Repair and the Transition to Sustainability

A qualitative study of electronics consumption at the University of Oslo

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Repair and the Transition to Sustainability

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Abstract

The sustainable consumption of electronics is essential to minimize the environmental impacts so that humans can use the natural resources not only in the present but also in the future without compromising future generations' needs (Brundtland & Khalid, 1987). However, due to unsustainable consumption of electronics, excessive amounts of e-waste are being generated, which directly impacts the environment and human beings.

Taking a Transition Design perspective, this research set out to understand consumers' mindset and to create future visions as a part of the transition to a sustainable future, which could be achieved by identifying and implementing different design interventions.

Set within the understanding of repair as a social practice, this study implemented an exploratory design approach, collecting data from the semi-structured interviews, observations, and focus group discussion. In the analysis of data, different barriers to repair are identified, hindering the circular economy of electronics in an academic institution. Repair is considered an ineffective and time-consuming task for the institution, which is less productive and less economical. This leads to less repair, more e-waste, and a barrier to sustainable consumption.

This thesis explores new design interventions in the transition towards a vision of sustainable consumption of electronics in an academic institution. The design interventions made in the study were then discussed with the IT engineers at UiO. This opened up many possibilities for the sustainable consumption of electronics by targeting the repair of used and disposed devices in an institution, which can provide both social and economic benefits.

By utilizing the results from community repair and social practice theory, this study suggests the social and economic benefits of collaborative repair in an academic institution. Collaborative repair in an academic institution enables multiple lifecycles of electronic devices, helps maximum recovery of the materials, and contributes to the circular economy. As a result, the collaborative repair in institutions enables the establishment of sustainable consumption behavior.

Keywords*: sustainable consumption; circular economy; transition design; electronics repair; social practice*

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List of Abbreviations

- UiO: Universitetet i Oslo (University of Oslo)
- IFI: Institutt for informatikk (Department for informatics)
- SDGs: Sustainable Development Goals
- EU: European Union
- EEE: Electrical and Electronic Equipment
- E: Electronic
- Mt: Million metric ton
- HCI: Human Computer Interaction
- CE: Circular Economy
- WRAP: The waste and resource action programme
- DIY: Do It Yourself
- SPT: Social Practice Theory
- TD: Transition Design
- IT: Information Technology
- TA: Thematic Analysis

1 Introduction

1.1 General Introduction

This thesis addresses some of the challenges the environment faces because of the excessive use of natural resources leading, among others, to climate change. The climate crisis has received considerable media attention in recent years and has manifested itself as a political and environmental problem (Bhamra & Lofthouse, 2007). "Climate change is probably the greatest long-term challenge facing the human race" (Blair, 2006, p. 4). Moreover, it is affecting every country and every individual. Therefore, it is now imperative to address the climate change problem on all levels, from the individual to the organization.

The earth is dependent on humans. As humans, we have the responsibility to preserve our nature and natural resources. In fact, humans are adopting a lifestyle that is beyond natures' ability. As a result, the earth's natural resources are overused, risking the ability of their availability in the future (Thøgersen, 2014). Today social transitions have become imperative for a more sustainable future.

Sustainable consumption will help protect the environment and eventually benefit human existence. The survival of our environment depends upon how we consume the elements and raw materials and how well we maintain the value of products by extending their lifespan. The effective response will be to form new ways of living, working, and playing across all sectors of society (Shove, 2010).

In this study I focus on the need for sustainable development, addressing the underlying reasons for unsustainable consumption of electronics which contributes to social and environmental unsustainability. Additionally, the qualitative study of social practices is considered as an approach to understand and support a possible pro-environmental behavioral change in this study.

1.2 Background

This research is a part of the Sustainability & Design Lab at the Department of Informatics (IFI) at the University of Oslo (UiO). The field of study focuses on designing sustainable use of technology.

In modern times, technology has been a necessity for humans. It is growing fast, leaving a significant impact on the environment and society. Technology is everywhere; directly or indirectly, every individual plays a part in its evolution. The advantages of technology ought weight the negative impacts of technology on humans and the environment (van der Velden & Taylor, 2017). Technology makes society increasingly consumption-oriented, leading to increased production and the overconsumption of natural resources. The increased consumption of resources is damaging the biosphere (Tonkinwise, 2015).

Technology is highly embedded in electronics, which contributes to complexity in smartphones (i.e., challenging circular economy of electronics). Today's business strategy is consumption focused. On the one hand, companies aim to sell as many products as possible. On the other hand, consumers are attracted by the novel products in the market rather than using them through their complete lifespan. As a result, electronics are the fastest growing waste stream in the world while only 17.4% of this is formally recycled and reused (Forti et al., 2020). Research shows that Norway is the country in Europe with the highest consumption of electronics per capita, generating 26 kg of electronic waste (e-waste) per person in 2019 (Forti et al., 2020). Not surprisingly, the UiO is a huge consumer of computers, mobile phones, audio-visual devices, and other electronic devices. This eventually leads to high e-waste production.

> *"According to the Ragn-Sells, the previous e-waste recycling company used by UiO, 64 tons of e-waste was disposed by the UiO in 2018 and 71 tons in 2019. Additionally, most of the electronic waste is mixed, while 84% is recycled and 16% is burned" (I-3, Table 4).*

As e-waste is growing every year at UiO, it is essential to identify the barriers of unsustainable consumption and possible implementations in the transition toward sustainable consumption. This study is based on qualitative research methods aiming to understand the underlying reasons for unsustainable consumption of electronics at UiO, particularly at IFI. Furthermore, this study considers addressing the problem from the standpoint of repair—the activity whereby devices are disassembled, and their functions are restored, which contributes to a circular economy by extending the lifespan of devices in an interactive way. Finally, the study will discuss how the repairing practice in an academic institution contributes to the transition to economic and social sustainability.

1.3 Motivation

Climate change is constantly affecting our planet. On the one hand, this is influencing human's health while, on the other hand, we are risking access to natural resources for the future generation. This has always been a point of interest to me. After taking the course called Design, Technology and Society (IN5010) at IFI at UiO, I could understand the relationship between technology and nature. Knowing how natural resources are heavily used without considering their consequences for the future generation disheartened me and motivated me to research how to decrease the overconsumption of natural resources.

As a student at UiO for many years, I have seen a large number of electronics in different buildings, and some of those devices were not being used for many years. Knowing this, I asked myself a question: *How can we bring these unused devices in use while others [UiO, students, employees] do not have to buy new devices?* After a short discussion with my supervisors, this question became prominent. We raised few other questions like *what happens when a particular part of a laptop is defective?* This motivated to constitute this research.

I was always curious about the impact humans have on the environment and how I can contribute to reducing the negative impact. Moreover, I love to keep using things for a long time. Therefore, I was always interested in repairing and reusing devices that I use in my daily life. It was always fun, and the learning process while engaging with electronic devices is even more satisfactory. This interest led me to understand how the repair approach can contribute to the sustainable consumption of electronics and what benefits the repair contributes economically and socially. From my earlier experience, I could see many advantages of repair of electronics, which otherwise would become e-waste. Therefore, I see possibilities of repair as one way for the sustainable consumption of electronics in an institution.

1.4 Toward Sustainable Development Goals

In September 2015, the United Nations (UN) and other UN member states adopted 17 sustainable development goals (SDGs) to be achieved by 2030 (Figure 1). The SDGs are adopted as a global call for action by all countries promoting sustainable development, "promoting prosperity while protecting the planet" (Alkire & Jahan, 2018).

The unsustainable consumption of electronics has resulted in a significant loss of valuable raw materials (such as gold, platinum, and cobalt) from the earth. Reaching SDG 12 (Figure 1) seems challenging in the context of the increasing production and consumption of electronics. Thus, this thesis aims to contribute to the SDGs, particularly SDG 13: climate change problems due to unsustainable production and consumption (Alkire & Jahan, 2018).

Figure 1: United Nations Sustainable Development Goals (van der Velden, 2018)

The UN's target is to substantially reduce waste generation through prevention, reduction, recycling, and reuse by 2030 (SDG target 12.5) (Alkire & Jahan, 2018). Likewise, SDG target 12.7 states, "promote public procurement practices that are sustainable." This study will look closer to the role of the consumer as a barrier and driver to sustainable consumption of electronics in an institution. Similarly, how new practices can be implemented in institution to sustain sustainable development and reduction of impacts on climate change, which is similar to the target 13.3: "awareness-raising and human and institutional capacity on climate change mitigation, adaption, impart reduction and early warning," that enables the goal 13.

1.5 Research Question

This research aims to explore the possibilities of sustainable ways of consumption of electronics in an academic institution. For sustainable use, the electronics should be used longer by extending lifespan by repairing and reusing. The repair approach is considered an approach to contribute to the circular economy and support sustainable consumption. However, repair work is little emphasized compared to replacing the artifacts (Van der Velden, 2018). Therefore, I wanted to identify the role of repair of electronics in circular economy and sustainable consumption. This leads to my first research question:

- *How can repair contribute to a circular economy in support of sustainable consumption of electronics in an academic institution?*

In the age of consumption-oriented markets, products are produced to be consumed for a particular time and then stop functioning. Similarly, consumers are attracted by the production of novel products and encouraged to use and throw culture (Dalhammar, 2019). These barriers contribute to the unsustainable consumption of electronics. Although some laws and policies are made to support the sustainability of electronics, manufacturers are still producing devices that are not repair-friendly, and consumers are not aware of the sustainable use of electronics. Therefore, it could be relevant to understand the barriers to repair in an institution. This leads me to ask the second research question:

- *What are the barriers to the repair of electronics in an academic institution?*

Any task must be beneficial for humans in one or another way. For example, while looking at the cheap devices in the market, a repair can be a relatively less economical, tedious, and time-consuming task. Thus, rather than thinking only from the economic perspective, it is sometimes significant to think beyond the economy and focus on environmental and social consequences. Therefore, this study explores the social practices of repair that can contribute to sustainability to answer the above research questions.

1.6 Overview of Thesis

In this section, I present the structure of this thesis and a short description of each chapter.

Chapter 2. Literature Review

This chapter presents the prior research relevant to my research, which includes the challenges of technology, unsustainable consumption and its challenges, and other relevant studies that support sustainable consumption: the role of product design, circular economy, repair, and policies in sustainable consumption.

Chapter 3. Theory

This chapter presents the brief description of social practice theory as a theory of change and how this concept has been relevant in sustainable consumption.

Chapter 4. Research Approach and Methods

This chapter presents the methodological approach of this study. The chapter also includes descriptions of the transition design approach, methods, and techniques used for different purposes and ethical considerations held during the study.

Chapter 5. Data Collection and Results

This chapter presents data collection and results from the different phases of the transition design framework. In addition, some challenges encountered in this study are discussed.

Chapter 6. Analysis and Findings

This chapter presents the method for data analysis and the results from the analysis.

Chapter 7. Discussion

This chapter discusses the empirical data in relation to previous literature, theory, and research question.

Chapter 8. Conclusion

This chapter summarizes the learnings from the thesis and discusses the possibility of future work.

2 Literature Review

In this chapter, I present the earlier research in a similar field of this study. This chapter begins with a brief introduction to the challenges of technology and growing electrical and electronic waste. Second, the problem of unsustainable consumption and its challenges humans and the environment face. Thirdly, this chapter reviews the notion of interaction design in the overconsumption of electronics. Lastly, this chapter examines the role of circular economy, repair, and policymaking in the sustainable consumption of electronics. In addition, other elements like consumer behavior, product design, and planned obsolescence are parts of the discussion in this study, and they are related to the consumption of artifacts. This literature review aims to establish, evaluate, and analyze how the consumption of technological and electronic products can challenge sustainability. Likewise, what factors affect or improve the sustainability of electronics?

Figure 2: Brainstorming of related words for literature review, made using mentimeter.com

Figure 2 illustrates a brainstorming of related literature. This was made with the purpose to narrow down the broad field of literature in unsustainable consumption.

2.1 The Challenges of Technology

As new mechanisms of innovation invent new technologies, humans are highly motivated to use such novel technological equipment. As a result, technology-embedded artifacts, such as mobile phones, computers, and other small electronics, are a part of everyone's life. They are used in almost every household, institution, and business around the globe. Moreover, the products being produced are based on what is attractive in the market, especially electronic equipment, which influences consumer behavior toward use and throw culture. In addition, the repair and reuse processes are not growing. Most importantly, technological products and artifacts are consumed in high amounts, resulting in unsustainable consumption of natural resources (Bauer et al., 2018; Forti et al., 2020).

2.1.1 Unsustainable Consumption of Electronics

The electronic industry is one of the fastest growing industry globally. Meanwhile, electrical and electronic equipment (EEE[1]) waste is the fastest growing waste. Millions of tons of EEE-waste are produced every year, and very few are recycled or repaired and reused properly. The amount of EEE-waste has grown by 1.8 million metric tons (Mt) from 2014 to 2019, and it is supposed to be 74Mt in total by 2030 (Figure 3). Only around 17.4% of this is recycled or reused, and the rest is dumped in the landfill improperly (Forti et al., 2020).

In 2019, among the larger shares of e-waste, the small electronic equipment (screens, small IT, and telecommunication equipment's) was the main, which was 17.4 million metric tons (Mt) out of 53.6 Mt in total. According to Forti et al. (2020), in 2019, continent Asia produced the most e-waste in the world while Europe the continent to generate most e-waste per person. A total of 16.2 kg of e-waste was produced per person (Figure 4). Similarly, Norway stands at the top of the list in Europe when it comes to electronic waste. It generated 26 kg of e-waste per capita in 2019, as illustrated in Figure 4. However, compared to food, clothing, and plastic, the

[1] According to Forti et al., (2020) EEE includes a wide range of products with circuity or electrical components with power or battery supplies (Step Initiative 2014). Almost any household or business use products like basic kitchen appliances, toys, tools to music, and ICT items, such as mobile phones, laptops, etc.

sustainability of electronics has got less attention and left behind in social and political discussions (Kuehr & Williams, 2003).

In their research, Forti et al. (2020) identified the challenges of e-waste in many countries in Europe. Even countries with effective e-waste management systems are a part of this problem because of relatively low collection and recycling rates. Similarly, Bauer et al. (2018) showed that Nordic countries stand way behind in reaching the target to SDG 12 by 2030. This target includes the whole life cycle of electronics, starting from its design and manufacturing to consumption and disposal.

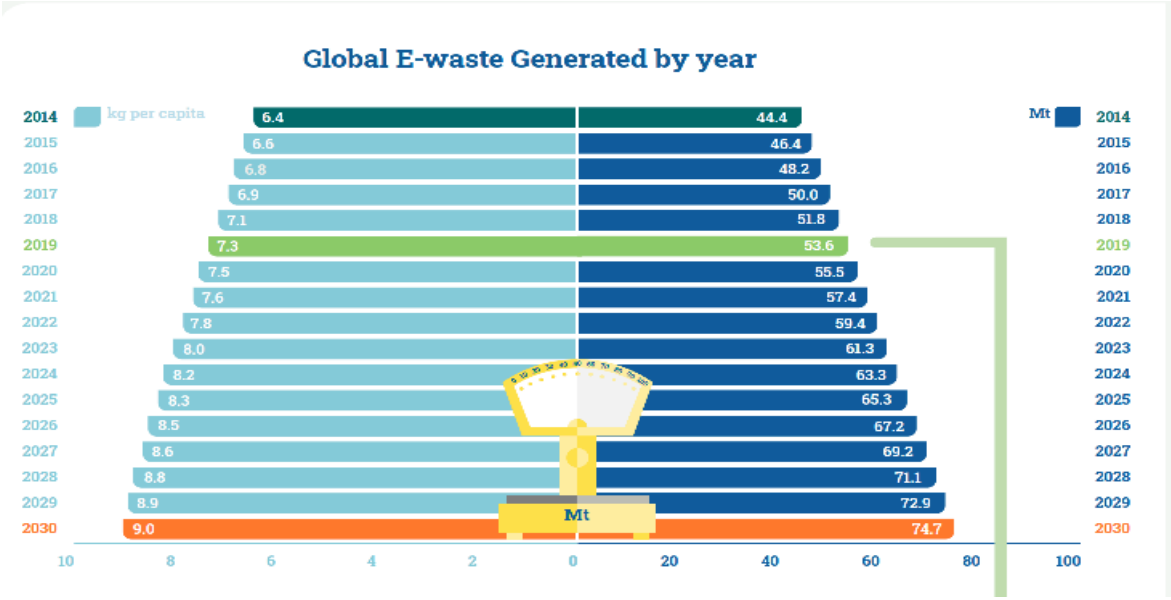

Figure 3: Global e-waste generated by year (Forti et al., 2020, p.24)

Country	Region	E-waste generated (kt) (2019)	E-waste generated (kg per capita) (2019)	E-waste documented to be collected and recycled (kt)	National e-waste legislation/policy or regulation in place
Nicaragua	Americas	16	2.5	NA	No
Niger	Africa	9.3	0.5	NA	No
Nigeria	Africa	461	2.3	NA	Yes
North Macedonia	Europe	16	7.9	NA	Yes
Norway	Europe	139	26.0	99 (2017)[47]	Yes

Figure 4: Country e-waste key statics (Forti et al., 2020, p.124)

2.2 Unsustainable Consumption and Environmental Challenges

Unsustainable consumption means improper use of resources in contrast to sustainable consumption, which means using products and services in the present with minimum environmental impact so that future generations do not have to compromise the use of resources: also known as sustainable development (Brundtland & Khalid, 1987). Unsustainable consumption has challenged the environmental and health issues in many countries. The carbon footprint from the high consumption of electronics is neglected, and maybe many users are unknown to its consequences. For example, a single computer used by an individual contains 1500-2000 different components produced from all over the world. A 17-inch monitor has a higher footprint than a refrigerator, which is far more in comparison to its physical appearance (Williams, 2004). Most of the used devices are piled up in drawers and closets when new ones are purchased. Kuehr and Williams' (2003) survey results showed that 30% of the world population stores old computers and buys new ones. This leads to the increased demand for non-renewable natural resources, which is quite worrying for the environmental challenges.

As Feenberg (2010) argued, people and the environment are affected by technology even when they are not a part of technology. For example, most electronic devices contain toxic materials like lead and mercury that are hazardous and require special attention (Arduin et al., 2020). This type of material can cause fatal health problems in humans when they are dumped in landfills. Similarly, when the e-waste produced in different European countries is shipped to African countries (Cosima & Steve, 2010), the people in those countries face consequences for their health and the environment. Although some countries may have strategies to prevent the overall damage, it is not guaranteed that this will not impact those who are not directly a part of technology.

Additionally, environmental impacts are due to high volume raw materials usage and overproduction of materials. Similarly due to our dominant way of living, which is use and throw culture, rather than repairing and prolonging the lifespan of an artifact, has contributed to unsustainable consumption and directly or indirectly accounts for the environmental impacts like climate change (Thøgersen, 2014).

2.2.1 Unsustainable Consumption as Wicked Problem

Rittel and Webber (1973) observed social and organizational planning problems that could not be solved with traditional linear approaches (like system-engineering) and termed this problem as a wicked problem. Jon (2012) defined the wicked problem as a sociocultural problem that is difficult to solve with traditional linear approaches due to the involvement of many stakeholders containing contradictory knowledge leading to natural and economic burden. Environmental degradation is one of them, and unsustainable consumption of products in daily life is one aspect: having unintended consequences and making them wicked problems (Ritchey, 2013).

Rittel and Webber (1973) argued that every wicked problem is a symptom of another problem. A problem in one place can have or could get consequences in another part of the world, as explained in the previous section with the example of the export of e-waste. Wicked problems can have indirect effects. Wicked problems have no stopping point, neither there is an existing solution (Rittel & Webber, 1973).

This problem of unsustainable consumption is increasing every year. This is an increasing global issue, interconnected to various elements in society, such as humans, environment, and technology, and making it a wicked problem. A single approach cannot solve this problem, and neither is possible by individual action. This requires multiple interventions over a longer period, from individual to society and on a global level. Thus, the study of sustainable consumption of electronics in an academic institution can be an intervention to address this problem.

2.3 Human Computer Interaction and Sustainability

In human–computer interaction (HCI), the design focuses more on designing the technology that enables humans to interact with technology in a novel way (Dix et al., 2004), emphasizing humans rather than the materials. The energy efficiency of electronics is prioritized while sustainability is less addressed from a materials perspective (Balkenende & Bakker, 2015).

It is now imperative to understand the impact of product design on sustainability. For sustainable use of resources, a focus on product design needs specific attention (Balkenende & Bakker, 2015). For example, the design of electronics needs improvement in the maintenance, reparability, and recyclability of an artifact. Furthermore, “digitalisation and its designs, technologies, and services have to transform from minimizing its negative impacts to generating

life and regenerating the planet" (van der Velden, 2018, p. 170). Thus, design plays an essential role in consumption patterns, and designers can significantly influence product design and how the users consume it.

2.3.1 Interaction Design

Interaction design is a part of information technology where designers focus on designing user experience: artifacts that meet user needs. Rogers, Sharp and Preece (2011) defined interaction design as "designing interactive products to support the way people communicate and interact in their everyday and working lives" (p. 9). When the design is more user-centric, the negative impacts of technology in the environment are not addressed, which has undermined gains of technology and digitalization (van der Velden, 2018). Van der Velden (2018) also argued that digitalization is not a problem, but how sustainable the technology is and how it contributes to SDGs established by the UN is the recent concern. Today's smartphones are designed to have a shorter lifespan, where replacing and the trade-off is easier than repair and maintenance (van der Velden, 2018). This short life cycle leads to overconsumption of electronics, further overproduction of e-waste, and eventually, the critical pressure on the use of natural resources drastically increased.

Balkenende and Bakker (2015) illustrated the challenges in sustainability of product design; electronics are not designed to be repair and reuse properly to their maximum life cycle. Electronics products are highly embedded and diluted with other materials, making them even harder to disassemble, which is the major step in all kinds of repair and recoverability of products (Balkenende & Bakker, 2015). Balkenende and Bakker (2015) argue that 80–90% of the value of a product is wasted during the recycling of electronics. Therefore, a product designer should design in such a way a product can be repaired, reused, and refurbished.

2.3.2 Planned Obsolescence

As defined in the Oxford Dictionary, planned obsolescence means the following:

> *"A policy of producing consumer goods that rapidly become obsolete and so require replacing, achieved by frequent changes in design, termination of the supply of spare parts, and the use of non-durable materials"(Oxford, n.d.).*

Product is intentionally made weaker, artificially limited to maximum life, making products obsolete after a specific time of use: which is predetermined by designers (Rosner and Ames, 2014). In some cases, the information of internal structure is not provided to the user. The example of the printer which stopped working after 200 prints (Cosima & Steve, 2010), and instance of anti-repair properties of Apple, products do not function even when the parts are exchanged between two original iPhones (Hugh, 2020). Furthermore, Mitchell (2018) argued that Apple hides the product information from its consumers. Thus, product design and manufacturing strategies that make products weak and hide information can cause the unsustainable consumption of electronics in academic institutions.

Similarly, planned obsolescence is the producer's business model and associated with the consumers' use and throw culture (Dalhammar, 2019). Most people are attracted by new models and designs, which makes them change things often, leading to rapid production. On the contrary, if consumers do not change the product before its end, producers will have few incentives to manipulate the new devices (Dalhammar, 2019). Therefore, planned obsolescence of electronics has consequences on unsustainable consumption.

2.3.3 Sustainable Interaction Design

Traditional design needs a change. Introducing sustainable interaction design is an approach to addressing critical resource problems. Sustainable design helps to protect our environment, benefits human and economic growth (van der Velden, 2018). Sustainable design focuses on resource efficiency rather than humans. According to Van den Berg and Bakker (2015) following five elements require special attention while designing a product for multiple lifecycles, contributing to the circular economy:

1. Maintenance: the product should deliver the performance if it is with the consumer.
2. Upgradability: the ability of a product to function according to the change being made.
3. Disassembly: the ability to open every component, which helps to extend the longevity.
4. Modularity: every smaller component can be repaired and replaced or recovered.
5. Recycling: reuse and recover of materials to their end life.

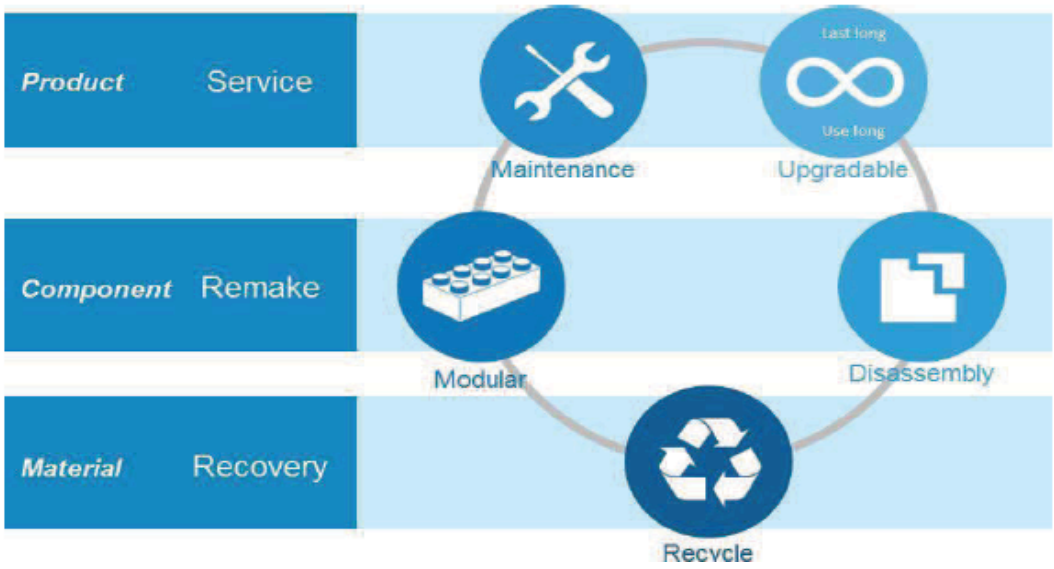

Figure 5: Circular product design (Balkenende & Bakker, 2015).

Balkenende and Bakker (2015) argued that it contributes to sustainable consumption when a product ensures these five properties (Figure 5). On the contrary, products that lack these properties are barriers to transition to the circular economy and sustainable consumption. Instead, they end up in landfills, resulting in the loss of resourceful materials and economy.

2.4 Circular Economy

The Waste & Resource Action Programme (WRAP) defined circular economy (CE) as "an alternative to tradition linear economy, in which we keep resources on use for a longer time, extract the maximum value from them whilst in use, then recover and regenerate products and materials at the end of each service life" (WRAP, 2021). The concept of a CE is to balance production and consumption patterns, which help reduce the environmental impact and drive greater resource productivity (WRAP, 2021). CE helps minimize resource input and waste emissions by closing material and energy loops (Figure 6). CE is achieved by designing long-lasting artifacts and repairing, reusing, refurbishing, and recycling them (van den Berg & Bakker, 2015). Similarly, Hernandez et al. (2020) stated that a CE ensures maximum product recovery while reducing resource use through repair (service and maintenance), reuse (components), and recycling (materials). The maximum value is recovered when the diameter of the circle is smaller (Figure 6).

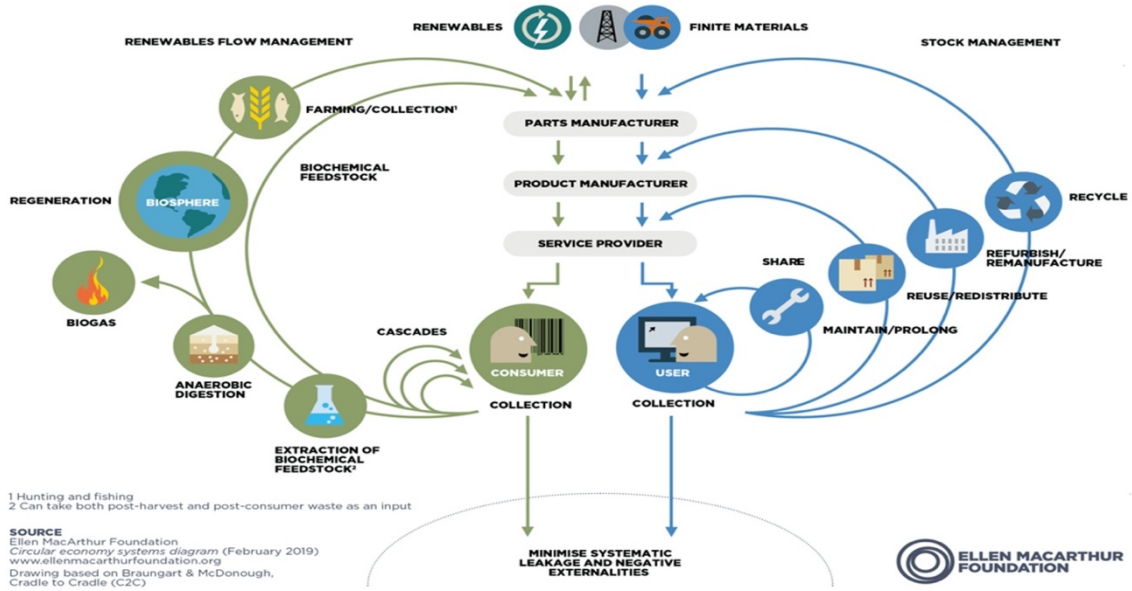

Figure 6: Circular economy diagram of a product (Copyright Ellen MacArthur foundation, 2017).

Research results show that products with minimal defects are less emphasized and thrown in the garbage even when they can be reused and repaired (Dalhammar, 2019). Due to the use and throw culture in today's industrialized world, many valuable materials are thrown without care. This is because novel products highly attract consumers in the market, which are often cheaper but don't have value in the CE (Althaf et al., 2019). Extending the lifespan of products in its continuous cycle is one way to reduce e-waste, use fewer non-renewable natural resources, and ensure a sustainable future (Hernandez et al., 2020). Thus, a CE is needed to focus on sustainability gains and aims to mitigate the climate change problem (Chizaryfard et al., 2020).

2.4.1 Role of Consumers in a Circular Economy

Maitre-Ekern and Dalhammar (2019) argue that consumers are the central element for a CE, and without their clear intention, the transition to a CE and the sustainable consumption of artifacts is impossible. Furthermore, the authors claim, consumer behavior plays an important role in extending the lifespan of artifacts through repair, maintenance, and reuse.

Table 1 below illustrates the different roles of the consumer in the CE. From the product is purchased and until it is appropriately recycled. In the chain of purchase, use, repair, and recycle products, consumers play a vital role from maintaining to repairing and recycling. Similarly,

(the act of) handling of electronics by costumers has a significant role in un/sustainable consumption. It includes single-use products, buying durable materials, and extending product lifespan through repair and maintenance work. Maitre-Ekern and Dalhammar (2019) argued that their behavior and attitude play a role from choosing a durable material to the proper circulation. Consumers can decide to buy products with a longer life cycle or a novel one that is cheap and breaks down quickly.

Table 1. Different roles of consumers in the consumption market (Maitre-Ekern & Dalhammar, 2019)

Main role	Main potential activities/interests that can support the CE
Purchaser	• Avoiding purchasing unnecessary items • Rewarding circular business models in their purchasing decisions • Making use of product labels, information and look for missing information • Optimizing the product choice • Purchasing re-used and second-hand products as alternatives to new products • Leasing instead of buying products and services • Focusing on the services instead of the products • Buying durable, high-quality products • Buying products for which spare parts are available
Maintainer	• Avoiding replacing products that work • Prolonging the life of products (proper use; maintenance; updates)
Repairer	• Preferring repair to buying new • Engaging with own repairs when possible (DIY); communities (for example, repair cafés) • Taking part in repair workshops etc.
Seller	• Avoiding throwing away items that can be sold or re-used
Sharer and collaborator	• Prioritizing sharing schemes over leasing or buying • Engaging with P2P schemes enabling sharing of resources
Engaging with waste sorting and re-use	• Handing in items for re-use rather than recycling • Ensuring waste is sorted and collected properly

Although consumers are considered as the center of the consumption market, they are not considered influential in the consumer market (Maitre-Ekern & Dalhammar, 2019). Balkenende and Bakker (2015), argue for the necessity of change, from product design, value chains, and new recycling methods that create waste into food to the change in consumer behavior in transitioning to the CE. This change process is highly relevant for electronics, where valuable materials like gold are highly integrated into devices. Due to their dilution in other materials, it is difficult and, in some cases, impossible to disassemble them apart. This deep integration makes the repair and reuse of components complicated and time-consuming for the consumers.

2.5 Product Repair in a Circular Economy

Earlier scholars (Jackson et al., 2014; Mitchell, 2018) addressed the importance of repair in extending an artifact's lifespan and contributing to a CE. Additionally, Hernandez et al.(2020) stated that repair is the first step in recovering the product's value in its life cycle and keeping them in a circular system. Similarly, Jackson et al. (2014) highlighted the other contribution of repair work in HCI and sustainability through his ethnographical work in Bangladesh. The authors highlight three areas where repair work is beneficial. Firstly, in establishing craft-based knowledge and innovation. Secondly, repair work is embedded in local and transnational flows that connect local practices to global networks and institutions and thirdly, in the design and operation of complex interactive systems locally and globally.

Repair is identified as an appropriate platform of education: learning possibilities of product design by seeing where early careers learn while observing the senior technicians, from a small task like organizing tools, more minor repairs to larger complex operations with increasing premiums on both knowledge, skills and judgment (Jackson et al., 2014). The result of repair is an outcome that ranges from financial to environmental and cognitive benefits. Figure 7 presents the different levels of repair and social and economic benefits.

Similarly, Mitchell (2018) argued that repairing can be done to fix technical problems and helps people explore the use of everyday materials and their performance. Through repairing things, people develop knowledge and can find sustainable ways of consumption. Furthermore, Mitchell (2018) highlights the other benefits of repair: gaining pleasure and excitement, overcoming the risk in the repair process, changing consumer behavior, and rethinking consumer goods. The author also discusses the process of separation (dissemble) of objects to produce technical descriptions for the do-it-yourself (DIY) process and distributes the knowledge from institutional to the global level. Disassemble is quick and easy disconnect of parts from each other in all form of repair, reuse and recycle of devices (Balkenende & Bakker, 2015).

2.5.1 Barriers to Repair

In this study, I have discussed how product design mainly focuses on producing a product with a performance at the lowest cost, suitably for mass production. But the challenge in the repair

of electronics specifically starts with increasing integration of microdevices and their functionalities, and embedding of electronics in other materials (Balkenende & Bakker, 2015).

Figure 7: Dimensions of repair (Hernandez et. al., 2020)

Furthermore, Hernandez et al. (2020) illustrate other possible barriers that limit the repair work, which are:

1. lack of knowledge on how products work
2. lack of spare parts, technical information, and restricted contracts
3. lack of economic incentives to repair the product
4. lack of engagement, emotional economical attachment to products
5. lack of design and manufacturing features promoting repairability. (p. 2)

Similarly, Sauerwein et al. (2019) illustrated the importance of clearly stating that products are initially designed for ease of repair and reuse. In contrast, Mitchell (2018) argued that materials are highly integrated in a product. Consumers can only see and feel the outer layers of products,

making it difficult for consumers to discover inner working mechanism of products. Similarly, the author highlights the decreasing order of product technical description: stating from little information to 'no serviceable parts inside' in new devices.

2.6 The Restart Project

In 2013, The Restart Project was established with its base in London (Cole & Gnanapragasam, 2017). The project was established to conquer the consumerist model of electronics and the increasing e-waste problem worldwide (The Restart Project, 2020). Since then, the Restart Project has established many branches in several countries. Restarters Norway is one of them and they organize the 'repair parties' so called Fiksefest. Restarters is encouraging people to participate actively in the self-repair process and contributing to establishing a repair culture (Restarters Oslo, n.d.).

This social project is a community-based repair project run by volunteers, and it provides a space for people to meet in a neutral venue and learn about repairing and sustainability. The project has led to the repairing of thousands of devices and saved almost 2.5 tonnes of electrical waste since its establishment (The Restart Project, 2020). They aim to encourage people to use things longer and establish attachment with the artifacts and reduce e-waste. As a result, people have become more resource-conscious, which has become a part of the "inner circle" of the CE (The Restart Project, 2013). Such initiatives in an institution can play an essential role in promoting repair and drives to sustainable consumption.

2.7 Policymaking in Sustainable Consumption

Policymaking appears as a crucial element in the sustainable consumption of electronics. Dalhammar (2019) argues policymaking in lifestyle, rights, markets, and consumer behavior can form a new consumption pattern. The author argues that existing policies do not address the current need for electronics consumption, and new local policies taken together in the long term can change mindset and markets.

Despite the existence of policies for sustainable production and consumption, such as the right to repair, Dalhammar (2019) criticized the problem of implementing and reinforcing these laws and policy at the local level. The author states that policies from governmental and organizational levels can sustain sustainable consumer behavior. 'Right to repair' is considered

a possible solution to strengthen sustainable consumption by sustaining consumers' right to buy durable and repairable products, which forces producers to produce repair-friendly products (Hernandez et al., 2020). Likewise, this can be resolved by creating more robust policies for producers, as the producer should take full responsibility for artifacts until they complete the life cycle (Dalhammar, 2019). Because consumer patterns periodically vary, the law should be established according to the new consumption circumstances (Maitre-Ekern & Dalhammar, 2019).

Similarly, policy plays a significant role in changing practices (Sahakian & Wilhite, 2014). However, policies in changing consumption habits are not defined (Dalhammar, 2019). Implementing such procedures can strengthen the purchase of durable and reliable products relative to cheaper ones with the same usability, without the life cycle being underrated.

3 Theory

In this chapter, I will present a theoretical framework on how social practices contribute to understanding and bringing pro-environmental changes in our society through different practices. I will first highlight what social practice theory is and how it contributes to changing perceptions, behaviors, material choices and contributes to the development of sustainable habits.

3.1 Theory of Change: Practice Theory

This thesis was inspired by and uses the framework of social practice theory. This study uses social practice theory as a guide to understanding attitude, behaviors, and choices in social practices. The research aims to find how premises about social practice (repair) can be combined and produce a framework to understand and implementing possible changes in everyday lives (Shove et al., 2012). Shove et al. (2012) also argued that social practices can communicate the practical implications and suggest changes that address climate change and sustainability. In this thesis, I aim to identify the current barriers in repair practice and implement possible changes that support the transition to a sustainable future. Thus, social practice theory is used to understand repair practices in an institutional context and as a lens to understand how the change in practices in an academic institution contributes to sustainable consumption.

3.1.1 Social Practice Theory

A theoretical approach, having roots in the mid-20th century, has been recently brought forward to understand the study of consumption and sustainability (Sahakian & Wilhite, 2014), namely social practice theory. Social Practice Theory (SPT) is understood as a conceptual alternative in the problem-solving approach (Reckwitz, 2002). SPT embraces the holistic view of practice-oriented approaches: how behaviors, attitudes, and practices emerge and diffuse (Shove et al., 2012). In SPT, the practice itself is taken as the center of analysis, rather than individuals who perform the task and other social structures around it. It is practices that help individuals to understand the world around them and other social norms and values.

Although there is no concrete definition of SPT, Reckwitz (2002) defined it as follows:

> *"routinized type of behaviour consists of several elements, interconnected to one another: forms of bodily and/or mental activities, 'things' and their use, background knowledge in the form of understanding, know-how, states of emotion, and motivational experience"* (p. 249).

From social fields to institutional complexes, they are structured by routines of social practices. These practices occur in a sequence of time, repeatedly, and through breaking and shifting structures. Sometimes, some of the existing social structure is broken down in a sequence of discursive events in such a way to form a new system that is more sustainable and pro-environmental (Reckwitz, 2002). New practices forms variety of performances which is a result of 'crisis of routines' (Kuijer et al., 2013).

In the field of SPT, different scholars define practices and ways of creating new practices (Reckwitz, 2002; Shove et al., 2012; Wilhite, 2013). This study is influenced and based upon the work of Wilhite (2013) in the field of social practice and sustainable consumption. According to Wilhite (2013), practices are structured by three pillars: cognitive ability and physical dispositors, materials including technology and infrastructure, and social and cultural world, which includes social norms, setting, values, and institutions. Thus, the focus should be made on every element of practices, including people, materials, and knowledge, instead of solely on the practices themselves.

3.1.2 Elements of Social Practice

Social practices are formed by the combination of knowing, working, organizing, and forming an innovation (Brown & Duguid, 1991). This further comprises empirical knowledge which involves everyday social and working practices. Similarly, Wilhite (2013) highlights the composition of distributed agency, routine, behavior, reflexivity, and habit as the building blocks of social practice. Likewise, a practice depends on a person's action, experience, technical knowledge, learning opportunities, available resources, and encouragement (Warde, 2005). These elements are used to analyze the role of an individual or organization in a practice. Isolating one from other may create a space in understanding the outcomes of practices.

Furthermore, a practice combines images, skills, and materials in collaborative work between skilled practitioners and novices (Jackson, 2005). "Practices range from ephemeral doings to stable long-term of activity" (Rouse, 2007, p. 499), which helps with the normalization of

objects and arrangements to form a new competence and new knowledge is gained gradually (Ingram et al., 2007). SPT builds knowledge through "exploration of the embeddedness of mental activities in the complex socio-technical system, analysis of the interconnectedness of bodily routines of behavior, mental routines of understanding and the use of objects" (Reckwitz, 2002, p. 258).

Thus, the focus should always be on how elements of practice are held together instead of thinking about certain elements to be included in practices (Gherardi & Perrotta, 2014). It is relevant for me to understand how different elements of social practices form new practices and contributes to understanding sustainable consumption.

To understand and analyze how these elements and pillars shape social practice, Wilhite (2013) states the role of distributed agencies: agency of things, agency of individuals, and agency of routines that reflect upon behavior and habit that develop during the interaction. Every social practice needs an agent, a carrier, or a catalyst to transfer the practices over generations (Reckwitz, 2002). Individuals are taken as skilled practitioners and active carriers of practices and activities throughout life (Hargreaves, 2011). Individual carries social norms and values in social practices at the first stage and second as autonomous agents responsible for making decisions and choices, and changes in society (Shove, 2010).

3.1.3 Applications of Social Practice Theory

SPT has been used in various scientific, gender, and organizational studies (Reckwitz, 2002). Holland and Lave (2019) highlight the role of SPT in developing emotion, attachment to artifacts and motivation, during the arrangements and social practices. The social practice also helps to pro-environmental behavioral change of individuals (Hargreaves, 2011), this is described later in this chapter. Furthermore, SPT can help understand the entanglement between humans and non-humans that form a practice over time (Durrani, 2018). This entanglement can override individuals' cognitive factors, which further helps in behavioral change, and new practice is formed.

Hong and Easterby-Smith (2012) argue SPT helps develop a conceptual framework to understand the learning process in organizations. Organizations are primarily seen as learning place where common practices are regularly practiced, preserved, and changed (Hong & Easterby-Smith, 2012). Every practice is the consequence of individual action (Sahakian &

Wilhite, 2014), including socially complex and culturally-specific practices in organizational practices. These can be transferred and reproduced quickly across society from an organization (Hong & Easterby-Smith, 2012). SPT helps to identify the knowledge repositories, organizational routines, and enterprise context in an organization (Sahakian & Wilhite, 2014). Sahakian and Wilhite (2014) argued that along with previous knowledge, a dynamic understanding of organizational context (situation) can be the key to a successful learning practice in the organization.

Scholars like Wilhite (2013) and Shove (2010) elaborated on the importance of SPT in everyday consumption. Sustainable consumption is an individual habit (Jackson, 2005). Jackson (2005) argued that even after adopting the best intention, individuals might end up with unsustainable results. In contrast, Durrani (2018) argued that doing collaborative practice can solve the problem of individual unsustainable choices to some extent and helps develop sustainable behavior and habits.

3.1.3.1 Understanding the Material Artifacts in Social Practice

As Wilhite (2013) illustrated, understanding the nature of materials, the material agency, is pivotal in sustainable social practices. In the words of Ingram, Shove and Watson (2007), SPT is helpful to gain a better understanding of how "designed artefacts shape and are shaped by the contexts on which they are used" (p. 4). SPT also gives a better understanding of every aspect of materials and society from a different perspective (Hargreaves, 2011). Further, SPT contributes to understanding material knowledge and how it can influence the practice over time (Wilhite, 2013).

When implementing the SPT in community repair, Durrani (2018) found that social practices helped identify positive and negative quality material artifacts. The author also argues communal social activities help to get a collaborative local, sustainable solution for global ecological problems, where participants learn about socio-material and environmental aspects of their use. Furthermore, understanding the material artifacts play an essential role in the consumption of material artifacts (Jackson, 2005).

3.1.3.2 Understanding Sustainability in Social Practice

Consumption is refined due to interaction between different consuming agents, materials, and products and guided by the social-cultural context that forms a consumption practice (Wilhite, 2013). Consumption patterns are locked in and influenced by social, institutional, and cognitive

constraints in selecting goods and services (Jackson, 2005). Understanding the agency distributed over people, things, and social contexts can help change sustainable practices (Sahakian & Wilhite, 2014).

SPT provides an opportunity to improve humans' lifestyle (i.e., education, learning, socializing, economics, and cultural perspectives) in different ways (Wilhite, 2013). For example, sometimes one's practice trigger other in a similar situation to think of new practices. Wilhite (2013) provided an example of how energy consumption in a neighbor's home triggered another family with a similar household but consumes more energy to think about their consumption habits and make changes in their energy consumption behaviors. This kind of social learning can motivate people to develop sustainable habits: learning from other in the society.

Today's unsustainable consumption is a problem of not having unified practice approaches and connections between the practice elements (Hargreaves, 2011). Where individual decision-making processes have dominated consumption patterns; it is also affected by the design of artifacts and production systems (Sahakian & Wilhite, 2014). Decision-making is related to the three paradigms of social practices described by (Shove, 2010): attitude, behavior, and choice (ABC). ABC is highly dominant in sustainable consumption and climate change (Shove, 2010). A person's performance depends on their knowledge of materials and technology, opportunities, available resources, and previous engagements and experiences (O'Connell, 1998 as cited in Warde, 2005). SPT helps to form pro-environmental activities, shifting focus from the individual level on how practices are developed, reproduced, restabilized, and in the end, how it helps to maintain practices through performances (Hargreaves, 2011).

Shove (2010) argued that "Social changes depend upon values and attitudes (the A) which drive the behavior (the B) of individual choice (the C)" (p. 1274). The author argued that combining three paradigms can generate social practice and identify pro-environmental behaviors (Shove, 2010). SPT helps develop new forms of living, working, and playing in all sectors of society and providing alternative ways of thinking that make a vigorous change in the extensive use of resources (Shove, 2010).

> *Understanding everyday routinised practices is primary. Instead of focusing on products, technologies, and individuals, everyday practices help change an individual's behavior and choice (i.e. Performance) over time (Sahakian & Wilhite, 2014).*

Along with ABC, habits and lifestyles play vital roles in the sustainable consumption of products (Jackson, 2005).

3.1.3.3 Habits and Behavior in Social Practice

Some of the practices are habits of an individual, followed over a long time in a routinized behavior. For example, the processes of eating and sleeping that are frequently practiced over time are habits. Wilhite (2013) illustrates through an instance of bathing: how bathing has evolved over time and regained its shape over time, from a habit of cleaning germs to using different products like scented soaps in the present time. The habit of bathing has gradually changed, and new habits are formed accordingly. Wilhite (2013) argued that repeated activities in everyday life form a habit and develop new practical knowledge.

Habits are influenced by long-term exposure to materials people use, a culture they grow up in, and their society. To validate this, we can see the example of Wilhite (2013), where the author presents the case of Indian migrants. When migrants expose themselves to a new culture, new knowledge gets evolved, and they develop a certain habitus typical of their social-cultural context. The habitus is varied from habits, but habitus plays a role in defining habits. For example, the routinized practice of new experience can absorb into habitus and slowly becomes a habit of doing (Wilhite, 2013).

However, habits and habitus can be varied according to the elements of practice: materials, culture, and how often a procedure is carried out. Particularly materials change over time, producers and engineers are changing the form and function of artifacts: these can negatively impact practices and influence habit formation (Wilhite, 2013). For example, the complexity of materials plays a role that works against the resistance of habit and makes habit weaker (Wilhite, 2013).

> *"Habits of mind and behavior develop in a social and cultural context" (Zey, 1992, p. 14)*

Similarly, behavioral change can be both destructive and constructive. Here, my focus is on the latter one, where social practices are mentally and bodily routinized and provide positive cognitive abilities (Reckwitz, 2002). Some scholars illustrate the influence of social marketing and information campaigns on public behavior, which works against the sustainable lifestyles and consumptions (Jackson, 2005). However, Hargreaves (2011) argues this kind of approach

can be highly individualistic and may fail to regulate social norms and conventions and relations in performing social practice. Instead, learning by trial, observing others' behaviors and mistakes, and observing the world around us can be effective and promising for changing behaviors (Jackson, 2005). This shortcoming can be addressed by practicing activities together in communities and institutions (Brown & Duguid, 1991). Understanding habits and behavior is central to the analysis of consumption practices which depends on participants' physical and cognitive abilities.

3.2 Concluding Reflections

Change in social practices is needed for developing sustainable consumption patterns (Strengers & Maller, 2014). Consumption is displayed by two factors: a sense of purchase and using-up the artifacts; both are conceptualized by individual behavior, attitude, and the choice of artefacts, termed as personal responsibility (Warde 2005). Although technological innovation also has a significant influence in changing social practices, "change in sustainable consumption is collectively achieved by establishing the relation between material artefacts, social contexts, and individuals" (Wilhite, 2013, p. 139).

The repairing and reuse of electronics are significant ways to understand the sustainable practice of electronics in daily lives. In this way, a social practice creates an alternative learning process that aims to be a sustainable solution in many ways. It would be interesting to explore how collaborative repair in an academic institutions like UiO can expose new practices and knowledge, and contributes to CE and support the sustainable consumption.

4 Research Approach and Methods

In this chapter, I will present the philosophical paradigm, methodology, data collection methods, and ethical considerations applied in this study. A positive relationship between theory, philosophy, and research methods can help us make a more informed decision and think through constraints to avoid adverse effects. To obtain a more profound understanding of repair practices in sustainable consumption, this study utilizes a qualitative interpretive research approach. In addition, qualitative research methods and a transition design framework are used to understand the consumption pattern of electronics.

4.1 Philosophical Paradigm and Methodology

This research explores the sociotechnical phenomena and identifies practices in different social contexts. Thus, this research is exploratory in nature and aims to provide a more comprehensive understanding of a phenomenon (i.e., repair of electronics). This understanding can be gained by engaging with stakeholders in the field of study and learning about the phenomenon through experiences and the meanings people assign to them (Walsham, 2006). This is different from the other research approaches where the goal may be to support or critique a specific point of view.

The aim of this study is not to prove something statistically or numerically. Instead, the goal is to understand social and cultural phenomena. This study focuses on the qualitative research approach rather than the quantitative approach. Quantitative methodologies are more effective when seeking statistical data from a greater number of participants. Qualitative constructive research favors direct access with the users, thus enabling the researcher to identify sociotechnical issues and understand data on a deeper level (Walsham, 2006). Specifically, through the workshop used in this study, I want to identify and evaluate whether it is possible to reuse and repair items that are thrown in the garbage. I also seek to explore the learning that participants gain from this kind of social practice.

As a part of qualitative research on HCI, this research is based on philosophical assumptions. Ideas and beliefs are used to complete the research (Myers, 2021). These philosophical assumptions are paradigms. Myer (2021) highlights upon three underlying paradigms: positivist, interpretive and critical (Figure 8). The *positivist paradigm* is based on truth, and

reality is objectively given. However, the *critical paradigm* focuses on oppositions, conflicts, contradictions, and social changes.

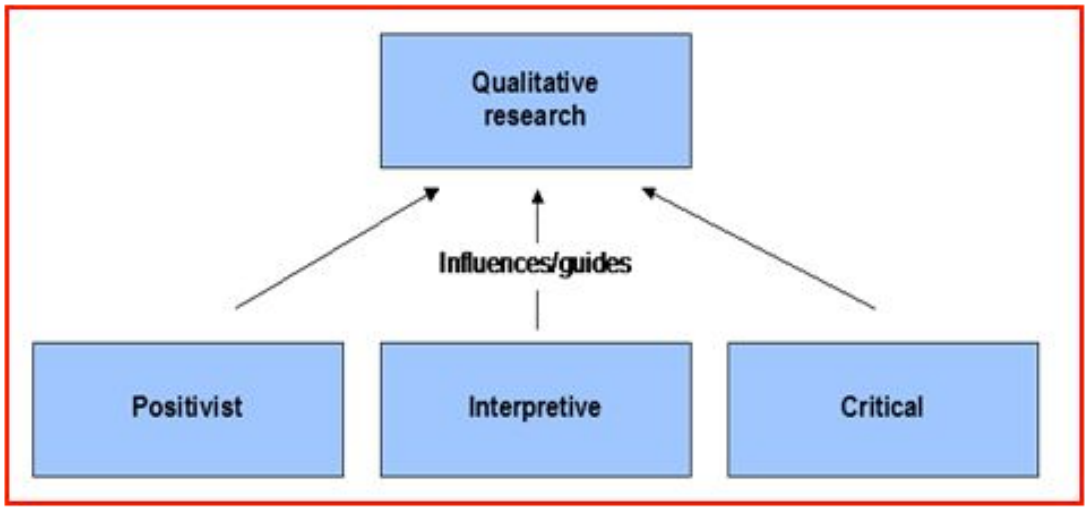

Figure 8: Underlying Philosophical Assumptions (Myers, 2021)

On the contrary, the *interpretive paradigm* assumes that social reality is not singular or objective, yet human experiences somehow shape it in different social contexts (Myers, 2019). This position holds that humans' knowledge of reality is formed through social constructions and shared knowledge in the form of intersubjectivity (Walsham, 2006). Walsham (2006) argued that in interpretive research, involving stakeholders through the process allows in-depth access to people's issues and helps gather data at a deeper level. In interpretive research, a researcher is involved in studying people's attitudes and behavior in a social context to recognize the relationship and impact of humans on environmental problems, thereby shedding light on how reality is gained from social constructions (Myers, 2019). The researchers' personalities, backgrounds, and knowledge will shape how the research is conducted and can influence the results of this study. Thus, the interpretive paradigm aligns most closely with the underlying epistemology of this research.

Three different types of research questions can be used in qualitative interpretive research: descriptive, normative, and constructive questions (Kalleberg, 1992). *Descriptive* questions are most often used to evaluate things (e.g., why things change or remain unchanged). *Normative* questions are mostly used in evaluating arguments (what is allowed and what is good), and

constructive questions help the researcher to identify social critics and problems and to understand and improve the existing conditions.

Constructive research is logically used to suggest and discuss improvements to existing practices (Holter & Kalleberg, 2002; Kalleberg, 1992). Because this research focuses on identifying the barriers to unsustainable consumption of electronics and finding areas of improvements, my constructive approach will be as follows: "*what can and should actors do to improve the situation?"* (Kalleberg, 1992, p. 53). It focuses on understanding the phenomena through meanings people assign to practices and activities. In the present case, I utilized interviews, a focus group, observation, and interaction with participants in the community repair workshop. Further, the use of a transition design approach is utilized to understand and improve the consumption pattern through repair practice in an organization.

4.2 Transition Design

In this research, I choose transition design (TD) as my methodological tool. TD is a new but known for prominent problem-solving method in organizations (Irwin, 2018). The main focus of TD is to visualize and map the current problems and put forward the new ways of designing to move toward a more sustainable future. TD is a complementary design approach to existing design approaches, which builds upon existing solutions that are already addressing wicked problems and aims to transition to a larger sustainable vision (Irwin et al., 2015). The design is considered to be central to the process of transition (Irwin, 2018). This design approach can develop radically new ideas and visions for the future by implementing the modest design in the present (Irwin, 2015). This design in the present can challenge the existing paradigms and keeps changing and evolving new paradigms toward positive social and environmental change (Irwin, 2015).

TD is an approach that does the following:

> Addresses unsustainability as a structural problem of how we make and use things and propose to do more with the things we already have, through maintenance, repair, refurbishment, and redesign […] rather than recycle, the things we no longer use. (van der Velden, 2018, p. 170)

Similarly, TD can address "wicked problems," such as climate change, the loss of biodiversity, the depletion of natural resources, and other social problems (Irwin, 2015), which means TD

helps in fluent use of technology and natural resources over a longer time. Similarly, transition designers are further ambitious to transfer systems. They understand how to work iteratively and take a different approach in addressing problems (Irwin et al., 2015).

This thesis aims to address the unsustainable consumption of electronics at the institutional level, in this case UiO, and aims to solve the problem at a higher level. UiO is a large consumer of different electronics, which includes various stakeholders benefiting its service and has some relation to the producer and supplier chain, making it a complex, interrelated system. Therefore, this thesis uses a TD approach to understand stakeholders' conflicting ideas and mindset, where the problem could have been differently understood by the stakeholders. Problems keep changing, and new problems evolve on a large scale. Moreover, these problems are interconnected, and any smaller section interventions can unexpectedly influence the other in different part (Irwin, 2018). Thus, TD is chosen as an appropriate methodology in this thesis.

4.2.1 Transition Design Framework

TD comprises various practices. The TD framework helps bring different practices together in four main categories related to system-level changes that are mutually influencing and co-evolving with each other (Irwin, 2018). These practices can evolve and change in the transition period, which helps researchers to stimulate the actual interventions needed to solve the specific problem. The four steps of the TD framework and related practices are illustrated in Figure 9.

In this study, I use TD framework to align and work systematically in the problem area (RQs) of this study. Using this framework helps to bring all practices involved in the process together and in a systematic way. The framework helps discuss the problem and addresses solutions at appropriate scale levels (Kossoff, 2015). Kossoff (2015) also suggested that the framework can include every social domain and collaborate with everyone to transition to sustainability. This is important because of the broad chain in the consumption of electronics. It involves different stakeholders from production to consumption and recycling. In this study, I will go through the four important elements of TD: identifying the practices of visioning, theories of change, posture and mindset, and new ways of designing.

Figure 9: Transition Design Framework (Irwin, 2018).

4.2.1.1 Vision for Transition

TD aspires to a future-oriented long-term vision, in which the problem of the present has been resolved: addressing the hope and desires of people (Irwin, 2018). Creating future vision helps to visualize how the future can be like, analyzing the past activities that inform the design process in the present. This process requires different tools and approaches to enable various stakeholders to involve in creating future visions. When developing visions, it is essential to be dynamic and grassroots-based, starting locally and keep them open-ended and speculative (Irwin et al., 2015). Although we think of designing for a sustainable future, we might not know the actual result and the impact of our visions. Therefore, this vision can be changed, and new ones are evolved according to the changing situation of problems over the time horizon.

Future visioning

In this study, experimental futures (Section 4.3.2) were used to create future visions (scenarios). Visions represent the lifestyle-based locally but connected globally with the use of technology. Two different visions are created and Backcasted (Section 4.3.1) in three horizons of time. Three horizons consist of three distinct phases: now, mid-vision (in-between), and future vision, as listed in Tables 2 and 3. A mid-term vision (in-between) was created to test the experimental future in the present at the IFI library. Visions are created in utopian perspectives concerning the sustainability of electronics use.

Vision 1

In 5 years from now, the amount of e-waste generated at IFI will be reduced by 70% as a result of increased focus on repair and reuse. This can be achieved by introducing repair practices at a different level, for example, from repairing more often at IT department at IFI to an establishment of a repair space for students, combined with new policies and procurement agreements aiming to buy repairable products. *IT department* is referred to a unit who has responsibility for IT services at UiO, i.e., from procurement to maintenance and service of devices.

Future vision In the year 2025	All defective electronics will be firstly collected at one place, for example, at the library. Then a repair hub is established to repair, and reuse discarded electronics, a place where students can deliver some reusable parts and/or re-collect the things they could use from older devices destined to end up as e-waste. The department will also make used devices available for students.
In-between	A pop-up desk/trolly consisting of defective devices will be placed at the library. The aim is to repair, reuse, and learn about the materials and product design while dissembling the device. Similarly, this activity aims to motivate and establish pro-environmental behavior among different stakeholders at IFI.
Now	Just minimal is carried out for expensive materials. It is resulting in excessive e-waste.

Table 2: Vision 1- Repair of used electronics

Vision 2

Today's investment in electronics will be reduced. The CE system of electronics will be stronger by repairing, reusing, and recycling at an academic institution. Primarily, the focus should be on buying repairable and reusable products. Secondly, the recycling of electronics can be carried within the organization, instead of giving away to external recycling companies.

Future vision In the year 2025	The administration will make a strategy for introducing e-waste recycling robots at the IFI. Devices will get complete disassembly, and high-cost elements like gold and aluminum will be separated while other parts will be repurposed for reuse.
In-between	Proper recycling: Along with other waste bins inside the building, it will be placed e-waste bins locally in different corners of the building for different devices. Students will have access to the recycling room.
Now	All electronics are thrown in a single container. They are not recycled and reused in an institution. Instead, an external recycling company carries out the recycling outside the vision of an institution.

Table 3: vision 2- New ways of execution toward a circular economy

Both of these visions aim to reduce e-waste in the future and contribute to sustainability. However, I wanted to take Vision 1 forward in the TD process. Vision 1, repair of electronics, will help to understand and identify the social and economic benefits of repair. Mainly, the test and evaluation of in-between activity (Table 2) will help answer the first research question of this study.

4.2.1.2 Theories of Change

In TD, theories from various fields and disciplines are central in understanding the dynamics of required changes in the complex system, challenging the current paradigms and assumptions. Theory of change comprises knowledge and ideas intending to guide the researchers with new tools and methods toward a sustainable future. It is important to make system-level changes (Irwin et al., 2015). Furthermore, these ideas are helpful to identify new approaches in problem-solving. Irwin et al. (2015) highlighted three important reasons for using theory in the TD framework:

1. Theory of change is always present in the course of action
2. Transitioning to sustainability requires an explicit change at every level in society
3. Every idea about change is grounded in wicked problems.

However, as complex systems keep changing, the changes cannot be controlled, and the outcomes cannot be predicted precisely (Irwin et al., 2015).

In this study, I chose to use SPT, which I have presented in the theory chapter (Chapter 3). I use SPT as a theoretical framework to understand the outcomes of repair practice in transitioning to a sustainable future. Repair as a social practice can be impactful in producing empirical knowledge in the social sciences (Reckwitz, 2002). This study uses SPT to change consumption patterns at academic institution and gradually develop sustainable behavior and habits.

4.2.1.3 Posture and Mindset

The transition to a sustainable future requires optimistic postures and mindsets of awareness, openness, self-reflection, and a desire to collaborate (Irwin et al., 2015). A particular change in a society, institution, and world needs a shift in mindset. Mindset is usually guided by cultural norms, values, assumptions, socioeconomic and political paradigms (Irwin et al., 2015). In TD,

because researchers are directly involved in interventions, researchers' mindsets are important in identifying the problem and the solution in the given context (Irwin et al., 2015). The designer's position, earlier experience, and cognitive knowledge help them propose the most effective solutions to holistic problems. Similarly, TD helps to understand the mindsets and postures of individuals, institutions, and the world through various methods.

My Mindset

As a consumer of artifacts, I always consider using devices for as long as possible by repairing and reusing them. I was worried about the negative impact on our planet due to the higher consumption of natural resources. As a transition designer, I wanted to design something that decreases the overconsumption of electronics and its impacts on the environment. I want to apply different methods to answer the research question, which is a utopian perspective, by introducing and suggesting new ways of repair practices in an academic institution.

UIOs' Mindset:

Similarly, understanding the mindset and posture of UiO is necessary because this research is based in the same institution. Conducting interviews, observations, and a focus group (Section 4.4) helped me understand the current posture and mindset UiO comprises. Similarly, the mindset they have plays a role in implementing possible changes in transiting toward sustainability.

4.2.1.4 New Ways of Designing

The concept of TD is to create a stainable future and sustainable everyday lives. After going through the three previous interrelated areas of the TD framework, new ways of design will take place. Design solutions from the grassroots level are emerged, which can be amplified to a bigger part of the world, and together it helps to transit toward a sustainable future. The design solutions aim to protect and restore social and natural ecosystems (Irwin et al., 2015). Irwin et al. (2015) argued that due to changing nature of the wicked problems, the designed present solution can have a short life span, can be useless at times, and new solutions can evolve over a long time. Because the wicked problem is complex and they keep changing over time, some designed solutions do need changes according to the problem's nature.

It is important for transition designers to open up "transdisciplinary teams to design new, innovative, and place-based solutions rooted in and guided by transition visions" (Irwin et al.,

2015, p. 10). Different methods were used for this purpose (Section 4.4). After understanding the current mindset and posture, my approach is to contribute to how new repair practices contribute to the existing challenges of practices in the repair and reuse of electronics in an academic institution and contributes to sustainability. The possible design process of sustainable consumption through the repair work is presented in the following chapter (Chapter 5). Similarly, I will discuss the possible social and economic outcomes of the practice of repairing electronics later in the discussion chapter (Chapter 7).

4.3 Methods for Visions

Lockton and Candy (2018) proposed seven terms that contribute to design the future vision in transition to a sustainable future. In this section, I will explain two of them which were relevant in this study.

4.3.1 Backcasting

To work with TD, I used the method of backcasting. It is a method whereby we first think of a utopian future and move backward to the present situation. Moving backward creates trajectories on achieving the desired future while creating small solutions in the present. Every element that comes in the pathway focuses on the present solution that leads to the desirable future. The main question we consider while moving backward should be: "what would it take for that to happen?" (Lockton & Candy, 2018, p. 911). Backcasting intends to identify relative elements and policy goals that need to be established now and onwards in a long horizon of time to achieve the desired future.

A method used to identify different pathways backward in time called 'three horizons' was used. In *three horizons* transition is divided into three phases: now, then, and in-between. It helps to create a coherent scenario from one step to another. Lockton and Candy (2018) stated that examining only one favorable future scenario can lead to incomplete results. Therefore, creating alternatives, not the ideal or preferred alone, but imaginal diversity helps to get better results. Likewise, two different visions were made in this study in Section 4.2.1.1.

4.3.2 Experimental Future

The experimental future is based on approaches of designing the desirable alternative futures. Although the future does not exist, we can create experimental scenarios and bring the distance between reality and imagination closer to experiment the future. These scenarios are based upon assumptions and interpretations from the past, emerging issues in the present, and producing a fantasy projected to be possible and preferable in the future (Lockton & Candy, 2018). This process helps in shaping the future we chose to transit. Experimental futures include designing interventions, looking at the future, and bringing it to life. As Lockton and Candy (2018) argued, anything in the future can be thought or felt by making it experimental.

I use this method to create future scenarios based upon assumptions and expectations from the past and problems in the present. I consider doing repair practice differently, creating different routines than the usual one, assuming to reduce the e-waste, and this experience can be seen as an experiential scenario (Lockton & Candy, 2018).

4.4 Data Collection Methods

This study uses different qualitative methods to gather and analyze the data. This includes interviews, observations, and a focus group in a naturally occurring setting, which provides an in-depth understanding of the user with which to get reliable and accurate data from the users (Crang & Cook, 2008). Interviews and observation, and the focus group were conducted to understand completely different phenomena and develop a new concept. Interviews and a focus group were used to understand the possibilities and challenges of repair and reuse of electronics in an academic institution while observation aimed to understand user behaviors and motivations for engaging in repair practices.

4.4.1 Observation

Observation is a qualitative research method, which allows a researcher to study a phenomenon in naturally occurring settings (Crang & Cook, 2008). The observations in this study were helpful in getting knowledge about the experience of individuals while doing self-repair and their motivation for participating in such activities.

Direct observations were carried out in a natural setting to understand the context where participants were doing self-repair. It helps to understand the participants through what they do

rather than what they say (Rogers et al., 2011). The observation was used to understand the different contexts: to understand the process of repair practice, to understand the nature of artifacts, to know what motivates individuals to participate in repair activities, and most importantly, the interaction and engagement of participants during the repair process.

Photos and notes were taken during the activity to supplement the observation. The data without notes and pictures can be hard to remember because many events can happen suddenly (Rogers et al., 2011). Pictures provide more descriptive and action expressing data from the event.

Table 4: Overview of data collection methods

	Methods	**Participants**	**Why**	**Duration/Place**
Initial	**Observation of Repair Party (O)**	Various	Understand the interest and impact of collaborative repair practices among individuals	2 hours / Fiksefest organized by Restarters Oslo
	Interview 1 (I-1) Followed by observation of e-waste container and store	Senior engineer and procurement head at IFI	The role of the IT department in consumption and management of electronics, mainly with focus on the role of repair in sustainable consumption	1 hour /IFI
	Interview 2 (I-2)	Senior engineer	Role of IT department	1hr/Law Faculty /Zoom
	Interview 3 (I-3)	Real estate sustainability head	Understanding the sustainable strategies	30 min /UiO/Zoom
	Interview 4 (I-4)	Student at IFI	Understand the case of repair and reuse in an academic institution	70minutes /IFI
Later	**Focus Group (FG)** (Replacing a repair workshop)	Employees at IT department in various faculties at UiO (diverse role)	Understand future possibilities of repair of e-waste in an academic institution	90 minutes /UiO/Zoom and Miro

4.4.2 Interview

The second qualitative data collection method used in this study was interviews. It is used in qualitative research to get an in-depth understanding of needs, practices, experience, expectations, and attitudes from the participants who interact with the system (Lazar et al., 2010). In this research, both physical and digital interviews were conducted according to the availability of place and situation.

In this study, open-ended, *semi structured* questions were used to understand the phenomenon (i.e., repair and reuse), which allowed the interviewee to respond freely. Unlike *structured* interviews, which are scripted and *unstructured*, there is a basically open conversation without any predetermined focus and can divert from the area you want to explore. Furthermore, open-ended questions help generate ideas and insights freely, which is a key advantage of conducting an interview.

4.4.3 Focus Group

Although interviews are often conducted with one interviewee, focus group (FG) is conducted with more people in a group. The focus group is a type of interview within a bigger group of interviewees: the number of participants can range from three to ten. “One form of group interview that is frequently used in marketing […], and social science research is the focus group” (Rogers et al., 2011, p. 232). Participants represent the sample of the target group. In my study, five IT engineers having previous knowledge of IT devices were recruited. The benefit of the FG is the sensitive issues can be discussed in an interactive way that might otherwise miss (Rogers et al., 2011). A collaborative tool Miro[2] was used to discuss the ideas together in one frame. This collaborative practice helps to build and exchange ideas before coming to one concrete decision/solution.

The FG was conducted to discuss the possibilities and challenges of the repair of electronics. Further, the goals of organizing an FG was to understand the existing challenges of repair within the organization and establish a repair culture in an organization that has social and economic benefits, in contribution to sustainability.

[2] Miro.com

4.4.4 Data Analysis

The analysis of the interviews and observations and an FG were conducted using the thematic analysis method. The interviews were transcribed, coded, and divided into themes and subthemes with similar data types. Key notes were taken in observation and FG. The detailed description of the analysis method and findings is explained in Chapter 6.

4.5 Ethical Considerations

In conducting interpretive research within an organization, a researcher must be aware of both the organization's privacy and other users involved in it. It is the responsibility of the researcher to take care of participants' safety and privacy (Lazar et al., 2010). Walsham (2006) illustrates the following concerns while doing interpretive research in an organization: (1) confidentiality and anonymity (2) reporting in the literature. Confidentiality and anonymity of both participants and organization were considered, and their right to withdraw from the project at any time in the project was guaranteed.

4.5.1 Informed Consent

Participants in this research were provided with a consent form (Appendix 1), containing information about the purpose of the study, what kind of data will be collected and who has access to their data. Photos were taken during the observation, and the interviews were recorded, which were later transcribed for analysis. All data was anonymized. The pictures were taken carefully, with no identifiable persons or organization in the frame.

4.5.2 NSD

Every research should be registered and approved by the Norwegian Centre for Research Data (NSD). This research was conducted following the General Data Protection Regulation and approved by NSD, project nr. 59898. The data gathered from participants was processed and stored according to the guidelines provided by NSD.

5 Data Collection and Results

This chapter covers the results obtained from data collection via the different methods presented in the previous chapter. This chapter is organized around the different phases of the TD framework focusing on understanding people's mindsets on repairing electronics, and the results from the presentation of visions with the IT engineers currently working at different IT departments at UiO.

5.1 A Mixed Approach

One session of participant observation and four interviews were conducted to identify the mindset and posture at this phase. First, participant observation was conducted to understand the repair practice from an individual perspective. It was more oriented toward the learnings and motivation for sustainable consumption people achieve by participating in community repair. The interviews focused on understanding the existing strategies and practices on sustainable consumption of electronics in an academic institution. Furthermore, to understand the experience of repair of electronic devices in an institution.

5.1.1 Participant Observation at Restarters Oslo

The data collection began with the observation of the community repair (Repair Party) organized by Restarters Oslo at Klimahuset[3] at Botanical Garden, Oslo. Restarters Oslo is a part of "The Restarters Project" (Section 2.6). The observation took place in early September 2020. The Repair Party was run by restarts with the help of volunteer repairers, and participants were invited through their Facebook page. Both the participants and repairers were of various age groups ranging from 20–40 years. Some repairers were novices while others had several years' experience in a similar field. For example, one mentioned that he worked as a professional repairer for 10 years. Similarly, there were different electrical and electronic equipment from a small mobile phone to computers and vacuum cleaners. Likewise, few participants had very old devices (> 10 years) stored on their grandparents' shelves, mainly with hardware problems.

[3] nhm.uio.no/klimahuset/

The main goal was to observe what a repair culture looks like, what motivates the participants to repair, what attachments participants carry with the artifact they want to repair, and what participants learn from the interaction with others? In general, identifying what collaborative repair practices contribute to sustainable consumption. I also observed the set up and different tools used in the Repair Party (Figure 10).

Because the Repair Party was carried out during the COVID-19 pandemic, this was one of the factors that limit the study in many ways. One was the direct involvement in the whole interview/observation process was impossible. The observation could only be performed from a distance of at least on meter, and the participants had their face masks on, which obstruct the facial expression during the event. However, I went around and asked questions to both participants and volunteer repairers. The questions were open-ended, and unstructured, meaning varied from participant to participant. Questioning the participants added some input on their motivation to repair.

Figure 10: Left- Owner Of the headphone is repairing together with Repairer, Right- Repair tools provided by restarters (Picture taken on Sep. 2020)

I observed the process of repair and the interaction between repairers and participants. Repairer asked a few questions to the participants while repairing, like the age of the device, where did they buy the device from, and why they want to repair it? Most of the participants were visiting the Repair Party for a second time because they were motivated and encouraged by their previous visit, meaning they could trust that 'repair is possible.' During the repair work,

participants observed the task carefully and asked the repairer about the defective component and other parts on devices. The repairer informed them to buy it and visit them back if they could not fix it themselves for those who needed new components. Therefore, some participants were visiting the Repair Party for the second time after identifying a problem in their first visit, and they could not fix the device at home. However, one participant mentioned that he tried to fix it at home following YouTube tutorials. After completing the repair, participants expressed their happiness and stated that they would continue repair practice in the future. Moreover, they want to motivate and encourage others to repair electronic products in the future.

5.1.2 Understanding Sustainable Strategies at the University of Oslo

To explore alternative design for this study, it was also significant to look after what strategies and targets do UiO endorse today. Therefore, one of the interviews was conducted with the head of sustainable development at the real estate department at UiO to understand the strategies and vision for sustainable consumption at UiO. This position holds the responsibility of following up the sustainability strategies and the progress on sustainable strategies. The interview was semi structured and was executed remotely using the digital tool, Zoom[4].

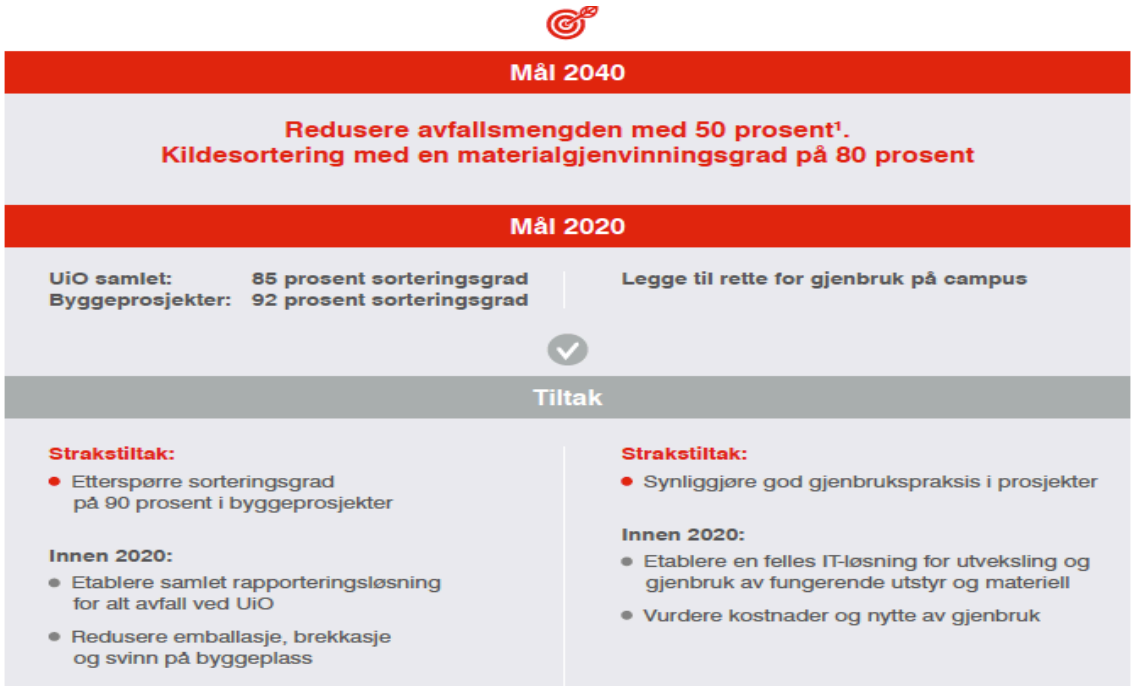

Figure 11: Strategy for Waste Reduction at UiO (Universitet i Oslo, 2018, p. 17)

[4] https://zoom.us/

It took less time than anticipated to understand the implementation of strategies as I came to know that interviewee was resigning his job, meaning "*the sustainable strategy is hard to follow and the sustainability work is too slow*," said the interviewee. However, I found that the institution has strategies and the targets to be achieved by 2040 in reducing waste (Figure 11), the follow-up has not been efficient, and *"the sustainable working group is working very slow*" (I-3). Similarly, it was discovered that the strategies do not precisely describe the specific target for e-waste management and reduction. They only describe waste reduction in general. The interviewee stated that the IT department and procurement department deal with the buying and maintaining of electronics: *"I cannot say exactly what happens in each department, there is no follow up resources."* This leads me to the next step of the interview, which is explained in the following sections.

5.1.3 Interview at IT Departments

Two different interviews (interviews 1 and 2, see Table 4) were conducted at two different IT departments at UiO. An interview guide with semi structured interviews was prepared to maintain data reliability and cover the same topics of interest in this study. Although some awareness was considered to allow the participant to speak freely without interruptions from the researchers' side, there were some pitfalls during the digital interview as described in Section 5.3.1.

The interviews helped me to understand their position at work, their role in the department, their services, and regular work activities. Because interviewees were also part of the organization, participants were informed about the ongoing research and its benefits to the organization in the future. The participants had various roles in the IT department. They had broader knowledge on different aspects of electronic devices, including what is needed to be replaced and what can be repaired. This discussion enabled me to gather helpful information on the different electronic devices used in an institution and the procurement policy and agreement with the supplier. Also, the agreements with the internal users such as employees, researchers, and students. The interview was helpful to know the repair approaches they execute by themselves and the repair and replace provided by suppliers that come within the agreement scheme.

Two interviews with the different persons but having a similar role provide even clear data on how the internal structure works. How the strategies (Section 5.1.2) are understood and

implemented and what kind of decisions are made by a responsible individual to repair, reuse, and replace devices.

In this phase, one interview took place face-to-face in a physical room while the other was conducted digitally using Zoom. The duration of each interview was approximately one hour. The physical interview was followed by a visit to the store where used and new spare devices are stored. I also got the opportunity to visit the e-waste containers and the room where containers and other devices were thrown, which a recycling company later transport.

5.1.4 Observation of E-waste Containers

I followed the informant for the tour of the e-waste room, which was down in the basement where you need special access to get inside. Students do not have access to this room. Only the person working in the IT department has access. However, I could visit there with the informant and observed different devices thrown there (Figure 12). Unfortunately, there was not much e-waste at my visit, as I was told, it was transported by a recycling company recently. I asked a few questions about the ages and reasons for the devices being thrown away. What happens when they are taken away? Who takes them, and will they be recycled? It was quite surprising that it's like a black hole for them when they are taken away. We concluded with the discussion on how we can use them within an institution in a way everything becomes visible and how we can benefit from the e-waste?

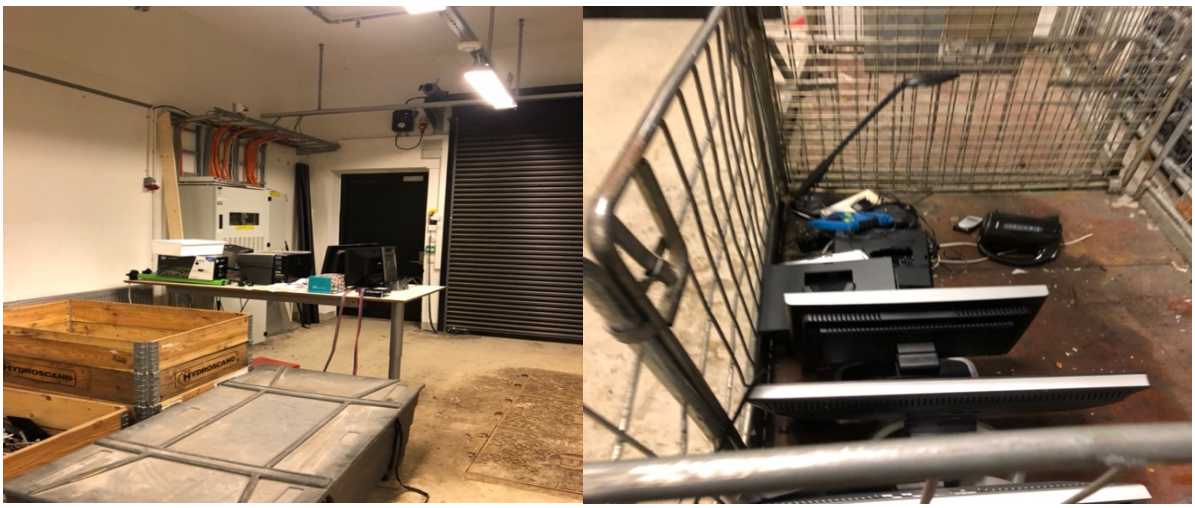

Figure 12: Left- Pictures of EEE-waste room, Right- EEE-waste in a same container (Picture taken on October. 2020)

5.1.5 A Case of PhD Student at IFI

Another interview was conducted with a PhD student affiliated with the institution, which helps to confirm the data provided earlier by the IT departments. The student had received a new laptop from the IT department during the first year of study for research purposes. Usually, a PhD position lasts three years, and the institution provides computers and other accessories during the study. The IT department has full administrative rights to the computer, and it is responsible for maintenance and care. This interview was based on the user experiencing a broken laptop and the process of repairing the broken laptop. This discussion was helpful to understand the nature of the device, like what kind of feedback it gives to the user when there is some damage or error. Similarly, how does the IT department handle the issue when there is a problem with the student's personal computer provided by the institution. It helped me to relate the data I earlier got from the department employees.

This case is an example that represents every PhD student, researcher, and employee at IFI and the service provided by the IT department. It allowed me to understand the time they had to wait to repair a part and how the department handles these cases: most importantly, what do they do when there is a clear sign of a damaged part in a device. Finally, understanding how the problem gets solved and what other difficulties a user experienced during the process. The trust issue was most highlighted during the discussion, this will be discussed more in the findings chapter.

5.2 Toward the Future Vision

After the initial phase of data collection, some design considerations were made to achieve the future vision of this study. This intervention is made considering the mixed data from the community repair (i.e., Repair Party) and the repair approaches used in academic institutions. Later, the FG was conducted to discuss the challenges and possibilities of the design intervention which will be described in Section 5.2.2.

5.2.1 Initial Design Approach

A. Repair Workshop at Institution Library (A Pop-up Trolley)

This workshop aims to bring discarded electronics back into use. Some devices are disposed by the IT department after small defects while others are replaced because they have been in

service for 3-5 years and their work efficiency has decreased. However, they might still work. It may be waste for university IT departments, but it can be of great benefit to students, employees, and researchers who care about repairing things and want to increase the lifespan of devices by repairing and reusing them. Similarly, this design approach aims to understand how collaborative repair in an institution contributes to the CE of electronics and develops a sustainable consumption behavior among the users in an institution.

Figure 13: Movable pop-up trolley

This approach consists of the following activities:

1. Gathering and setting up materials
2. Design of advertising template (Appendix 3)
3. Repair workshop at the library
4. Observation and follow up interviews

For this workshop, I started gathering the electronics, such as computers, laptops, keyboards, and so on, from the recycling area. This was done together in collaboration with personnel from IFI-Drift.[5] Drift is a first-line service for users who uses their IT devices at an institution.

The initial idea was to use a pop-up trolley that belongs to the university library (Figure 13) to store these electronic devices and repair tools. The trolley is designed so that it is easier to move to a different place where people can work efficiently, moving it to different areas. This trolley functioned as a prototype for a pop-up repair zone, an in-between activity in transition toward the sustainable future vision. I planned to borrow the trolley and put it outside of the IFI library. The idea was to put the discarded devices in the trolley and to let the participants carry the repair process with the help of a volunteer repairer. Students at IFI were the targeted participants for this workshop. Unfortunately, this idea became impossible as the COVID-19 restrictions continued. I had to change my plan and use an FG as a pre-planned workshop.

5.2.2 Implementation of the Focus Group

It became clear that the planned workshop could not take place due to COVID-19 restrictions. After ongoing discussion on different alternatives with supervisors and fellow students, I decided to do an online workshop, an FG with employees at the IT department at UiO. The theme discussed during the FG was how the repair of discarded electronics could contribute to sustainable consumption at UiO: its challenges and possibilities. Participants discussed mainly the policies, agreements, procurement process, and products that hinder the repair work. Similarly, some new suggestions for future changes were discussed.

A. Tools

This FG was carried out digitally, using the digital collaborative tools Miro[6] and Zoom. Miro is a reliable and effective tool for remotely and collaborative working. Zoom provides audio, visual communication features, and we can record the interviews easily in this tool. Similarly, the mind mapping diagram (Figure 14) was used to develop visual ideas and concepts, and structure the subject matter accordingly. A mind map is a diagram in which information from multiple participants is visually organized. The participants were encouraged to use different

[5] https://www.mn.uio.no/ifi/tjenester/it/kontakt/kontakt.html
[6] Miro.com

colors, text sizes, and Post-it Note colors to represent different topics. Figure 14 shows the visual illustration of mind mapping. This mind mapping diagram was designed and organized to guide the FG discussion.

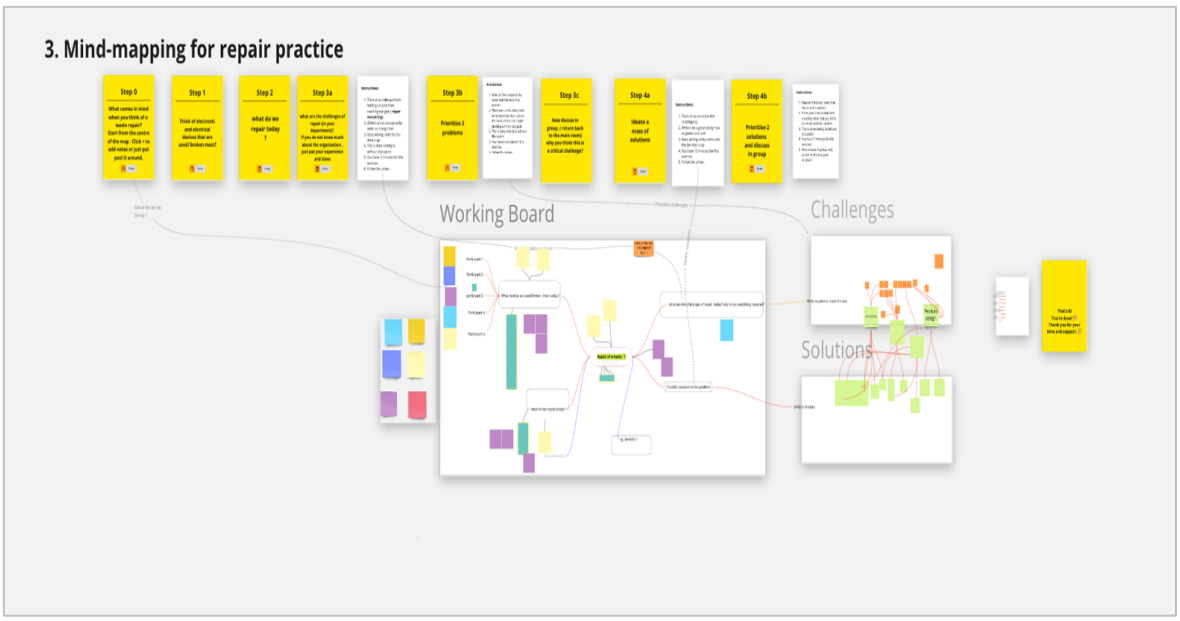

Figure 14: Visual overview of mind mapping diagram, used during the FG

B. Pilot Focus Group

Performing an FG online was a challenging task. On the one hand, it depends on the expertise and experience of a moderator (i.e., me). On the other hand, it depends on participants' willingness to use new tools. Although I have been using Miro during my study, it is a different experience for data gathering with people who are busy in the daily work, they have limited time. I conducted a pilot FG to minimize the potential pitfalls that could occur on D-day. Two round of pilot FG was conducted. The first one with my sister, to understand how Zoom and Miro work together remotely. It also helped to understand if the estimated time is enough for each task. Another round of pilot test was conducted with my supervisor to ensure that the content I present and the outcome I wanted to get was explicit. This pilot test was beneficial to get constructive feedback, and minor changes were made, which later came out to be very effective in the FG discussion.

C. Target Group

The participants recruited for the FG were IT engineers working at different faculty IT departments and who are familiar with procurement processes at UiO. Some of them were highly involved in all the activities from buying to disposing of the electronics while others had experience in maintenance and care of devices at institution. They had worked for few years doing IT support[7] at an institution. The main reason for choosing these participants was to get a broader perspective on repairing electronics and possibilities of repair in the future. There were five participants in the FG discussion, and it lasted for 90 minutes.

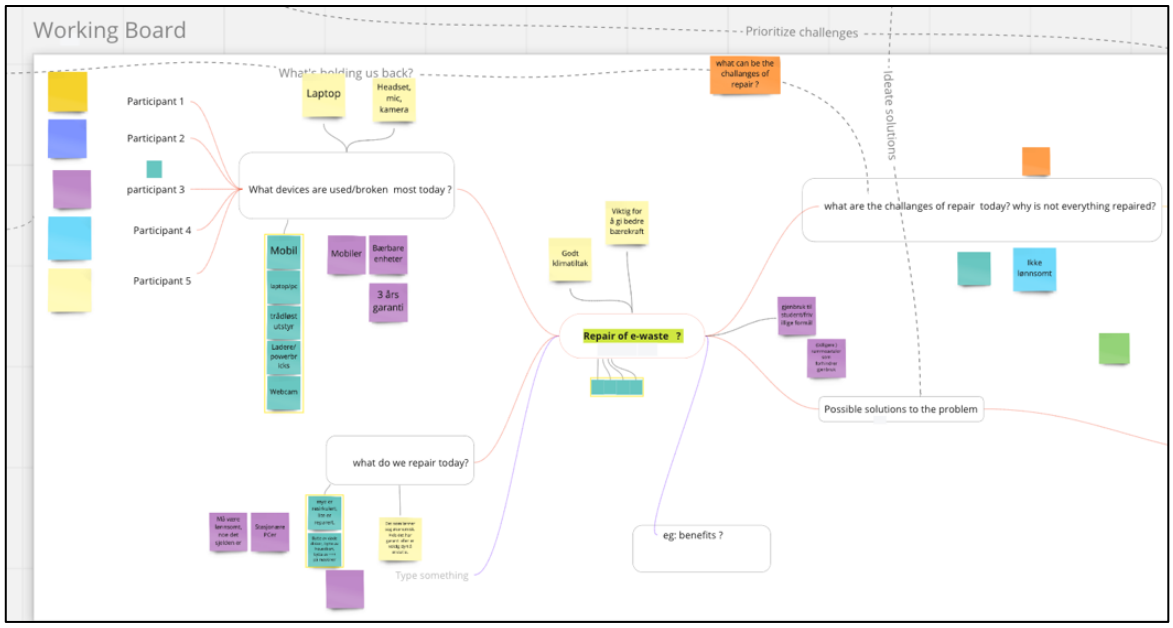

Figure 15: Digital FG map (Using Miro)

D. Focus Group Report

I conducted a digital FG on the 16th of March. It was executed in three phases. I commenced the session by welcoming and introducing the research question and its aim. It was followed by introducing participants, where participants talk about their working area, their interest in repairing and reducing e-waste, and their position in the respective department. Following this,

[7] "a team or department in a company or organization that provides technical help to people who have problems with its computer systems" (Cambridge dictionary)

in the second phase, I presented shortly how to use Miro because some of the participants had no experience in using this tool. After presenting the Miro, the participants were asked to use it. The question for this task was: "*write down the names of electronics that you use*." I asked to use separate colors provided for the participants. Doing this, I instantly noticed that one of the participants was not writing on the board. As we can see on the map (see Figure 15), the color given to Participant 4 is not used while Participant 2 chose to use a different color than the moderator recommended it. I realized it is important to record the process and asked for consent from all participants immediately. The third part was a discussion on the subject matter. The FG was semi structured, meaning that I had predefined questions ready, which are listed below:

1. What devices are repaired today?
2. What are the challenges of repair?
3. What can be the solution for the challenges?

During this phase, participants started discussing the devices that are mostly used, when and what devices are repaired, and the challenges of not repairing the rest of them. Finally, they were asked to discuss the possible solutions on how repair can contribute to sustainable consumption of electronics and reduce e-waste at the institution. Participants' experience in the different sectors within IT devices was crucial to get deeper feedback on the repair and reduction of e-waste at UiO.

5.3 Reflections from Digital Data Collection

After the Norwegian Government and Health Department introduced measures for containing the COVID-19 pandemic. This affected both the data collection and recruitment of participants for the workshop. I started to design my interview plans and workshop physically but later I had to do most of the data gathering digitally. Everything had to be changed quickly due to time restrictions to submit the thesis and uncertainties of reopening the university and other institutions.

5.3.1 Conducting Interviews Digitally

Two of the four interviews were conducted digitally. The remote meeting tool, Zoom, was utilized while conducting the interviews. Although I had some experience using the Zoom tool, I still faced some challenges while conducting the interviews.

1. Interruption of calls in the middle of the interview. The Zoom call was disrupted few times, and I had to use another device as a backup. The reason can be various factors, such as poor internet connection or the device's internal problem. However, this interruption during the interviews was enough to distract the interview flow, which created inconvenience for both the interviewer and interviewee.
2. Recording the voice was another challenge during the online interviews. During the first online interview, I faced a challenge recording the interview and kindly asked if my interviewee could do it for me. The interviewee agreed to do it. However, when I got the file, it was all lost. Thankfully, I had notes from the interview, and I could use them as keywords. In the second online interview, I used another device learning from the previous one and confirmed the recording was working. This minimized the problem but was not completely solved. Zoom got disconnected several times afterward.
3. To keep interviews professional and secure the informant's privacy, the choice of place is important. For example, while sitting in a university meeting room, hearing some extra noise disturbance from outside was apparent. One of the interviewees said, "*I can hear some background noises. Are you in a crowded place?*" I had to wait until the people move away from around the place I was sitting.

This challenges the workflow and trust problems with informants. Furthermore, it increases the risk of honesty of informants, and researchers risk missing data (Walsham, 2006).

5.3.2 Conducting a Focus Group Digitally

During this phase I faced some challenges from organizing repair workshop digitally to recruiting participants. I quickly started to find the required collaborative tool for facilitating a workshop, which allowed the participants to hold on the same page. I have used few collaborative tools like Miro, Padlet, and Figma during the course of my study. It was not hard for me to find one, but it was challenging to use it. Therefore, I searched for collaborative tools for remote work, and Miro was chosen for this purpose.

The most challenging aspect of the FG was finding the interested participants who want to share and discuss their work and the changes they could think about. The discussion was utterly dependent on them, and suddenly, checking e-mails every minute became a part of life at that time. Getting more participants and generating more ideas was vital for me to get more insight into the problem statement. This took a bit longer to prepare, and I had to postpone the planned FG once due to only a few participants could attend. The next time I sent an e-mail to several possible participants and asked to confirm their availability beforehand. Although some still did not show up, they were enough for the FG. This minimized the risk of postponing for the second time.

6 Analysis and Findings

In this chapter, I will present the method used to analyze the qualitative data of this study. The interviews I-1 and I-2 (see Table 7) were transcribed while only keywords were taken from the observation. Similarly, notes were taken from the interviews I-3 and I-4. Participants in the FG were asked to write their keywords during the discussion, and later the author of this study added other keywords during the audio transcription. The interviews and FG were conducted in Norwegian and transcribed in Norwegian, but later translated into English by the author during the reporting of findings in Section 6.2.

6.1 Thematic Analysis

Different methods can be used to analyze the qualitative data. Two methods were considered in this study: Thematic Analysis (Braun & Clarke, 2006) and Grounded Theory (Urquhart & Fernandez, 2006). Grounded Theory is often used to generate theory from data, which was not my aim in this thesis. In contrast, Braun & Clarke (2006) argues, "thematic analysis is a method for identifying, analyzing, and reporting patterns within data" (p.79). Furthermore, thematic analysis is flexible to use and provides rich and detailed data.

The thematic analysis (TA) was conducted after the final data collection from the FG. TA is interesting because data are qualitatively analyzed by discovering themes and concepts embedded in the empirical data (interviews, observations, and FG). First, I started highlighting the interesting and related data (Figure 16) and created relevant codes to summarize the meanings of sentences. Special codes were first generated from the dataset, and themes and subthemes were identified. Only a few were selected for the final analysis. The codes are of the descriptive form while the themes are more interpretive (Table 6). In this study, I will follow the six phases of TA (Table 5).

Table 5: Phases of thematic analysis (Braun & Clarke, 2006, p. 87)

Phase	Description of the process
1. Familiarizing yourself with your data:	Transcribing data (if necessary), reading and re-reading the data, noting down initial ideas.
2. Generating initial codes:	Coding interesting features of the data in a systematic fashion across the entire data set, collating data relevant to each code.
3. Searching for themes:	Collating codes into potential themes, gathering all data relevant to each potential theme.
4. Reviewing themes:	Checking if the themes work in relation to the coded extracts (Level 1) and the entire data set (Level 2), generating a thematic 'map' of the analysis.
5. Defining and naming themes:	Ongoing analysis to refine the specifics of each theme, and the overall story the analysis tells, generating clear definitions and names for each theme.
6. Producing the report:	The final opportunity for analysis. Selection of vivid, compelling extract examples, final analysis of selected extracts, relating back of the analysis to the research question and literature, producing a scholarly report of the analysis.

Step 1: Familiarizing yourself with your data

The first phase is familiarizing with the data. Because the data was collected by myself, I had a deep understanding of the data and got some initial analytic thoughts of interesting parts. This process was helpful to immerse me into the data.

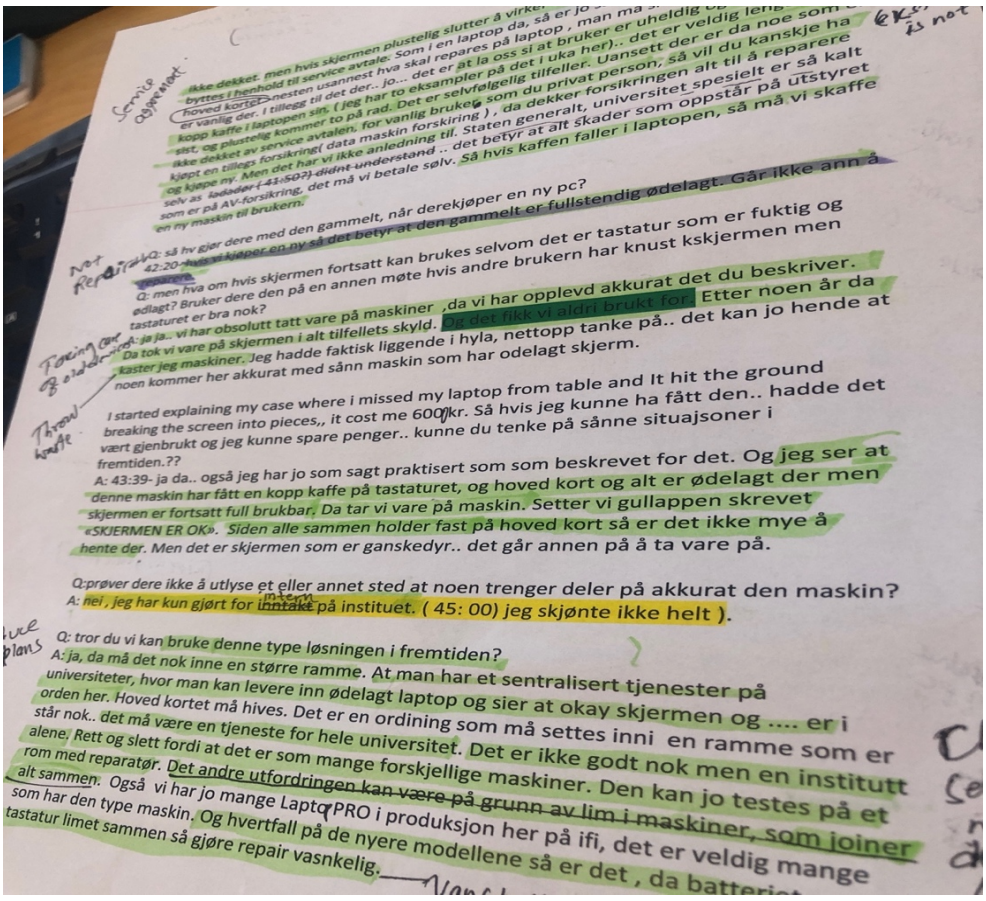

Figure 16: Highlighting the dataset using colored pen

Similarly, to utilize the time spent during transcription, I started to highlight the potential valuable words and sentences already during the transcription of interviews. Transcription was used as an early stage of analysis and helped me thoroughly understand the data. It is important to read the data at least once before starting the coding in the second phase (Braun & Clarke, 2006). After the transcription was completed, I read it once thoroughly before moving to the next step.

Step 2: Generating initial codes

After reading and familiarizing myself with the data, I started generating initial codes: Step 2. In addition, it was more efficient to highlight text during the transcription and while reading afterwards (Figure 16). Finally, I began coding dataset features with specific questions I want to answer in mind, namely, the challenges and possibilities of repair and the approaches to reduce e-waste.

Having predefined questions helped me organize the data into more meaningful groups, which helped me identify the themes that are the next step of TA. Braun & Clark (2006) illustrate that it is important to code as many themes as possible. In this study, two rounds of coding were conducted, as the first-round codes were revised, and new codes were added in the second round. The example of codes is listed in Figure 17. These codes were more of descriptive nature.

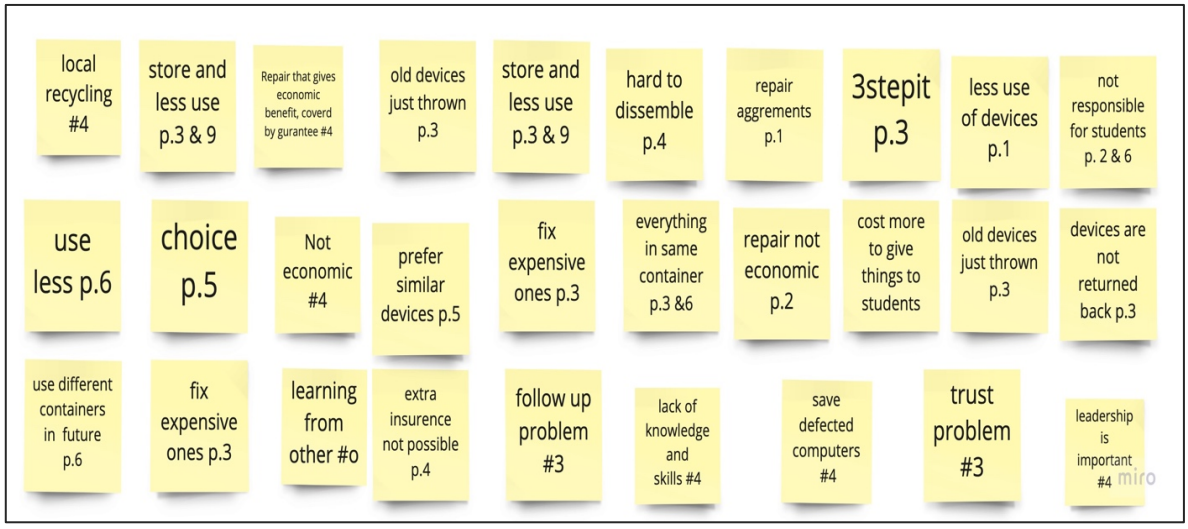

Figure 17: An example of the initial codes extracted

I wrote the codes in Post-it in Miro. Codes were marked with the page number and labelled with different symbols. The symbols and numbers are used to track the quotes later while writing up.

Table 6: Data extract, with codes applied; modified from (Braun & Clarke, 2006)

Data extract	**Coded for**
"Some devices disappear in the drawer and cupboard in the users' home, for example, mobile phones." *[noe havner i skuffet og skapet i det (1000) brukerens hjem. Mobil telefon for eksempel].*	Devices are not returned.
"All equipment we purchase is purchased with a service agreement, and the service agreement covers hardware defects that occur during normal use, [...] fall or moisture damage is not covered." *[Alt utsyr vi kjøper inn, kjøpes med service avtale og den service avtalen dekker hard-ware feil som oppstår under vanlig bruk [...] fall skade eller fukt skade er ikke dekket].*	Repair agreements

Step 3: Searching for themes

The third step is searching for themes. This phase starts when data is initially coded, and now there are lists of different codes that you discovered from your dataset. This is the phase in which I began the interpretive analysis of the data and make arguments about the phenomenon—this consists of gathering and combining all the related codes in one potential theme and subthemes.

I wrote the codes in the yellow Post-it and initial potential themes in the green Post-it (Figure 18). The first themes identified in this phase are: agreement, more recycle than repair, repairable, economic benefit, the lifespan of a device, time-consuming, products, store the parts, the less use, leadership initiatives, organizational structure, responsibility, knowledge, and skills, recycle, choice, and sustainable practices.

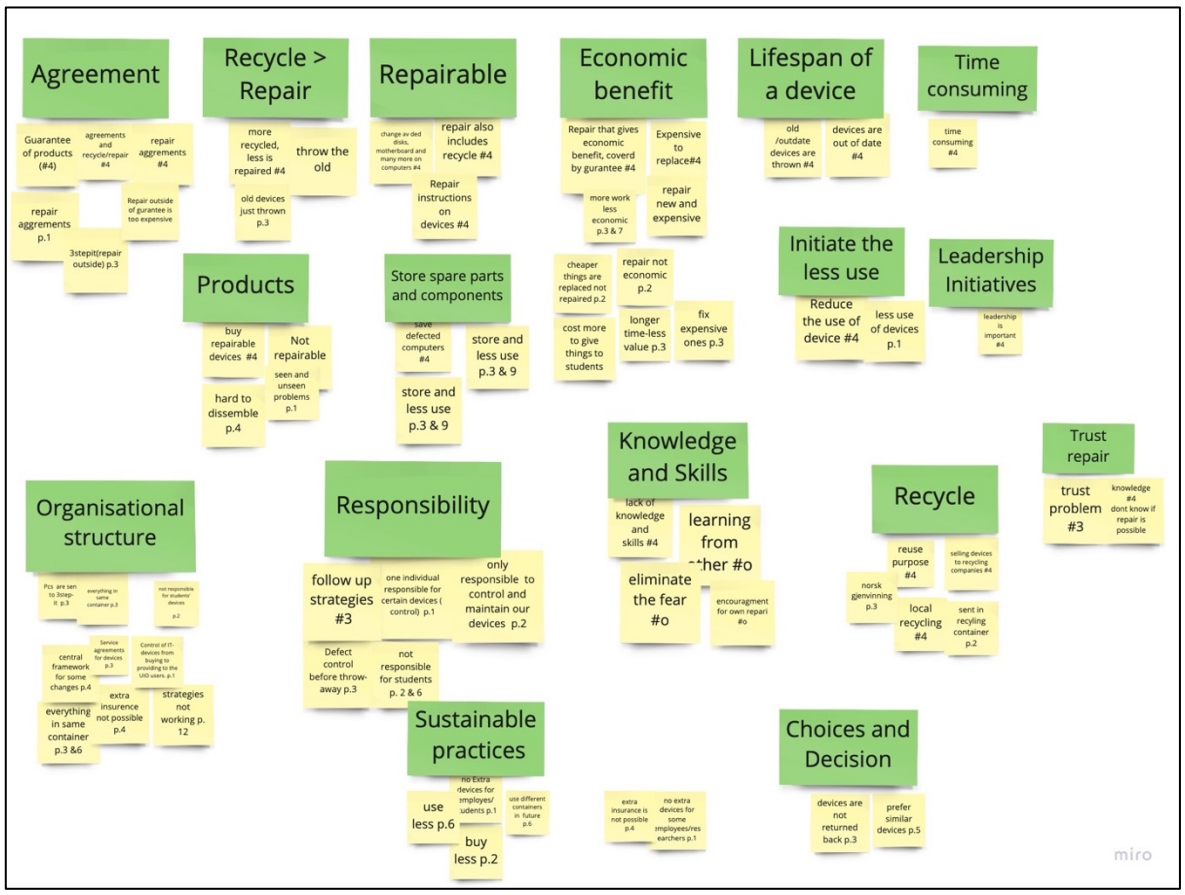

Figure 18: Codes arranged according to the potential themes

Step 4: Reviewing themes

After identifying the first potential themes, this phase reviews the identified themes and refines them. During this phase, some themes disappeared while others were merged, and some new themes emerged. According to Braun and Clarke (2006), this phase comprises two different levels of reviewing and refining themes. First, reviewing the coded data extracts, where you read all the collated extracts of each theme and ensure that your candidate themes form a coherent pattern. Second, if this is not coherent and the candidate themes do not fit in the main theme then we have to re-work on the themes, creating new themes, finding the suitable theme that fits more in an already existing theme, or just remove them from the analysis.

In this phase, I found some codes to be complex to categorize at this time, and they were categorized under *mystery* because they did not fit into any other theme (Figure 19).

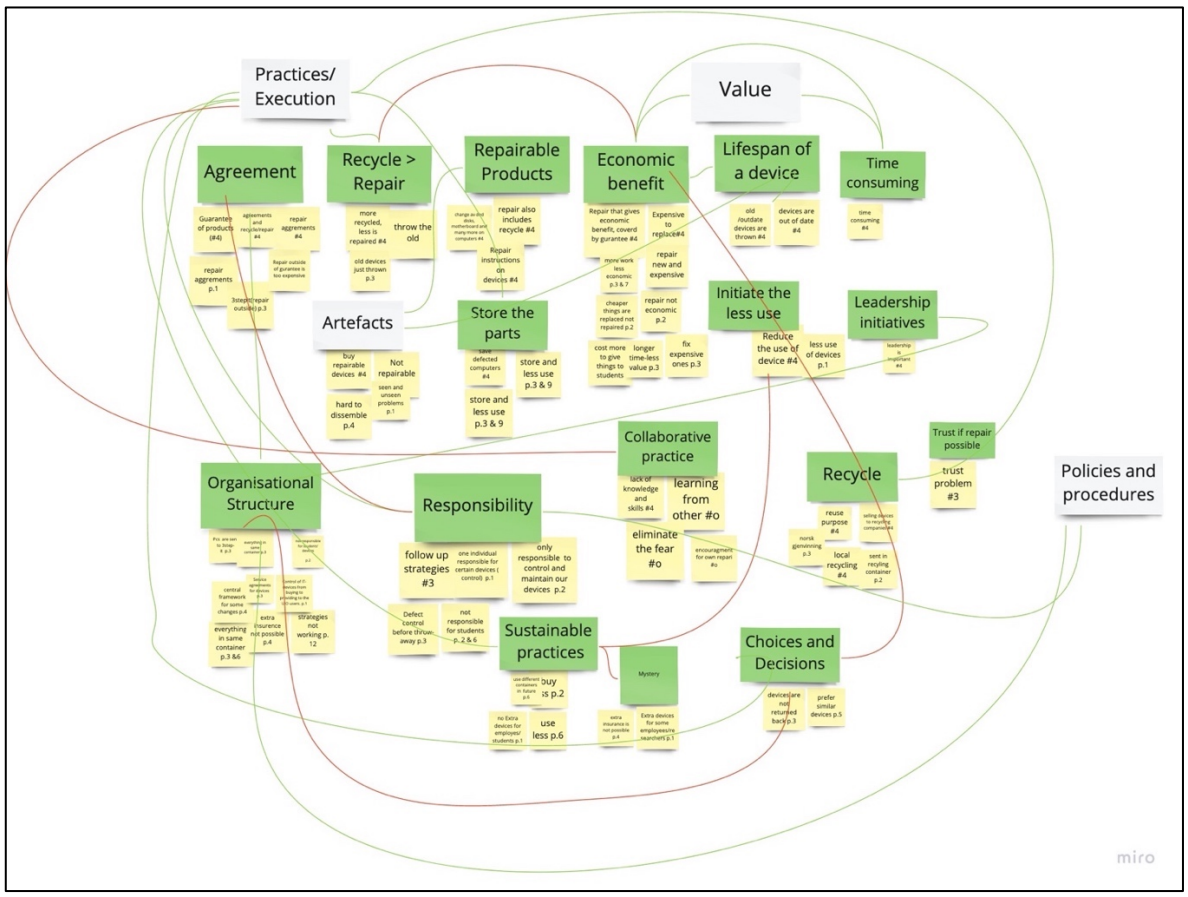

Figure 19: Linking of initial themes

Step 5: Defining and naming themes

This phase starts when you have enough themes, but you want to gather them, combine similar ones, and make the analysis even closer. This process makes that the inherent codes are significant and are clearly stating the characteristic of the parent theme.

It is important to identify clear and distinct themes, meaning themes should be distinguishable from each other. I started by drawing lines between themes that seem to have some sort of connection (see Figure 19). This task quickly helped to merge few different themes into one parent theme. I then merged few other themes that have links into one subtheme. The process quickly gets closer to identify the parent themes and subthemes. From this, a parent theme called *practice and execution* was formed. Similarly, other themes were identified including artifacts, value, and policies and procedures. The final thematic map is presented in Figure 20.

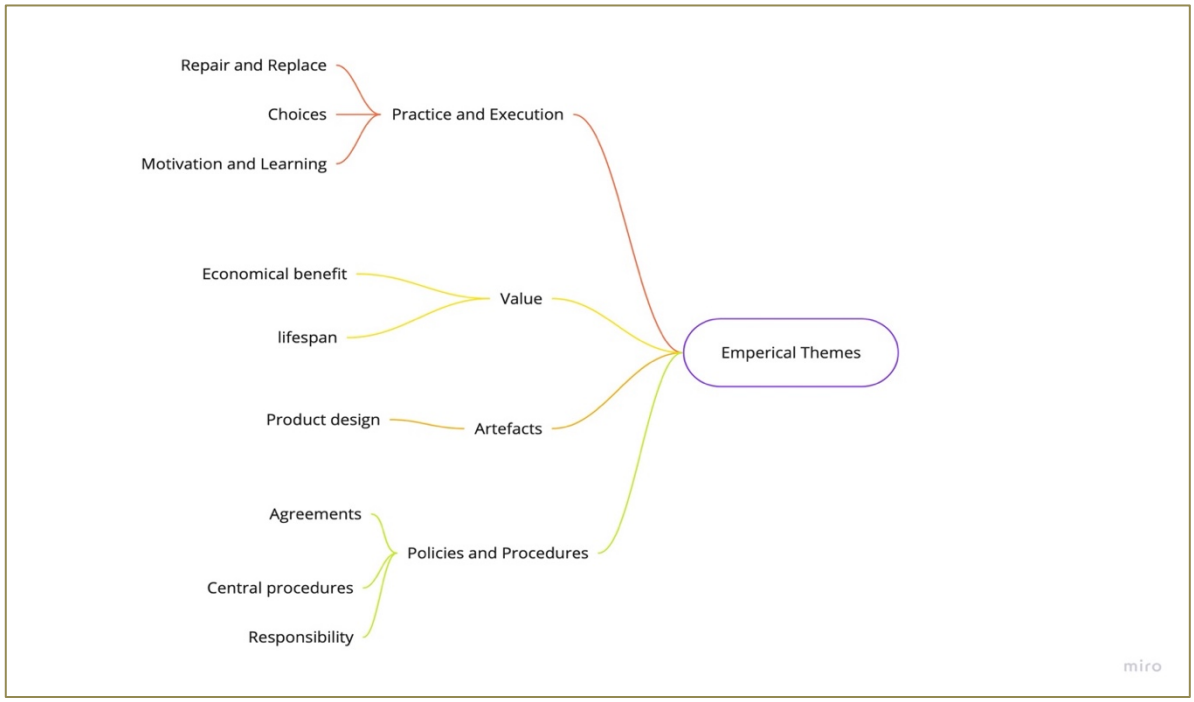

Figure 20: Thematic map representing themes from the dataset

Step 6: Producing the report

This phase is all about writing up the report when you have iteratively worked with themes, gained more understanding of the dataset, and ready to write your report. It is essential to write in a coherent, concise, and logical way, such that it gives a clear meaning and illustrates a story you want to present of your data. I started writing the analysis parallel to the coding process, and the results from the analysis were reported after the TA was completed. Writing simultaneously while analyzing the data using Post-it made it easier to balance the text and the actual analysis process. This result is presented in the following section.

6.2 Findings

This section presents the findings from the TA. For the informants based at IT departments, the repair work was perceived as time consuming and ineffective work. On the contrary, collaborative repair participants mention repair as a learning platform. Similarly, participants in the focus group reflected on the possibilities of institutional repair in sustainable consumption of electronics in an academic institution. The findings of the TA are presented systematically in the form of four parent themes and nine subthemes. In the presentation of results from the

TA, the characters and numbers like (I-1, I-2, I-3, I-4, O, and FG will be used to represent the dataset interviews, observation, and focus group, respectively (see Table 7).

Table 7: An overview of data gathering methods and actors involved

Methods	Participants	Why
Observation of community repair, Repair Party (O)	Various	Understand the interest and impact of collaborative repair practices among individuals
Interview 1 (I-1) Followed by observation of e-waste container and store	Senior engineer and procurement head at IFI	The role of the IT department in consumption and management of electronics, mainly with focus on the role of repair in sustainable consumption
Interview 2 (I-2)	Senior engineer	Role of IT department
Interview 3 (I-3)	Real estate sustainability head	Understanding the sustainable strategies
Interview 4 (I-4)	Student at IFI	Understand the case of repair and reuse in an academic institution
Focus Group (FG) (Replacing a repair workshop)	Employees of the IT departments in various faculties at UiO (diverse role)	Understand future possibilities of repair of e-waste in an academic institution

6.2.1 Theme 1: Practices and Execution

Practice and execution are an influencing factor in decision-making and motivations in repair work. This theme summarizes how the IT department handles the artifacts (i.e., the repairing, reuse, and replacement of electronics). *Practices and execution* was found to be the most influential factor in handling of electronics. *Execution* refers to the activities a person chooses in the time of performing a task. Most of the repair practices were found to be simply the choices of organization, leadership, and choices made by users who use devices provided by an academic institution (e.g., students, employees, researchers, and professors).

The theme practice includes currently practiced consumption behavior and some practices that are considered to be future implementations. The codes are related to the existing approaches in circular consumption of electronics and possible changes that can be made for more

sustainable consumption. The theme *practice and execution* combine three subthemes: repair and replace, choices, and motivation and learning.

Subtheme: Repair and Replace

The analysis of interviews [I-1 and I-2] and FG results showed that *replacing* is more commonly practiced than repairing or any other form of refurbishment. Informants in this study related the principle of caring and repairing has left behind and lost in today's consumer society where the replacement has been an easier task. This study shows that computers used for few years are directly thrown into the waste container, considering that they have served enough (5–7 years). Moreover, computers need to be upgraded as the changes in software's been made continuously. One participant (I-1) said the following:

> *"We have changed many machines while moving in [to the new building], and they are now ten years old these days. Just take the hard drive and send the rest for recycling." [vi har skifta mange maskiner når vi flytta inn, de er jo nå 10 år i disse dager. Det er bare å ta harddisken og sende resten på gjenvinning].*

The informant added,

> "*At some point all machines that are 5, 6, 7 years old, it is more relevant to replace them." [på et eller annet tidspunkt alle der maskiner som er 5, 6, 7 år gamle, det er mer aktuelt å bytte alle].*

Practice and execution also refer to the practices of e-waste recycling. External companies transport the e-waste collected at the institution, so the IT department does not know how the external company executes recycling. One participant informed some employees do not know where it goes from the basement, the place where it is collected. They just throw it there when devices are damaged and at some point, the e-waste disappears. This was expressed as follows:

> *"Sadly, I am really blank [what happens to the e-waste] because I do not see it when it is thrown away and we do not record what is thrown away. We do not really know" (I-2).*

From my observations, I found that electronics and electrical devices were not separated. Instead, mixed electronic and electrical waste was dumped in the same container. There was not much waste at my visit. However, I could still see a few computer screens and other

electronics in the same container, and the next container full of diverse electronic cables and other items (Figure 21). One of the containers on the left in Figure 21 was there for many years, said the informant [I-1]. I pulled one cable and asked if that works? The answer was, "*I have no idea if it works; these parts are from older devices."* However, these devices were not there at my visit.

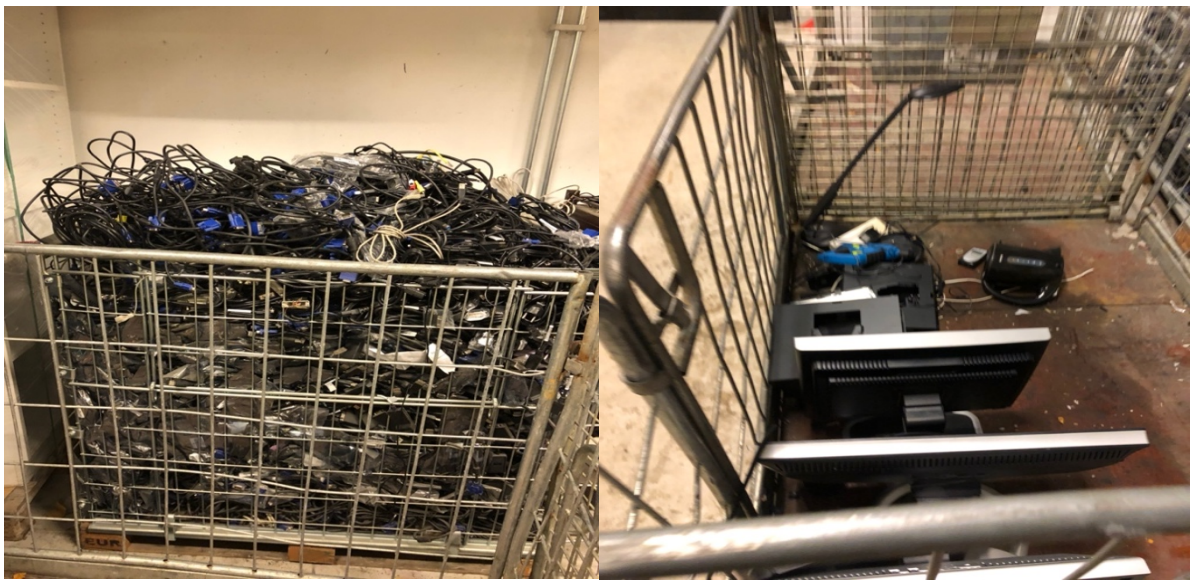

Figure 21:Left- Different cables in same container, Right- Computers and other electrical items

Subtheme: Choices to Make Decisions

A person can have a different *choice* while executing a certain task. Similarly, an individual's behavior and choices determine how to perform a given task at a specific time and situation. In this study, the informant reflects upon the right to make decisions for given task, making it easier for them to choose the more effective and economic practice rather than a sustainable one. When devices do not support the software or more devices of the same age are damaged, the last one is also dumped together because work efficiency increases when devices are similar: the maintenance work become easier.

One informant [I-1] said, "*Everything we choose to throw is certainly not useable for us" [Alt det vi velger å kaste er hvert fall ikke brukbar for oss].* However, what is useless and what is useful is just decided individually. The choice is connected to the economy, meaning when there is enough budget for the IT department, they can buy devices. Otherwise, they have to

repair old devices. Likewise, the choice is related to the effective work pattern of an individual or institution. One informant [I-1] expressed this as follows:

> "*If we buy PCs for student areas, we try to buy five, at least not one, we buy may be 50, so that we replace many at a time, operational wise it is an advantage to have many similar computer" [Hvis vi kjøper pc for student arealene, so prøver vi å innkjøpe 5, hvert fall ikke en, vi kjøper kanskje 50, sånn at vi skifter mange samtidig, og driftsmessig det er fordel å ha mange like maskiner].*

Similar devices make maintenance and care easier for the IT department. They can spare both time and money considering the working hours. On the contrary, repairing is considered a time-consuming task. One participant [FG] expressed this as, "*repair takes time from other important activities" [tar tid fra andre viktige aktiviteter].*

Sustainable choices are also considered by the IT department. For example, when I came across the store where old or defective devices were stored in the hope to reuse them. I observed many keyboards and mouses in containers (see Figure 22). The storeroom contained many other devices, including both new and old devices. However, as informant said most of them were there for many years, without being used.

Figure 22: Stored keyboards and mouses

Subtheme: Motivation and Learning

During my observation of the Repair Party, most participants reflected repair work as a challenging and risky task. The participants in the Repair Party at Restarters Oslo stated that collaborative work motivated them to participate in the repair of electronics. They also reflected on the change in behavior and choices now compared to their old habit. One participant stated this as, *"I have seen it [showing a radio] on my shelf since I was a child, it did not work, but when I heard about this event, I was excited to see what the problem was and if it could be repaired".* The participants reflected on exploring the device by themselves with experts' help, which motivates them to carry self-repair in the future. The collaborative practice was also connected to sharing skills and knowledge. One participant said:

> *"This kind of practices [collaborative repair] helps to exchange the knowledge and encourage each other to do self-repair […] also establish some kind of attachment with the artefacts when we repair them by ourselves" (O).*

Similarly, a collaborative repair can build trust. The participants at Repair Party expressed they started to believe and trust that repair is possible, and things can get a new life if you get proper knowledge and competence. Being directly participated will increase your skills and understanding of different artifacts. This kind of practice will make your think differently and make changes in your choice, repair instead of replacing. One participant added repair practice could further increase the product knowledge, and it may also make you think about the product [if it is repairable] before you buy a new one. The process of reverse engineering (disassembling device) is seen as a learning platform by the participants.

The participants expressed they started to carry self-repair at home after the previous visit to the repair workshop. This statement states how new habits and routines can be formed over a long period. For example, one participant [O] mentioned that:

> *"I have tried to repair my headphone at home. Because from the previous visit, I could see where the problem lies, and I was referred to buy the specific part. After getting apart, I thought I could fix it by myself, but unfortunately, I could not, and I am here today but the next time I am not scared to open up things and give it a try" (O).*

On the contrary, I-4 reflected on trust issues when one cannot see the repair process because it is done independently by the IT department. The experience was described as, "*Neither of us [after talking to the fellow student] know if it could be replaced or repaired."* However, "*it would have been nice to see the repair process and what actually happens to the device*." As a result, the users are cautious about their devices and whether they will be returned missing data stored in the device. Thus, collaborative repair is seen as a way to increase trust among the users. People could trust or get satisfied while they could observe or interact with the device by themselves.

6.2.2 Theme 2: Value

Interestingly, *value* was by far the most influential and interconnected theme in my analysis. *Value* is directly interlinked with the time to repair and the original cost of a device. For the informants, every practice relates to the economic benefit and time efficiency. Mainly, IT engineers stated that the repair process depends on how much value the product gives back compared to repair costs. The main theme of *value* includes two subthemes: *economic benefit* and *lifespan*.

Subtheme: Economic Benefit

Every electronic device has an economic value, and the value decreases from the first day you use it. The economic value influence consumer behaviour. In the consumerist society, products are made cheaper and attractive so that consumers are focused on using the new one instead of taking care of and repairing the old one. Similarly, the same kind of attitude was expressed by the informants in the IT department. From my interviews, it was found that few stationary computers are repaired while most of them are just dumped in the recycling bin after certain years of use. Informants stated cheaper things are preferred to be replaced instead of repair. IT department does not repair cheap devices while expensive devices get repaired. For the IT department, the time and labor cost compared to the new price of a device gets higher when repairing relatively cheap devices, like mouses and keyboards. This was expressed as follows:

> *"Investing lots of working hours […] costs money, to recover almost nothing -it's just useless" (I-1)* [*Investere masse arbeidstid […], koster penger, for å inn drive nesten ingenting- det er bare tull].*

The decreasing value of an artifact is seen as the main reason to replace instead of repair and reuse. In contrast to this, the expensive devices are repaired. Repair cost will still be lower than the market price of the same product. One informant [I-2] said:

> "*Once we sent our service camera to Switzerland for repair. I think it's 40k-50k for one camera and it was 10-15k to repair it. Then thanks to the repairer. It will work for more 5-10 years" (I-2).*

Sometimes, some valuable devices are preserved in the hope to repair or replace components in the future. For example, if laptops have defects in some parts, but they have other components that can be reused. However, after few years, they end up in the e-waste container where other electronic and electrical devices are thrown. One participant expressed this as follows:

> "*We have absolutely taken care of computers […] saved the screen [form a defected PC], but we never use them"* [*Vi har absolutt tatt vare på maskiner, [...] tok vi vare på skjermen i alt tilfellets skyld, og det fikk vi aldri brukt for. Etter noen år da kaster jeg maskiner] (I-1).*

Everything that increases the expenses at the IT department is avoided. Even the donation of PC's and other devices to students increases administrative cost for the IT department, and it is also ineffective task for them. The informants expressed it as a time-consuming task, which can be used in other important work.

Subtheme: Lifespan/Useful Life

The decreasing value of artifacts is considered to be a factor that influences repair. Repair work depends on the valuable life of a product: how long an artefact has been used and how long it can function after the repair. According to the informants, after being in service for 3–5 years, computers' market value falls to zero. Informant [I-1] stated this as follows:

> "*In the first year of service, a PC has its value 80% of its original cost, in second year the value is set to 50%, and in the third year its 20% and after three year there is only one time price of maximum 500 kr" [I første leveåret til pc-utstyr settes verdien til 80% av nypris, i andre år settes den til 50% av ny pris, i det tredje år 20% og etter 3 år så er engangs sum på 500 kr].*

When a device's value is significantly low, replacement becomes more inexpensive than repair and maintenance. When one can buy a new product even cheaper than it takes to repair, it is obvious people will go for the most economical option. Also, it is economical for the institute because new devices require less maintenance, and normally it is included in the agreement.

6.2.3 Theme 3: A Designed Artifact

The theme A*rtifact is* considered an influencing factor for IT departments when it comes to repairing devices. It was found as a common factor from both interviews and FG data. Participants mentioned this subject matter many times. This theme includes subject matters like whether products are designed with the intent to be repaired, whether the device contains information about repairability and upgradeability. The most common topic participants stated in interviewees [I-1 and I-2] and FG were the complex integrations of parts, planned obsolescence, and sometimes impossible to find the problem, making repair work expensive and impractical.

Subtheme: Product Design

Participants at FG highlighted that highly integration of components as a challenging factor in repair. For example, one participant [FG] said: *«Not everything can be repaired, worst in Apple*» [*ikke alt kan repareres, stygt på Apple].*

Especially, informants stated that new model computers are difficult to repair. In these computers, everything is connected to the motherboard. One participant mentioned the recent case they had with the battery power in a MacBook. However, they had to change both battery and keyboard as they were attached. This was expressed as [I-1]:

> *"Another challenge may be due to glue in machines which ties everything together, and at least on the newer [Apple] models, it is the battery and keyboard are glued together that makes repair difficult" [Det andre utfordringen kan være på grunn av lim i maskiner som limer alt sammen [...] og i hvertfall på de nyere modellene så er det at batteriet og tastatur limet sammen som gjør reparasjon vanskelig].*

However, devices that are easy to disassemble parts from are easy to repair, and people in the IT department can repair or replace the components. The interview with PhD student made it clear that changing a battery in a Dell computer was quickly done by the IT department.

The repair work gets easier when repair instructions are provided for the device. Unfortunately, today's product design process does not provide repair instructions, and some even hide the information. Both interview and FG participants mentioned this issue: lack of instructions in the device. The participant reflected that it requires more time to find information, whether the device is designed to repair? This was considered a barrier to products repair. The participants in FG discussed future possibilities to reduce e-waste, and one of them was buying repairable products—products that clearly state their life cycle and repair instructions, which can make repair work fruitful at academic institution.

6.2.4 Theme 4: Policy and Procedures

My final theme, *policy and procedures,* consist of the data related to the implication of policy and agreements in an institute. The theme *policy* is an interesting theme as it plays a role in understanding what role policy and agreements play in the repair and consumption of electronics. *Policy and procedures* include three subthemes: agreements, responsibility, and central procedures (i.e., organizational structure, and agreements with suppliers), which are related to repair and sustainability and is essential for me to consider in this thesis.

Subtheme: Agreements

Most of the repair today is done by the supplier, which falls under the agreement. Devices are bought with specific contracts with the supplier. Informant [I-1] illustrates this as:

> "*Everything is purchased with a service agreement, and the service agreement covers hardware faults that occur during the normal use. If the screen suddenly stops working or batteries do not work, them it must be replaced in accordance with the service» [alt vi kjøper inn kjøpes med service avtale og den service avtalen dekker hardware feil som oppstår under vanlig bruk [...]hvis skjermen plutselig slutter å virke eller batterier ikke virker, så skal den byttes i henhold til service avtale].*"

Another informant [I-2] said, personal blunders "*drop and moisture*" are not covered by the insurance. Repair outside agreements must be settled by the institution, and it is expensive for them. One participant in FG stated, "*repair outside guarantee is expensive."* Participants expressed that even the extension of the agreement is costly for the institution, and this is not practiced. One participant [FG] added it is not even possible in the existing procurement policy.

Subtheme: Responsibility

For most people, some tasks are routinized and remain constant over time. Task like cooking, cleaning, and eating are regular and consistent for many individuals. Some just do it as a part of everyday life. In contrast, others are given the responsibility to perform something either as part of their daily life or to complete a task for a particular organization. The university is a larger platform consisting of several branches (faculties and departments), where one makes strategies, and it's the another to perform the task. Some things are centralized, where others are locally executed in individual level. Sometimes they must make quick decisions. As one informant [I-1] said, *"Many things are solved in a corridor talk" [Det er mange ting som løses i korridor prat]*.

On the contrary, most of the task is specified. IT engineers mentioned their responsibility is to provide service in the institution effectively and efficiently. The responsibility given to them shapes their motivation to perform a particular task. In my study, the participants informed they do not have a responsibility to look after students' computers. Students can take their problem, but the IT department will focus on the service area they provide. For example, suppose the student has trouble with a wi-fi connection, IT department look if their routers are sending signals; it is their responsibility to provide wi-fi. The informant [I-1 and I-2] added, if the student has a problem with the wi-fi antenna, we are not responsible for fixing it. The informant [I-1] summed up as follows:

> *"Our main area of responsibility is to make all our equipment work in such a way that our users can use the equipment without trouble" [Vårt hoved ansvarsområdet er jo å få alt av utstyret vårt til å fungere på sånn måte brukerne våre kan bruke utstyret]*.

Most of the participants reflected on the responsibility they are given. A routine they follow in a regular working hour, and they practice the same routines instead of shifting to other practices. The workload increases when they start looking for other activities.

In this study, it was found that the responsibility comes from the user at an academic institution as well. Most of the devices provided to researchers and employees are not returned after the completion of the study. The informant [I-1] said the following:

> *"Many things end up in the drawer and closet of 1000 users' home. I never get mobile phones again for recycling» [mange ting havner i skuffet og skapet i det 1000 brukerens hjem. jeg får jo aldri mobile telefoner igjen for gjenvinning]"*

However, the IT department was not very much interested in bringing them back after 3–4 years of use. One participant (I-2) said that even if they want to collect and give away or donate something, they must go through the paperwork, which is a Norwegian policy for every organization. Again, this process costs more working hours to go through the process, for a device whose monetary value is reduced to 500kr.

Subtheme: Central Procedures

During the FG discussion, participants expressed positive thoughts about changes that can be made, such as giving away to students and a workplace where people can repair together. However, it was not the one IT department that can implement this service, it has to go centrally. For example, one informant (I-1) said the following:

> *"It has to go through the larger framework. You have a centralized service at universities where you can hand in broken laptop and say that the screen is okay and can be used, […] it must be the service for the whole university" [da må det nok inne en større ramme. At man har et sentralisert tjenester på universiteter hvor man kan levere inn ødelagt laptop og sier at okay skjermen kan brukes […] det må være en tjeneste for hele universitet].*

Despite the current barriers, both the interview and FG participants believe there are solutions for every problem, but solutions should be passed centrally, and it takes time. Sometimes, there are central strategies and policies, but the individual working in the field does not think about them while performing the task. Everyone will look for an effective and economical solution despite central policy and procedures when it is a routinized work for a responsible person working at specific area. In the following chapter, I discuss the findings about the barriers to institutional repair and sustainable consumption and how the change in practices and routines can contribute to developing sustainable behaviors, aiming to answer the research question of this study.

7 Discussion

In this chapter, I will discuss the significant findings of this study and compare the outcomes concerning the previous literature from Chapters 2 and 3. After a study of repair practice from an individual level to an academic institution, this thesis discloses various repair challenges in the institutional level and contrasts the dynamic on future possibilities (alternatives) of repair in an institution that contributes to sustainable consumption. The social practice theoretical lens was used to discover the alternative perspectives that emerge through everyday practices (Fenwick, 2015).

In the first section, I will discuss the role of repair in the CE of electronics. The second section shed light on the barriers of repair. Lastly, this study discusses the alternative ways of repair practice that can contribute to sustainable consumption by understanding the distributed agency of materials, skills, and knowledge, as presented in Chapter 3. Thus, this chapter aims to discuss the following research questions:

- *How can repair contribute to a circular economy in support of sustainable consumption of electronics in an academic institution?*
- *What are the barriers to the repair of electronics in an academic institution?*

7.1 Circular Economy of Electronics at UiO

This thesis aims to shed light on how the repair of electronics contributes to the social, ecological, and economic strengthening of the CE in an institution. Data from interviews [i-1 and i-2] and FG is analyzed to answer the first research question: *How can repair contribute to a circular economy in support of sustainable consumption of electronics in an academic institution?*

As is apparent from the literature in Section 2.5, repair plays a significant role in the CE by extending the lifespan of electronics. Repair is the first step in recovering the product's value in its life cycle and keeps the product in the CE (Hernandez et al., 2020). However, the data gathered in this project shows that repair is seen as an ineffective and expensive option for an institution like UiO. The participants of this study reflected on repairing devices as a time-consuming and expensive task. Expensive in a sense repair cost more than buying a new device of similar model. The interview results showed that expensive materials are repaired while

cheaper materials (such as mouses and keyboards) are thrown in the waste container. The informant stated that repair takes time and increases the overall cost for the IT department.
In contrast, repairing expensive devices was more economical than purchasing the new ones. Similarly, most of the repair work is carried out by the supplier, as includes in the agreement. Devices are usually dumped when defected after 3 years of service agreement is over, because repairing them does not support the internal economy. The results of less repair in an academic institution contributes to more e-waste and increasing consumption of electronics. This the repair is less valuable in CE loop.

The results show that IT department has practiced some effective incentives, which could contribute to the CE. For example, the devices from defective laptops are stored for a while in the hope to replace the component in other devices. However, the execution to reuse the components and devices has not been productive. In other words, it can be argued as the reuse of devices and components has not contributed to the CE.

Likewise, it was apparent from the interviews that devices are replaced in large quantities. It was stated that replacing many devices at a time increases work efficiency. In other words, it requires minimal time for the maintenance and care of devices, and the IT department can use the time in other important work, meaning they save time and hence money in a long chain when there are devices in service. However, sustainability and its impacts on nature is less considered—neither the CE of an artifact.

Additionally, it can be argued as the value of a device is decided by the organization's internal economy, without any connection to other values, such as environmental sustainability and cognitive benefits such as learning and sharing skills that contributes to sustainable behavioral change. For the institution, the strengthening of the internal economy seems to be an utmost factor rather than a CE of a product that does not contribute to internal economy. This can be argued as the novel products in the market, which are often cheaper but do not have value in the CE (Althaf et al., 2019).

The current CE of electronics in an institution is illustrated in Figure 23. The vertical lines represent the normal life cycle of devices at UiO. While the dotted line in the middle represents a section in the life cycle where UiO is not a part of but can influence the CE of electronics at UiO. Similarly, the green and red lines represent the sustainable and unsustainable consumption pattern respectively.

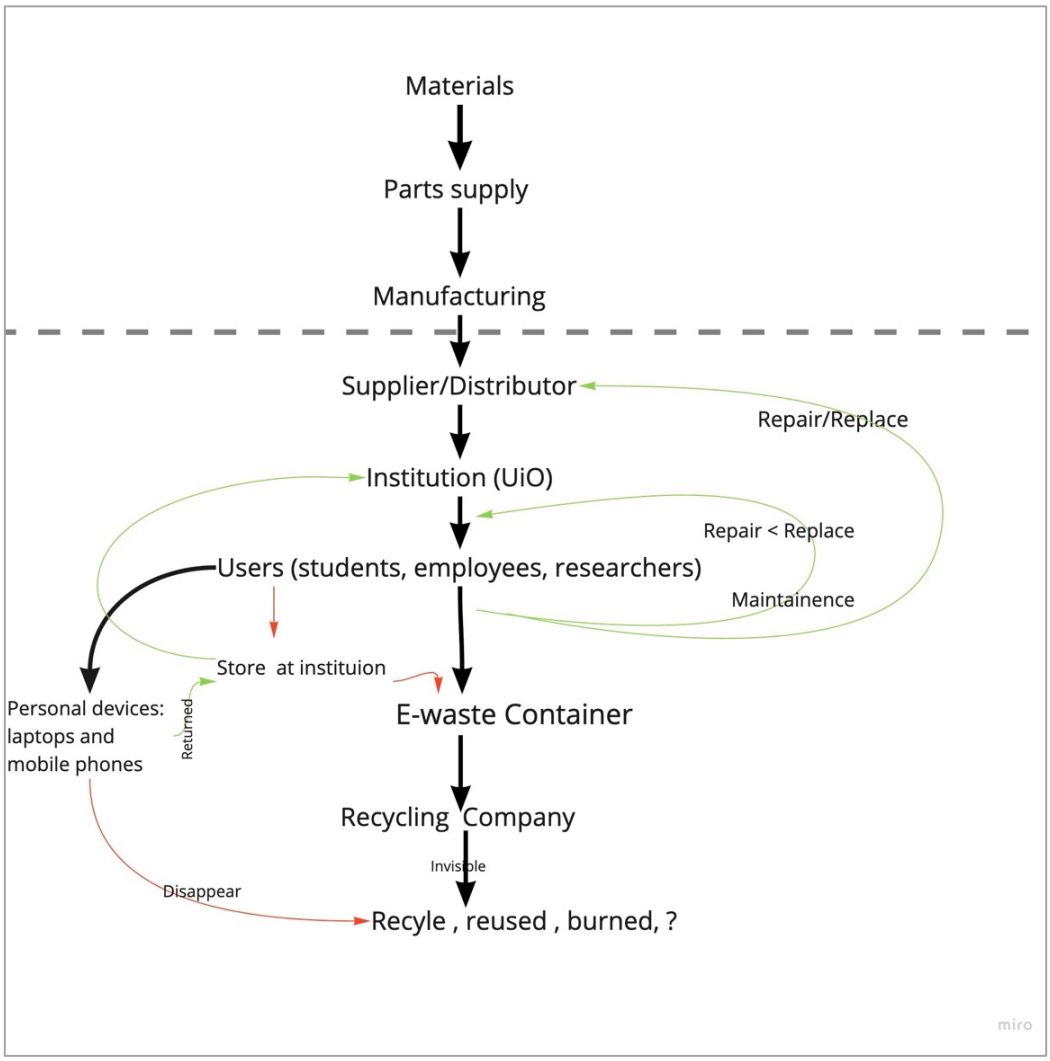

Figure 23: Current situation of CE of an electronic product at UiO

In the literature, Section 2.2, this study elaborates the impacts of unsustainable consumption of electronics on humans and environment such as climate problems. Similarly, during the course of research, it was found that UiO consumes a higher number of materials. This means the natural resources have been highly exploited in other parts of the world. This can be argued as the overconsumption of electronics leads to large amount of e-waste, which contributes to environmental problems. There are reasons for the overconsumption of electronics that the participants of this study reflected on. These barriers are discussed in the following section.

7.2 Barriers to Repair

What are the barriers to the repair of electronics in an academic institution?

The findings of this study show that the consumption-focused business models firstly hinder the CE that profit from preventing the CE loop (repair and reuse). Secondly, it comes to consumer behavior while handling the products. The significant barriers from the analysis of data show: a lack of incentives to repair, which is defined by the behavior, choice, and responsibility. Similarly, product design, economic value, and attachment to products were other barriers reflected by the participants of this study.

1. Consumer Incentives: posture and mindset

The research shows that consumers play a huge role in the CE and sustainable consumption (Maitre-Ekern & Dalhammar, 2019). Consumption is displayed by two factors: a sense of purchase and using-up the artifacts (Warde, 2005). Both are conceptualized by individual behavior, attitude, and choice of artifacts. For example, consumers can refuse to purchase devices designed to be dead after specific tasks and encourage to buy repairable and easily recyclable devices. Similarly, consumers can choose whether to repair and bring devices into the CE loop or throw them and replace them with new ones. Warde (2005) argues that consumption can be influenced by or based on earlier experience, responsibility, knowledge of materials and environmental consequences, and encouragement from each other. These factors can influence individual choices and behavior toward un/sustainable consumption. Similarly, Hernandez et al. (2020) argue repair can be affected by economic incentives, engagement, emotional attachment to the products.

The analysis of this study shows that individual behavior and choice are crucial in the sustainable use of devices in an institution. It was apparent from the interview that work efficiency and the internal economy is regarded as the main factor rather than sustainability. It can be argued that in an institution, repair depends on its internal economy, work efficiency, and lifespan of a product. The result shows that the maximum service time for electronic devices is 3-5 years, after which they are discarded in the container for recycling. Additionally, informants said; every device they throw today is useless for the IT department. This is argued as there is a lack of emotional and economic attachment to the product, which is a barrier to product repair (Hernandez et al. 2020). While having similar computers in an academic

institution increases efficiency and productivity. This might be why the IT department buys more than one computer at a time and throws or stores the older ones. This can be argued as the existing practice of repair, and reuse has been routine for the IT engineers and has not been forced to think of an alternative solution. The author, Kuijer et al. (2013), argues that practicing similar routines and not being triggered by other practices can be a barrier to unsustainable consumption behavior.

Another possible explanation can be that consumption remains ruled by deliberation of efficiency and effectiveness concerning the achievement of routines and use-values (Warde, 2005). This study's findings show that the employees' responsibility determines their specific working area and performing activities besides the area can be ineffective and unproductive. For the IT engineers responsible for IT devices, their concern will be to provide an effective service for their users. For the employees, replacing many devices at the same time has more advantage in its operation and maintenance. Thus, new products give good productivity and require less maintenance. This is argued as the consumption of electronics in an institution has been dominated by the responsible person's attitude, behavior, and choice (Shove, 2010).

Consumer behavior at UiO seems to be challenging in sustainable development. The individuals in the IT department can make individual decisions while consuming the materials. The findings show that mostly IT department choose to replace before repair and reuse, meaning repair and maintenance require more time away from other important activities. In contrast, replaced devices are not necessarily damaged or not functional, and they can be used for other learning purposes. However, this seems to be less considered. It could be argued that the consumer's choice is seen as the main challenge in repair and sustainable consumption in an academic institution (Bauer et al., 2018). This can be because of not having sustainable guidelines and looking at everything from economic benefit rather than sustainable solutions.

Furthermore, it can be argued that consumers lack awareness of the hidden consequences of their unsustainable consumption at the institution. As mentioned in interviews, recycling is carried out outside the institution by an external recycling company. The employees are unaware of the recycling process. What gets recycled and reused is beyond their vision. They lack understanding on the consequences, overconsumption and high production of e-waste can create on the other side of the world. This can be argued as a lack of alternative ways of thinking that can make a vigorous change in the extensive use of resources (Shove, 2010).

2. Product Design and its Economic Value

As Balkenende and Bakker (2015) argue, product design can be the main barrier of repair; the devices are designed to function for a certain task which makes replacing cheaper than repair. This was apparent from the findings in this study. The informants stated that the highly integrated components in an Apple device make repair expensive, as the whole central motherboard must be replaced when the keyboard is damaged. Sometimes it is impossible to repair. As participants mentioned, the lack of information about the repairability of the product is another challenge. Similarly, it was informed that devices used for few years do not support the new software updates. This can be argued as the products are not upgradable and do not support the change being made in the software.

Due to the complex integration and dilution of different materials, it is impossible to disassemble the components, which is a major step in all kinds of repair and recycling (Balkenende & Bakker, 2015; van den Berg & Bakker, 2015). This can be argued as the products are not modular; disassembling of parts is impossible, which hinders the repair and replace of components in a device and contributes to generate more e-waste. This can be further argued as the product design is not sustainable, leading to unsustainable consumption of natural resources. Similarly, we can argue that the devices used in an academic institution are not sustainable.

While developing electronic devices, the designers aim to maximize the sales (more consumption) of devices. However, as a sustainable interaction designer, rather than putting an effort in people, a focus should be placed on materials, which helps people use materials for a longer time, making repair cheaper and more accessible than replacing. It could be argued as product design should persevere the properties of reparability, modularity, and upgradability (Balkenende & Bakker, 2015). Similarly, the product design should include the carbon footprint it leaves behind in the biosphere while enforcing providers with stricter policies and agreements can make the repair more accessible and reduce e-waste. This aligns with SGD 13, which states the role of consumers and producers is vital in sustainable consumption.

7.3 Recommendations to Overcome Barriers of Unsustainable Consumption

This study found that the repair of electronics at UiO is considered from an economic perspective only, ignoring sustainability and learning perspectives. The result from the FG and community repair (O) highlights different possibilities of sustainable consumption: purchasing sustainable products (i.e., repairable), improvising policies and agreements, a place where everyone can come and learn to repair "*Repair Zone,"* are a few of them. This can be argued as IT engineers do see the possibility of reducing e-waste by practicing new routines. This idea aligns with one of the short-term visions of this thesis: establishing a repair place where products can be disassembled and components can be repaired, replaced and reused.

This study discusses the following recommendations for alternative practices that institution can consider based upon the findings of this study and previous related theory:

1. Crisis of Routines

As is apparent to the SPT, sometimes one's practice can trigger others in a similar situation to think of new practices. This was evident from the interview [4], when the student went to repair the device, the IT department would have exchanged it, but the student's initiative to repair the device created a new performance and routine. This is only an example. Similarly other users at the institution can create various scenarios, such as students and researchers asking for repair instead of replacement, asking for components, which compels the institution or IT department to change their routines and performances. It can also be the other way, where all the users (staff/researchers/students) must use a computer for five years instead of three years. They are responsible for maintenance and care for themselves in the given time, which creates a type of economic attachment. Thus, repairing and reducing the use of devices will be a new routine and gradually develops into a habit. This can be argued as existing social structures can be broken down into discursive events, and new designs can be formed (Reckwitz, 2002).

The participants from the interview [i-1 and i-2] clearly stated that some initiatives to preserve and give away materials and components did not function well. They ended up throwing the devices away after storing them for a long time. This can be argued to be a case of not having effective execution because the setting is invisible or unknown to another user. However, proper implementation of such incentives could be converted into positive results if new practices and the crisis of routines are introduced (Kuijer et al., 2013), together with stronger

laws and policies by the institution. In other words, implementing incentives in the physical context and executing issues in everyday practice in a different setting of arrangements, actions, and materials can help create different routines (Warde, 2005).

2. Buying Sustainable Products

From the findings, product design was considered to be the barrier to repair and reuse in the institution. However, buying sustainable products which provide reparability and recoverability can play a significant role in the future. Similarly, more robust policies for suppliers can be implemented. The repair agreement with the supplier can be extended from 3 to 5 years. In this way, suppliers are pushed to deliver sustainable i.e., repairable and reusable devices (e.g., fair phone,[8] framework[9]). The institution can decide what they want rather than what the supplier offer. Dalhammar (2019) argued that this introduces strong policies to producers, as the producer should take full responsibility for artifacts until its entire life cycle can minimize the problem of unsustainable consumption. Furthermore, it can be argued that reducing the purchase of devices designed to be dead after specific tasks and encourage them to buy devices that are repairable and easily recyclable can help promote sustainable development.

Apparent to the literature, a product design should consider the following: Maintenance, modularity, upgradability, and disassembly (Hernandez et al., 2020). This means it should be easy to disassemble the device in an institution to repair and reuse components. The upgradeability of a device is equally important to prevent the replacing culture in an institution. Similarly, the modularity of a device will help the institute execute the repair, reuse and recycle within the institution. It means repair gets easier and contributes to sustainable consumption and a reduction in the use of resources.

3. Repair Zone

In this study, the findings show old devices were thrown away while old does not necessarily mean broken or useless. They can be used in institutional repair practices for learning purposes. Repairing the electronic devices within an institution can encourage students and other employees to the sustainable use of devices. Moreover, having a specific place for repair

[8] https://www.fairphone.com/en/story/
[9] https://frame.work/?utm_source=densediscovery&utm_medium=email&utm_campaign=newsletter-issue-128&fbclid=IwAR0kcqgVfFWCAHQKGIBRaiO9gItOppAp5XYEhCCIhZ4kc9au3yCkFixyRjw

activities within the institution is vital. This can connect people and strengthen bonds between people because it helps to build the regularity of practices (Fenwick, 2015).

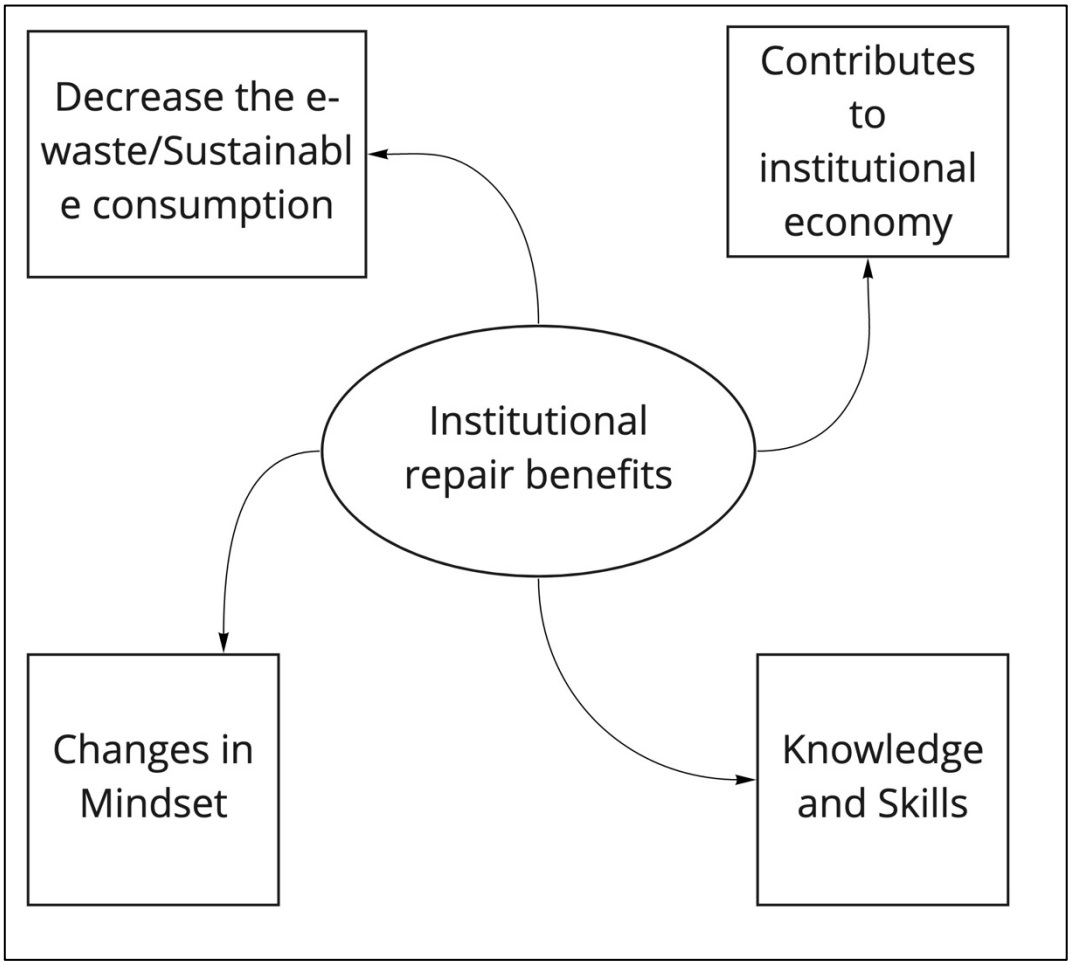

Figure 24: Conceptual model for benefits of institutional repair

A ‘repair zone’ is a place where anyone can do a pop-up repair at university. Having permanent pop-up repair places inside the institution buildings can help to magnify the benefits of repair practices in larger communities. Involving in repairing can help to develop new habits and develop understanding of the products. Another possible advantage can be that collaborative repair offers a platform to build culture. Similarly, the continuous disassembly and reassembly of an artefact provide material knowledge, which can be an eye-opening factor for many users on the use of their devices. In the same way, dissemble of devices can create understanding about the design process and develop trust and confidence in self-repair (Jackson et al., 2014). This was evident for the participants in the Repair Party [O] and student at the institution. The participants [O] reflected on their direct involvement in repair practice as they could minimize

the fear of opening the devices after their participation and were more confident and motivated than before. People with different skills can help each other, enabling the beginners to learn both techniques, benefits of repair and social benefits. Durrani (2018) argues collective repair accelerates the pro-environmental changes among the participants. This can be argued as 'repair zone' can be a place that can encourage participants to think sustainably and reject the use and throw activity. Figure 24 summarizes the possible social and economic benefits of repairing electronics in an institution.

From the collaborative repair practices people can take knowledge with them and pass it through generations. It is argued as users often learn ways to care for artifacts faster from their family members (Gwilt et al., 2017). It was evident for the participants in the Repair Party (O), as they described that they had some repair interest by seeing their family members' practices. On the one hand, repair helps to expand the material knowledge among individuals. On the other hand, it helps build skills, develop sustainable behaviors, and support the CE (see Figure 25). Similarly, sustainable consumption can be promoted from an institutional level to the global networks (Hong & Easterby-Smith, 2012). This can be argued that repair practices in an institutional area can contribute from local sustainable solutions (repair, reuse and recycle) to the global climate problems.

We can argue that this intervention at the institution can steer today's linear process in a complex system to a more circular and sustainable one. The positive change in consumer behavior helps to extend the life cycle of materials and bring them into the CE. One participant from the FG stated, repair also includes recycle and establishing a 'repair zone' in an institution can enable the internal recycling process. This can be argued as the current cycle of CE can be extended from repair and maintenance to recycling within the institution. On the one hand, repair of discarded electronics reduces the actual e-waste going out of the institution. On the other hand, students can repair many devices, which can reduce the workload for IT departments, and components extracted during the repair can be used back to support the CE within an institution. The conceptual model for a possible CE in an institution is illustrated in Figure 25. The circle inside the dotted lines in the figure illustrates the different steps: maintenance, repair, reuse and recycle, that contributes to CE. Three circles on the right side are mainly the contribution by IT departments while the circle in left side is contribution by students in the CE cycle. The red lines illustrate the linear life cycle of products at UiO.

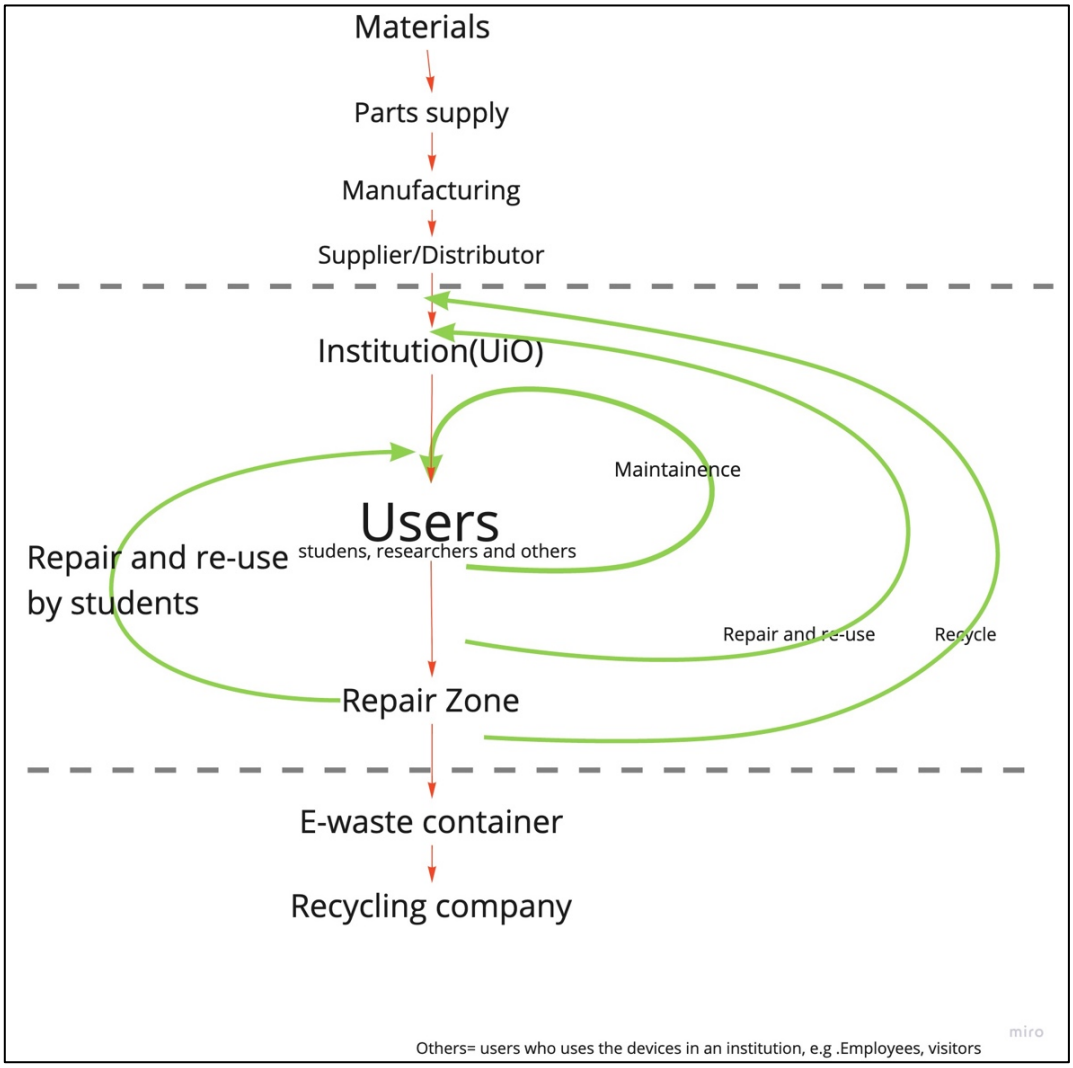

Figure 25: A model for purposed CE

7.4 Limitations of the Study

In this section, I will reflect on "*how did the use of methodology 'TD' contribute to and limited the results of this study?*

This study followed the approach of TD and future visions to guide the research. The approach includes long-term thinking, implementing interventions, and introducing new practice theories, which is a complex and time-consuming task. The time for this study was too short to intervene and see the changes. In other words, "waiting and observing" at multiple levels over different time horizons (Irwin, 2018), was not possible in the short time of this study. As apparent to the TD literature, the involvement of all stakeholders in the process is "imperative"

in TD. In this study, only a few stakeholders were considered, while in the chain of the production and consumption of electronics comprises various drivers. Engaging different stakeholders can be fruitful when finding the solution for the wicked problem. Similarly, the involvement of more actors provides a broader range of expertise and perspectives, which means problems can be analyzed better based upon their experience and different perspectives.

The study could have been more comprehensive if we could include more stakeholders like suppliers, top management team, students at a different level, researchers, and other policymakers such as government and UiO. This would have enabled discussions of both long-term and short-term visions, with better in-between activities in transition to sustainable consumption of electronics in an institution. Moreover, the involvement of stakeholders can make the interventions easier and effective.

8 Conclusion

In the journey of exploring the benefits of repair in sustainable consumption of electronics in an academic institution, qualitative data was gathered from several participants from both community-based repair and institutional repair. As this research was practice-oriented, the data presents the participants' ideas and beliefs about repairing and maintaining electronics as part of their work and interest.

Institutional repair data shows that electronic repair is inefficient and expensive for the institution. This is why small electronics are frequently replaced and disposed when the repair agreement from the supplier is over; product repair outside the agreement is expensive. Repair in an academic institution is focused on economic benefit, not on sustainability or on the contribution to a CE.

Based on the community repair data and informed by social practice theory, this study suggests that repairing used devices in an academic institution can change the mindset and behavior of electronics consumers. Instead of focusing solely on the economic benefits, repair brings on other social benefits, such as developing knowledge and skills among the consumers. Furthermore, establishing a grassroots repair culture in an institution will help create the consciousness of sustainable use of devices among the students, contribute to a CE, and support sustainable consumption of electronics. Finally, this study suggests the new circular economy of electronics in an institution that enables multiple lives to the devices within an institution, resulting in a decrease in the generation of e-waste.

8.1 Future Work

This study mainly focused on understanding the complexities of the sustainable consumption of electronics in an academic institution. The focus was on the role of repair in extending the life of electronics, and the research was centered in one academic institution. However, collaborative research between different disciplines in different academic institutions could provide different results, which helps to contribute to the sustainable consumption of electronics. Similarly, more elaborative study with the involvement of stakeholders during the entire length of a project, from identifying the problem to implementing a solution, can give other sustainable results that can help contribute to the sustainable use of electronics in an

institution. Furthermore, different social experiments can be carried out using other design methods like Research through Design and Participatory Design. This enables to make interventions, test them and redesign based on the earlier design results.

Secondary Consumers

Although an institution is a primary consumer of electronics, the students, researchers, and employees are the secondary users. An institution is the one that decides what to buy and throw, but the role played by secondary consumers in an institution can be interesting to discover. In this research, one student was considered to understand the institution's role in the context of repair. This research suggests sustainable design interventions based upon community repair and social practice theory; however, experiments and testing of design interventions, including different users at an academic institution, can be done in-depth study. This helps to identify other possibilities on how secondary users can contribute to the sustainable consumption of electronics in an academic institution.

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10 Appendices

Appendix A- Consent form

NSD prosjekt nr. 59898

Vil du delta i min master oppgave om «Håndtering av elektrisk og elektronisk utstyr ved Universitet i Oslo»?

Jeg er en masterstudent i informatikk: design, bruk og interaksjon ved Institutt for informatikk (ifi) ved Universitetet i Oslo. Mitt arbeid tilhører Sustainability og design forskningsgruppe. Med dette skrivet ønsker jeg å informere hva prosjektet mitt har som formål, spørre deg om du vil delta i prosjektet, samt berette hva deltagelse vil innebære for deg.

Formål

Formålet med mitt prosjekt er å undersøke om elektroniske enheter, deres levetid, hvor mye EE[10]-avfall som er går ut av bygningen og hvor mye som er gjenbrukt til å skape ny verdi. Hvordan kan eventuelle barrierer til mer EE-avfall løses og implementeres i det kommende livsvitenskaps bygget? I forbindelse med at jeg konkret ønsker å lære mer om hvordan reparasjon bidrar til en bærekraft fremtid, ønsker jeg å høre om: hvordan du håndterer e-avfall og hvordan er det dere praktiserer og planlegger med å gjenbruke eller reparere utstyr? Formålet med Focus gruppe er å forstå ditt syn på temaet, slik at jeg kan komme med bærekraftige løsninger som kan møtes behovene for en bærekraft bygg.

Deltakelse

Du blir spurt om å delta fordi du faller innenfor min målgruppe, definert som ansatte som håndterer EE-avfall på et av Universitetsbygg. Focus gruppe/intervju værer i ca.1 time og jeg kommer til å gjøre et opptak av lyd, samt ta enkle notater.

Frivillig deltakelse

[10] Electrical and electronics

Det er frivillig å delta i mitt studentprosjekt. Du kan når som helst avslutte eller trekke tilbake informasjon som er gitt. Du kan når som helst velge å trekke samtykket uten å måtte oppgi grunn. Dersom samtykket trekkes vil eventuelle personopplysninger som er innsamlet om deg slettes og det vil ikke innebære noen negative konsekvenser for deg at du velger å trekke ditt samtykke.

Personvern: innsamling, oppbevaring, behandling og bruk av dine opplysninger

Ingen sensitive personopplysninger (jf. Personvernforordningens artikkel 9 og 10) vil bli innsamlet. Personlige opplysninger om deg vil kun benyttes til formålene beskrevet i dette informasjonsskrivet. Jeg behandler opplysningene konfidensielt og i samsvar med personvernregelverket.

Personlige opplysning innsamlet i opptaket vil bli anonymisert og rapporteringen senest 1.juni 2021. Veilederen få vite hvem som er blitt deltatt, men ingen andre enn meg vil høre lyd opptaket og det som oppbevares av anonymisert rapportering fra diskusjon vil følge Universitetet i Oslo sine rutiner for sikker oppbevaring.

Navn og kontaktinformasjon erstattes med pseudonymer. Dataen som oppbevares, inkludert anonymisert data, vil ikke bli publisert og vil heller ikke kunne tilbakeføres til deg.

Hva skjer med innsamlet data når studentprosjektet avsluttes?

Alle notater, opptak, transkribering og opptak av lyd opptak blir slettes senest august 2021. Dette gjelder også anonymiserte og avidentifiserte opplysninger om deg.

Rettigheter

Vi behandler opplysninger om deg basert på ditt samtykke. Så lenge du kan identifiseres i datamaterialet, har du rett til:

- innsyn i hvilke personopplysninger som er registrert om deg, og å få utlevert en kopi av opplysningene,
- å få rettet personopplysninger om deg,
- å få slettet personopplysninger om deg, og
- å sende klage til Datatilsynet om behandlingen av dine personopplysninger.

Hvor kan jeg finne ut mer?

Hvis du har spørsmål til studien, eller ønsker å benytte deg av dine rettigheter, ta kontakt med min veileder Maja van der Velden ved institutt for informatikk ved UiO. Vårt personvernombud ved Universitet i Oslo er Roger Markgraf-Bye (personvernombud@uio.no) ved avdeling for personalstøtte. Du kan også finne mer om prosjekt i NSD, ved å oppgi prosjekt nummer 59898.

Jeg ber deg å samtykke i deltagelsen ved å undertegne på at du har lest og forstått informasjonen på dette arket.

Med vennlig hilsen

Suresh Sapkota

Tlf: 46591622

e-post: Sureshs@ifi.uio.no

Veildere: Maja van der Velden: majava@ifi.uio.no

Andrea Gasparini: a.a.gasparini@ub.uio.no

Samtykkeerklæring

Jeg har mottatt og forstått informasjon om studentprosjekter Elektrisk og elektronisk håndtering ved Universitet i Oslo å delta i lyd diskusjon.

Jeg samtykker til at mine opplysninger behandles frem til studentprosjektet er avsluttet.

_____

Sted og dato

_____

Fullt navn

_____

Signature

Appendix 2- Pamphlet for repair workshop

REPAIR AND REUSE WORKSHOP

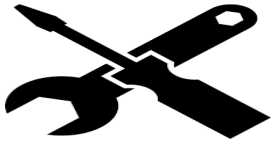
SUSTAINABILITY & DESIGN LAB

Be the change: repair for our sustainable future!

Norwegians have the world's highest consumption of electronics. We throw away around 26 kg of e-waste per person every year. University of Oslo is one of the major contributor of e-waste among them. According to Rang sells(gjenvinning), 64 tons of e-waste was produced in 2018 and 71 tons in 2019 at UiO. We believe lots of this can be already re-used and repaired. Production of new electronics requires large amounts of chemicals, water and fossil fuels. This harms nature and the climate.

Date: *26. and 28. January*
Time: *10:30 -14:00*

Where: *Georg Sverdrups hus Blindern, Moltke Moes vei 39, 0851 Oslo, 1.st floor*



"It is often cheaper to repair than replacing with new one"

Register yourself here:
https://docs.google.com/forms/d/1KCBwZU2mTHjk_WRnpiUYGM_WeqrtP4ICJ9O8grl0GCQ/edit

HVORFOR REPARERE? By repairing what you already have ...

- …You can save money and natural resources
- …you can learn how your electronics are design and help other
- …you do not have to buy a new device every time, rather you can repair it by yourself
- .. you will increase the knowledge of your device and how they work

We provide broken laptops, mobile phones, chargers, keyboards, mouse, repair kits and repair guide.

"We encourage you to bring your broken devices, repair it at first if not provide the re-usable parts to other".

What do you learn?

- Encourage each-other to practice self-repair.
- Encourage yourself that it is not dangerous to do repair in your own, rather it provides you knowledge about the materials and establish an attachment with your devices.
- Social practice as a learning platform, pass ideas, share knowledge.

It is a part of master thesis at University of Oslo at Institute for informatics. My research area is sustainable use of electronics at University of Oslo and how it contributes to the circular economy? As a part of it, my approach is repair in decreasing electronics and electrical waste. I hope you will be a part of it and contribute to my research.