevention, for example, housing associations or	This is already the case with the collection at the recycling centers in the Sysav region. The difficulty is always what is the role of the municipality - what can and should the municipality do? What relationships should we have with business and non-profit players?

			is a little bit cowardly, since no one dares to put pressure on producers to take responsibility for sustainable consumption. At the same time, I understand that our society must benefit the economy based on the sale of new products, which in turn is also a structural error. In the future, I think we need to work with labeling of goods that give a picture of how long a product should last, and I think we have to work more with design for repair, which lies at the producers' table.	similarities, where one combines environmental benefits with social contexts, and encompassing this can create a ripple effect that can generate behavioral changes which in turn can be waste-reducing.	

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Lunds universitet

Miljövetenskaplig utbildning
Centrum för miljö- och klimatforskning
Ekologihuset
223 62 Lund