ReStore

A social-economic model for increased repair and reuse

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Aalborg University Copenhagen
MSc Sustainable Design
Master's Thesis

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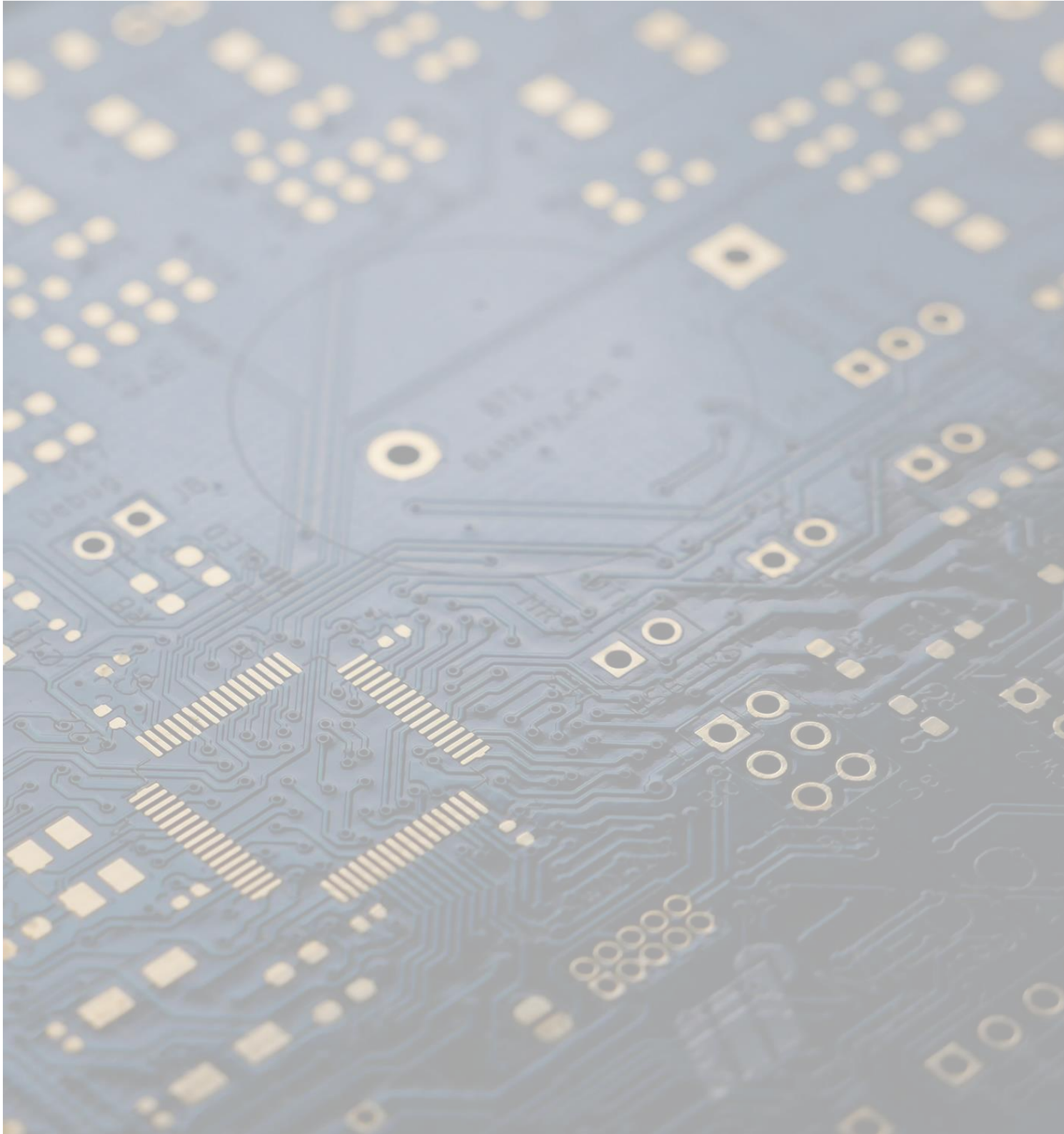

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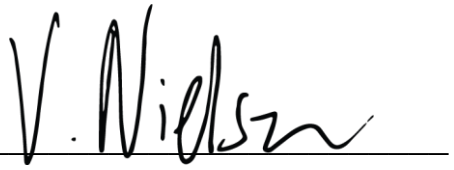

Abstract

With the project described in this thesis, the authors have investigated the potential for increasing the rates of which e-products are repaired and reused. This matter has been explored in a local context on the Danish island of Bornholm. Repair and reuse of e-products are generally regarded as a more sustainable alternative to the currently dominating practice of material recycling, since it leads to more efficient utilization of the embedded resources which in most e-products can be attributed primarily to the material extraction and manufacturing stages of the products' life cycles. Through initial document studies and interviews with local actors and experts within the fields of repair and waste management, we have defined the following research question:

> How can we develop a **scalable social-economic model** based on principles for **circular economy** in order to **prolong the lifespan of e-products**, thus creating both economic, environmental, and social value?

This research question has served as a guide throughout the project and helped to restrict the design space. A concept has been proposed, which builds on private-public partnerships and social-economic principles.

Preface

This Master's Thesis is written by Jeppe Hagh Møller and Victor Hede Nielsen who are two students from the Master's program Sustainable Design at Aalborg University Copenhagen. The project has been conducted in the period from February to June 2021.

The thesis aims to explore how the lifespan of electrical and electronic products can be prolonged through development of a social-economic model. The project has been devised in collaboration with the local waste management company on Bornholm, BOFA. Thus, we would like to show BOFA our appreciation for giving us the opportunity to contribute to their vision of becoming a waste-free island by 2032. We would especially like to thank David Christensen, who has been the main contact person from BOFA.

Furthermore, we would like to thank Carsten Aalling (Møbelfabrikken), Jens Kragh (FGU Bornholm), Joackim Penti (Bornholmermarked), Johann Aakjær (Service Centret Bornholm), and Odinn Magnusson who all have turned out to be central to the project.

We would also like to thank Niels Remtoft (Dansk Affaldsforening) and Ole Morten Petersen (DAKOFA) who both have been of great help with regards to understanding how the Danish and European waste systems are organized.

Finally, we would like to thank our supervisor, Michael Søgaard Jørgensen, who through his own research and during weekly meetings has supported and guided us through this thesis.

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1. Setting the stage

This chapter constitutes an introduction to the thesis. In the following section, we will first bring a short presentation of waste production as a general problem. Subsequently, we will narrow down the problem to concentrate on electrical and electronic waste and concurrently frame the goal and scope for the thesis. Then, we will present the definition of sustainability that has been applied throughout the project. Finally, we will outline the design process and the structure of the thesis.

1.1 Waste as a problem

Recent data shows that two billion tonnes of municipal waste is generated annually on a global scale (World Bank, 2018). Projections show, that if the take-make-dispose paradigm continues to prevail, the annual waste generation is expected to increase by 70% towards 2050 (European Commission, 2020), which will entail detrimental impacts to the environment, such as climate change, chemical pollution, loss of biodiversity, and depletion of scarce resources (Miljøministeriet, 2020).

If we explore the waste problem in a European context, statistical data reveals that Denmark generates the most household waste per capita (Eurostat, 2020). In 2018 Denmark produced 766 kg of municipal waste per capita. This is significantly higher than the European average of 489 kg. As Figure 1 illustrates, the amount of municipal waste generated in Denmark is also significantly higher than in other countries that Denmark normally compares themselves to, such as Germany (615 kg per capita), The Netherlands (511 kg per capita), and Sweden (434 kg per capita).

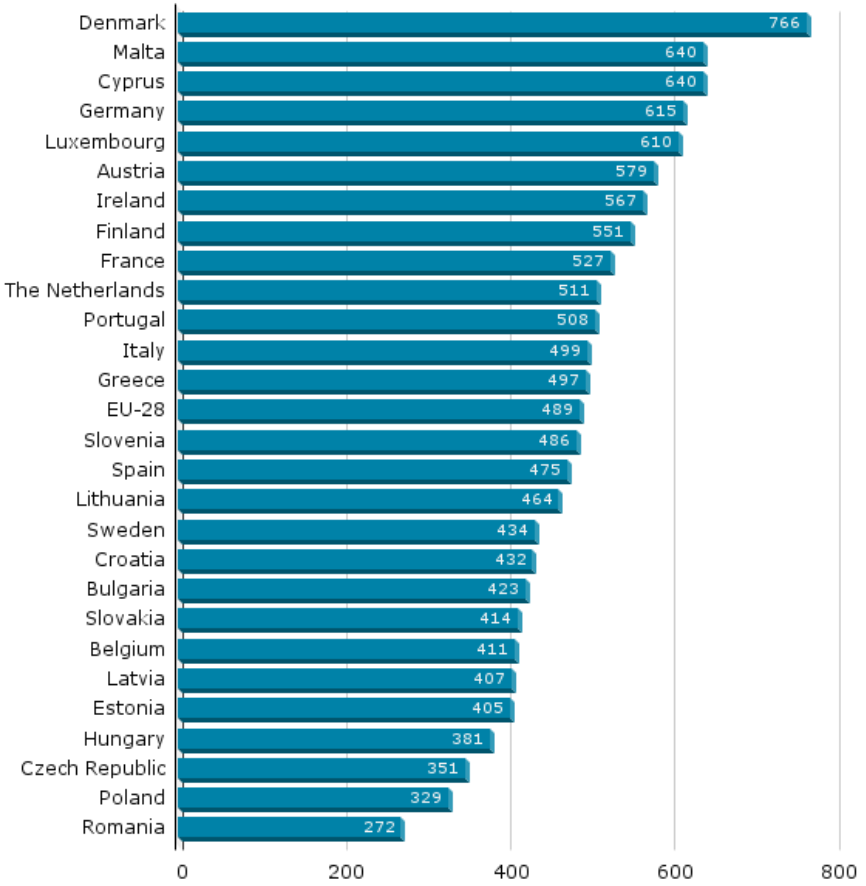


Figure 1. Household waste per capita (kg) (Eurostat, 2020)

Even though Denmark is the country in the EU that produces the most waste per capita, municipal waste generation is a vast problem for all countries in the Union. As an initiative to reduce the massive waste generation, the EU has launched the Circular Economy Action Plan (European Commission, 2020). This new framework aims to accelerate a sustainable transition which keeps the resource consumption within the limits of the planetary boundaries while ensuring long-term economic growth. The action plan contains different targets, which each member state must accommodate. Besides the Circular Economy Action Plan, the EU has initiated a range of different plans for improved waste treatment, containing specific goals which the member states must comply with. To exemplify, each member state must recycle a minimum of 50% of plastic packaging by 2025 while 65% of all municipal waste must be recycled by 2035 (European Union, 2018).

These targets may seem staggering for some countries while they for others are too unambitious. Despite not being an independent member of the EU, the Danish island of Bornholm is an example of the latter. Bornholm has a vision of being the first waste-free society in the modern world no later than 2032. At that time the incineration plant, which is operated by the local waste management company, BOFA, will be decommissioned (Christensen et al., 2020). This is a very ambitious vision which may even be perceived as unrealistic. It should be noted however, that waste free in this context implies that all waste generated must be either reused or recycled.

As a step in the transition away from incineration and landfilling, BOFA has already undertaken and initiated a range of different projects with the aim of exploring future scenarios for waste management on the island. To give an example, the FUTURE project aims to improve waste prevention and reuse through the involvement of civil society in initiatives such as second-hand markets driven by local associations. Another example is the WASTEMAN project with the purpose of optimizing waste collection systems in collaboration with the local citizens.

However, in spite of focusing on several waste fractions such as plastic, food waste, and municipal waste in general, BOFA has not yet initiated a project regarding electrical and electronic waste (e-waste). This is despite e-waste being the fastest growing waste streams globally as well as nationally (Parajuly, 2017; Miljøstyrelsen, 2020) and moreover entails severe negative environmental impacts such as depletion of critical raw materials, resource intensive manufacturing processes, challenges regarding end-of-life treatment, and relatively short lifespans, just to mention a few (Parajuly, 2017; Belkhir & Elmeligi, 2018; Parajuly et al., 2019, 2020). In addition, only 44% of all marketed electric and electronic products (e-products) were officially collected for recycling by the collective schemes in 2019 on a national scale (DPA-System, 2020). Even though the recycling rates can be improved significantly, it would from a circular economic point of view be preferable to prolong the lifespan of e-products through e.g., repair and reuse (Parajuly et al., 2020).

1.2 Goal and scope

We perceived the fact, that BOFA has not initiated a project concerning e-waste as an opportunity to assist them in fulfilling their vision of becoming waste-free by 2032. So, during initial meetings with BOFA,

we agreed to investigate how Bornholm may accommodate the problems regarding e-waste. Thus, our mission is to ensure longer lasting e-products through repair and reuse on Bornholm. This mission is directly related to a general vision of sustainable consumption of e-products through the decoupling of consumption and negative environmental effects. As such, our mission statement has served to narrow the scope of the project and restrict the design space for potential solutions. Similarly, the mission statement has helped define a more specific research question which we have sought to answer during the project. The relation between our vision, mission and research question is illustrated in Figure 2. In order to work towards our mission statement, while also contributing to BOFA's vision, our project is based on the following research question:

> *How can we develop a **scalable social-economic model** based on principles for **circular economy** in order to **prolong the lifespan of e-products**, thus creating both economic, environmental, and social value?*

We will seek to answer this research question within the geographical scope of Bornholm but will, as the research question alludes to, aim to develop a model that can be scaled to other contexts. Furthermore, this thesis is centered around the stock of e-products on Bornholm i.e., products in their use phase. Thus, we will exclusively focus upon developing a concept that extends the use phase of e-products as illustrated in Figure 3.

Figure 2. Vision, mission, and research question

In order to answer the research question, we will have to expand our knowledge within different topics. Therefore, we must seek answers to the following three sub-questions. Firstly, are the streams of e-products and e-waste massive enough in order to underpin a business model centered around repair and reuse? Secondly, which local actors must be mobilized in order to implement the social-economic model successfully? And finally, which business model based on circular economy and social-economic initiatives, would be most suitable for an implementation in the local context, while also scalable to other regions of Denmark? We will aim to answer these questions by applying a multimethodological approach consisting of a combination of quantitative and qualitative methods. This will be more thoroughly described in Chapter 4.

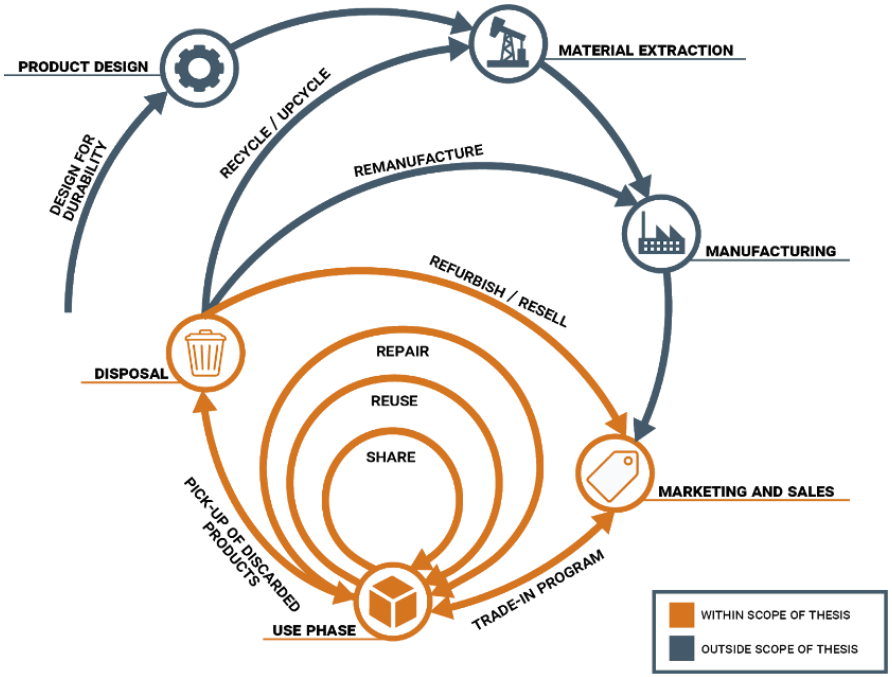


Figure 3. Scope of the thesis. Inspired by Lacy and Rutqvist (2016)

1.3 Sustainability definition

As engineers in sustainable design, our task is to create and implement truly sustainable solutions. Even though there is no universally agreed upon definition, the term 'sustainable development' originates from the Brundtland Report, or Our Common Future, which was published in 1987 by the United Nations (UN) (Brundtland et al., 1987). They define sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." (p. 41). This definition has through the years paved the way for international commitments and approaches to sustainable development. One of these is Doughnut Economics suggested by Raworth (2012, 2017). In short, Doughnut Economics is a framework describing the boundaries within which humanity can be safe and just. The model is founded on eleven social dimensions developed during the UN Rio+20 conference and nine environmental limits based on the planetary boundaries (Rockström et al., 2009).

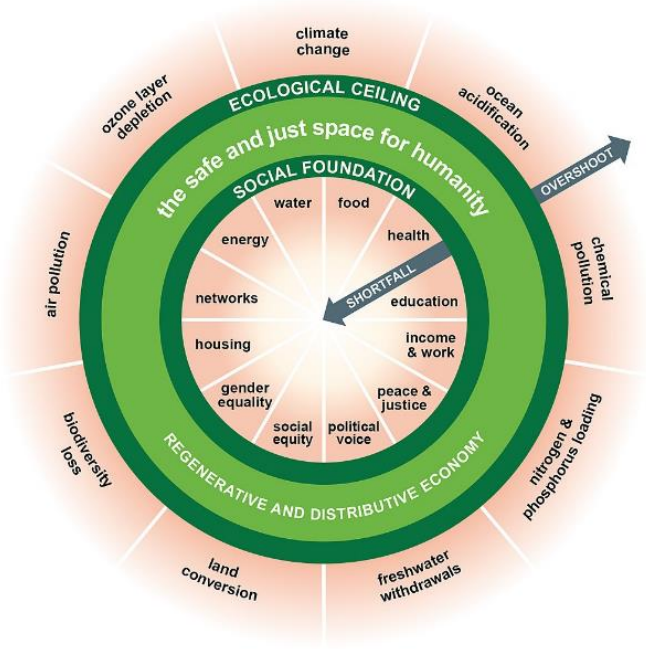


Figure 4. Doughnut Economics (Raworth, 2017, p. 38)

Raworth (2012, 2017) describes with the doughnut that economic sustainability is constrained by the other two pillars, environmental and social sustainability.

We have decided to build our definition of sustainable development upon Doughnut Economics, as "everyone's lives must be built on the social foundation of human rights while remaining below the environmental ceiling, and that economies must be structured and managed to make that possible." (Raworth, 2012, p. 8). Therefore, economic development related to lifespan extension of e-products should take place within these limitations.

As previously mentioned, the Brundtland Report (1987) has inspired scholars and practitioners within the field of sustainable development and has since its publication revolutionized the world of sustainability. This brings us to a final remark on sustainable development. Ceschin and Gaziulusoy (2020) present an overview of different design approaches for sustainable development, e.g., 'ecodesign' and 'design for social innovation'. They have assembled these in a model illustrated in Figure 5. The figure is constructed of a horizontal axis which consists of the parameters 'insular' and 'systemic' and a vertical axis which consists of the parameters 'technology' and 'people'. The parameters jointly constitute five levels of innovation in which the design approaches are categorized. The five levels are: 'material/component level', 'product level', 'product-service system level', 'spatio-social level' and 'socio-technical system level'.

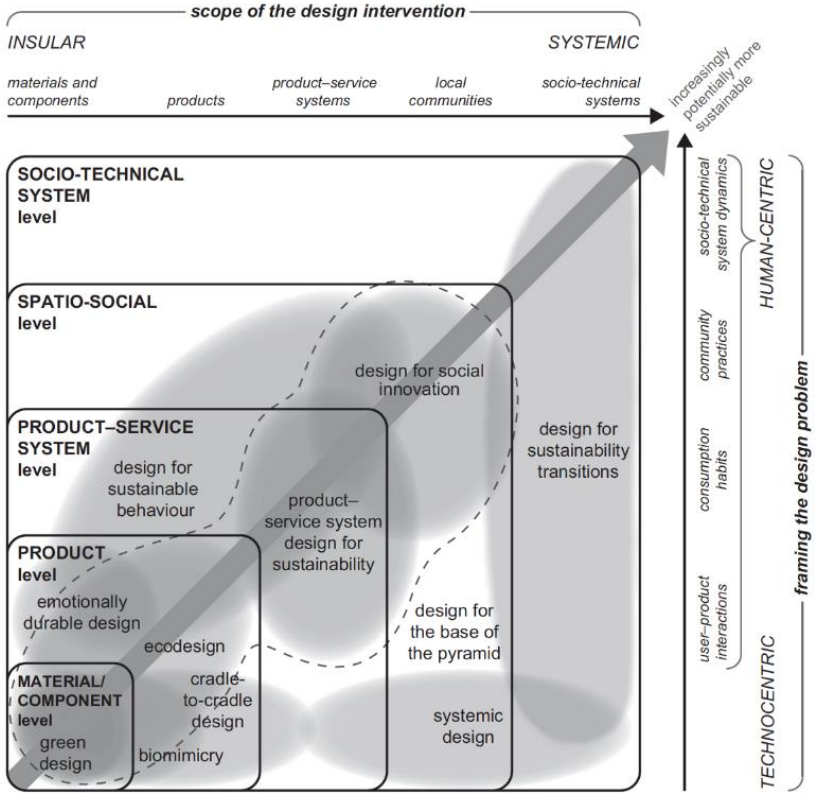


Figure 5. Design for sustainability approaches (Ceschin & Gaziulusoy, 2020, p. 148)

The design approaches within the first-mentioned level have according to Ceschin and Gaziulusoy (2020) the lowest potential of achieving a high sustainability impact while design approaches within the last-mentioned have the highest potential. This is illustrated by the diagonal arrow. They claim that the reason hereof is, that:

> These socio-technical systems will require a combination of innovations ranging from new technologies, materials and products to new services and business models, new behaviour and social practices, and new policies and regulations. For this reason, achieving these envisioned future systems will require design and innovation teams to use a combination of DfS approaches covering all innovation levels. (p. 158)

Designing strategies for the socio-technical level requires however a larger effort to realize, which we recognize. Nonetheless, we have throughout this thesis aimed towards designing for a socio-technical transition in order to deliver a concept that on long terms has the highest potential of achieving a great sustainability impact.

1.4 Design process

Although the project officially started in the beginning of February, we had already established contact with BOFA two months earlier. Throughout November and December, we had a couple of meetings with David from BOFA, who besides working as a project manager at BOFA also works for Aalborg University as an associate professor. During these meetings, he presented BOFA's vision to us and we discussed how we could contribute to achieving it. We reached an agreement and when the project officially began in February we knew what we wanted to research and had an idea of how to approach the challenge.

However, the intended process is rarely identical to the actual design process as one's knowledge foundation expands during a project and the perception of what really is important to research thus changes over time. The following sections will provide an overview of the design process we have been through during this project. Firstly, we will present a timeline which shows all interactions we have had with relevant actors. Then, we will illustrate the design process through application of a double diamond model (Design Council, 2005).

	Date	Contact person, organization	Purpose
	November 27th, 2020	David, BOFA	Initial meeting. Introduction to BOFA's vision and mega challenges and discussion of potential subjects for thesis
	December 15th, 2020	David, BOFA	David talked about current BOFA projects which support the vision. From this, we decided to work with e-waste
	February 16th, 2021	David and Brian, BOFA	We presented current research in order to brief BOFA. We discussed further directions for the thesis.
	February 23rd, 2021	Ole Morten Petersen, DAKOFA	When interviewing Ole Morten, he talked about political aspects of e-waste system and problems of e-waste
	February 23rd, 2021	Niels Remtoft, DAF	The interview with Niels resulted in a better understanding of Danish waste system and barriers for better treatment
	March 3rd, 2021	DAKOFA webinar	We were invited to a DAKOFA webinar regarding increased repair and reuse of e-products
	March 17th, 2021	Joackim Penti, Bornholmermarked	Talked about the second-hand market of e-products and how many visitors they have every month
	March 18th, 2021	Johann Aakjær, Service Centret Bornholm	Talked about which products he repairs, how much, who the customers are, potential barriers for repairs, etc.
	March 18th, 2021	Martin, Expert & Punkt1	Do Expert & Punkt1 repair products? Technically, yes. But they prefer to sell new products. Cheaper and more conv.
	March 23rd, 2021	Carsten Aalling, Møbelfabrikken	Talked about Møbelfabrikkens vision and future plans and an established collaboration with FGU Bornholm
	April 14th, 2021	Dorte Langemark, P4 Bornholm	We were interviewed by P4 Bornholm to talk about our collaboration with BOFA and our project in general
	April 26th-29th, 2021	Field trip to Bornholm	
BORNHOLM	April 26th, 2021	Visit at BOFA	Was shown around by David and saw, i.a. how much e-waste the locals discard every day
BORNHOLM	April 26th, 2021	Odinn	He presented his theory about the only way we can solve the e-waste problem. He is willing to educate students.
BORNHOLM	April 28th, 2021	Visit at Service Centret Bornholm	We saw Johann's facilities and asked more thoroughly into how much repairs of different e-products cost
BORNHOLM	April 28th, 2021	Visit at Møbelfabrikken	We were shown around by Carsten and saw great opportunities to expand with a new e-products shop
	May 4th, 2021	Jens Kragh, FGU Bornholm	Briefed us about how FGU works. He said more internship places for the students would be great
	May 31st, 2021	David, BOFA	We discussed different concept elements with David to confirm if they were feasible

Figure 6. Overview of interaction with relevant actors

As already mentioned, and as the timeline in Figure 6 also shows, the design process unofficially started in late November. Since then, we have been in touch with several actors who individually have been important for the process. Some actors, here among Ole Morten Petersen from DAKOFA (Dansk Kompetencecenter for Affald og Ressourcer) and Niels Remtoft from DAF (Dansk Affaldsforening), have been helpful with regards to understanding how the Danish and European waste systems are organized. Other actors, such as Johann from Service Centret Bornholm and Carsten Aalling from Møbelfabrikken, have been key actors regarding the current repair activities and the state of the e-waste problem on Bornholm. Interacting with these people changed the design process as we obtained knowledge and insights through the meetings we were not aware of, by which the process has taken new turns multiple times.

Despite slight changes in focus during the process, it can roughly be divided into four phases; discover, define, develop, deliver. This approach is based on the double diamond model. In the first diverging phase, we have gathered empirical knowledge from document studies, interviews with actors, and surveys. This knowledge has established the foundation of the work performed in the analysis. Afterwards, in the first converging phase we narrowed the scope and formulated the research question. Then, based on the analysis, we entered the third phase in which we explored the design space. In this phase, we considered different concepts that could accommodate the research question. Finally, in the fourth phase we specified the concept we believe can help Bornholm solve the e-waste problem. However, the concept we will present is in no way a final product but should rather be seen as a means to initiate and facilitate discussions between implicated actors. Therefore, an extra diamond could be added in the end, which represents a re-develop and a re-deliver phase.

In spite of the double, or triple, diamond being illustrated as relatively linear, the design process has been iterative. It can be pictured through application of Newman's squiggle (Gekeler, 2019) which illustrates the changing focus during the design process. In order to illustrate the process, we have combined the two models into one. This is pictured on Figure 7.

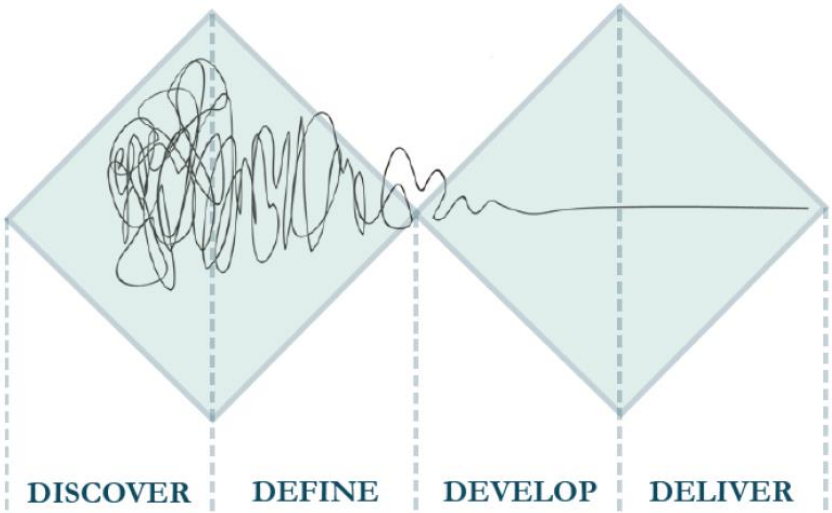


Figure 7. Double Diamond model combined with Newman's squiggle. Inspired by Design Council (2005) and Gekeler (2019)

1.5 Structure of thesis

This section will provide a short overview of the coming chapters and their contents. The following chapter, Chapter 2, will bring a state of the art. Here, the latest research and developments within relevant fields will be explored. Chapter 3 and Chapter 4 describe respectively the choice of theoretical and methodological approaches. Chapter 5 presents empirical data which we throughout the design process have gathered from document studies, surveys, and interviews. Chapter 6 outlines the analysis which establishes the foundation of the conceptualization presented in Chapter 7. In Chapter 8, we will bring a discussion upon different aspects related to the project that both lie within and without the scope. Furthermore, we will assess the design process and make some reflections hereupon. In Chapter 9, we will conclude upon the findings and discuss if the research question has been answered sufficiently. Finally in Chapter 10, we will present recommendations for further research.

CHAPTER 2

2. State of the art

This chapter will outline the most recent and relevant research made within the field of e-products and e-waste management. It will start by presenting some of the negative environmental impacts linked to manufacturing of e-products and generation of e-waste. Then, the challenge regarding short lifespans of e-products will be elaborated by exploring why the average lifetime of e-products are usually shorter than the designed lifetime. Subsequently, we will investigate how different regulations, mainly inspired by the waste hierarchy, have been implemented with the aim of accommodating the challenge of increased e-waste streams. Then, we will explore how different circular economic business initiatives can entail increased sustainability when implemented successfully. And finally, we will bring three case studies regarding repair initiatives which we have studied to obtain inspiration and knowledge that can help us answer the research question.

2.1 Environmental aspects of e-waste

E-waste has through the past two decades been the fastest growing waste streams globally (Parajuly, 2017). In the period from 2014 to 2019 the global stream of e-waste proliferated from 44.4 million tonnes to 53.7 million tonnes, which is an increase of approximately 20%. According to several scholars (Planing, 2015; Meloni et al., 2018; and Parajuly et al., 2019) this tendency is caused by a take-make-dispose paradigm. Projections show that if this paradigm continues to dominate the industry of e-products, the amount of e-waste will double by 2045 (Parajuly et al., 2020).

In 2019, only 19.4% of the global amount of e-waste was officially collected and recycled. This rate varies greatly from region to region and ranges from 0.9% in Africa to 42.5% in Europe. The flow of e-waste that is not documented as being collected and recycled is largely unknown, but is assumed to be exported to developing countries, dumped, or recycled outside of official systems with extremely detrimental effects on the environment (Forti et al., 2020). If we investigate the flows of e-products in a national context, the average Dane bought 30.5 kilos of e-products in 2019 which is significantly higher than the European average of 20 kg per capita (Eurostat, 2020). Kumar et al. (2017) describe a tendency which indicates that the consumption of e-products per capita is proportional to the country's GDP per capita. By investigating this tendency further, we see on Figure 8 that there is a connection between the two parameters (Eurostat, 2020). On Figure 8, the blue dots represent the connection between GDP per capita and marketed e-products per capita in European countries. The red line illustrates the tendency described by Kumar et al. (2017).

The growing consumption of e-products can seemingly be linked to increased wealth of nations. At the same time, decreasing prices of e-products is another factor contributing to the increased consumption (Hebsgaard, 2019). Furthermore, increasing prices for repairs have caused Danish consumers to repair fewer of their broken e-products (Hansen, 2018; Danmarks Statistik, 2021a).

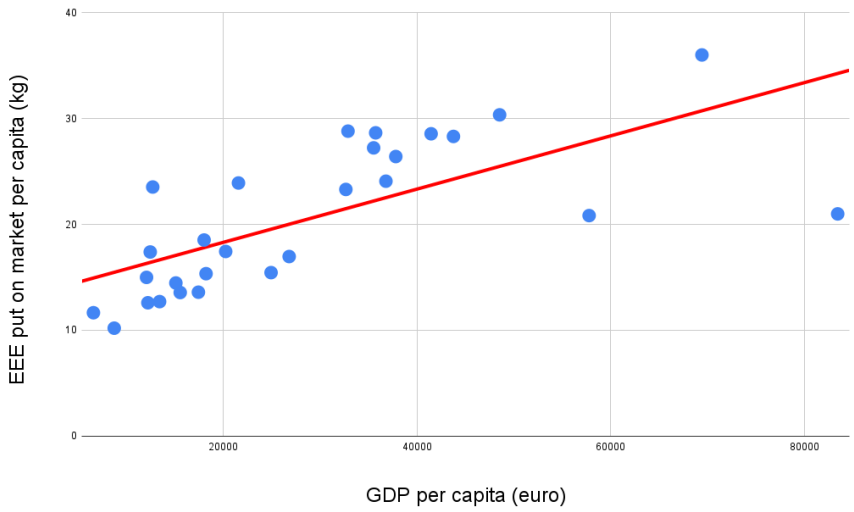


Figure 8. Connection between GDP per capita and e-products put on market (Eurostat, 2020)

Despite being the fastest growing waste stream, the volume of e-waste in Denmark is not significant relative to other waste fractions such as bulky waste, food waste, and construction waste (Miljøstyrelsen 2020). However, of these waste fractions, e-waste is the one with the highest CO_2 coefficient (Metabolic, 2020) which consolidates the fact that the e-waste streams must be diminished in order to accommodate both national and global objectives of reducing CO_2 emissions. See Figure 9.

Another reason why e-waste streams should be diminished is the high content of precious metals and critical raw materials. To exemplify, Parajuly et al. (2019) assert that manufacturing of a smartphone requires 70 stable metals from the periodic table. The resource intensity of e-products can in part be ascribed to fast developing technology. "As products continue to miniaturize and become sophisticated, several materials in the form of metals, alloys, and polymers are needed to achieve multiple functionalities and quality." (Parajuly et al., 2019, p. 12). Some of these materials are recovered and recycled after the products' end-of-life. However, it is estimated that elements such as gallium, indium, and other rare earth metals are recycled at a rate of less than 1% (European Environment Agency, 2020a).

Units	WEEE	Construction waste	Food waste	Bulky waste	Plastic waste
amount (tons)	24,700	1,029,500	196,600	134,600	33,000
CO_2-eq (tons)	326,000	301,000	105,000	108,000	78,700
CO_2-eq per amount	13.19	0.29	0.54	0.80	2.38

Figure 9. CO_2 -eq from different waste streams in Region Hovedstaden in 2016 (Metabolic, 2020)

According to Belkhir and Elmeligi (2018) the short lifetime of e-products is a problem as the majority of environmental impacts are related to the manufacturing process. Belkhir and Elmeligi (2018) bring an example of a mobile phone of which the non-use phases, here among the manufacturing process, make up 85-95% of all lifecycle emissions. The European Environmental Bureau (2019) claims that the non-use phases of a mobile phone make up 72% of the total climate impact. The specific number in itself is not so important. What really is important is the fact that several manufacturing processes of e-products are more

resource intensive compared to the use phases by which e-products should last as long as possible in order to suppress resource intensive production processes. Nevertheless, this is not applicable for all types of e-products. To exemplify, 75% of life cycle emissions from washing machines stem from the use phase while that number for vacuum cleaners is 79% (European Environmental Bureau, 2019). Parajuly et al. (2019) describes a tendency that environmental impacts have shifted from mainly stemming from use phase to production and material extraction due to advanced technological development.

> The environmental impacts of the first e-products (mainly energy-intensive household appliances) with longer lifetimes were mostly linked to the 'use' phase of the products. But as e-products become more advanced, and use an increasing number of resources, the environmental impacts are now shifting from 'use' to the 'production' and 'material extraction' stages. (p. 13).

In general, they argue that the more resource intensive the production of a product has been, the longer it must last in order to live up to its environmental imprints.

2.2 Actual lifetime versus designed lifetime

In a report published by the European Environment Agency (2020b), it appears that the average lifetime of various e-products is significantly shorter than the designed lifetime. A television is for instance designed to last 25 years but has an average lifetime of 7.3 years. According to the European Environment Agency (2020b), it has become more customary to acquire a new television instead of repairing a broken one due to the fact that e-products quickly become obsolete. The European Environment Agency (2020) defines obsolescence as "the condition of no longer being used or useful" (p. 1). The issues regarding televisions can be caused by different types of obsolescence. To exemplify, it could be incompatibility obsolescence, i.e., the hardware is no longer compatible with the newest software or vice versa (Bartels et al., 2012; European Environment Agency, 2020a), or psychological obsolescence which by Spinney et al. (2012) is defined as "when a product still functions adequately but becomes 'worn out' in our minds and is replaced whilst still functional" (p. 348).

Psychological obsolescence has become propagated recently as users quickly become dissatisfied with their e-products for example because of aesthetical, cosmetic, or technological reasons. The European Environment Agency (2020a) claims that it is the fast developing technology that affects the users' mindsets which lead to unsustainable consumption patterns. They refer to a German study which shows that 60% of all discarded flat screen televisions in 2012 were replaced simply because owners desired newer and better models. Figure 10 provides an overview of different types of obsolescence and their definition.

Type of obsolescence	Definition
Economic	A product is cheaper to replace than repair
Incompatibility	A product is no longer software/hardware compatible
Mechanical	A product has defect components
Planned	A product is designed to have a short lifespan
Psychological	A product functions but appear obsolete to the user
Technological	A product is outdated due to technological developments

Figure 10. Different types of obsolescence (Bartels et al., 2012; Spinney et al., 2012; European Environment Agency, 2020a)

An e-product can become obsolete due to one or multiple types of obsolescence at the same time. No matter the reason, obsolescence is the main reason e-products' lifetimes are usually shorter than the designed lifetimes (European Environment Agency, 2020a). The fact that e-products' lifespans are too short is according to Jørgensen (2020a) a challenge that deserves more focus than it currently gets. He sets up a dilemma which discusses product lifetime versus energy efficiency. By referring to three international studies, here among the European Environmental Bureau (2019), he concludes that only when a broken product is in the poorest energy class, it is environmentally beneficial to replace it with a newer and more energy efficient product instead of repairing it. By referring to the three studies, Jørgensen (2020a) claims that it is more important to make repair opportunities more accessible and more economically attractive rather than encouraging users to buy newer and more energy efficient models.

2.3 The waste hierarchy

The concept of circular economy (Ellen MacArthur Foundation, 2013; Korhonen et al., 2018) offers a framework for ensuring that maximum value is created from the resources embedded in materials and products throughout their lifetime. This is to be achieved through closing, slowing, and narrowing resource loops (Bocken et al., 2016). Highly inspired by the framework of the circular economy, the EU introduced in 2008 the waste hierarchy which serves as a guideline for how waste management should be prioritized (European Union, 2008). As Figure 11 shows, waste prevention is presented as the number one priority followed by preparation for reuse, recycling, recovery, and finally disposal.

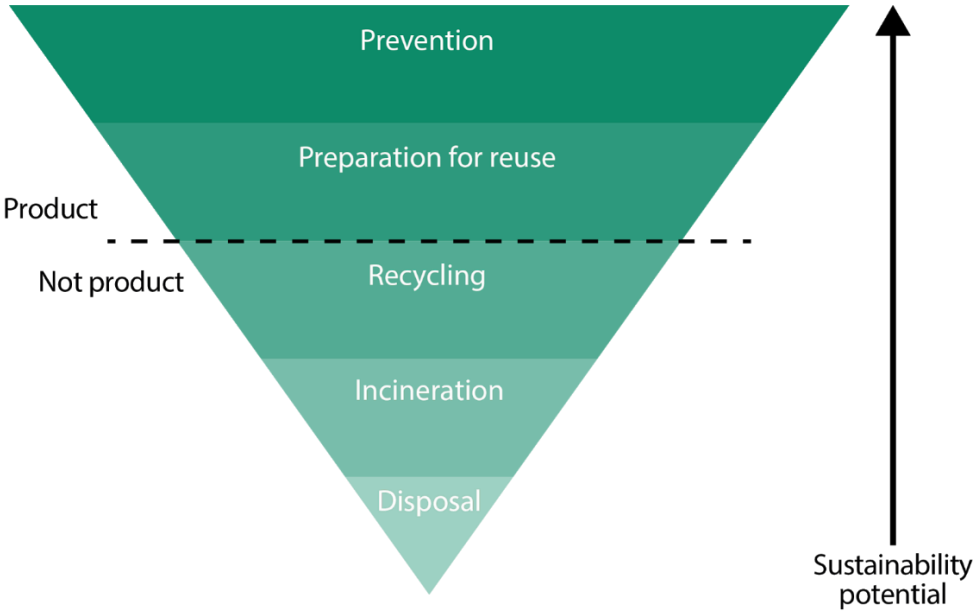


Figure 11. The waste hierarchy. Inspired by European Union (2008)

The EU applies this hierarchy as a point of orientation when developing and improving new and existing regulations and directives that seek to accommodate the challenges of waste management. An example of this is Right to Repair (European Commission, 2020). In short, the initiative entails that, manufacturers must supply internal and external spare parts of marketed e-products for professional repairers for seven years after production has ended while consumers can access external spare parts, e.g., sealing strips and racks for washing machines, for ten years. Furthermore, the initiative implies that it must be easy to replace spare parts without breaking the e-product entirely. In spite of the good

intentions, Right to Repair has faced criticism from different sides, here among Jørgensen (2020b) who accuse it of being a right to spare parts more than a right to repair. He refers to a study from 2017 made by Ingeniørforeningen which shows that it is rarely the lack of access to spare parts that refrains consumers from repairing broken e-products. Rather, it is a matter of cost. The study shows that 25-30% of all potential repairs are skipped due to the fact that it is too expensive compared to buying a newer model. This is what the European Environment Agency (2020a) refers to as economic obsolescence. Therefore, Jørgensen (2020b) emphasizes the price as a decisive factor. Thus, Right to Repair should also secure reasonable prices for repairs.

Right to Repair is however not the only initiative that shall help the EU climb up the waste hierarchy. Other examples could be the EU-wide take-back scheme or the WEEE-directive (European Union, 2012; European Commission, 2020). The first-mentioned is not implemented yet but is just a proposal suggested as a part of the Circular Economic Action Plan (European Commission, 2020). In short, it aims to prolong the lifetime of e-products through a well-established return system. EU citizens can return or sell discarded smartphones, tablets, chargers, etc. and thereby contribute to prevent e-products from becoming waste which is in accordance with the highest level of the waste hierarchy.

The other example, the WEEE-directive, which was first introduced in 2003 and later has been recast in 2012 (European Union, 2012) stipulates requirements for the rate of collection and recycling of e-waste and thereby drives environmental benefits such as resource efficiency and reduced carbon emissions. In general, the requirements in the WEEE directive pushes the member states towards establishing e-waste management systems that lead to substantially higher rates of collection and treatment than in the rest of the world. However, most e-waste is still not being managed within the official systems (Forti et al., 2020). Furthermore, the official systems for e-waste management tend to be primarily centered around material recycling and energy recovery, meaning functionality and most of the products' embedded value is lost in the process (Parajuly & Wenzel, 2017a). For the same reason, the WEEE-directive has, like Right to Repair, faced criticism. Cole et al. (2019) state that recycling of e-waste obviously is a better solution than incineration and disposal but that the WEEE-directive counteracts higher levels of the waste hierarchy.

> Recycling has, to date, been the primary treatment method for e-waste. This is problematic because it has neglected, to some extent, the potential to increase product longevity, repair and reuse. Ambition and innovation appear limited by current legislation, which may be used as a minimum standard, limiting activities at higher levels of the waste hierarchy. (p. 425).

In accordance with the criticism, Miliute-Plepiene et al. (2019) have performed calculations which indicate that reusing e-products rather than recycling them is 25 times more efficient with regards to reducing carbon emissions. Therefore, the WEEE-directive may appear self-contradictory to some extent as it counteracts more environmentally efficient solutions.

Besides lifetime extending initiatives, the EU has different regulations and directives that across Europe aim to reduce application of toxic chemicals and hazardous substances (REACH and RoHS), and to improve energy efficiency (Ecodesign). These initiatives are naturally

important for the regime of e-product and e-waste but will not be described more thoroughly as they relate to product design and therefore are outside the scope of this thesis.

2.4 Current system for e-waste management

E-waste in Europe is treated in accordance with the WEEE-directive, which is based on the principle of extended producer responsibility (EPR) (Parajuly, 2017; Cole et al., 2019). This means that producers and importers of e-products (whom we from now on will refer to as producers as a matter of simplicity) hold the responsibility for the treatment of an amount of e-waste corresponding to the volume put on the market in the respective countries. Each member state must establish a national authority responsible for collecting data about the producers along with the quantities of e-products put on the market and e-waste being collected and treated (European Union, 2012). In Denmark, this authority is DPA-System (Dansk Producentansvars System) which is a non-profit organization established by the Ministry of the Environment and Food of Denmark (Miljøstyrelsen, 2016a).

Although the responsibility will always be with the producer, most e-waste management is in practice facilitated by collective schemes. These are private commercial businesses which producers pay to manage most of the administrative and practical tasks related to the management of the e-waste (DPA-System, 2014; DPA-System, 2019). With regards to marketed e-products, all companies bringing e-products to market must register in the national register of producers. It is DPA-System who administers this register. Producers are obliged to supply an annual report of the number of e-products put on market.

Based on the amounts reported, the collective schemes are allocated an amount of e-waste for treatment, corresponding to the amount put on the market by its members (Miljøstyrelsen, 2016a). Figure 12 provides an overview of the physical flows and flows of data in the Danish system for both e-products registration and e-waste management.

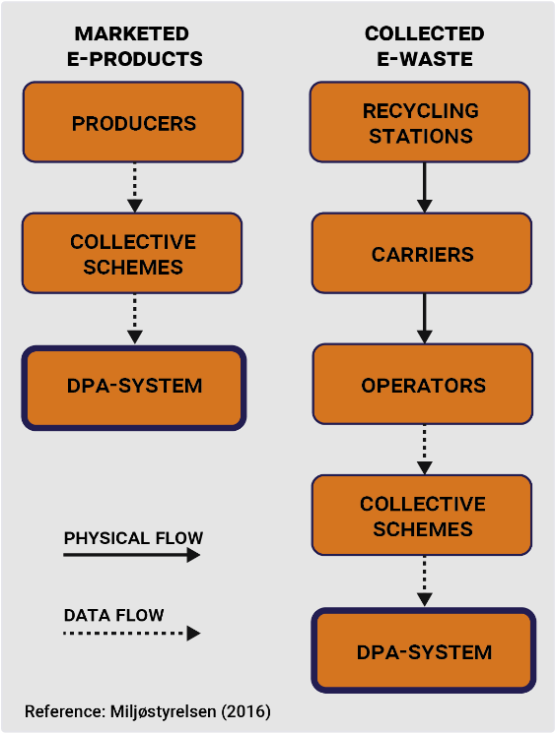


Figure 12. Physical and data flows in the Danish system for e-waste management (Miljøstyrelsen, 2016a)

To summarize briefly, the waste hierarchy serves as a guideline for how waste management should be prioritized with regards to environmental considerations. As we have mentioned, current implementation of the WEEE-directive has been criticized for not sufficiently being based on the principles of the waste hierarchy (Cole et al., 2019). This is a problem due to more factors than just environmental aspects.

2.5 Social and economic benefits

According to several scholars (McMahon et al., 2019; Riberio-Broomhead & Tangri, 2021), the waste hierarchy also functions as a guideline for job creation, as the higher levels in the hierarchy can entail more jobs compared to the lower levels. McMahon et al. (2019) gives an example stating that "a social enterprise approach to the re-use of white goods would provide more jobs than the equivalent amount of recycling for those most vulnerable to unemployment." (p. 1008). Furthermore, Riberio-Broomhead and Tangri (2021) have developed their own hierarchy, based on the EU waste hierarchy, which shows how many jobs each treatment method potentially could generate. The numbers in Figure 13 are the potential of jobs generated per 10,000 tonnes of waste processed.

Based on their research, Riberio-Broomhead and Tangri (2021) claim that "waste management approaches that have the best environmental outcomes also generate the most jobs." (p. 3). The study is not made specifically upon e-waste, but they claim that the data is applicable in that field as well.

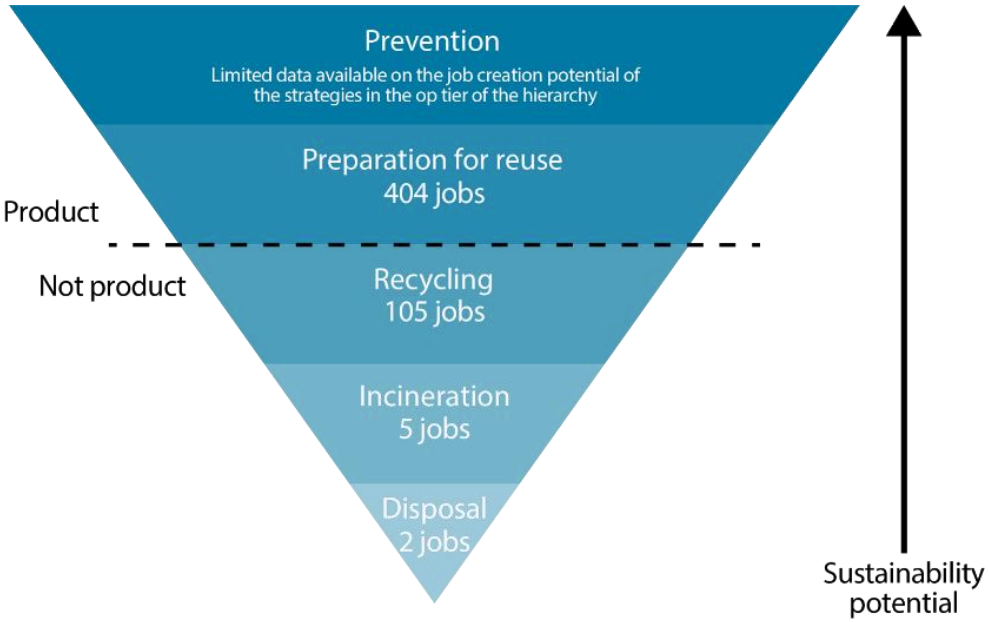


Figure 13. Job creation based on the waste hierarchy. Inspired by Riberio-Broomhead and Tangri (2021)

With regards to the economic aspects, the consultancy company, Accenture Strategy (2017), has suggested that the economic value that can be created from reuse exceeds the value created from recycling by a factor of 168. In another study, Parajuly and Wenzel (2017b) have investigated the economic potential of repairing and reselling used e-products that have been discarded at municipal recycling stations in Denmark. In their study, Parajuly and Wenzel sorted discarded e-products according to their condition and estimated resell values based on the listing price for similar used products on various second-hand sales platforms. Seemingly, the value of the products in their study are

less than those presented by the report from Accenture Strategy (2017). However, this difference does not change the conclusion that reuse is preferable to recycling from an economic point of view.

2.6 Existing repair initiatives

As a final remark on the state of the art, we will in this section bring three examples of established repair initiatives. The aim of investigating this has been to obtain inspiration and knowledge that can help us answer the research question.

The first repair initiative is located in Flandern, Belgium. De Kringwinkel, which directly translated means thrift shop, emerged in the early 1990s. From the very beginning the ambition was threefold. Firstly, they wanted to reduce waste and secure sustainable use of materials. Secondly, they wanted to create jobs and provide learning experiences for people on the edge of the labor market. And finally, they wanted to provide materials and products of high quality at low prices (Cools and Oosterlynck, 2015). The network consists of 28 centers in which all kinds of products and materials are repaired and refurbished. From here the goods are distributed to 162 stores in which they are sold. Recent numbers from 2019 show that De Kringwinkel has 5,800 employees of whom the majority have been long-term unemployed (Cools and Oosterlynck, 2015; De Kringwinkel, n.d.). Furthermore, numbers show that De Kringwinkel collected 87,600 tonnes of goods in 2019 which resulted in 74,000 tonnes less CO_2 emissions (De Kringwinkel, n.d.).

Besides being a well-established repair network, De Kringwinkel has also been a source of inspiration for similar initiatives. In 2013, the network, Repair Café Danmark, was established, highly inspired by the Belgian initiative. Today, a total of 52 repair cafés constitutes the network within the borders of Denmark, of which one of them is located in Nexø on Bornholm. The repair cafés in Denmark are driven by volunteers who guide and assist people with broken products in order to minimize waste generation. It is free to repair products in the repair cafés, but it is never a guarantee that the volunteers have the sufficient know-how to assist. The fact that the initiative is driven by volunteers is reflected in the opening hours which varies from café to café as some are open twice a week while others are open once a month (Repair Café Danmark, n.d.).

The last repair initiative we will introduce aims to prolong the lifespan of domestic appliances. In 2016, De Grønne Hvidevarer was established. The purpose of the business is to prevent well-functioning domestic appliances from turning into waste. In order to avoid the regulations from the WEEE-Directive, De Grønne Hvidevarer has entered a collaboration with a collective scheme by which more, and otherwise discarded products, can reenter the market. When the project started, De Grønne Hvidevarer offered 6 months of warranty on all sold items which has since increased to 24 months.

CHAPTER 3

3. Theory

This chapter will outline the theoretical framework we have applied throughout the thesis. Firstly, we will present the Multi-Level Perspective (MLP) (Geels, 2002, 2011) and the quasi-evolutionary model (Smith et al., 2005) which both are examples of theories within socio-technical transitions. Then, we will bring theoretical aspects of Actor Network Theory mainly inspired by Callon (1986) and Latour (1991). Finally, we will present the theoretical framework of circular economy.

3.1 Socio-technical transitions

Several theories of socio-technical transitions have been presented over the last decades. Two examples of such theories, which we will introduce in the following, are the MLP (Geels, 2002, 2011) and the quasi-evolutionary model of socio-technical transitions (Smith et al., 2005). These theoretical perspectives provide different views on how innovation relates to established systems of technologies, institutions, social practices, legislation etc., and how such elements of a system can function as either barriers or accelerators of radical change. The application of theories of socio-technical transitions have allowed us to reflect upon how our scoping of the problem and the aim of our research relates to broader societal structures. Thus, we have been able to better understand how the conceptualization of specialized solutions for a local context might influence the potential for change on a larger scale.

3.1.1 Multi-Level Perspective

The MLP has been introduced by Geels (2002) as a theory of technological transitions (TT) and how they occur. The multiple levels referred to in the MLP are the socio-technical landscape, socio-technical regimes, and technological niches.

Geels (2002) define a TT as, "long-term technological changes in the way societal functions are fulfilled." (p. 1257). In this context, a technology should be understood as a 'configuration that works'. Thus, TT is also the transition from one socio-technical configuration to another. Furthermore, he argues that "TT do not only involve technological changes, but also changes in elements such as user practices, regulation, industrial networks, infrastructure, and symbolic meaning." (p. 1257). It is elements such as these that make up the socio-technical regimes, perhaps the most central concept of the MLP. Although not static, regimes are inherently stable as a result of the linkages between their constituent elements. Thus, socio-technical regimes form technological trajectories and technologies become path dependent, since the regimes make up the selection environment in which innovations are to be adopted. Technological developments within regimes are therefore mostly incremental by nature. A key focus of the MLP is how regimes can be destabilized in order to enable more radical changes, i.e., TT.

According to Geels (2002), radical innovation occurs within technological niches. In such niches, innovation is protected from the selection environments of the regime. Thus, they can function as

'incubation rooms' for radical innovation. According to Geels (2002), such niches are crucial since they make up the basis for TT.
Geels (2002) states that socio-technical regimes are situated within a socio-technical landscape, the third and final level of the MLP. The landscape is the sum of external factors that make up the structure in which the regimes exist. The landscape cannot be changed by the regime itself and thus constrains the socio-technical configurations. Landscapes do change, however more slowly than regimes. Changes in the socio-technical landscapes can exert pressure on the regime. Sufficient pressure can lead to a destabilization of the regime, enabling opportunities for niche innovation to challenge the socio-technical configurations of the selection environment.

Geels (2011) has elaborated on how the MLP relates to sustainability transitions. According to Geels, sustainability transitions have three main characteristics that separate them from most other transitions. Firstly, sustainability transitions are often more purposeful than other types of transitions. The incentive of private actors to contribute to sustainability transitions is often minimal, since sustainability is a collective goal rather than something that directly rewards the individual actor. Secondly, sustainability transitions require political intervention, since more sustainable solutions can often not compete within the established economic frame conditions. This is also, in part, a result of sustainability being a 'collective good'. Thirdly, in many fields where the need for sustainable transitions is particularly pronounced, incumbent actors control 'complementary assets' such as specialized knowledge, technology, or infrastructure that strengthens their position compared to niche innovators who are typically the frontrunners in sustainability innovations. Strategic reorientation of the incumbent actors is therefore often necessary to accelerate the implementation of such innovations. Based on these considerations, Geels (2011) points out that the structural transformations required for sustainability transitions are faced by many challenges in reorienting the actions of incumbent actors and lock-in mechanisms related to e.g., economies of scale and established infrastructure.

During our project, we have utilized the MLP in an effort to identify the selection environments and path dependencies within the socio-technical regime of e-products. We have investigated how landscape changes exert pressure on the regime, enabling niche innovations to change the socio-technical configurations of the regime. We have sought to exploit such opportunities to conceptualize niche innovations which may become part of a sustainable transition.

3.1.2 Quasi-evolutionary model

The MLP has been subject to criticism from other scholars since it was introduced by Geels (2002). Some of the critiques have revolved around a perception that the MLP does not sufficiently emphasize the agency of actors, both internal and external to the regime. Among the critics are Smith et al. (2005) who argue against Geels' (2002) notion that radical innovation can only stem from niches since incumbent actors are subject to a high degree of path dependence. Smith et al. (2005) introduce a quasi-evolutionary model of socio-technical transitions in which many tensions and opposing selection pressures exist within regimes, giving rise to transformative potentials and adaptive capacity among incumbent actors.

In the quasi-evolutionary model, regime transformations are a function of two processes: "1. Shifting selection pressures bearing on the regime. 2. The coordination of resources available inside and outside the regime to adapt to these pressures" (Smith et al., 2005, p. 1494). However, for a regime transformation to take effect it is necessary for the selection pressures on the regime to be articulated towards a specific direction of change. Adaptive resources can be present both inside and outside of the regime. It is the availability and coordination of such resources that Smith et al. (2005) define as adaptive capacity.

On the topic of governance activities relating to socio-technical transitions, Smith et al. (2005) state that "The art of governing transitions becomes one of recognising which context for transformation prevails, and which drivers offer the best leverage for guiding change in a desirable direction." (p. 1498). The authors define four different transition contexts which can be seen in Figure 14.

The transition contexts are a function of two parameters: The degree to which adaptive resources are internal or external to the regime and the degree to which the responses of actors are coordinated. The two-dimensional framework can be beneficial since it guides the identification of the prevailing transition context. If the identified context is deemed unsuitable for the desired transition, governance activities might be focused around supporting an alternative context. Smith et al. (2005) state that governance

> may seek to address the form, intensity, articulation or orientation of the selection pressures that act on target regimes. Or it may address the quality and distribution of adaptive capabilities, including the capacity to mount a coordinated response and the availability of resources (such as finance, legitimacy or competence*)"* (p. 1494).

Through application of the quasi-evolutionary model of socio-technical transitions we are able to identify adaptive capacity among regime actors, instead of seeing them as strictly path dependent. Thus, pre-existing structures are allowed to play a role in the desired transition. Such elements are highlighted by Geels (2002) as aspects that can accelerate the implementation of radical innovations.

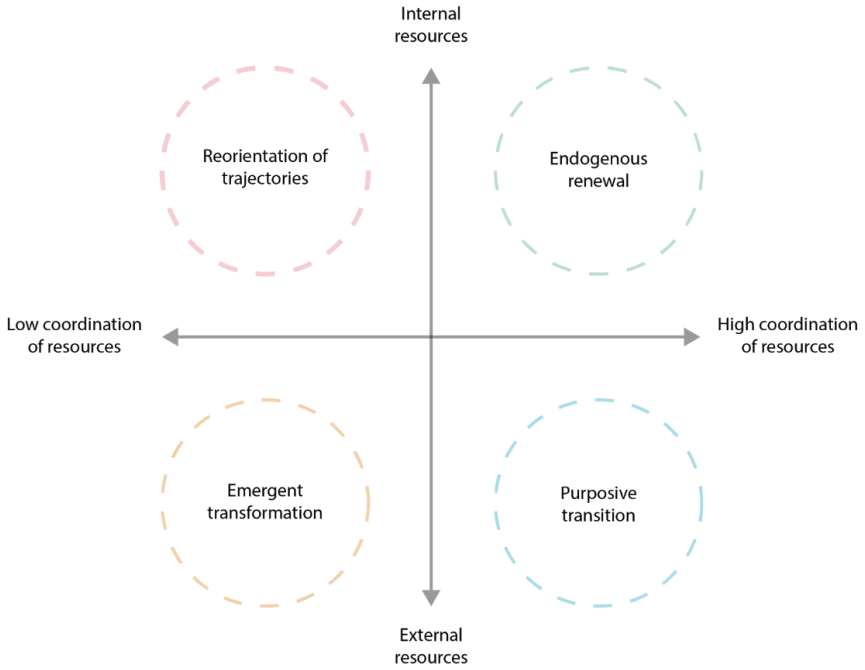


Figure 14. Transition contexts. Inspired by Smith et al. (2005)

The theories of socio-technical transitions serve as a valuable tool in understanding the structures and path dependencies of regimes along with the prerequisites and dynamics of transformation. We believe for instance that the concept of adaptive capacity can be very beneficial in the conceptualization of solutions that can contribute to a sustainable transition. However, these theories tend to be predominantly descriptive and analytical by nature and are far less specific in terms of how the prerequisites can be established in practice. We see the challenge of coordinating adaptive resources to work towards a shared goal as a matter of translation, and as such we will apply Actor Network Theory as a framework for understanding how such coordination might be achieved in practice.

3.2 Actor Network Theory

Actor Network Theory (ANT) provides a socio-technical approach to investigate how heterogeneous networks of human and non-human actors are constructed, maintained, and reconfigured. Latour (1992) defines an actor as any entity that can be made the source of an action. An actor can therefore be both human or non-human. In ANT, networks are thus composed of heterogeneous entities that affect each other in different ways (Latour, 1996). A study of these heterogeneous networks is therefore also a study of socio-technical change. Latour (2005) more recently argues that such networks should in fact be called worknets, since they are always dynamic rather than static. Usually, it is these dynamics of the networks which are of most interest to researchers since they can reveal agency within the network and potential pathways for change.

3.2.1 Four moments of translation

Callon (1986) has studied how networks can be intentionally reconfigured to support a desired change. He argues that this reconfiguration of a network, or translation, is a process consisting of four moments: Problematization, interessement, enrolment, and mobilization.

The first moment of translation, problematization, consists of two parts. Firstly, problematization is concerned with identifying a network of relations, dependencies, and alliances in order to reveal the goals and motivations of actors. Secondly, the problematization aims at defining and framing a problem in such a way that the interests of the previously identified actors converge in resolving the given problem. Thus, an obligatory passage point (OPP) will be established, which can be seen in Figure 15.

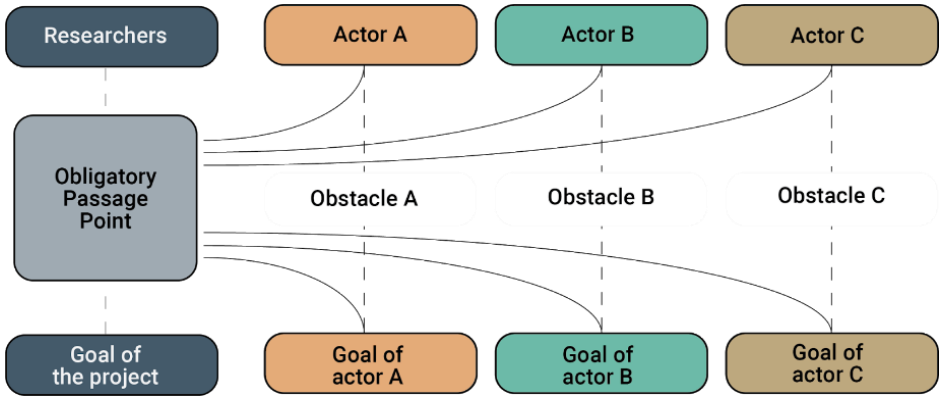


Figure 15. Obligatory Passage Point. Inspired by Callon (1986)

Following the problematization, interessement is about 'locking' actors into roles which have been imposed on them by the entity seeking to drive the translation process towards a desired outcome. Since actors are likely to have competing agendas, this process can be challenging. To guide the process, devices of interessement can be deployed to stabilize the roles and identities of actors. Hansen and Clausen (2017) define such devices as "non-human elements which are circulated by key actors in order to inspire other actors to support the change." (p. 346). Successful interessement leads to the third moment of translation, enrolment. At this stage of the translation, the roles that were previously proposed are defined and interrelated. In the final moment of translation, mobilization, actors have taken upon themselves the proposed roles and independently continue to work towards a shared goal. This can only be achieved if the supposed spokespersons for larger collectives of actors are sufficiently representative of the interests and agendas of the individual actors. It should be noted that the process of translation is continuous and never a completed task.

3.2.2 Programs

Latour (1991) introduces the notion of programs and anti-programs with his example of a hotel manager's efforts to make customers leave their keys in the reception when leaving the hotel. From this example, we see how the opposing agendas of the customers at first obstructs the manager's program of action as they continue to bring the keys with them when leaving the hotel. However, through a series of translations, an increasing number of customers are mobilized. To achieve his goal, the hotel manager utilizes different devices. The heavy weight attached to the keys proved to serve as an effective interessement device since it helped to "lock" actors into the roles necessary to support the manager's program of action.

Throughout the project, we have utilized an ANT approach to identify key actors which can be mobilized in the implementation of a potential solution. As part of our analysis, we have investigated what types of agencies exists or can be delegated between these actors and how they might influence the socio-technical systems related to repair and reuse of e-products on Bornholm. We have also sought to identify the programs and anti-programs among actors as a basis for defining an obligatory passage point through which a translation is feasible. As a strategy for increasing the probability of a successful mobilization, we have constructed interessement devices as a means to counter potential anti-programs among actors.

3.3 Circular Economy

Circular economy is a theoretical framework and an expression for economic models inspired by the cradle-to-cradle design approach. There is no globally agreed upon definition of circular economy, and it is according to Korhonen et al. (2018) "loosely based on a fragmented collection of ideas derived from some scientific fields including emerging fields and semi-scientific concepts." (p. 39). However, even though there is no established common code of practice, "it is essential that products are returned at their end-of-use to be reused, repaired, refurbished or remanufactured" (Poppelaars et al., 2020, p. 1). In Figure 16, we see the effect of well-implemented circular economy initiatives illustrated by the blue line. The orange line represents a classic linear economic business model.

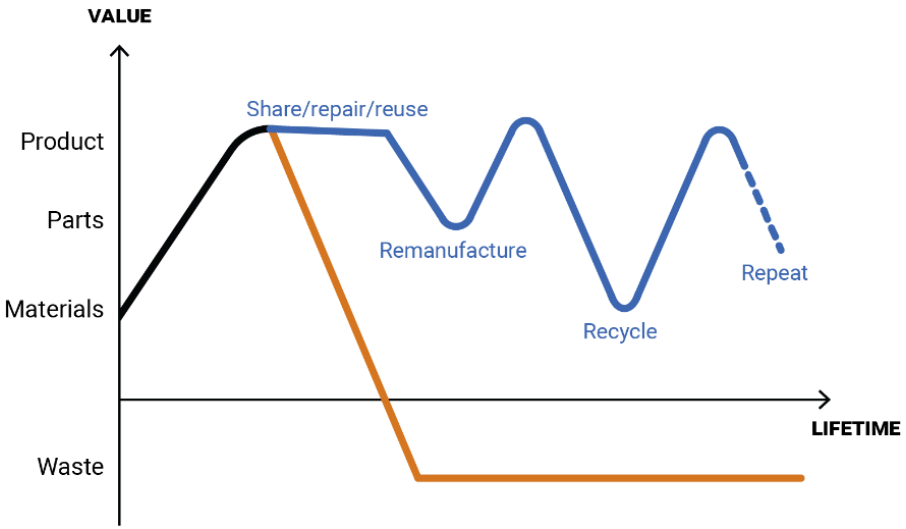


Figure 16. Circular economy vs. linear economy. Inspired by European Environment Agency (2020b)

Nonetheless, according to Ghosh (2020) several scholars have formulated many different definitions of circular economy and as a matter of fact "the concept of the circular economy has also attracted much criticism on several grounds including the reasons for having different definitions of the concept." (p. 5). In order to avoid criticism for having various definitions and to maintain consensus throughout the project, we have applied the definition suggested by Korhonen et al. (2018) combined with the definition suggested by Bocken et al. (2016).

The reason for applying Korhonen et al. (2018) is that they connect the framework of circular economy to the perspective of sustainable development, with their definition:

> Circular economy is an economy constructed from societal production-consumption systems that maximizes the service produced from the linear nature-society-nature material and energy throughput flow (...). Successful circular economy contributes to all the three dimensions of sustainable development. Circular economy limits the throughput flow to a level that nature tolerates and utilises ecosystem cycles in economic cycles by respecting their natural reproduction rates. (p. 39).

As this definition alludes to, Korhonen et al. (2018) describe the potential of a successful circular economy as a win-win-win situation with regards to economic, environmental, and societal benefits.

However, Korhonen et al. (2018) do not describe how a circular economy can be implemented successfully in business model strategies which we are interested in. Therefore, we have combined it with the definition suggested by Bocken et al. (2016) who describe how a linear business model can become circular by following three different design strategies and thereby affect the resource loop in three directions, which are slowing, narrowing, and closing. This is illustrated in Figure 17.

Bocken et al. suggest how implementation of different circular business models can affect the loop of a product in one or more directions. These business models are mainly directed towards manufacturers, which lie outside the scope of this thesis. Nevertheless, they describe a model named 'Extending product value' which aims to slow the loop by exploiting the value of products. The entity who becomes the exploiter depends on the specific implementation of the business model but Bocken et al. state that the exploiters generally are the manufacturers

who recover products after end-of-use. However, "Other examples are business models, where third parties focus on exploiting the residual value of a manufacturer's, brand or retailer's products." (Bocken et al., 2016, p. 314).

As the quote alludes to, it is sometimes third parties who take action if they detect an untapped opportunity within a specific field. Through this thesis, our research points towards such an untapped opportunity by which we have aimed to implement an 'extending product value' business model in order to exploit the gap.

In general, we have applied circular economy as a theoretical framework to assess the current system and to develop guidelines which break with the current paradigm.

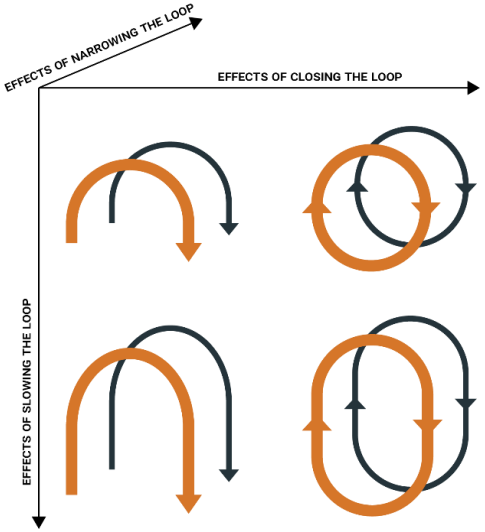


Figure 17. Strategies for affecting the resource loop. Inspired by Bocken et al. (2016)

CHAPTER 4

4. Methodology

The following sections will provide an overview of different quantitative and qualitative methods we have applied throughout the project. The methods have been applied for research, analysis, and conceptualization.

4.1 Document studies

Document studies can be used as a method for gathering large amounts of knowledge in a relatively short amount of time. It can allow for the identification of areas of particular interest and potentials for additional research (Bowen, 2009). Throughout the project, although primarily in the early stage, we have conducted document studies to get an overview of the newest academic research within topics such as sustainability, circular economy, and environmental and economic impacts of e-waste. Besides academic research, we have conducted document studies on national and international legislation, political plans, and case studies from other European countries. The studies have allowed us to quickly get an overview of current actions within the field along with recommendations and principles which should potentially be incorporated in the conceptualization of more sustainable future systems for e-waste management.

4.2 Semi-structured interviews

Through the design process, we have conducted interviews with different experts and local actors. All interviews have been semi-structured which Ahlin (2019) defines as interviews that "include a set number of survey questions that will be asked of all respondents while also incorporating opportunities for more detailed inquiry into topics that arise during researcher– respondent discussions." (p. 4). So, the aim of performing interviews has been to seek insights to unanswered questions but at the same time give the interviewees the possibility to talk about topics we were not necessarily aware of. This approach has turned out to be valuable as various problems have been identified through the interviews.

4.3 Stock and flow diagrams

Inspired by the Systems Thinking Theory suggested by Meadows (2008), we have applied stock and flow diagrams to map flows of physical goods such as e-products and e-waste. Meadows describes how stocks can be changed by intervening in the system,

> Stocks are the elements of the system that you can see, feel, count, or measure at any given time (...). Flows are filling and draining, births and deaths, purchases and sales, growth and decay, deposits and withdrawals, successes and failures. A stock, then, is the present memory of the history of changing flows within the system. (Meadows, 2008, pp. 17-18)

Thereby, stock and flow diagrams are a useful methodology to detect unprecedented issues such as depletion of substances in stocks and critical accumulation of materials. Throughout the thesis, we have applied stock and flow diagrams in two different ways. Firstly, we have used them to illustrate the vision of the research and to identify points of leverage at which the highest potentials for intervening in the system are located; and secondly, to explore if the stock and flows of e-products

and e-waste are massive enough in order to underpin a business model for increased repair and reuse.

4.4 Survey

A survey can be an effective approach to obtain empirical knowledge from a specific segment. According to Groves et al. (2004) "A survey is a systematic method for gathering information from (a sample of) entities for the purpose of constructing quantitative descriptors of the attributes of the large population of which the entities are members." (p. 2). There is no fixed procedure for performing a survey. However, Ponto (2015) claims that a series of questions must be defined and that they must be delegated to a chosen segment.

We have through the project surveyed a segment of the local citizens of Bornholm. This has resulted in empirical data which we have extracted for two main reasons. Firstly, the data has been applied to obtain an understanding of the locals current practices with regards to acquisition and repair of e-products, and secondly to avoid designing a solution they would not be interested in.

4.5 Affinity diagram

Affinity diagrams can be utilized as a method for organizing empirical knowledge, making large amounts of data easier to interpret by revealing commonalities between the individual data points (Holtzblatt & Beyer, 2017). Thus, it can also help in defining the requirements for solutions that one seeks to develop. During the project, we have utilized the method in order to get an overview of data from our survey. The affinity diagram allowed us to identify common themes that the respondents identified as problematic, by grouping the individual statements that related to one another. The diagram also gave us a clear impression of what issues were the most prevailing, since some groups of statements were clearly larger than others. Thus, the method allowed us to identify key barriers that we would need to target in our conceptualization.

4.6 Problem tree and objective tree

Similarly, to the affinity diagram, a problem tree can be used as a method for structuring and analyzing empirical knowledge, since it can help in "identifying the major problems and their main causal relationships." (MIT, n.d.). The problem tree thus provides a visual representation of how different problems relate to each other. Moving downwards in the problem tree, we get an indication of what causes the overarching problems. These causes are typically more specific and narrow in their scope. Thus, they help us understand what aspects of the problems should be targeted with our designed solutions.

After mapping out the problem tree it can be converted to an objective tree by going over all individual points on the tree and reversing the negative problem statement into a positive future objective (CSNM, n.d.). The resulting objective tree consists of one or more overarching goals that should be closely related to the design brief (Cross, 2000). These overarching goals branch out to more specific objectives which should be targeted in the conceptualization of potential solutions.

We have constructed a problem tree based on all issues we have identified throughout the project. Following this, we converted the

problem tree to an objective tree in an effort to ensure that the results of our conceptualization were qualified and based in reality.

4.7 Business Model Canvas

Osterwalder and Pigneur (2010) suggest a business model concept which aims to establish a common language everybody understands and that can facilitate a discussion. They have named the concept Business Model Canvas. The concept is established on the general definition of a business model which is to describe the rationale of how organizations create and deliver value (Osterwalder & Pigneur, 2010). It consists of nine building blocks which altogether indicates how an organization intends to create value which most frequently is equal to how they intend to earn a profit.

We have in the conceptualization phase formulated a Business Model Canvas with the intention of creating a business model which can facilitate a discussion about the feasibility of potential solutions among relevant actors.

CHAPTER 5

5. Gathering of empirical knowledge

In this chapter, we will first present data we have obtained from two different surveys. The first survey is conducted by Norstat (2020) focusing on consumer practices in Region Hovedstaden (the Capital Region of Denmark). The other survey is devised by us concentrating on consumer practices on Bornholm. Both surveys have provided much interesting data. However, only the data that have been applied during the research will be presented (see appendix for complete survey results from Bornholm). After introducing the empirical data obtained from the surveys, we will present knowledge and insights gained from the interviews we have conducted throughout the project.

5.1 Survey from Region Hovedstaden

In 2020, an international data provider, Norstat, conducted a survey on behalf of Aalborg University (Norstat, 2020). The survey was sent to households in Region Hovedstaden who were asked about buying and repair habits in regard to different product lines here among e-products. A total of 1,005 households responded to it. The distribution of males and females is equally divided, and all age groups from 18-70+ are represented. Furthermore, people with different educational backgrounds are represented, from elementary school to higher education such as bachelor's and Master's. Thus, the survey has a high level of validation.

One of the purposes of the survey was for Aalborg University to obtain a thorough understanding of households' general behavior in regard to e-products and e-waste, and furthermore to investigate how various types of e-products differ from each other. This relates to which products the households have acquired recently; their willingness to buy second-hand; differences in longevity of the products; and if the households have repaired broken products.

The survey was conducted in 2020 but is based on the households' experiences in the period from January 2019 to September 2020, i.e., a survey period of 21 months. Products that were either bought or broken before or after this period are not implicated in the survey. The definition of e-products covers eight different product categories which are mobile phone, PC, TV, fridge/freezer, washer/dryer, dishwasher, kitchenware, and tools.

Our objective of applying the survey has been similar to Aalborg University's original purpose, i.e., to achieve a comprehension of households' practices in regard to e-products and e-waste. Furthermore, we have extrapolated the data to a local context on Bornholm in order to portray e-product and e-waste streams on the island.

5.1.1 Acquisition habits

Figure aa provides an overview of how many households that in the period from January 2019 to September 2020 have bought a product from the different product categories. Furthermore, it shows whether the acquisitioned products were second-hand or new.

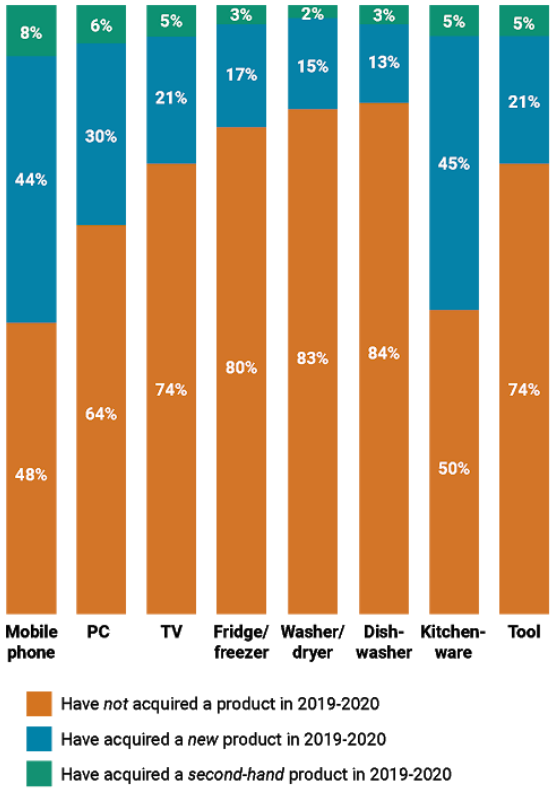


Figure 18. Acquisition habits of new and second-hand e-products (Norstat, 2020)

Overall Figure 18 shows that the majority of the households have not acquired a new nor a second-hand e-product across the eight product categories in the test period except for mobile phones and kitchenware. This is illustrated by the orange bars. If we look into acquired products, the blue bars show the percentage of households that have acquired a new product. It can be derived that kitchenware (45%) and mobile phones (44%) are the most common e-product categories for households to acquire as new. On the contrary, domestic appliances which implies fridge/freezer (17%), washer/dryer (15%), and dishwasher (13%) are the least acquired e-products.

5.1.2 Broken products

Figure 19 shows how many households that have experienced that product from one or more of the eight categories broke during the survey period.

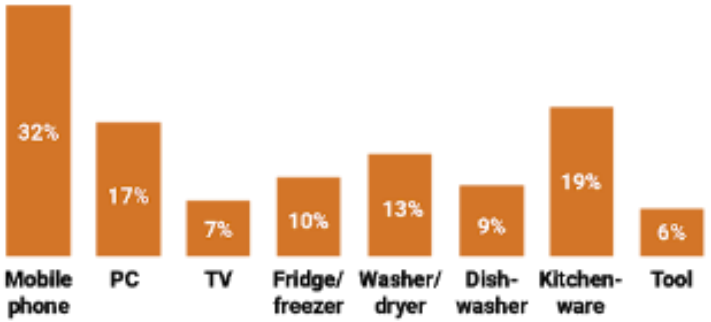


Figure 19. Percentage of broken e-products (Norstat, 2020)

As it shows, almost one third (32%) of all households experienced that a mobile phone broke during the survey period. This is by far the product group that breaks the most. Kitchenware (19%) and PCs (17%) were the other two product categories that broke the most. However,

the numbers may be distorted to some extent. To clarify, the average household has for example most likely more mobile phones than washing machines. Therefore, the chance of experiencing a mobile phone breaking is naturally more likely to happen compared to a washing machine. However, it is more likely that the average household has more kitchenware than mobile phones by which that theory is not ubiquitous. To obtain a more thorough understanding of this, it is necessary to explore the average lifespan of the product categories.

5.1.3 Average lifespan of e-products

Figure 20 provides an overview of how old the products were when they broke. The horizontal axis shows yearly intervals from 0-2 years, 2-5 years, and 5-10 years. This means that the marks on each graph at 2 years represent the percentages of products that were maximum 2 years old when breaking. The same is applicable for the 5 and 10 year marks. Some products were more than 10 years old when they broke. However, we have left these out as a matter of visual simplicity. The share of products that were more than 10 years old when they broke can be found by subtracting each of the 10 year marks from 100%. To exemplify, the fridge/freezer (yellow graph) at 10 years is at 55% which means that 45% of the broken products were more than 10 years old when they broke. It appears however not from the survey whether these products were for instance 11 or 30 years old when breaking.

From Figure 20, we can see that mobile phone (orange graph) has the steepest slope in the first five years. 88% all phones broke before year 5. PCs and kitchenware have also short lifespans as respectively 58% and 57% broke within the first five years. On the other hand, product categories like fridge/freezer, washer/dryer, dishwasher, and TV have longer lifespans as respectively 45%, 38%, 37%, and 34% lasted longer than 10 years. Therefore, it seems that the lifespan of e-products is proportional with the acquisition rates from Figure 18 and the breaking rates from Figure 19. To exemplify, mobile phones, kitchenware, and PCs which have the shortest lifespans are at the same time the most acquired products and the ones that break the most. Thus, we can identify a tendency showing that the majority of households buy new products when the old ones break. Therefore, it could be interesting to explore what refrains households from repairing broken e-products.

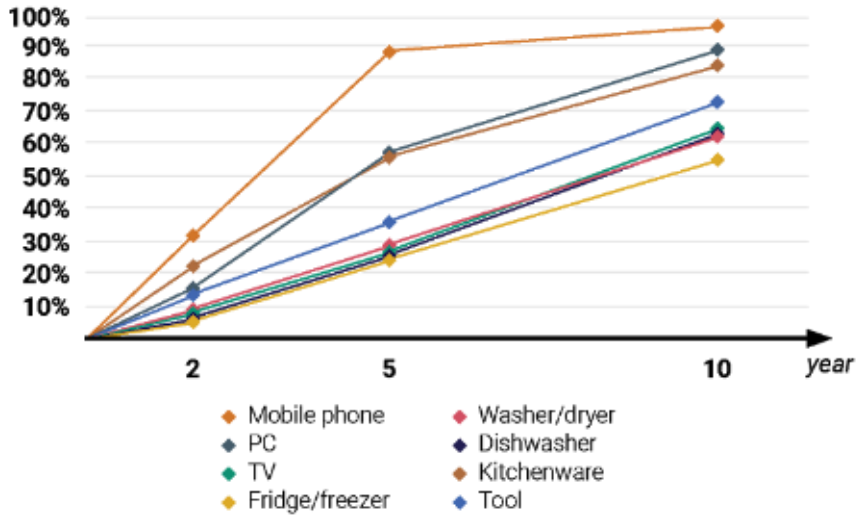


Figure 20. Average lifespan when breaking (Norstat, 2020)

5.1.4 Mapping reasons for repairs and non-repairs

Figure 21 shows the three most common reasons why products were repaired or not in each product category. The figure shows for instance that 41% of the households who decided not to repair a broken kitchenware did not do it because they found it impossible. The same tendency is applicable for TVs. The most common reason for not repairing broken products is the price.

5.2 Survey from Bornholm

In order to obtain a more thorough insight regarding buying and repairing habits of the local citizens on Bornholm, we created a survey. The survey was to some extent inspired by the survey made by Norstat (2020) as we wanted to make some of the results comparable by which among other things, we asked about people's acquisition and repair habits. However, the agenda of sending out the survey was not all the same by which some of the questions are different. To specify, one of the purposes was to obtain knowledge regarding the maximum limit the people on Bornholm are willing to spend respectively for repairs of broken e-products and buying second-hand e-products which Norstat (2020) did not investigate in their survey. The reason why we were interested in this is that we wanted to explore whether the maximum limits correlate with the actual prices for repair and buying second-hand or if regulations need to be implemented in order to lower the asking price. Furthermore, we wanted to derive inputs from the locals on Bornholm in order to make sure our project was to the greatest extent possible guided by the experiences and desires from local actors.

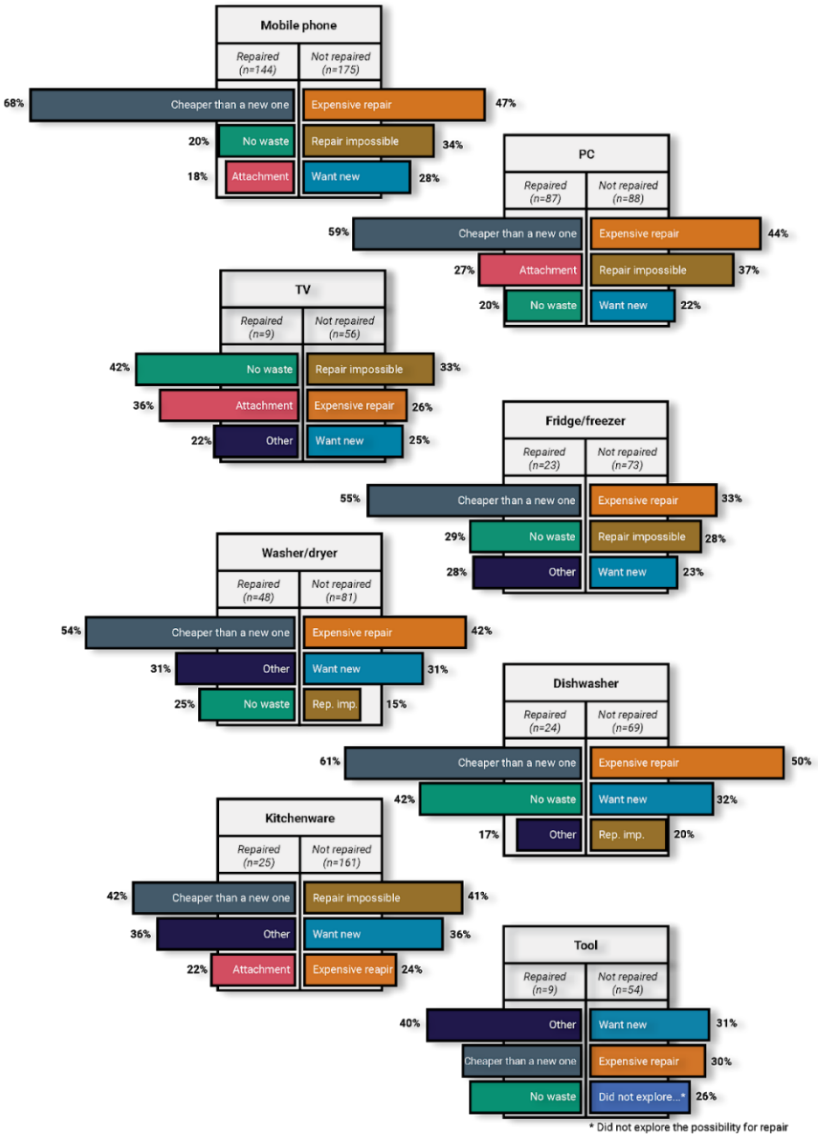


Figure 21. Main reason for repairs and non-repairs (Norstat, 2020)

To reach out to the citizens of Bornholm, we joined various groups on Facebook for locals like 'Bornholm er vores Ø', 'Razzia - Fotovogn Bornholm', 'Bornholms Klatreklub', and 'Debatforum Bornholm'. However, in spite of these groups being directed towards the local citizens, people from outside the island could potentially still access our survey. Therefore, in order to avoid answers from non-locals we asked in the very first question whether or not the respondents have residence on Bornholm. If the respondents answered 'No' to this, they were transferred to a page at which they were told we unfortunately could not use their inputs. This resulted in four respondents who had accessed but kindly were told they could not participate. This left us with a total of 106 respondents who all had residence on Bornholm.

5.2.1 Demography of the respondents

To assess if the respondents are representative of the population of Bornholm, we asked about their age and postal code. Figure 22 provides an overview of the latter.

Figure 22. Geographical distribution (Own survey, 2021)

As it shows, people from all nine existing postal codes have answered the survey with the majority living in Rønne. This is not surprising as one third of all people on Bornholm live in Rønne. However, in this survey they constitute 57% of all the respondents by which there is a distortion.

Figure 23 illustrates the age distribution of the respondents (blue bars) and the citizens of Bornholm (orange bars).

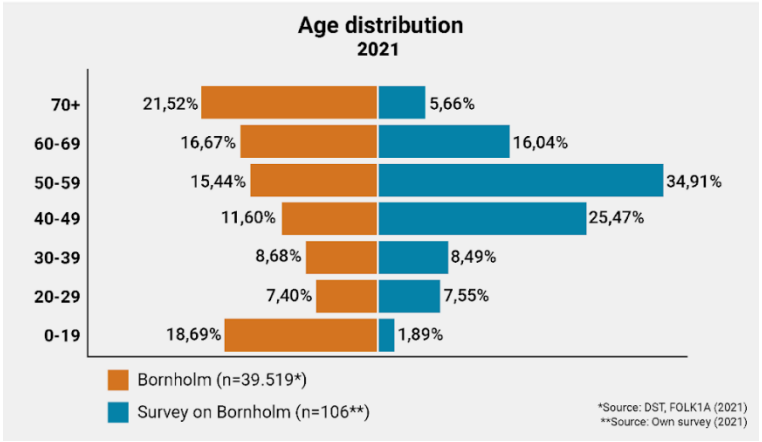


Figure 23. Age distribution (Own survey, 2021)

Figure 23 shows that the two age distributions are imbalanced. For instance, it shows that respectively 18.69% and 21.52% of the citizens on Bornholm are 0-19 years old and 70+ while the respondents in the same age groups only constitute 1.89% and 5.66%. However, it is not

surprising that only few people from these two age groups have answered the survey as repair and reuse of e-products either do not interest them or they simply do not have the abilities to access surveys through Facebook. This distortion has naturally entailed majorities in other age groups like for instance 40-49 and 50-59. Nonetheless, in spite of distortions in both geographical and age distribution, we do not see that as barriers to assess the survey as being representative by which the data can be applied as a part of the analysis.

Before asking about peoples' acquisition and repair habits, we asked them where they prefer to buy new and second-hand e-products. We see in both scenarios that most of the respondents prefer both online and physical shops. Furthermore, when it comes to either or, we see that most people prefer local shops.

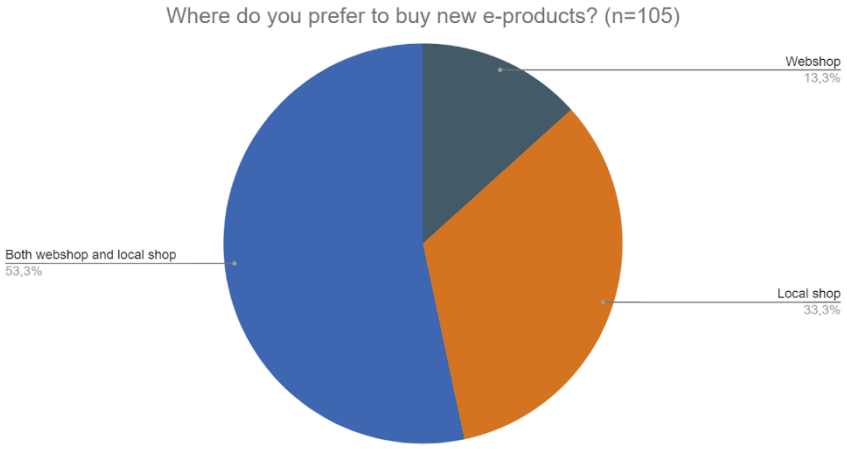


Figure 24. Acquisition habits, new e-products (Own survey, 2021)

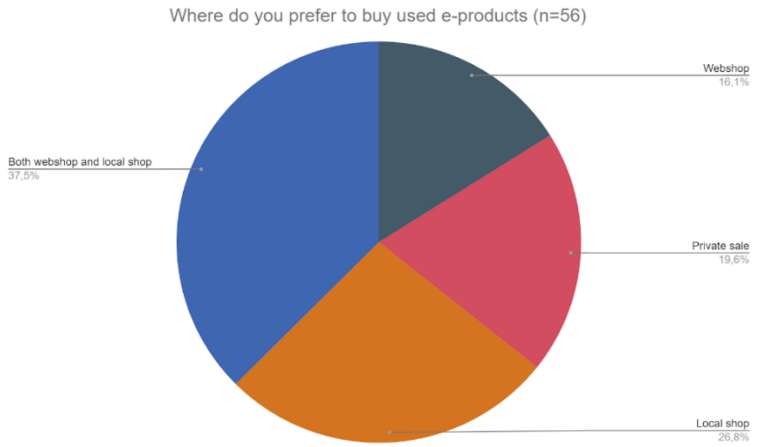


Figure 25. Acquisition habits, second-hand e-products (Own survey, 2021)

5.2.2 Acquisition habits

By investigating peoples' acquisition habits regarding both new and second-hand e-products, we got the possibility to make comparisons in regard to frequency and volume.

By looking at Figure 26, we can see the differences in how often, i.e., frequency, the citizens of Bornholm buy new and used e-products. The orange bars represent when the respondents last acquired a used e-product while the blue bars illustrate when the respondents last acquired a new e-products. As it shows, 54% of the respondents have never acquired a used e-product while only 27% have acquired a second-hand product within the last year. Compared to this, 88% of the respondents have acquired a new e-product within the same period. Therefore, it seems that new e-products are more attractive to acquire compared to

second-hand e-products. Figure 26 does however only show the frequency of acquiring e-products, and not the volume. Thus, the number of second-hand e-products could technically be higher than new e-products. This is however not the case.

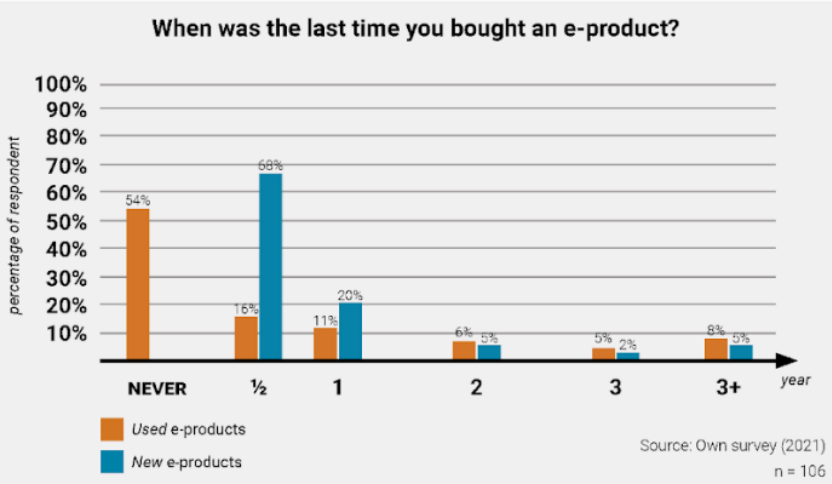


Figure 26. Frequency in acquisition of new and second-hand e-products (Own survey, 2021)

Figure 27 shows how many second-hand and new e-products the respondents have acquired within the last two years. The reason why we are only interested in what people have acquired within the last two years is first of all that it is irrelevant what the respondents acquired 10, 15 or 20 years ago as the acquisition habits were different back then compared to today (Grundtvig, 2020) and secondly that it becomes more difficult for the respondents to recall the exact number of products when the time frame is too long.

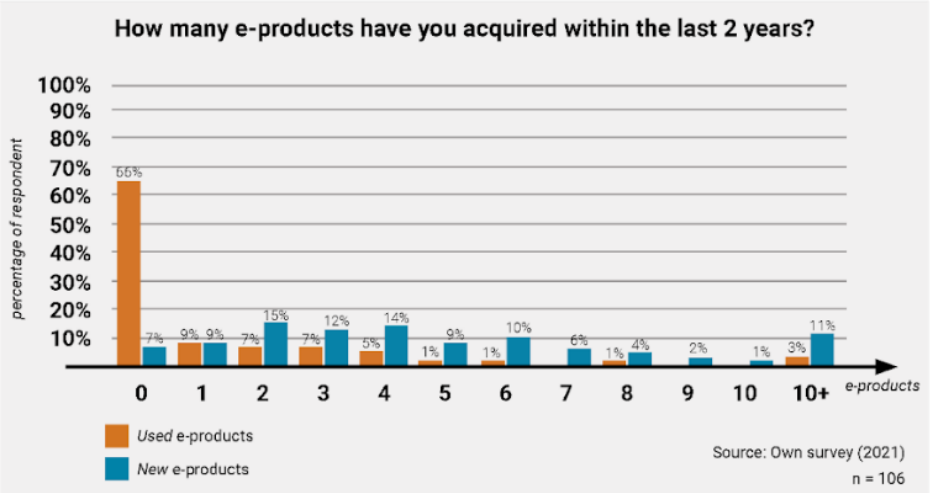


Figure 27. Volume in acquisition of new and second-hand e-products (Own survey, 2021)

Not surprisingly as Figure 26 also showed, the majority of the respondents have not acquired a second-hand e-product within the last two years. With regards to acquisition of new products, we see a broad distribution which tells us that peoples' behaviors and needs, and thereby their acquisition habits, vary a lot.

5.2.3 Repair habits

Figure 28 provides an overview of how many of the locals that within the last two years have repaired a broken e-product. As it shows, less than 25% have repaired a product which gives an indication that repairs on Bornholm are not propagated.

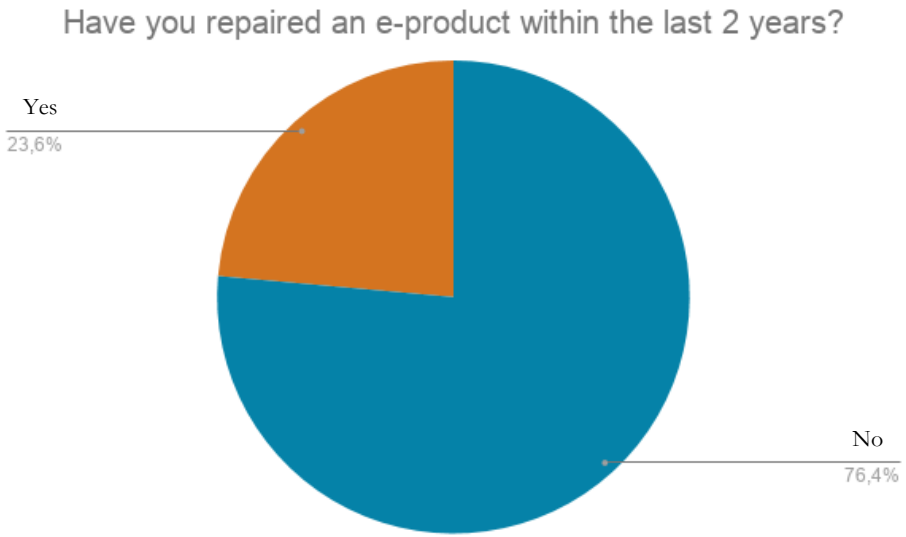


Figure 28. Repair habits (Own survey, 2021)

5.2.4 Willingness to pay

The figures in the following section take their starting point in a total of six different scenarios. Three of the scenarios are related to the willingness to pay for repair of a broken e-product while the other three scenarios are related to the willingness to pay for buying second-hand e-products. The six scenarios can be seen in Figure 29.

Willingness to repair	Willingness to buy second-hand
Scenario 1: The screen on your smartphone breaks by an accident. It is no longer fully functional. It annoys you as you are fond of it. The phone is **1.5 years** old but the warranty does not cover screen-breaks. You paid **DKK 4,000** for the phone and a new similar would cost the same. How much are you willing to pay for a repair so the phone once again becomes fully functional?	*Scenario 1:* You have decided to buy a new smartphone. You have selected a model that fulfill your needs. It costs **DKK 4,000** from new. The same model is for sale as second-hand in a local shop. The used phone is **2 years** old and in a great condition. How much are you willing to pay for the second-hand smartphone?
Scenario 2: You are using your blender when it suddenly breaks down. The blender is **3 years** old by which the warranty is no longer valid. You paid **DKK 800** for the blender and a new similar model would cost the same. How much are you willing to pay for a repair so the blender once again becomes fully functional?	*Scenario 2:* You have decided to buy a new blender. You have selected a model that fulfill your needs. It costs **DKK 800** from new. The same model is for sale as second-hand in a local shop. The used blender is **2 years** old and in a great condition. How much are you willing to pay for the second-hand blender?
Scenario 3: Your washing machine has not been centrifuge properly for a month. It is 8 years old and your extended warranty expired after **5 years** by which it is not valid. You paid **DKK 6,000** for the washing machine and a new similar would cost the same. How much are you willing to pay for a repair so the phone once again becomes fully functional?	*Scenario 3:* You have decided to buy a new washing machine. You have selected a model that fulfill your needs. It costs **DKK 6,000** from new. The same model is for sale as second-hand in a local shop. The used blender is **5 years** old and in a great condition. How much are you willing to pay for the second-hand washing machine?

Figure 29. Six scenarios (Own survey, 2021)

In order to detect patterns in the respondents' answers, we have built a system of coordinates illustrated in Figure 30. The horizontal axis represents the willingness to buy second-hand e-products while the vertical axis represents the willingness to repair broken e-products. By answering the survey each respondent has given a total of six yes/no. Three yes/no regarding buying second-hand and three yes/no regarding

repairing broken e-products. Thus, each respondent's answer correlates to a coordinate in the system.

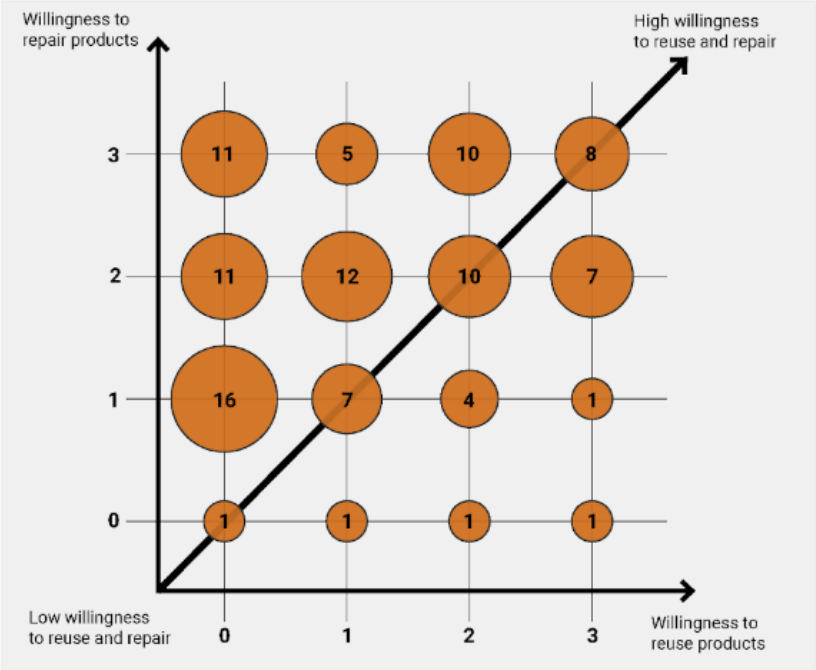


Figure 30. Willingness to repair and buy second-hand (Own survey, 2021)

The numbers in each of the circles indicate how many of the 106 respondents that have answered the specific combination of yeses and noes. To illustrate, eight respondents have answered that they are willing to repair all three e-products and at the same time would be willing to buy all three e-products rather than buy them from new. The diagram indicates that more respondents are willing to repair the broken products rather than buying second-hand products.

There might however be a minor source of error connected to the willingness to repair as the respondents initially were not asked if they were willing or not but just how much they would be willing to spend for a repair. Furthermore, it is worth mentioning that Figure 30 only illustrates *if* the respondents would be willing to either repair or buy second-hand and not how much they realistically would be willing to pay for it. This is what Figure 31 shows.

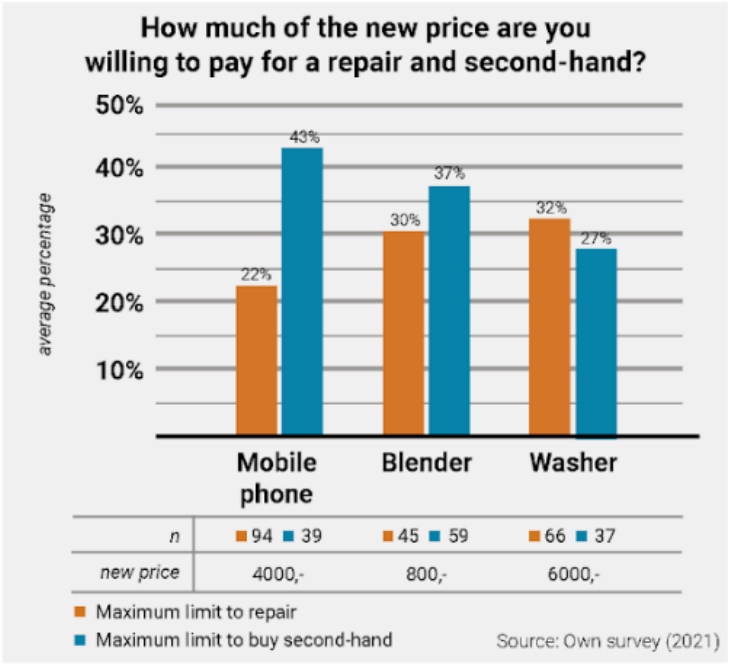


Figure 31. Maximum limit for repair and second-hand

Based on the six scenarios, we can first of all see how many of the respondents are willing to either repair or buy second-hand (illustrated with the n-values). Furthermore, we can see how much, relative to the price of a new product, the average respondent is willing to pay for either repair or buying second-hand, illustrated by respectively the orange and blue bars. The general tendency shows that the average price that respondents were willing to pay for second-hand e-products was higher compared to repairing broken products.

To sum up, more respondents would rather repair than buying second-hand while the maximum limit spent for buying second-hand is higher compared to repairing. This outcome may however be distorted by the source of error mentioned previously.

5.3 Interviews

We have through the design process been in touch with several actors who individually have been important for the process. The following sections will show some of the interviews we have conducted throughout the project. We will only include the interviews that have been relevant for the research and have likewise not included the conversations we have had with employees from BOFA. The first two interviewees are experts within the national waste system and have been helpful to understand how the system is organized. The other interviewees have provided knowledge and insights with regards to the current e-product and e-waste situation on Bornholm.

5.3.1 Ole Morten Petersen, DAKOFA

In the early stage of the project, we arranged an interview with Ole Morten Petersen, the CEO of DAKOFA, which is a Danish non-political knowledge building network for waste and resources, as we were interested in the general viewpoints of such an organization on the topic of e-waste. We believed that the interview could potentially provide us with unique insights that could influence the direction of the project.

On the topic of e-waste, Ole Morten stated that he believes it is an interesting waste fraction with a lot of room for innovation in terms of end-of-life treatment. He specifically pointed to the resource intensive manufacturing of e-products and their contents of precious metals and rare-earth elements as factors contributing to the inadequacy of current recycling methods. Ole Morten highlighted the potential of new circular strategies for extending the lifespan of e-products as key to the reduction of their environmental impacts. We asked whether he knew of examples where such initiatives have been implemented. Ole Morten provided an example from Spain, where the government has initiated a project to create social-economic jobs related to repair and reselling of e-products that have ended up in recycling stations. In continuation hereof, Ole Morten pointed to the implementation of the WEEE-directive as a legal barrier for more intelligent circular solutions since the collective schemes are granted ownership of the e-waste. He stated that the idea of EPR is good but that, to some extent, the collective schemes in practice removes the responsibility of the individual producers and undermines the motivational factor for producers to design products differently.

The interview generally supported our initial perception that product life extension through social-economic initiatives would be a valuable strategy to pursue. It also highlighted the importance of legal ownership as a factor in our conceptualization, as political and legal barriers could otherwise put a stop to the implementation of potential solutions.

5.3.2 Niels Remtoft, Dansk Affaldsforening

To gain a better insight into the roles and ambitions of municipalities in relation to management of e-waste, we arranged a meeting with Niels Remtoft who is a special consultant in Dansk Affaldsforening (DAF). DAF is an interest organization for its members, which are municipalities and municipal companies related to waste management. The organization has a board consisting of local politicians and its tasks are primarily to advise politicians and facilitate knowledge exchange between the members.

Going into the interview, we wanted to gain a more solid understanding of how municipalities and municipal companies may play a role in pursuing new circular strategies for mitigating the negative environmental impacts of e-products through product life extension.

During the interview, Niels highlighted that the role of municipalities has changed as a consequence of EPR and the collective schemes, since the municipalities no longer have any influence on how e-waste is treated after it leaves the recycling stations. He noted, however, that material recycling was also the dominant practice before implementation of the WEEE-directive.

Niels mentioned that some of DAF's members have started experimenting with social-economic models for repair of e-products as part of employment programs, but that such activities have primarily been focused on product types like lamps and domestic appliances. More complex e-products like IT equipment have not received the same attention, especially products that may contain personal information from previous users. Later in the interview, we asked Niels what he thinks are the main barriers for securing more repair and reuse of e-products, to which he highlighted the legal barriers caused by the WEEE-directive. He pointed out that products which have become waste cannot be taken back for repair and reselling, since they are owned by the collective schemes as soon as they enter the recycling stations. Niels stated that, in this regard, the repair activities facilitated by DAF's members are in fact a form of civil disobedience. It is his interpretation that products that need repair are by definition waste, but he agrees however that it seems to be a legal grey area.

Similarly, to the interview with Ole Morten Petersen, the interview with Niels highlighted the importance of legal ownership. The interview made it clear that it would be necessary to either conceptualize solutions that involve a collaboration with the collective schemes, or to identify ways to not have e-products classified as waste while repair is still an opportunity.

5.3.3 Joackim Penti, Bornholmermarked

In order to obtain an insight of the second-hand market on Bornholm, we contacted Joackim who is the CEO of a local, digital sales platform called Bornholmermarked. The platform is a counterpart to more well-known second-hand platforms such as Den Blå Avis or Facebook

Marketplace but is addressed to locals or people with connections to the island. Joackim told us that Bornholmermarked has about 30,000 unique users every month by which it seems that there is a market for buying and selling second-hand products. However, he said that e-products are not the most popular products sold on the platform but that product lines like domestic animals, holiday homes, and textiles are more common. Furthermore, we were interested to hear more about Bornholmermarked's new feature called *Stores*. Joackim explained that they have entered collaborations with several local second-hand stores who monthly pay a small amount of money which gives them the opportunity to apply Bornholmermarked as a sales channel. Thereby, the local stores reach hypothetically out to 30,000 unique users every month which potentially can entail increased awareness of the individual store and thus more sales.

5.3.4 Johann Aakjær, Service Centret Bornholm

By performing desk-research we discovered Service Centret Bornholm who according to their own website can repair all kinds of e-products. We contacted the owner, Johann, to learn more about the operations of the company. Furthermore, we wanted to explore what obstacles that may occur during repairs, what he thinks refrains local citizens from repairing broken e-products, and if he could see the potential of expanding his business model to include resale of second-hand products. By talking with Johann, who is an authorized repairer, we got all our questions answered. He explained that he is able to repair all kinds of products but that he mainly repairs mobile phones, laptops, and domestic appliances and not product categories such as kitchenware or televisions. This tendency is caused by different parameters such as lacking awareness among the locals with regards to what is feasible to repair. Additionally, he said that it is not a matter of acquiring spare parts but rather the high salary that most often refrains people from repairing broken e-products.

Furthermore, Johann said that he recently has employed a young man who previously had a hard time finding a job as he is not able to work a fulltime nor complete an education. Now he works at Service Centret Bornholm four days a week from 8-12. His main task is to repair phones, but Johann has plans to train him to repair all sorts of e-products.

5.3.5 Martin, Expert & Punkt1 in Nexø

We contacted the local Expert & Punkt1 in Nexø with the aim of talking with one of the larger e-product distributors on the island. On their website it appeared that they, besides selling new e-products, also repair broken e-products in their repair shop. We wanted to know more about this service and in general to obtain a deeper insight in their business model. When calling, it was one of the employees, Martin, who picked up the phone. Martin confirmed that Expert & Punkt1 have their own repair shop but that repairs are not a significant part of their business. In most cases it is not financially beneficial for the customer to repair due to high costs compared to buying a new product. In general, it appeared that Expert & Punkt1 prefer to sell new products rather than repairing broken e-products. Furthermore, they did not seem interested in entering a collaboration with other local repairers in order to increase the market of repaired or second-hand e-products.

5.3.6 Carsten Aalling, Møbelfabrikken

Møbelfabrikken is a place for local entrepreneurship and projects with green agendas. To give an example hereof, Repair Café Nexø, which is part of Repair Café Danmark, is located in Møbelfabrikken. Here, local volunteers are present twice a week to guide local citizens to repair broken products such as textiles and furniture.

We contacted the manager, Carsten, who welcomed us at Møbelfabrikken when we visited the island in April. Carsten showed us around and talked very enthusiastically about the vision and all their ideas. Their vision is to become the leading hub on Bornholm for sustainability projects. Møbelfabrikken has already established wood and textile workshops where the Repair Café takes place. However, the current facilities cannot underpin a scaled up business model by which Carsten seeks new opportunities.

One of Carsten's ideas is to reorganize an old warehouse into a place for repair and resale of different products. When asked about the potential for Møbelfabrikken to play a role in the repair and reuse of e-products, Carsten stated that this could be the focus of the warehouse he wanted to reorganize. Carsten emphasized that a fulltime employee must manage the repair workshop but was unsure whether such a new repair shop should be affiliated to Repair Café Danmark or not.

5.3.7 Jens Kragh, FGU Bornholm

With the intention of further investigating the feasibility for a social-economic aspect of potential future solutions, we contacted FGU Bornholm which is an educational institution for young people up to the age 25. FGU, which in Danish is short for Forberedende Grunduddannelse (Preparatory Basic Education), offers the students an educational place at which they can prepare themselves for high school, vocational education, or employment. We wanted to know more about FGU Bornholm, their future ambitions, and if the students have internships during their time at FGU. Therefore, we established contact with one of the teachers at FGU Bornholm, Jens, who answered all our questions. Jens told us many interesting things about FGU but what we found the most interesting, and relevant for the project, regarded the students' internships. We imagined that FGU and local repairers could enter a collaboration which would benefit all actors. The students would get some practical experience, the repairers would get more and cheaper labor, which potentially could lower expenses related to repairs and thereby either lower the price for local citizens or increase the profit for the repairers. Luckily for us, Jens and FGU Bornholm in general were keen on the idea for FGU Bornholm to enter collaboration with local repairers as he believed practical experience is a great way to learn for the students.

5.3.8 Odinn Magnusson, Local visionary

After the distribution of our survey, we were contacted by Odinn Magnusson, a local citizen of Bornholm, who expressed an interest in discussing a theory of how we might counter the issues of consumerism and products having too short lifespans. Odinn owns a second-hand shop and is an autodidact mechanic and repairer of all kinds of products. After receiving an email from Odinn, we called him to hear more about his ideas. He told us that he has been developing his own theory for over a decade and believed it would be of interest to us. We therefore arranged a meeting during our trip to Bornholm.

Our initial impression of Odinn was that he seemed very knowledgeable about technological developments, production, obsolescence, and repair, and was very passionate about sustainable consumption. He highlighted how he believes that fashion within the e-products industry plays a significant role as a type of planned obsolescence, contributing to a decreased lifespan of products, and that unconscious consumerism leads to low quality products dominating the market. A key element of Odinn's theory is therefore, that education of kids and young people is the only realistic way to avoid unsustainable consumerism in the future. He believes that consumers need to develop a solid understanding of how products are made, function and can be repaired, and that a generation of people that has required such knowledge early in their lives will, through their purchasing habits, force manufacturers to design products that last.

The interview with Odinn inspired us to give more thought to education as a factor that is not only relevant with regards to developing skills to repair e-products, but also as an element that can help drive production and consumption in a more sustainable direction. It also became apparent to us that someone like Odinn might be of great value in driving local repair initiatives and training future repairers.

CHAPTER 6

6. Analysis

In the analysis, we will initially map out the current streams of e-products and e-waste, through the application of stock and flow diagrams. This is done in order to assess whether or not the material flows can underpin a business model focusing on increased repair and reuse of e-products. Following this, we will explore which barriers currently deter local consumers from wanting to buy used e-products or to have broken e-products repaired as an alternative to buying new. Furthermore, we will investigate the structures and dynamics within the regime of e-products and e-waste through a theoretical perspective of socio-technical transitions. Finally, we will apply an ANT approach to exploring how a process of translation might help to coordinate the efforts of local actors in order to accommodate our mission of ensuring longer lasting e-products through repair and reuse.

6.1 Current system

To accommodate the research question, it has been necessary to obtain a comprehension of the current material flows on Bornholm. Inspired by Meadows (2008), Figure 32 represents a stock and flow diagram which visualizes the stream of e-products on the island. The differences in inflows and outflows sums up the stock.

The main purpose of Figure 32 is to provide a figurative overview of present stocks and flows, and thereby show where in the system we can intervene in order to make a difference. In spite of not having specific numbers, the thickness of the arrows symbolizes estimated volumes of the flows. In order to determine the estimated sizes of the inflows, we have applied data from Norstat (2020). With regards to the outflows, we assume that the distribution is similar to the nationwide allocation by which 82% is recycled, 10% is incinerated, 6% is landfilled, and 2% is reused (DPA-System, 2020). The thickness of the arrows is relative to each other but not proportional.

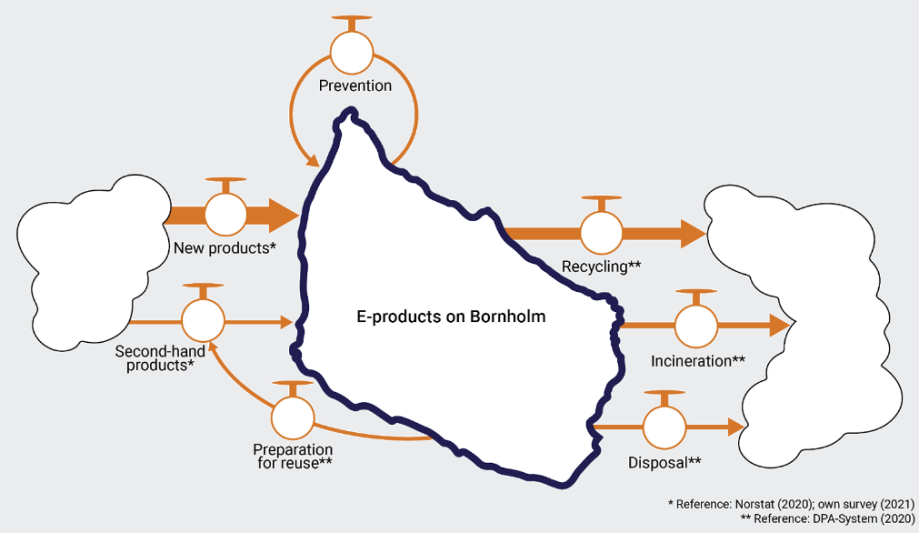


Figure 32. Stock and flow diagram of current system. Inspired by Meadows (2008)

From Figure 32, we can see where in the system we should intervene in order to change the flows of the current system. To exemplify, the outflows of incineration and disposal are currently greater than preparation for reuse which, in an environmental context, is not the most optimal (Cole et al., 2019). Also seen in economic and social

contexts, reusing should be furthered at the expense of the other types of treatment (Accenture Strategy, 2017; McMahon et al., 2019; Riberio-Broomhead & Tangri (2021). Thus, it seems that there is a huge unresolved potential both economically, environmentally, and socially, as only few e-products currently are prepared for reuse or prevented from becoming e-waste through repair.

The aim of this project is to develop a concept that will contribute to increasing preparation for reuse and preventing e-products turning into e-waste prematurely. These processes are illustrated on Figure 33 which also highlights how different flows must be changed.

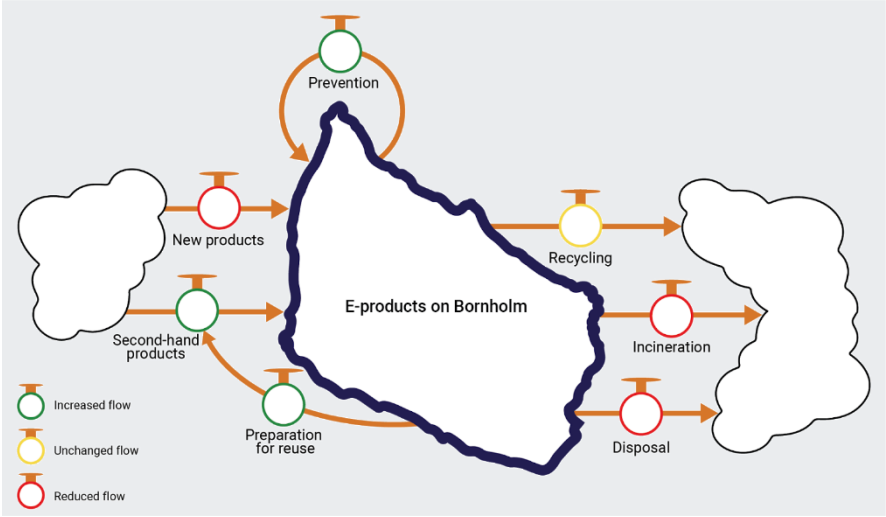


Figure 33. Stock and flow diagram illustrating the aim of this thesis. Inspired by Meadows (2008)

While the flows of new products, incineration, and disposal will be reduced, we imagine that the outflow of recycling will remain unchanged. The reason hereof is that all types of e-products will become waste at some point, no matter how many times they are repaired or reused, and therefore eventually will be gathered by collective schemes. However, it is hard to estimate whether the recycled volume will increase or decrease in the future as the recycling rate most likely will increase while marketed volumes will preferably decrease.

6.2 Specification of data

In order to determine whether or not the current streams can underpin a social-economic business model for repair and reuse, it has been necessary to concretize the inflows and outflows. The following sections show how we have estimated the inflows of e-products on Bornholm. Subsequently, we will outline how we have estimated the outflows of e-waste on Bornholm.

6.2.1 Estimation of inflows

With regards to the inflows, i.e., marketed e-products, we have attempted to find data through desk-research. It has however not been possible to determine exact data of marketed e-products in specific municipalities. Therefore, we have estimated the streams ourselves. This, we have done by applying two different approaches. The first method results in a comprehensive number for all e-products marketed on Bornholm measured in tonnes. The other method seeks to quantify how many products that have been marketed in different product categories. The first method has a high level of reliability but cannot assess how many units there have been sold. The other method has a

low level of reliability as many uncertainties are attached. However, it provides an estimate of how many units there have been sold which is significant in order to determine whether or not the current streams can underpin a business model for repair and reuse.

6.2.2 Method 1

To estimate a generic volume of all marketed e-products, we have applied national data in a local context by multiplying how many kilos of e-products the average Dane buys with the number of citizens on Bornholm. Data from 2020 shows that the average Dane bought 30.5 kg of e-products in 2019 (Eurostat, 2020) while the population on Bornholm in the same year was 39,600 (Danmarks Statistik, 2021b). Thus, by multiplying the two factors, 1,200 tonnes of e-products were marketed on Bornholm in 2019.

6.2.3 Method 2

To quantify how many units that have been marketed, we have extrapolated data from Norstat (2020) to a local context on Bornholm. To exemplify, 44% of all households in Region Hovedstaden acquired a mobile phone in the survey period by which we assume that 44% of all households on Bornholm did the same. According to Danmarks Statistik (2021d) there were 20,300 households on Bornholm in 2019. Thus, data from the survey show how many households that in the survey period acquired new e-products within eight product categories. Furthermore, these numbers have been converted to yearly estimates instead of the survey period of 21 months. The results from this method can be seen in Figure 34.

Product category	% of households	In survey period (21 months)	In 12 months
Mobile phone	44%	8,932	5,104
PC	30%	6,090	3,480
TV	21%	4,263	2,436
Fridge / freezer	17%	3,451	1,972
Washer / dryer	15%	3,045	1,740
Dishwasher	13%	2,639	1,508
Kitcenware	45%	9,135	5,220
Tools	21%	4,263	2,436
Total		41,818	23,896

Figure 34. Number of new e-products acquired on Bornholm (Norstat, 2020)

The results from Figure 34 undoubtedly have several uncertainties attached. Firstly, the estimation is based on an extrapolation from Region Hovedstaden to Bornholm by which we assume that the distributions are the same for the two geographical locations. Secondly, the data from Norstat (2020) is made upon households and not units. Therefore, the output from Figure 34 actually indicates how many households that have acquired one of the products and not how many. Thus, the estimates are minimums and can potentially be higher. Furthermore, it is important to emphasize that the number of units sold within the eight product categories does not exclusively constitute all 1,200 tonnes of e-products marketed on Bornholm as other product categories have been marketed as well.

6.2.4 Estimation of outflows

With regards to the outflows, we were once again interested in both a total amount and an estimation of how many e-products that become e-

waste. This time we succeeded in finding specific data of how much e-waste there is generated annually on Bornholm through the DPA-System. Most recent data (DPA-System, 2020) shows that Bornholm generated 675 tonnes of e-waste in 2019. This means that each citizen on Bornholm in 2019 generated 17.1 kg of e-waste.

E-WASTE FRACTION	VOLUME
LARGER E-PRODUCTS	233
MIDSIZE E-PRODUCTS	105
DOMESTIC APPLIANCES	114
SMALLER APPLIANCES	169
SCREENS AND MONITORS	47
LIGHT SOURCES	7
PHOTOVOLTAIC SYSTEMS	0
TOTAL FOR BORNHOLM	675
PER INHABITANT (kg)	17.1

Figure 35. Volume of different e-waste fraction on Bornholm in 2019 (DPA-System, 2020)

As Figure 35 shows, the total of 675 tonnes is divided between seven different fractions. Since these numbers exclusively are based on weight, the split between quantity of products may be very different. Once again, it was not possible to determine estimates of how many products that annually become e-waste through desk-research by which we applied the same approach as from the second method above. To exemplify again, 32% of all households in Region Hovedstaden experienced a mobile phone breaking during the survey period. We have extrapolated these numbers to local context on Bornholm and furthermore converted the numbers into a yearly reference instead of a period of 21 months.

Product category	% of households	In survey period (21 months)	In 12 months
Mobile phone	32%	6,496	3,712
PC	17%	3,451	1,972
TV	7%	1,421	812
Fridge / freezer	10%	2,030	1,160
Washer / dryer	13%	2,639	1,508
Dishwasher	9%	1,827	1,044
Kitcenware	19%	3,857	2,204
Tools	6%	1,218	696
Total		22,939	13,108

Figure 36. Number of broken e-products yearly on Bornholm (Norstat, 2020)

From Figure 36, we see an estimate of how many e-products from the eight product categories that break every year. We can see that the estimates show that 13,108 e-products break annually on Bornholm based on the eight product categories. Especially smartphones, computers, and domestic appliances are product categories that often break. For example, the specific number for broken smartphones corresponds to approximately ten units breaking every day. However, by following this approach the same uncertainties are attached.

Furthermore, it is once again important to emphasize that the data from Figure 36 does not exclusively constitute all 675 tonnes of e-waste on Bornholm as other product categories also become e-waste. By transferring the numbers from both inflows and outflows into a stock and flow diagram, we see that the inflow of e-products is almost twice the outflow of e-waste. This can at first sight be interpreted that the stock of e-products on Bornholm accumulates in households and at workplaces due to hibernation (Miljøstyrelsen, 2016b; Wilson et al., 2017).

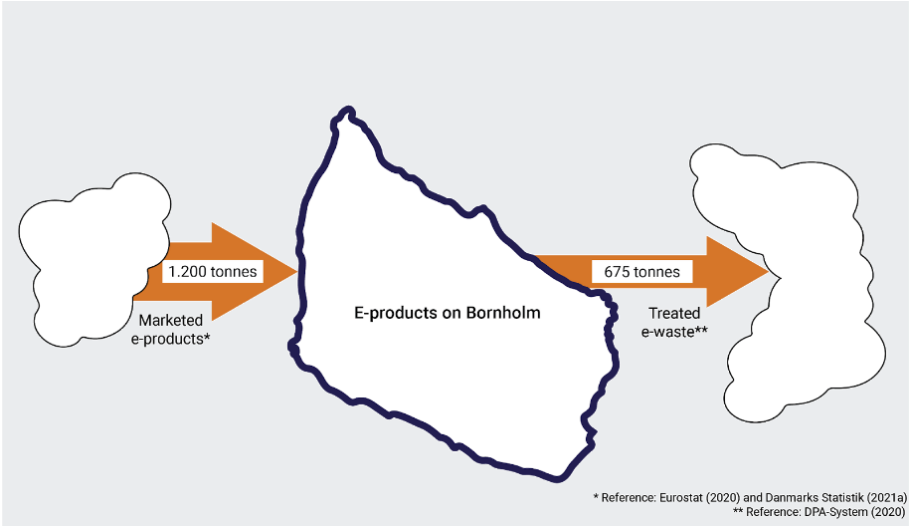


Figure 37. Stock and flow diagram of e-products marketed, and e-waste generated on Bornholm

However, this is not the absolute truth. Miljøstyrelsen published a report in 2016 (Miljøstyrelsen, 2016a) which estimates volumes of different amounts of e-waste streams that are not being managed by the collective schemes, and where DPA-System therefore has no data. These are defined as shadow streams.

6.3 Shadow streams

According to Miljøstyrelsen (2016a) there are eleven different shadow streams. However, we believe some of these can be merged such as 'thefts of smaller e-products from households' and 'thefts from recycling stations'. Figure 38 shows how we have categorized eleven shadow streams into six. Furthermore, the figure indicates the estimated volumes of each shadow stream on a national scale assessed by Miljøstyrelsen (2016a).

Shadow stream (Miljøstyrelsen)	Shadow stream (categorized)	Volume (in DK)
E-waste collected from companies	E-waste collected from companies	17,500 tonnes
Take-back of used e-products	Take-back of discarded e-products	16,400 tonnes
Take-back of non-sold e-products		
Thefts of e-products from households	Thefts of e-products	15,900 tonnes
Thefts of e-waste from recycling stations		
Missorted e-waste from households	Missorted e-waste	9,000 tonnes
Missorted e-waste from companies		
Missorted e-waste from recycling stations (metals)		
Missorted e-waste from recycling stations (cables)		
Accumulation of e-products in households	Accumulation of e-products in households	8,600 tonnes
Export of used e-products	Export of used e-products	5,000 tonnes

Figure 38. 11 shadow streams categorized into six shadow streams and national volumes (Miljøstyrelsen, 2016a)

As a remark on accumulation of e-products, we would like to emphasize a disagreement with the fact that accumulation is referred to as a shadow stream by Miljøstyrelsen (2016a). When e-products accumulate/ hibernate in households they do not leave the system like the other shadow streams. Wilson et al. (2017) claim for instance that the average phone hibernates for three years before it is forwarded in the system. Therefore, we consider accumulated e-products as a delayed process before they eventually are discarded as e-waste at the local recycling station. Shadow stream or not, accumulated products constitute a great share of e-products in the households as 11% of all e-products have not been used within the last year (Miljøstyrelsen, 2016b). Additionally, Miliute-Plepiene (2021) have found that 33% of Swedish households have at least one mobile phone that is less than four years old, which is not being used. Therefore, we have included hibernating products in the following section, as it is relevant to estimate the local streams of accumulated e-products and furthermore to explore how these products can reenter the loop and create value for new users instead of becoming obsolete while hibernating.

6.3.1 Shadow streams on Bornholm

By extrapolating data from a national perspective to a local context on Bornholm, we have estimated the local shadow streams. Through application of method 1 from above, we have calculated how much the volume of each shadow stream corresponds to per capita in Denmark and afterwards multiplied this by the quantity of citizens on Bornholm. As before, we assume that the population of Bornholm is 39,600 (Danmarks Statistik, 2021b) while data shows that the population in Denmark in 2019 was 5,806,000 (Danmarks Statistik, 2021b). This method has resulted in the following numbers illustrated in Figure 39.

Shadow stream (categorized)	Amount (Denmark)	Volume (Bornholm)
E-waste collected from companies	17,500 tonnes	119 tonnes
Take-back of discarded e-products	16,400 tonnes	112 tonnes
Thefts of e-products	15,900 tonnes	108 tonnes
Missorted e-waste	9,000 tonnes	61 tonnes
Accumulation of e-products in households	8,600 tonnes	59 tonnes
Export of used e-products	5,000 tonnes	34 tonnes

Figure 39. Shadow streams volumes on Bornholm

When combining all the shadow streams, including accumulation, to the official number for collected e-waste, it adds up to 1,168 tonnes which is close to the 1,200 tonnes that is marketed.

Without considering the shadow streams, the proportion between marketed e-products and treated e-waste seemed unbalanced. We have considered the shadow streams on Bornholm for mainly two reasons. Firstly, we have implicated them in order to obtain the most correct picture of the current system. And secondly, we have considered the shadow streams due to the fact that the volume of actual products that can underpin a repair and reuse business model is higher than it may seem when only considering the official numbers declared by DPA-System.

To conclude, we have now seen that material recycling is the predominant practice for end-of-life treatment of e-waste and that this is not the optimal solution in terms of sustainability. We have also seen that the flows of e-products on Bornholm represent significant volumes, and therefore also significant value. We would therefore argue that the availability of discarded and hibernating e-products is not a factor limiting the possibility of implementing concepts for increased repair and reuse. However, other factors may exist as barriers for achieving this goal. This matter is the topic of the following section.

6.4 Locals' barriers

Taking a step back, we have identified a range of problems throughout our empirical research that represent barriers for reaching our mission of enabling longer lasting e-products through repair and reuse. The different problems have been arranged in a problem tree which is illustrated in Figure 40.

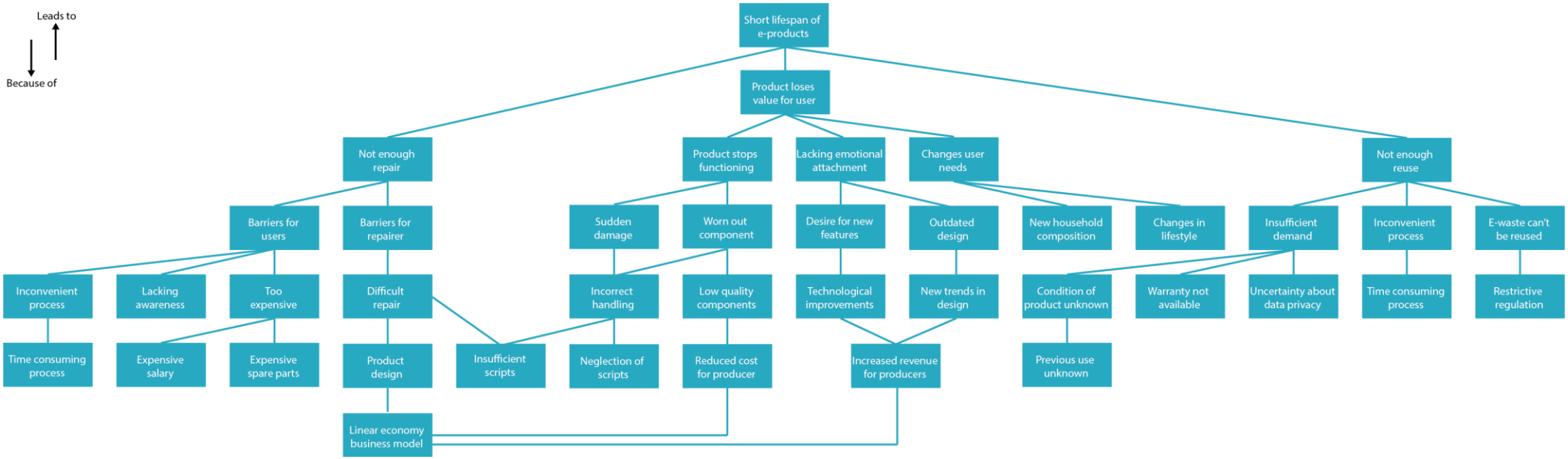


Figure 40 Problem tree. Inspired by MIT (n.d.)

In the problem tree, the identified problems have been organized in different levels, from general to more specific problems, with lines between individual problems indicating causality. As such, the first problem from the top, 'short lifespan of e-products', relates directly to our mission statement. This overarching problem branches out to more specific problems that can be considered its causes.

The problem of 'not enough repair' is an example of a problem leading to the short lifespan of e-products. As we can see in the problem tree, this can be caused by either barriers for the users or barriers for the repairers. Barriers for the users include price and inconvenience, which again can be branched out to their causes. The problem of price for example can be attributed to expensive salary and expensive spare parts. This series of problems have been discussed with Johann from Service Centret Bornholm and other repairers we have talked to as part of our empirical research. From these interviews we have learned that the high salary in Denmark is generally the largest contributor to repairs being expensive. Additionally, as we have previously described, our empirical research has highlighted price as the primary determining factor for whether consumers chose to repair broken products (Jørgensen, 2020b; Norstat, 2020).

We can therefore conclude that means of reducing this cost is of high relevance in the process of conceptualization. Another problem is 'not enough reuse'. This problem can again be attributed to a range of different causes. This group of problems have to a large extent been based on results from our own survey, where we asked the respondents to describe which factors would make them refrain from buying used e-products. Following the survey, we organized the different responses to this question in an affinity diagram, see Figure 41. This gave us an indication of which factors were most problematic in terms of making reuse more attractive to the consumers, and thus also what elements would be most relevant to explore during the conceptualization. From the affinity diagram we saw for example that a very large number of the responses related to concerns about warranty and remaining lifespan of the used products.

By utilizing the problem tree, we have been able to map all of the problems we have identified throughout the project in a way that indicates their individual cause and effect. While some of the problems identified lie outside the scope of the project and not all problems necessarily need to be solved in order to achieve our mission, the problem tree can be seen as a basis for conceptualization. It also allows for consideration about which actors and resources might be suitable to tackle the different problems.

In the following sections, we will first explore which systemic elements constitute barriers for achieving our mission of ensuring longer lasting - products through repair and reuse, and secondly which actors and resources are available to contribute to a sustainable transition.

Figure 41. Affinity diagram. Inspired by Holtzblatt and Beyer (2017)

6.5 A socio-technical transition perspective

In the following sections we will investigate the structures and dynamics within the regime of e-products and its waste through a theoretical perspective of socio-technical transitions. We seek to identify potential drivers for change towards more sustainable practices, along with barriers that can become a hindrance for radical innovation. The e-waste sector is under pressure as a result of growing populations and consumption along with the accompanying detrimental environmental effects such as the rise in greenhouse gas emissions and resource depletion (Miljøministeriet, 2020). Following these developments, environmental concerns and plans for sustainable development have

over the past years become widely recognized as important topics on the political agenda, both nationally and internationally. We see examples of this tendency with countries' commitment to e.g., the Paris Agreement, Basel Convention and UN's Sustainable Development Goals. As we have previously described, the rapid increase in the amounts of e-products that surround us in our everyday lives is a significant contributor to the detrimental effects our consumption has on the environment. We have also seen that consumption of e-products is strongly linked to the growing wealth of nations and that there is a discrepancy between the resource intensive manufacturing and the relatively short lifespan of e-products. As a consequence of these alarming tendencies becoming more evident, we also see broad political changes related to e-products and their waste.

Slow and gradual developments such as increasing consumption, population growth and increasing political focus on environmental concerns represent changes to what Geels (2002) would define as the socio-technical landscape. Landscape changes can exert pressure on the trajectories of an otherwise highly path dependent regime, potentially opening a window of opportunity for radical innovation. According to Geels (2002), such innovations can only emerge from technological niches that are external to the regime since they cannot compete in the established selection environment of the regime during their development. In this context, niches function as protective spaces in which new technologies can mature. Pressure from the socio-technical landscape can change the selection criteria of the regime, allowing new technologies to enter and transform its future trajectory. As a counter argument to this view on socio-technical transitions, Smith et al. (2005) state with their introduction of the quasi-evolutionary model of socio-technical transitions, that varying degrees of adaptive resources can in fact exist among incumbent regime actors and that the availability and coordination of such resources make up the adaptive capacity necessary for regime transformations. Through our analysis we utilize perspectives from both the MLP and the quasi-evolutionary model. We believe that the MLP provides a good approach to understanding how different socio-technical structures contribute to the path dependency and accompanying inertia of the regime. However, our empirical research has indicated that the regime is not as strictly path dependent as the MLP would have us believe. We would also argue that the MLP's neglect of agency among regime actors means that the emergence of radical innovation is to some extent left to chance. While that may in some cases be true, it is not particularly useful in the facilitation of a desired change. We have therefore also utilized the quasi-evolutionary model of socio-technical transitions, since it has allowed us to, more purposefully, seek to identify adaptive capacity that can contribute to a sustainable transition.

In order to understand the potential for a socio-technical transition we must first characterize the structures and dynamics of the current regime of e-products, which we define as the regime relating to all lifecycle stages of e-products, from material extraction to end-of-life treatment. This includes human actors, social practices, rules and regulation, knowledge, technologies etc., all embedded in infrastructures and institutions. In this regard, it is relevant to investigate which factors contribute to the stability of the regime and which internal or external forces seek to destabilize it in an attempt to change its trajectory. The list of elements contributing to the regime's stability is long and we will

here only expand on the ones we find to be the most influential in shaping its developments.

6.5.1 Path dependency of the current regime

The take-make-dispose approach to production and consumption is no less prevalent within the regime of e-products than in most other sectors. Several factors contribute to upholding the status quo in this regard. For instance, the waste management sector has seemingly become a stabilizing factor for the design and manufacturing industry and vice versa. Since material recycling is the dominant practice within e-waste management, there is little to no direct incentive for producers to design products with more environmentally efficient end-of-life scenarios in mind (McMahon et al., 2019; Parajuly et al., 2019). Similarly, the way in which products are designed and manufactured stabilizes the operations related to e-waste management. Most products are not designed for e.g., rapid disassembly or remanufacturing, and the business models of manufacturers are predominantly not considering products' end-of-life potential. Therefore, manufacturers further stabilize the dominant practice of recycling companies, i.e., mechanical separation of materials with the aim of recovering and recycling those with the highest economic value (Kumar et al., 2017; Meloni et al., 2018; Markussen et al., 2019). The dominant practices of the recycling industry, to some extent, become a framework condition for the wider system of e-waste management, since large investments have gone into establishing infrastructure and streamlining the current processes of material recovery. Attempted changes to the regime's trajectory will therefore most likely meet significant resistance from the recycling industry, as they will seek to defend their position within the system.

Current legislation on e-waste management can be seen as another factor contributing to the stabilization of the regime's trajectory. Although several legislative initiatives have been made to minimize environmental impacts and ensure the circularity of e-products, they have mostly been in line with the established technological trajectory. As we have previously described, the WEEE-directive has stipulated increasing requirements for collection and recycling rates in the EU's member states. A central element in the WEEE-directive is the principle of EPR. The fundamental idea of EPR is that making individual producers responsible for the end-of-life treatment of their marketed products will increase their incentive to design and manufacture products that are better at retaining their value through longer lifespans and more optimal circular end-of-life scenarios. However, the WEEE-directive has been subject to much criticism for not delivering the expected results in terms of environmental effects (Miljøstyrelsen, 2015; Cole et al., 2019). Some critics argue that since the WEEE-directive is in most cases implemented through collective schemes, it relieves the producers of their individual responsibility, thus not creating sufficient incentive for producers to design products differently (Petersen, O., M., personal communication, February 23, 2021). Moreover, since the implementation of the WEEE-directive entails that the collective schemes have legal ownership of all e-products once they have been classified as waste, the ownership in itself serves as a barrier for increasing the rate of which products are repaired and reused (Petersen, O., M., personal communication, February 23, 2021; Remtoft, N., personal communication, February 23, 2021). It can be argued that the way in which the WEEE-directive has been implemented is to some extent a consequence of the selection criteria bearing on the regime, since it has been implemented in a way that requires minimal deviation

from the established trajectory of development. In a sense, the development of the regime follows the path of least resistance and is therefore typically incremental by nature.

The behavior of consumers represents another important aspect that is influential in shaping the trajectory of the regime. Planing (2015) provides an example of how consumers' behavior can constitute a barrier for companies' transition towards more circular business models, stating that consumers are not purely rational in their purchasing habits, but often rather make decisions based on subjective beliefs about products or services. This means in practice that consumers are for example not always willing to pay more for products with a longer expected lifespan or return used products for a small reward once they are no longer needed, even though such aspects would decrease the lifetime cost of a certain good. Parajuly et al. (2020) also highlight that "Transition towards a circular economy is not possible without a fundamental change in consumer behaviors regarding green purchase, adaptation to new business models and acceptance of product upgrading that involves repair and remanufacturing." (p. 5). We realize that such fundamental change can be difficult to achieve, especially because "the marketplace behavior of consumers are not always consistent with their attitude or ethics" (Parajuly et al., 2020, p. 4).

Results of our survey show another concrete example of seemingly irrational consumer behavior, in that respondents were on average willing to pay almost twice as much for a second-hand smartphone than they would for the repair of a broken phone of the same model, although the resulting product in both cases can arguably be considered equal. Our empirical research has generally shown that price is the most significant barrier for consumers' willingness to repair (Norstat, 2020; Karlsen, J., A., personal conversation, April 24, 2021) and those high salaries are the primary cause of repairs being relatively expensive (Miljøstyrelsen, 2015; Aakjær, J., personal conversation, April 24, 2021). Since consumer behavior to a large extent controls the activities of companies, it can function as a barrier for radical changes in the way they do business. On the other hand, since the operations of most companies are still predominantly structured around linear economic business models, they generally have an interest in maintaining the consumption habits of their customers in order to generate increased revenue through additional sales. As such, this reciprocating relationship between consumers and producers becomes another reinforcing factor for the stability of the regime.

6.5.2 The potential for regime transformation

Taking all the different aspects that we have described in the previous section into consideration, it is clear that the regime of e-products is subject to a high degree of path dependency. It is also clear that the environmental effects of the current regime, including rapidly growing amounts of e-waste, its contribution to climate change and increasing depletion of scarce resources is unsustainable. These latter factors are exerting significant pressure on the regime, opening a window of opportunity for change towards a more sustainable developmental trajectory. We must therefore identify strategies for a socio-technical transition of the regime. The central question thus becomes to which extent adaptive resources exist within and outside of the regime, and how such resources and responses of actors might be coordinated and mobilized in a transition towards a more sustainable future regime.

According to Smith et al. (2005), a prerequisite for a socio-technical transition is that selection pressures on the regime are articulated towards a specific direction of change. The pressures bearing on the regime of e-products are primarily being articulated through legislative initiatives and different political plans such as the Circular Economy Action Plan (European Commission, 2020) and Handlingsplan for Cirkulær Økonomi (Miljøministeriet, 2020). In a more local context of Bornholm, the selection pressures have been articulated through the vision of becoming a waste-free island. This vision is further expressed through a series of specific goals that serves as a guideline for concrete projects that have been initiated by the municipality and BOFA.

Besides the articulation of selection pressures, Smith et al. (2005) points to adaptive capacity as another critical element required for regime change. Adaptive capacity should be understood as the product of two factors: Firstly, the availability of adaptive resources such as knowledge, competencies, capital etc. These can be either internal or external to the regime. Secondly, the coordination of such resources and responses of actors.

Through our empirical research, we have identified adaptive resources among a range of different actors which can potentially serve as a driver for a sustainable transition. Such resources are seemingly present both within and outside of the regime. As we have discovered through our interview with Johann, Service Centret Bornholm represents a significant resource in the form of knowledge and competencies to repair all sorts of e-products. Besides the obvious incentive of repairs generating revenue for the company, Johann seemingly has a genuine ambition and personal motivation to increase repair and reuse for the benefit of the environment. As such, the repair company serves as an example of an incumbent actor with resources to support a sustainable transition of the regime. However, although part of the regime, the company on its own also represents an actor that is not very central to the dominant practices of the regime and has very limited power to influence the trajectory of development.

Bornholmermarked is another example of an incumbent actor that can potentially add to the adaptive capacity of the regime. Similarly, to Service Centret Bornholm, Bornholmermarked is not a powerful actor in terms of agency to shift the developmental trajectory of the regime. However, it possesses significant resources in the form of its sales platform, which has a wide reach to the citizens on the island, as well as insights into the consumer behavior of its users.

The citizens of Bornholm naturally also play a part in the regime, given their role as consumers. As we have previously described, consumer behavior is influential in shaping the actions of companies. However, it is perhaps not valid to punctualize this group as one actor. At least, consumers should arguably be considered as a more conflicted actor, given the diversity of the group and the differences in their preferences, actions and convictions. Unregarded of these differentiations within this group of actors, their purchasing power represents a significant resource, although initiatives to align their efforts might be needed in order for them to significantly alter the selection criteria of the regime.

Besides these incumbent actors, we have identified a range of actors external to the regime that we believe are also capable of contributing to its adaptive capacity. Such actors include FGU Bornholm, which we

believe could serve as a valuable asset, since the goal of the organization is to bring knowledge and competencies to the young people enrolled in their programs. In the context of a sustainable transition, these young people could represent a significant resource in terms of labor and their acquired knowledge related to repair and reuse.

Møbelfabrikken is another actor that is external to the regime of e-products but could potentially play a role in responding to the selection pressures bearing on the regime. The organization already facilitates different repair activities, although not related to e-products, and has an ambition of supporting sustainability projects on the island. Møbelfabrikken has an established relationship with FGU, since it houses wood, sewing and metal workshops where FGU students are occupied with different activities. During our interview with Carsten Aalling, we learned that Møbelfabrikken has space that could be transformed into a facility for repair of e-products and reselling of various used products. In this regard, Møbelfabrikken also represents adaptive resources of value to a transition.

Some citizens may possess resources that make them able to play a role besides their role as consumers. Odinn is an example of such. Given the skills he has acquired in repairing various types of e-products, he may also be of value in a transition context.

Lastly, our primary collaboration partner, BOFA, serves as an example of an incumbent actor contributing to the adaptive capacity of the regime. This is especially true since they arguably have a more dominant position in the regime than the other actors. As a part of the regional municipality of Bornholm it is also the actor with the most actual power to delegate roles and give legitimacy to other actors. Within the scope of our project, we therefore also identify BOFA as the actor with the most agency in terms of planning and carrying our governance activities related to the socio-technical transition in a local context, since "Power is intimately related to agency, the ability to take action and hence the ability to intervene and alter the balance of selection pressures or adaptive capacity. Hence power facilitates agency" (Nafe et al., 2020, p. 50).

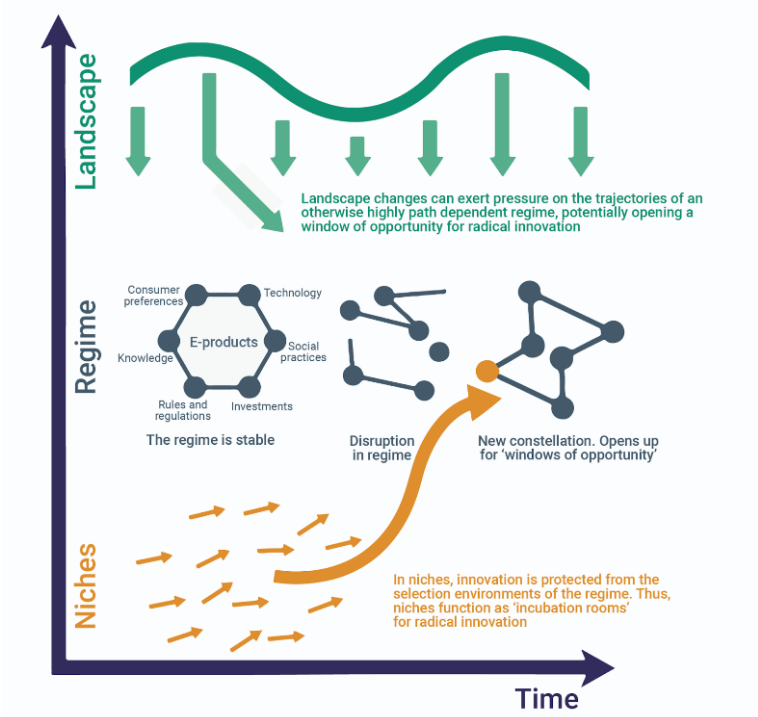


Figure 42. The Multi-Level Perspective with e-products as the regime. Inspired by Geels (2002) and European Environment Agency (2016)

As we have previously mentioned, Smith et al. (2005) state on the topic of governance that "The art of governing transitions becomes one of recognising which context for transformation prevails, and which drivers offer the best leverage for guiding change in a desirable direction." (p. 1498). They define four different transition contexts, each representing a distinct type of transformation. It should be noted however, that these represent ideal types and that real-world transitions are rarely so binary. Hence, in reality, different transition contexts usually coexist. As we have now seen, adaptive resources can be found both within and outside of the regime.

Since we have identified BOFA, FGU, Service Centret Bornholm, and Møbelfabrikken as actors that could play significant roles in solving the e-waste problem in a local context of Bornholm, we have established a transition context in which the locus of adaptive resources is both internal and external. The remaining factor determining the transition context is thus the extent to which the responses of actors are coordinated. Since our research has indicated that none of the local actors can facilitate the desired change on their own, it has become evident that a high degree of coordination between actors is needed. A pivotal goal and the primary objective of BOFA's governance activities thus becomes to ensure such coordination, in order to support a regime transformation in a context spanning between 'endogenous renewal' and 'purposive transition' which is illustrated in Figure 43.

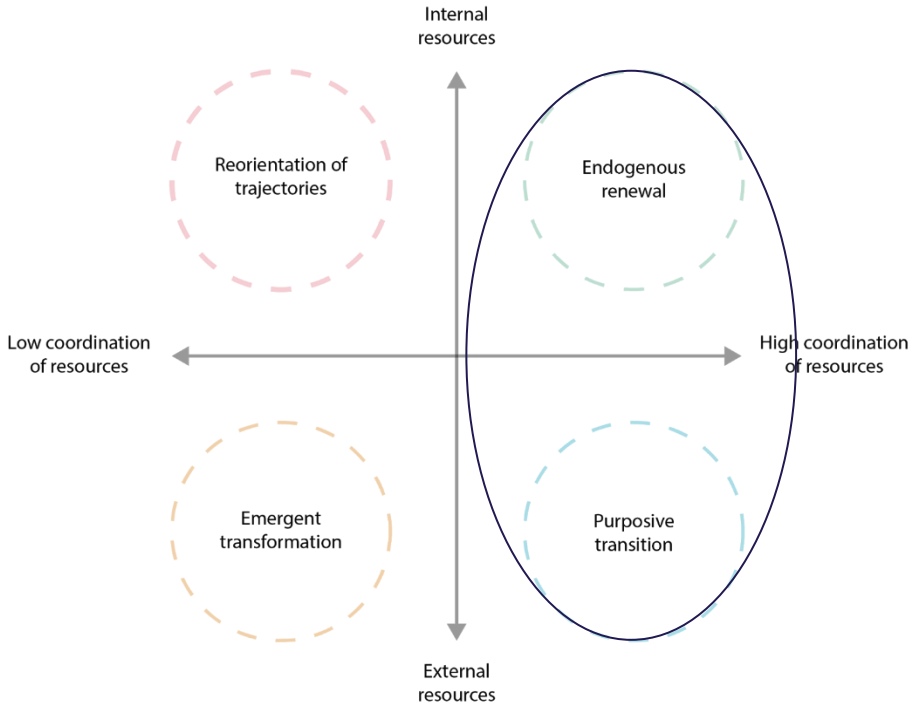


Figure 43. Transition contexts. Inspired by Smith et al. (2005)

6.5.3 A coordinated response

As we have now seen, the pressure on the regime is being articulated on multiple levels towards introducing more optimal circular solutions. At the same time, we have seen that adaptive resources are present both internally and externally to the regime of e-products. A remaining question thus becomes one of how we might ensure coordination of these resources in working towards a more sustainable regime, as Smith et al. (2005) state that "It is these latter two elements (the availability of resources and the ability to coordinate responses) that we identify as the

adaptive capacity available for regime transition". (p. 1492). We will argue that the theories of socio-technical transitions are not particularly action oriented but rather predominantly analytical and descriptive. They outline the prerequisites and dynamics of transitions but are less specific in terms of how they can be achieved in practice.

Since Geels (2002) argues that regimes are strictly path dependent and that no adaptive capacity for radical transformation can therefore exist within the regime, the primary objective becomes to create protective and nourishing environments for technological niches to develop. We shall not go further into details on this matter, since we do not subscribe to the belief that regimes are strictly path dependent.

Smith et al. (2005) emphasizes the importance of governance related to regime transformation since "It may seek to address the form, intensity, articulation or orientation of the selection pressures that act on target regimes. Or it may address the quality and distribution of adaptive capabilities" (p. 1494). However, much is left to interpretation in terms of how governance activities may in practice e.g., change the distribution of adaptive capabilities.

Furthermore, we believe that the hierarchical distinction of actors in both the MLP and the quasi-evolutionary model to some extent leads to a neglect of the role of less 'powerful' actors. Instead, we will apply the framework of Actor Network Theory (ANT) since we believe it represents a more practice oriented approach to ensuring the coordination of actors in order to reach a desired outcome. In ANT, this is achieved through the process of translation (Callon, 1986). We are not the first to suggest that ANT can contribute to the theories of socio-technical transitions (Geels, 2011). Geels dismisses this suggestion, given the difference in ontological views of the two theories. However, we would argue that this is in practice not of major significance. The flat ontology of ANT might even be of great value in this regard since some actors, as we just mentioned, can seem to be neglected in the hierarchical ontology of the MLP. In the flat ontological perspective of ANT, the adaptive resources that must be coordinated (Smith et al., 2005) represent actors in and of themselves. Since translation is a process of coordinating actors to work towards a specific goal, we believe that ANT provides an excellent framework for understanding how such coordination might be achieved in practice.

Since the problems we have identified require responses from various different actors, we are back to the challenge of coordinating the adaptive resources they each represent and the question of whether this can be achieved through a process of translation.

Our process of identifying actors that could be of benefit to a sustainable transition and the investigation of their individual motives, ambitions and alliances can be considered part of the initial phase of the translation process; problematization. It is essential that we consider which actors should be included in the network, but also which actors should be excluded. For instance, the actors that we have identified as potential contributors to the adaptive capacity of the regime should for obvious reasons be included, whereas the actors that will seek to defend the status quo of the regime should be excluded. An example of such an actor is the collective schemes since their dominant status will most likely perpetuate recycling as the preferred practice of the regime. The

process of problematization is therefore also about defining the roles that the different actors should ideally fulfill.

The second part of problematization is the establishment of an obligatory passage point (OPP) which in the case of the project has been directly derived from our mission statement. As such, the OPP becomes to answer the question of how the life of e-products might be extended through repair and reuse on Bornholm. In this way we have sought to make the result of our conceptualization indispensable for the actors that should be enrolled in the network, in order for each of them to achieve their individual goals.

Following the problematization, we must ensure the interessement of actors that should be part of the network. Interessement is the process of making actors take upon themselves the roles that were proposed to them during the problematization. This process can prove to be extremely challenging since some actors might resist due to opposing agendas. If we consider the translation to be a reconfiguration of the network to support our program of action, the active resistance towards the translation can be thought of as anti-programs. Although it is not possible to precisely predict which anti-programs may arise during any given process of translation, it can be useful to contemplate how potential conflicts might be mitigated.

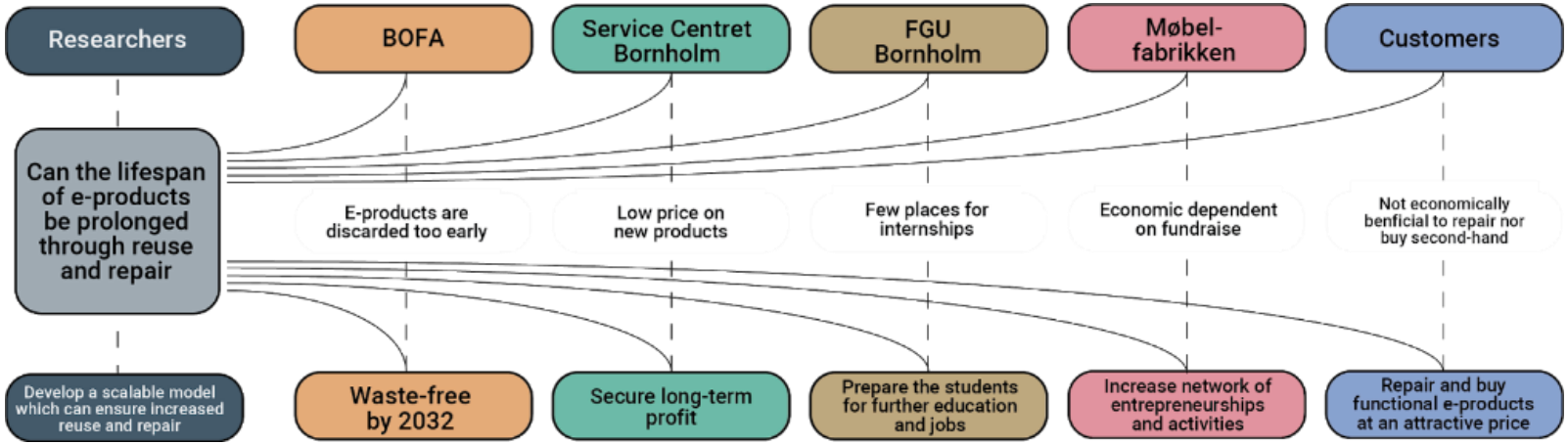


Figure 44. Obligatory passage point, barriers, and goals. Inspired by Callon (1986)

We could for example speculate that many consumers would oppose buying used e-products because of a fear that the used products will break shortly after the purchase since our affinity diagram has suggested that this is a very widespread concern among the consumers. Another example could be that retailers purposefully encourage customers to buy new products because the retailers earn a larger profit from that. Other examples of potential anti-programs can be seen in Figure 45.

Anti-programs such as these can be detrimental to the chances of interessement and therefore also the translation. The deployment of various interessement devices can therefore be necessary in order to succeed in the translation. These are non-human elements that can help to 'lock' actors into the roles that are required of them in order to support a desired change, for example by making it obvious for the individual actors how they can benefit from it.

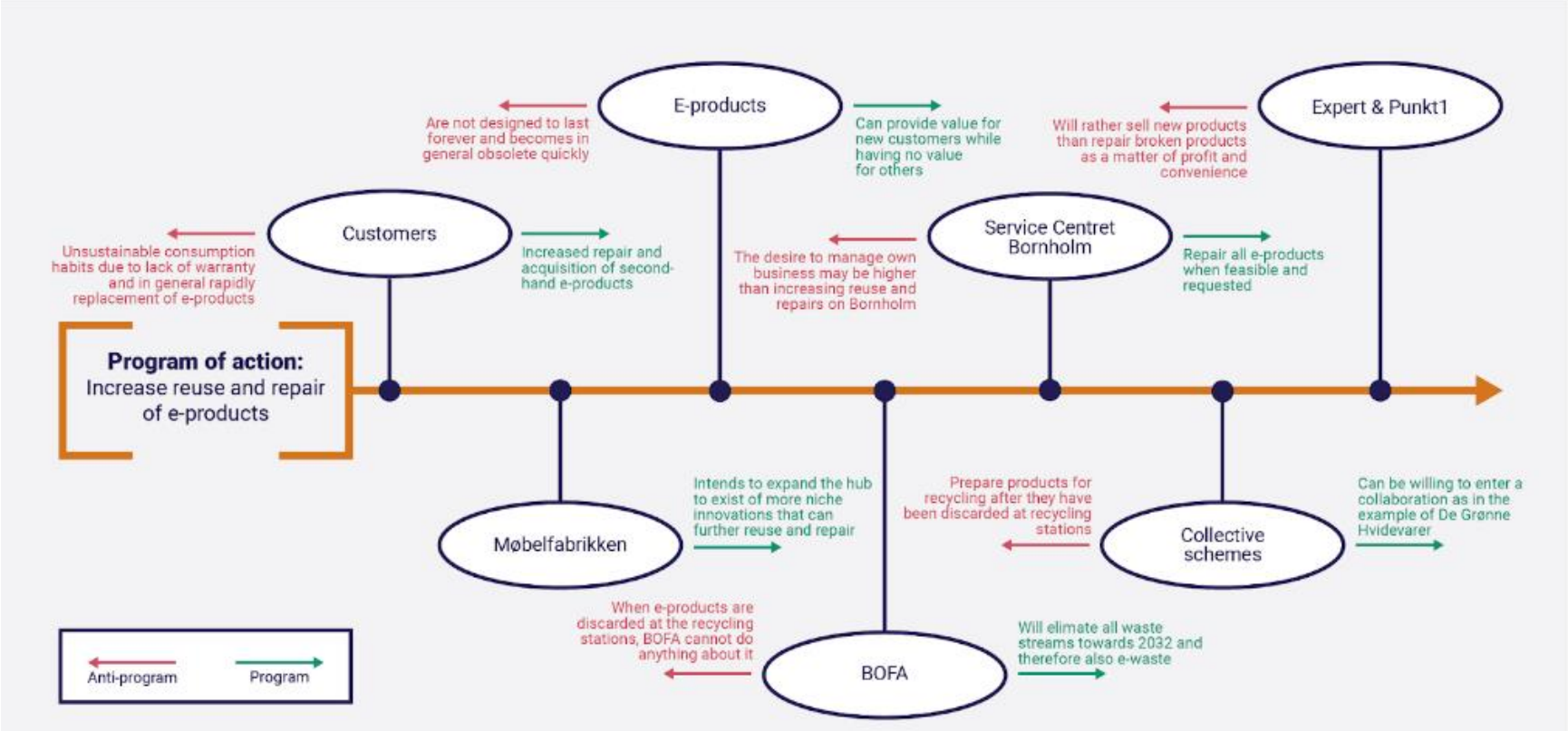


Figure 45. Program of action and conflicting anti-programs

As such, the interessement devices help to stabilize the roles and identities of actors in the process of translation. Examples of interessement devices targeted at the previously mentioned anti-programs could be warranty on used e-products or reduced tax on revenue from repairs. These can be seen in Figure 46.

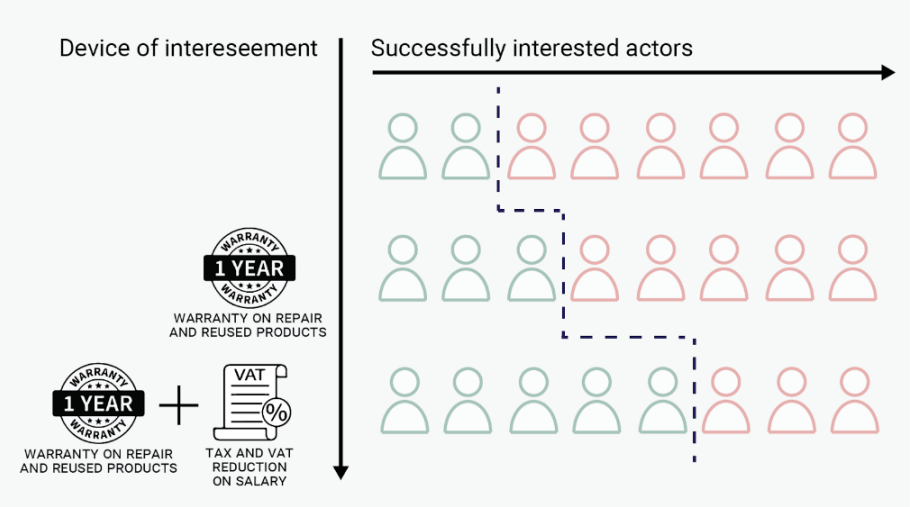


Figure 46. Implementation of interessement devices. Inspired by Latour (1991)

Successful interessement leads to the third moment of translation; enrolment. At this stage, alliances are formed through the interrelating and coordinating of roles which is achieved through negotiation. We argue that this interrelating of the roles directly relates to the coordination of adaptive resources that Smith et al. (2005) state is imperative to the adaptive capacity needed for regime transformation.

Lastly, the final moment of translation is the mobilization of actors in their assigned roles. Here, the actors independently continue to work towards the shared goal, and each contribute to maintaining the network.

At this stage of the project, it is not possible to assess whether mobilization can be achieved, as it depends on the circumstances of interessement and enrolment. This matter will be elaborated further in the discussion in Chapter 8. However, we believe mobilization is achievable since the problematization is firmly grounded in our empirical research, through which the actors that we have identified as carriers of adaptive resources have expressed willingness to contribute in various ways to the establishment of more sustainable practices related to the regime of e-products. The results of our conceptualization should therefore help to guide the attempts of interessement and enrolment.

CHAPTER 7

7. Conceptualization

In the following sections, we will first bring a description of the process that has led us to the concept we believe can further repair and reuse of e-products on Bornholm. Then, we will bring a detailed explanation of the suggested concept by applying a Business Model Canvas. Finally, we will assess the sustainability potential of the concept through application of different methods.

7.1 Objective tree

In order to conceptualize a business model that can support the suggested transition, we have converted the problem tree into an objective tree, which can be seen in Figure 47. The purpose hereof has been to ensure that the results of our conceptualization are qualified and based on real life obstacles identified through the analysis. To do so, all problems have been translated into objectives.

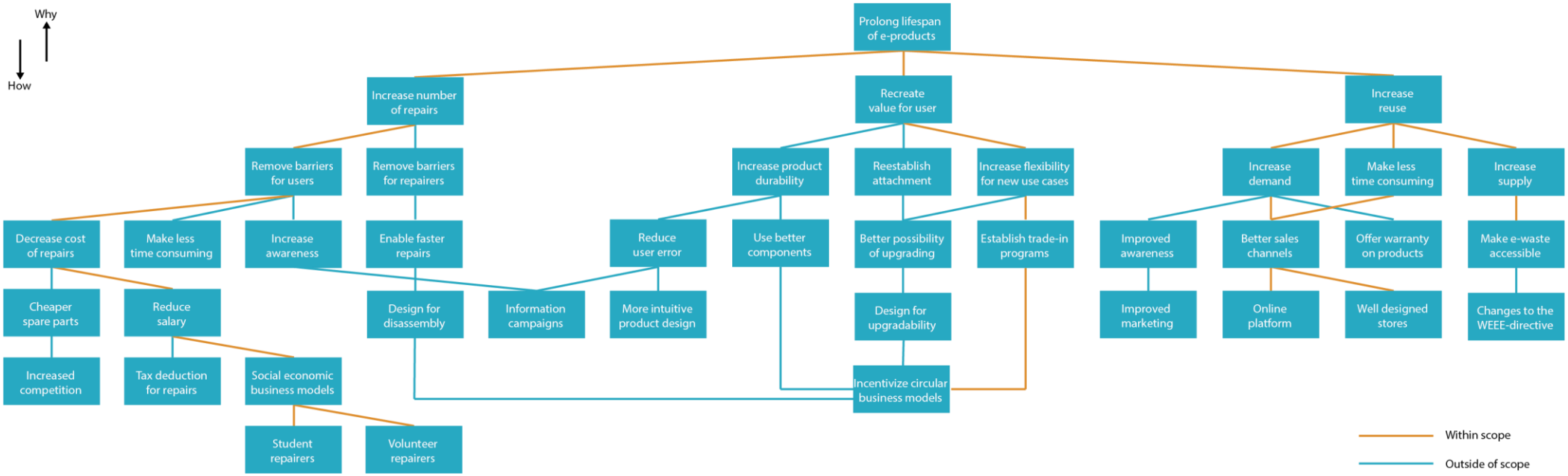


Figure 47. Problem tree converted into objective tree. Inspired by Cross (2000) and MIT (n.d.)

However, not all identified objectives lie within the scope of the thesis of which 'changes to the WEEE-directive', 'design for upgradability', and 'cheaper spare parts' are examples. Therefore, we have classified the objectives by marking the ones within the scope with orange strokes while the ones that lie outside the scope have remained blue.

By following this approach, we have identified various objectives that individually represent potential constituent elements of a concept that can fulfill the research question. To bring an example, the problem tree showed that repairs of e-products are too expensive, considering what customers are willing to pay, due to high salary expenses. The objective tree shows that this problem can be accommodated through 'reduced salary' to which 'student repairers' and 'volunteer repairers' are feasible solutions.

Some of these constituent elements, such as 'online sales platform' and 'trade-in program, can furthermore serve as interessement devices directed towards the customers, as illustrated in Figure 48. These elements can be valuable for the translation that shall support the concept. We have attempted to implicate as many objectives as possible that lie within the scope, in order to accommodate the majority of the problems. The goal has been to develop a social-economic business model that on the one hand aims to recreate values of discarded and broken e-products and on the other hand can create a connection between the labor market and young people who struggle to find their way into the labor market.

However, there is not one single way such a business model can be implemented as many aspects need to be taken into consideration. We will in the following sections bring some of the reflections we have made in order to develop the most robust business model.

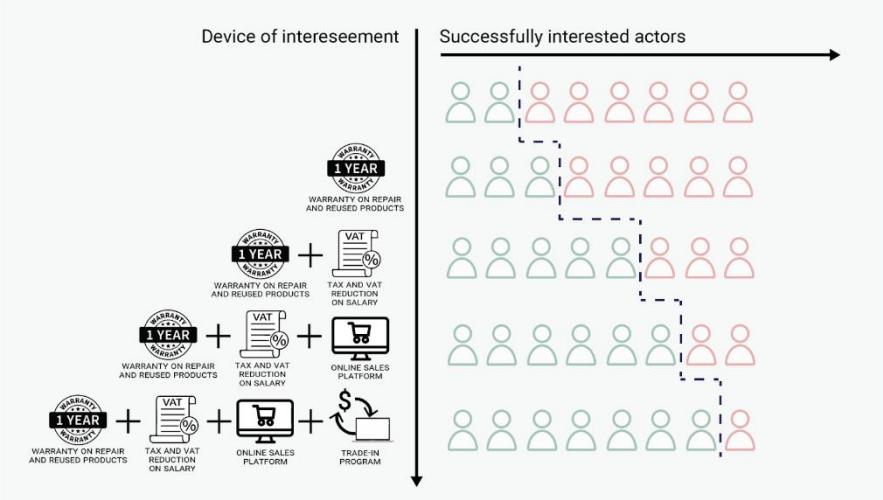


Figure 48. Effect of successful implementation of interessement devices. Inspired by Latour (1991)

7.2 ReStore - A social-economic business

Through the process of exploring means to eliminate the different problems outlined in the problem tree, we have developed a concept for repair and reuse of e-products, which we have named ReStore. The name stems from its ambiguity as it both means the act of bringing things back to their former state and the fact that the concept serves as a store for repair and reuse of e-products. ReStore is a result of our attempt to resolve the various problems through utilization of the adaptive resources we have previously identified among local actors. As a concept for increasing repair and reuse, it builds on the principle of

slowing resource loops. In terms of business models supporting this principle, Bocken et al. (2016) states that "Whereas gap exploiters [4] exploit products from other companies as they see an untapped opportunity, in an ideal case, manufacturers themselves develop business models that support reuse and remanufacture." (p. 314). As we have previously described, design for reuse and remanufacture is not a widespread practice among producers of e-products. Therefore, ReStore should function as a gap exploiter to create a business based on the residual value of e-products that would otherwise be discarded and recycled. While developing the concept of ReStore, we have looked for inspiration among repair initiatives that have already been established, such as Repair Cafe Denmark, De Grønne Hvidevarer, and De Kringwinkel. Especially the threefold ambition of De Kringwinkel, which are reducing waste, creating jobs, and providing high quality products at low prices, has been influential in shaping the concept. Also, we have to a large extent based the concept on the goals and ambitions of BOFA, since we wanted our concept to serve as inspiration and a guide for their further work towards making Bornholm a waste-free island.

We will here outline the main principles of ReStore. In the following section, we will give a more detailed presentation of the different elements making up the concept through the application of a Business Model Canvas. The overarching idea of ReStore is to establish a repair and reuse shop based on a private-public partnership between Møbelfabrikken, FGU, BOFA and Service Centret Bornholm. ReStore will be owned and managed by Møbelfabrikken and physically located in an existing warehouse on the property. The role of BOFA will be to set up distinct containers on the recycling stations for e-products that might be repairable or directly resalable. The content of these containers should be picked up and brought to ReStore where the products should be sorted, repaired, and sold again as used products. Besides the repair and reselling of e-products that have been discarded at BOFA's locations, private citizens of Bornholm should be able to bring broken products to ReStore, in order for them to be repaired at a relatively low cost. Furthermore, the citizens of Bornholm should be able to donate broken e-products to ReStore, or to sell functioning products that can be resold for a profit.

The day-to-day operations should be managed by Johann from Service Centret Bornholm who has extensive knowledge in repairing e-products and running a repair business. The partnership with FGU should entail that there will at all times be two or three FGU students working closely with Johann as part of an internship program. Johann should train these students in diagnosing the products for different malfunctions and in conducting various types of repairs. As such, ReStore should be a place for the students to do practical work related to repair and reuse, while developing skills that can help them be able to enter other positions on the job market later on in their lives. Another task for the students working at ReStore should be to document the repairs they conduct and create guides for future reference. Over time, this aspect will lead to the establishment of a knowledge resource that can be valuable to future students. As a final aspect, we imagine that ReStore should be able to host and facilitate workshops for elementary and high school students, and in this regard serve as a valuable resource in educating young people in topics related to sustainability, repair, and reuse. ReStore should thereby play a role in inspiring future generations of consumers to develop more conscious and responsible practices.

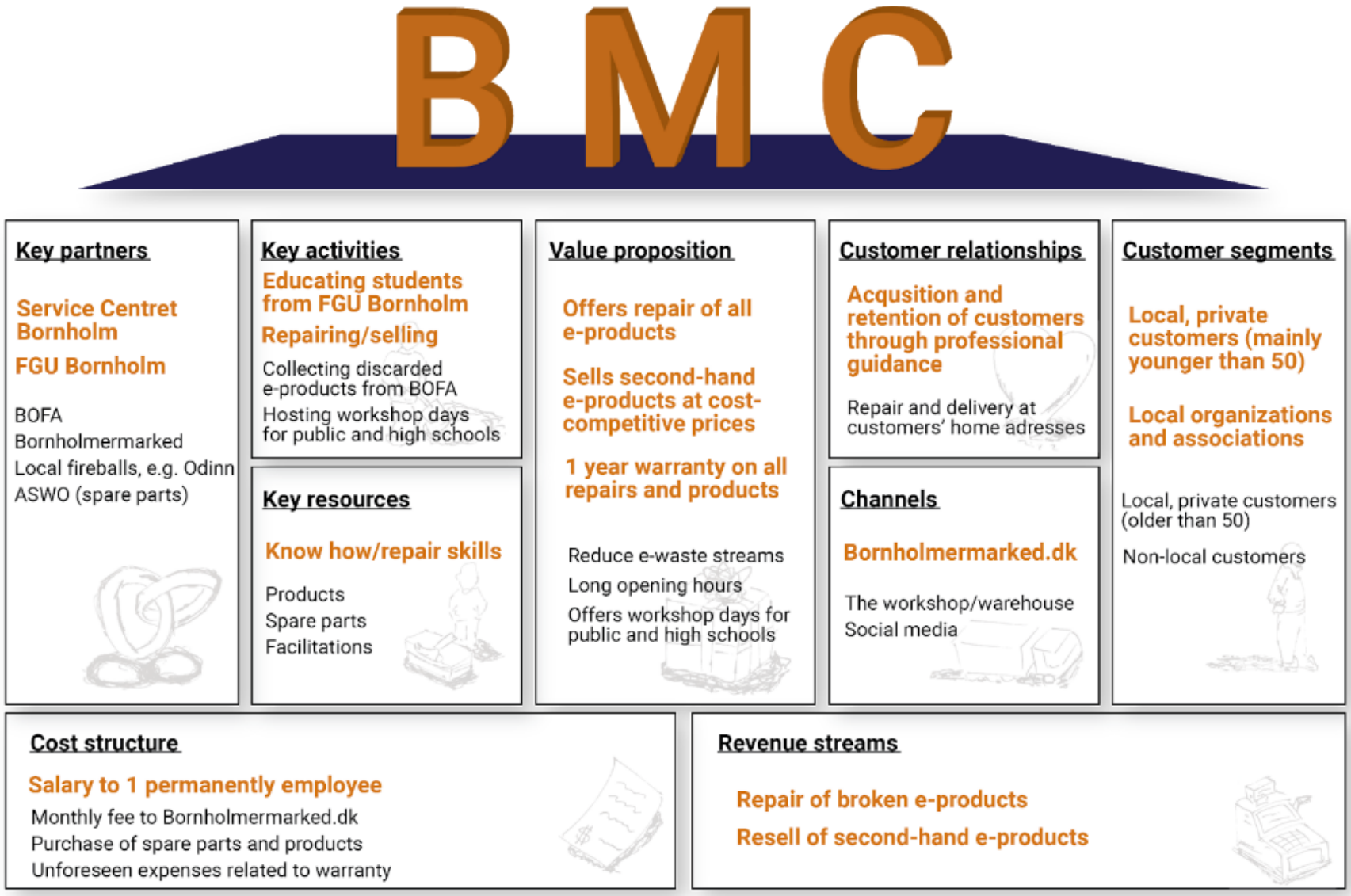


Figure 49. Business Model Canvas of ReStore. Inspired by Osterwalder and Pigneau (2010)

7.3 Business Model Canvas

The following sections will one by one thoroughly describe the nine building blocks known from the Business Model Canvas proposed by Osterwalder and Pigneau (2010). The canvas presents the social-economic business model of ReStore which we believe can give rise to increased repair and reuse and thereby prolong the lifespan of e-products locally on Bornholm. The canvas is in no way a final product of the business model but should rather be seen as a means to initiate and facilitate discussions between implicated actors, as Osterwalder and Pigneau suggest.

7.3.1 Customer segments

This business model serves to attract local customers, mainly private users. This is with regards to both repairs and purchasing of second-hand e-products. We can see from our survey that roughly one fourth of local citizens have repaired at least one broken e-product within the last two years. Of these, two thirds were carried out by citizens younger than 50. Furthermore, the survey showed that the citizens younger than 50 are the ones who also buy the most second-hand e-products. Therefore, we must assume that the local customers who ReStore can attract are under the age of 50. However, ReStore does not discriminate against age and will aim to embrace all age groups. In fact, a successful interessement of people older than 50 years would be advantageous as the population on Bornholm is slightly older than the national average.

Besides private customers, we see local organizations and associations such as sports clubs, nursing homes, and libraries as evident purchasers of used e-products as budgets such places can be limited. In spite of aiming towards the locals, ReStore could potentially have non-local customers through online sales channels. As Joackim from Bornholmermarked said, they have 30,000 unique users every month from both inside and outside the island. This opens up the opportunity to make long distance sales while repairs only remain an option for the locals.

7.3.2 Value propositions

To increase the market for repair and reuse of e-products and thereby make the products circulate, it must become more attractive for the customers. As Jørgensen (2020b) claims and as we saw from the affinity diagram and Norstat (2020), the price most often is a decisive factor for which reason the price needs to be attractive. Otherwise, it would not be sufficiently cost competitive compared to buying new products. Therefore, in order to make the products circulate, ReStore's most substantial value proposition is to offer their customers high quality at low prices (Cools & Oosterlynck, 2015). As ReStore is a social-economic initiative operated by one fulltime repairer assisted by students from FGU Bornholm, costs related to salary are kept down. Thus, they can repair and sell e-products cheaply and thereby accommodate the

maximum limits the locals are willing to spend for respectively repair and acquisition of second-hand e-products (own survey, 2021).

The affinity diagram pointed out another essential element that currently refrains the customers from buying second-hand products, namely the lack of warranty. Obviously, ReStore may not be able to offer the same warranty on reused products as if the products were new due to the low prices. However, ReStore offers warranty on all sold and repaired products with the exception of user induced damages such as screen breaks, exposure to water, etc. within the first year.

Moreover, another value proposition regards the opening hours. ReStore is open Monday to Friday as an ordinary shop which gives more opening hours compared to Repair Café Nexø which is open twice a week in the evenings. This may appear more appealing for the customer by which it is an important value to offer.

At last, as Odinn emphasized, the transition towards more sustainable consumer patterns can only be achieved if the youngest and future generations are educated to understand how e-products are composed and how they can be repaired. Therefore, besides being a repair and second-hand shop, ReStore offers the opportunity for public school and high school students to come visit for field trips to learn about sustainability, circular economy, and how to prevent e-products from becoming waste.

7.3.3 Channels

ReStore has an advantage of being a subdivision to Møbelfabrikken as the entrepreneurial hub located in Nexø is familiar to many locals and has many visitors. So, besides being a repair workshop, the facilities will likewise function as an exhibition and a shop for second-hand e-products. However, in order to raise awareness among all customer segments, ReStore must, just like Møbelfabrikken, promote themselves through social media (Aalling, C., personal communication, April 28, 2021). Additionally, they must create a website at which contact information, price lists, etc. are accessible. Furthermore, we saw from the survey that 55% of the respondents who currently buy e-products prefer to buy them online. Therefore, in order to propagate online market sales, a collaboration with Bornholmermarked will be entered. For small monthly fee (Penti, J., personal communication, March 17, 2021), ReStore can sell their products through the frequently applied sales channel.

7.3.4 Customer relationships

As ReStore is managed by Johann, who from Service Centret Bornholm has more than 20 years of experience with repairs, one of the trademarks of ReStore is the high level of professionalism. Together with the beneficial prices, it is this professionalism that shall secure both

acquisition of new customers and retention of current customers through personal counselling. Furthermore, as a link in maintaining customers, ReStore offers the possibility of repairing and delivering e-products at customers' home addresses.

7.3.5 Revenue streams

The concept of ReStore is different from traditional repair cafés in many ways. One of the biggest differences is that the customers in repair cafés must fix the products themselves with help from the volunteer superusers. Therefore, repairs in repair cafés are free of charge but it is never a guarantee that the products can be fixed nor that the repairs are assisted by an authorized repairer. In ReStore, repairs will always be either performed or supervised by an authorized repairer. Thus, it is not free of charge to have e-products repaired. However, compared to other local repair shops, the price on repairs can be kept down due to the fact that many repairs are performed by students from FGU Bornholm who have been taught how to repair different e-products such as smartphones and tablets. Besides earning a profit on repairs, ReStore will secure income through resale of second-hand e-products. These products will be sold at a beneficial price for the customers, as most products have either been given to or picked up by ReStore at one of BOFAs distinct containers for discarded e-products. Additionally, the income generated from resold e-products will also keep the price on repairs down. Furthermore, delivering products and repairing products at customers home addresses will generate income as well.

7.3.6 Key resources

The business model is to a high extent dependent on the know-how/skills that it requires to repair broken e-products. That is why Johann is picked as the one to manage ReStore, as he has many years of experience with repairs of all kinds of e-products. Additionally, Johann is the only repairer on Bornholm who is authorized to repair e-product from LG and Samsung within warranty. Besides repairing and reselling products, Johann must also take action as a mentor for the students from FGU which is a role he is used to as he currently, in Service Centret Bornholm, educates a young man who has had difficulties making it into the labor market.

Other key resources are the products and spare parts required for repairs. The business model would not be feasible to implement without these elements. The products are essential with regards to both resale and repair while the spare parts are necessary for the latter. At last, the physical surroundings are requisite in order to underpin a well-designed store as one of the solutions identified in the objective tree. ReStore will take place in one of Møbelfabrikken's warehouses of approximately 450 square meters. This is a significant upgrade for Johann who currently has approximately 30 square meters for repairs and 20 square meters for storage.

7.3.7 Key activities

As presented throughout the previous building blocks, the key activities in ReStore regards repairing and reselling e-products. These are the main activities that will generate an income that can substantiate the business model. Furthermore, ReStore will purchase products from the customers with the aim of reselling it with a profit. When selling a product to ReStore, the customers can choose between receiving a credit voucher or cash at a lower value compared to the voucher.

What differentiates ReStore from other repair companies is the fact that ReStore also educates students from both public schools, high schools, and FGU Bornholm. The two first-mentioned through workshop days at which the students learn about e-products composition and how to repair them. And the latter, students from FGU Bornholm, through a proactive mentoring program. The students will throughout their education at FGU have internships at ReStore with the purpose of preparing the students for either an upper secondary education or a traineeship at the labor market. This is already a permanent part of their education. However, according to Jens from FGU, it is from time to time difficult to find collaboration companies the students can have their internships in (Kragh, J., personal communication, May 4, 2021). Therefore, ReStore will help to secure more internships on the island. Nonetheless, it has a maximum capacity of 2-3 students per internship period as Johann has to manage this task as well.

Additionally, a key activity will be to collect discarded e-products from BOFA's distinct containers. These containers will be placed outside of BOFA's sites, so the products do not become waste and thereby avoid being governed by the WEEE-directive. At last, which Johann also does currently in Service Centret Bornholm, a key activity will be to remove well-functioning spare parts from otherwise broken products.

7.3.8 Key partners

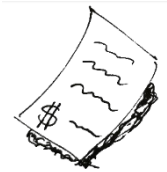
The majority of the involved actors have already been mentioned through the BMC. However, to emphasize their importance and how they interplay, we will in this section describe the key partners. As previously described, Møbelfabrikken will be the main actor in this business model as ReStore will take place in their facilities. However, Møbelfabrikken does not have the abilities to manage an authorized repair workshop themselves by which they enter a collaboration with Johann. Johann is one of the leading repairers on the island but seeks for more square meters as his current facilities have become too small compared to his business.

Furthermore, FGU Bornholm, BOFA, and Bornholmermarked are decisive partners. The first-mentioned due to the fact that they provide the students for the mentoring program. BOFA, because they set up the distinct containers and in general are interested in eliminating waste streams on the island and thereby accommodating their vision of 2032.

And the last-mentioned, Bornholmermarked, as they provide the online platform that intends to propagate the market for reused e-products.

Besides these partners, ASWO will play a vital role as they are a leading provider of spare parts. Service Centret Bornholm buys all spare parts from them (Aakjær, J., personal communication, April 28, 2021) and we imagine that ReStore will do the same.

As a last key partner, we have been in touch with Odinn who is a local visionary. When visiting Odinn during our stay at Bornholm, he passionately claimed that education of kids and young people is the only realistic way to avoid unsustainable consumerism in the future. In spite of not having an education as an authorized repairer, Odinn knows how to repair all kinds of products. When asking him if he could see himself in the position as a mentor for young students, he said it would be an honor. Therefore, we consider Odinn as a driving force in the business model as he could be a volunteer repairer at ReStore.



7.3.9 Cost structure

The monthly rent for ReStore is low as it is located in Møbelfabrikken's facilities. Therefore, ReStore must only pay a given share of the total rent. The most resource intensive expense is related to the payment of Johann. This is a fixed monthly salary. Besides this, ReStore has variable costs related to purchase of spare parts, which in the end will be paid by the customers, and also purchasing of products from the customers. Furthermore, they have to pay a smaller fee to Bornholmermarked for having access to thousands of customers online. Additionally, ReStore have to pay when they buy well-functionally discarded products from customers.

At last, some unforeseen expenses may occur as a result of the warranty on all repaired and sold products.

7.4 Translation of the network

A process of translation is required in order to establish a network of the previously described actors to support the implementation of ReStore. The problematization is covered by our analysis and concept description, since we have outlined the necessary roles for the different actors and established an obligatory passage point through which the efforts of actors should be aligned to solve the shared goal of increasing repair and reuse. However, some aspects regarding the ambitions and motivations of the individual actors remain uncertain. These aspects relate to the feasibility of achieving interessement and it is therefore highly relevant to investigate the uncertainties in more detail going forward. Considerations regarding this will be discussed further in Chapter 8.

Interessement of the various actors outlined in the concept description is crucial to a successful implementation of the concept and the coordination of adaptive resources. Because of this, ReStore builds on a wide range of elements that we believe can function as interessement devices, enabling actors to see how they can benefit from taking part in the concept. As we have previously described, these are largely based on

the findings from the objective tree, as they are elements through which we seek to break the barriers that would otherwise keep actors from wanting to support our solution.

The enrolment of actors relies on a successful interessement. It is therefore too soon to tell whether this can be achieved. Furthermore, the feasibility of mobilization depends upon the extent to which the actors we have been in contact with during our analysis sufficiently represent the larger group of actors for whom they are supposed spokespersons. This is another topic for discussion in Chapter 8.

Because of the uncertainties that remain, ReStore should not necessarily be seen as a strictly defined concept that should be implemented in a one-to-one fashion, but rather as an inspiration and guide for how the actors we have identified as carrier of adaptive resources together can contribute to the mission of enabling longer lasting e-products through repair and reuse. Therefore, the BMC functions as a representation of the concept which can facilitate further discussion about the specifics of its constituent elements and implementation. Going forward, we recommend that BOFA should function as the concept owner and ensure further detailing in close dialogue with the central actors involved in ReStore along with other stakeholders.

In the following section, we will outline and discuss aspects relating to the sustainability potential of implementing the concept of ReStore.

7.5 Sustainability potential of ReStore

When assessing the sustainability aspects of ReStore, we will refer to different factors. Firstly, we will emphasize that increased repair and waste prevention through reuse of e-products are more environmentally beneficial compared to lower levels in the waste hierarchy. Considered in a circular economic perspective, and according to the waste hierarchy, recycling, incineration, and disposal of products and materials are suboptimal as additional energy is required and due to resource intensive manufacturing processes. To specify, if e-products are incinerated rather than reused or prevented from being waste, it will entail an increased amount of greenhouse gas emissions and furthermore loss of resources, here among critical raw materials. However, it is only a guarantee if increased repair and reuse of e-products actually suppress extraction of critical raw materials. This aspect is largely dependent on consumer practices. Secondly, climbing up the waste hierarchy will increase the potential of creating more jobs. The possibility of creating jobs is almost four times bigger when preparing for reuse rather than recycling, and even larger compared to incineration and disposal. Furthermore, as the example of De Kringwinkel showed, the people who get employed through social-economic repair initiatives are most often people who previously have had problems making it into the labor market or have had troubles finishing an education (Cools & Oosterlynck, 2015). Thus, ReStore has the potential of embracing marginalized people and thereby enhance the social foundation according to the Doughnut Economics (Raworth, 2012, 2017).

The following sections will bring more specific calculations of the sustainability potential of ReStore with regards to environmental aspects

and the economic potential. The calculations will take their starting points in three different scenarios of lifespan extension.

7.5.1 Environmental potential

As mentioned previously, the European Environment Agency (2020a) claims that the average lifetime of various e-products is significantly shorter than the designed lifetime. Figure 50 illustrates different scenarios of how much CO_2 Bornholm can reduce if the stocks of mobile phones, computers, and washing machines are lifespan extended with respectively 1, 3, and 5 years.

For each of the three product categories the average lifespans and estimated stocks on Bornholm are stated. The average lifespans are based on numbers from the European Environment Agency (2020a) while the stocks are based on assumptions and statistical data. To briefly outline the rationale behind the assumptions, we presume that every citizen on Bornholm on average has one mobile phone. Furthermore, we assume that 7 out of 10 own a computer. These assumptions are not based on statistical data as it has only been possible to find data for how many households that possess the products and not how many people. At last, we assume that 83% of all households have one washing machine (Danmarks Statistik, 2021c).

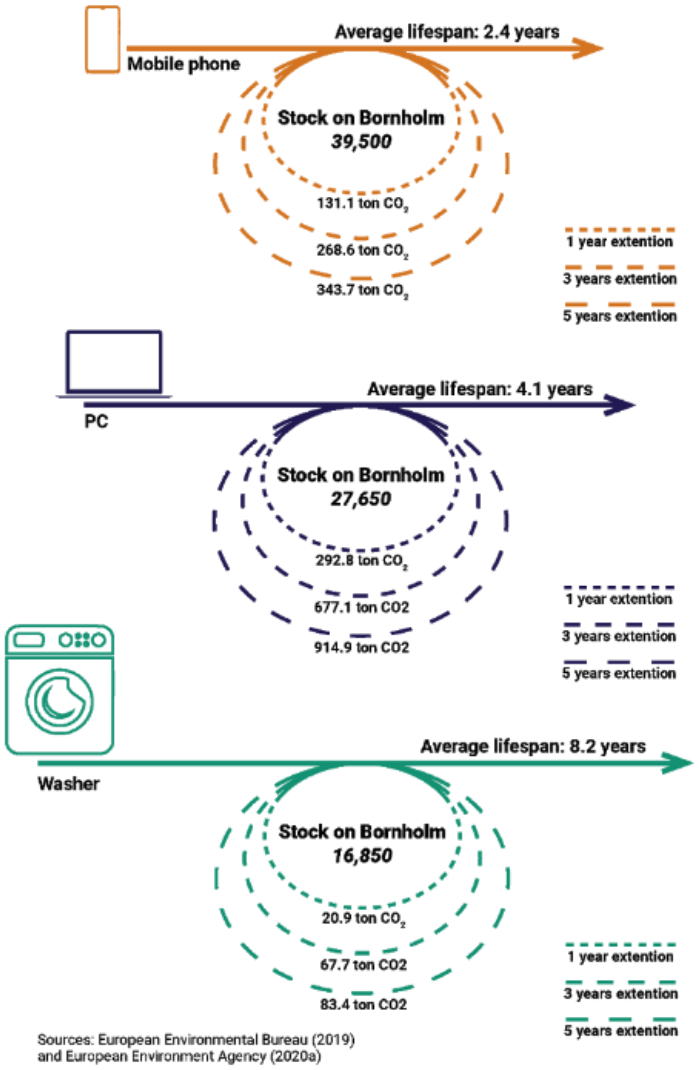


Figure 50. Climate change reductions of three scenarios

Not surprisingly, the washing machine is the product category that entails the lowest CO_2 reduction per unit by lifespan extension due to the fact that the majority of its climate impact stems from the use phase while the majority of the climate impacts of both mobile phones and computers stems from the non-use phase (European Environmental Bureau, 2019).

However, it may not seem realistic to prolong the lifespan of all mobile phones, washing machines, or computers by 5 years. If we set up a more realistic scenario in which the lifespans of all mobile phones are prolonged by 1 year and the lifespans of computers and washing machines are prolonged by 3 years, Bornholm would save a total of 876 tonnes of CO_2. Besides emitting less CO_2, it would help Bornholm to reduce the amount of e-waste.

7.5.2 Economic potential

Prolonging the lifespan of e.g., a washing machine will not only entail environmental gains but also economic profits for the customers. We have set up three new scenarios to calculate how much a customer can save by prolonging the lifespan. By applying a functional unit of 60 years of washing, with 220 washes a year (Energistyrelsen, 2016), we compare the three scenarios in which the lifespans of the washing machines are respectively 10, 12, and 15 years. Thus, in the first scenario the customer will acquire six washing machines during the 60 years. The customer will acquire five machines in the second scenario, and four machines in the last scenario. The first washing machine in all three scenarios consumes 0,49 kWh per laundering. From that, we have considered a yearly increase in energy efficiency of 2% as a matter of technological improvements. This assumption reflects in the consumption costs illustrated in figure 51 as scenario 1 has the lowest consumption costs attached due to constantly newer and more energy efficient machines. However, the frequent replacement of machines induces larger acquisition costs which over 60 years implies that it is more expensive to replace frequently in spite of energy efficiency improvements.

	Scenario 1 Avg. lifespan: 10 years	Scenario 2 Avg. lifespan: 12 years	Scenario 3 Avg. lifespan: 15 years
Consumption costs through 60 years	DKK 9,310	DKK 9,500	DKK 9,780
Acquisition costs through 60 years	DKK 36,000	DKK 30,000	DKK 24,000
Total costs through 60 years	**DKK 45,310**	**DKK 39,500**	**DKK 33,780**

Figure 51. Economic benefits for customers by lifespan extending a washing machine

From figure 51, we see that a two year lifespan extension, from 10 to 12 years, results in a surplus of DKK 5,810 which can be used for repair if necessary. A five year lifespan extension, from 10 to 15 years, results in a surplus of DKK 11,530 which likewise can be used for potential repairs. Therefore, we can reject the myth concerning that in the long term it is cheaper to replace an old washing machine with a newer model in an economic perspective, unless the old machine has a very poor eco label (Öko-Institut, 2018).

We are aware that these scenarios are simplified as other aspects such as water consumption are not considered. Therefore, they serve only as a guidance and not as an absolute truth.

As a final remark on the sustainability potential of ReStore, we would like to emphasize that the concept in itself cannot induce a sustainability transition, which Ceschin and Gaziulusoy (2020) describe as the design approach with the highest potential for sustainability. Nonetheless, ReStore is intended to represent a scalable model for increasing the lifespan of e-products through repair and reuse, although the specific actors should obviously be substituted to fit the local context of implementation. For instance, FGU, municipal recycling companies, and private repair companies exist in locations all throughout Denmark. Should the principles of ReStore become more dominant in a wider context, it may exert pressure on other regime actors, forcing them to adopt more sustainable practices. Thus, the concept can potentially function as a basis for more substantial changes, and thus also a significantly higher sustainability potential.

CHAPTER 8

8. The project in perspective

As we now have seen, the concept of ReStore represents a solution with the potential to mitigate environmental impacts from consumption of e-products more effectively than the current dominant practices of material recycling. However, a range of questions still remains unanswered with regards to the potential, implementation, and scalability of the concept.

Firstly, it is relevant to discuss whether the concept sufficiently tackles the problems that have been identified as central to achieving our mission of ensuring longer lasting e-products through repair and reuse on Bornholm. For obvious reasons, the concept does not target all of the issues identified during our empirical research, since some are outside the scope of the project. We will discuss some of these aspects later in this chapter. However, some key questions that lie within our scope also remain unanswered. For instance, we have seen that many functioning e-products hibernate in citizens' homes. This is problematic, since they represent a significant resource investment that is not being utilized until they will eventually be discarded and treated as e-waste. Research has shown that financial rewards can serve as an effective incentive helping to re-activate hibernating e-products (Miliute-Plepiene, 2021). However, it is uncertain whether the possibility of selling used e-products introduced with ReStore will be sufficient incentive for the citizens of Bornholm, as we cannot qualify how much ReStore can pay for various used products, while still maintaining a profit margin. Furthermore, other aspects such as convenience would most likely play a decisive role in determining whether the possibility is deemed attractive by the consumers. This is a matter that will require further investigation.

An additional concept element that could potentially contribute to decreasing the number of hibernating e-products is the implementation of a scheme that would enable citizens to rent or borrow products. This could potentially motivate consumers to buy less products which are only used occasionally, thereby decreasing the overall inflow of new e-products. Such an initiative might also have the effect of making consumers less inclined to keep used products as a back-up that may or may not be needed in the future when buying new e-products, thereby enabling the products to create new value for other consumers. We have currently not included this aspect in the concept of ReStore since we have been unable to determine the market for such services and whether it is feasible for ReStore to provide sufficient value in this regard. Furthermore, we believe that the initial goal of ReStore should be to establish itself as a widely recognized and trustworthy facilitator of repair and reuse before potentially expanding its business to other areas.

Another element that is still linked to a relatively high degree of uncertainty is the aspect of ReStore's warranty on repairs and used products. As we have seen in the affinity diagram in Figure 41, lacking warranty and insecurity about remaining lifespan of used products constitute a major concern among the respondents of our survey and must therefore be considered a barrier for increased reuse. Although we have presented warranty as a value proposition of ReStore, it has yet to be validated whether it is feasible to offer such warranty on all used products and repairs and whether the warranty period should potentially be either shorter or longer than the one year we have proposed. As we

have previously described, De Grønne Hvidevarer initially offered a six month warranty period which has since been increased to two years. We therefore believe that a one year warranty is a realistic baseline, although this should be investigated further, e.g., through dialogue with Johann.

Questions about the feasibility of interessement, enrolment and mobilization of actors in the proposed network of alliances also remain unanswered. First of all, BOFA has to take upon themselves the task of carrying the project forward. In this regard, we hope that this thesis along with a presentation of our empirical findings and the conceptualized solution can serve as interessement devices, as it will hopefully highlight how it may help BOFA work towards the vision of the waste-free island. Whether or not this will lead to mobilization is uncertain, as other networks based on alternative programs of action may seek to enroll BOFA in competing alliances. For instance, the proposed role for BOFA entails that they should establish distinct containers to collect e-products that have potential for repair and reuse, which should then be picked up by ReStore. Although BOFA has expressed a willingness to do this, we cannot yet determine how they will react if they are faced with resistance from the collective schemes. There are also still unanswered questions about the legitimacy of providing this stream of products directly to ReStore, as it may be seen as an act of distorting competition. Therefore, ReStore may have to pay what can be considered fair market value for the products collected in the distinct containers (Themsen, 2017).

On the topic of interessement, it is also highly relevant to consider the potential challenges related to interessement of Johann. It may be difficult to make him take on the role proposed to him by the concept of ReStore. This is especially true if it requires him to abandon his existing business. Therefore, different arrangements of his relation to ReStore should be explored. This may include forms of joint ownership, or perhaps a constellation where Johann can utilize some of the space in the warehouse at Møbelfabrikken for his own business. In any case, ReStore would become a competitor to Service Centret Bornholm. Interessement of Johann therefore heavily depends upon a partnership in which Johann is sufficiently incentivized to support the concept of ReStore.

As a last note on the topic of translating the network, it is necessary to consider whether the actors that we have identified as carriers of adaptive resources throughout our empirical research represent the attitudes of the wider group of actors whom they supposedly represent, and as such function as spokespersons. For instance, we cannot be sure whether Jens Kragh sufficiently represents the motivations of the students of FGU. Since a central element of ReStore is the utilization of their labor, the willingness of students to enroll in internships at ReStore is crucial to the concept. Similarly, we cannot be sure whether the respondents from our survey sufficiently represent the attitudes of the wider population of Bornholm, although we have sought to target a representative segment. Additional market research should therefore be conducted concurrently with further detailing of the concept.

Besides the considerations about the process of translation, we are left with a range of unanswered questions regarding the scalability of the concept. It is for example relevant to consider whether the principles of ReStore could be applicable to other types of products. We see no direct reason why this should not be the case. In the local context this could

be achieved by incorporating the existing wood, sewing and metal workshops on Møbelfabrikken. FGU students could also be working with repair activities in these facilities but should be managed by regular employees with expertise in these other areas. It should be noted however, that expanding ReStore to incorporate more types of products will most likely lead to more difficulties in scaling the concept to other parts of Denmark, as it will require the mobilization of more expertise, facilities, and resources in general.

On the topic of scaling ReStore to other geographical areas, we will argue that this is a feasible long-term goal. Both municipal waste management companies and FGU represent adaptive resources that already exist throughout Denmark. While repairers and repair facilities will have to be identified for each additional location, we believe that there is a solid foundation for scalability. Although some elements will vary, as we just mentioned, we will argue that it is important for the individual locations to be unified under one well defined brand. We believe that this is an important aspect in order for the concept to become more widely recognized and be attributed with increased credibility. As we have previously described, such unified branding has proven to be of great value for other initiatives such as De Kringwinkel (Cools & Oosterlynck, 2015).

A scaling of ReStore will naturally lead to a more significant sustainability potential since more customers will lead to increased repair and reuse, which in turn will lead to reduced environmental impacts, while also generating more jobs and economic profit. Besides these obvious benefits, we will argue that the more widely recognized ReStore becomes and the more customers it attracts, the greater its potential to contribute to a sustainable socio-technical transition will become. The reasoning behind this statement is in part that a more widespread practice of repairing and reusing e-products may over time put pressure on governments and other regulatory bodies to adapt regulation to better support such practices. Furthermore, it may make producers of e-products more aware of the potentials in incorporating more circular strategies into their own business models in order to exploit the residual value embedded in their products. Because of potential implications such as these, we believe that ReStore, or similar initiatives, may be able to initiate a series of transformations in other parts of the regime, thereby permanently changing its trajectory through a socio-technical transition. In this regard, ReStore can be considered as a type of radical niche innovation that changes the future trajectory of the regime, although involving both regime and non-regime actors.

Closely related to the discussion of a wider socio-technical transition, we have a series of considerations related to how factors that are outside the scope of this project may influence the overarching vision of more sustainable consumption of e-products. As we have just alluded to, the producers can play a massive role in decreasing the environmental impact of e-products since they can design the products for different end-of-use scenarios. Products that are for instance designed for 'dis- and reassembly' or 'ease of maintenance and repair' would contribute to making repair more attractive, since it would lower the overall cost (Bocken et al., 2016). Such design strategies would therefore be a great benefit for initiatives such as ReStore. However, we will argue that producers would most likely only implement such design strategies if they were either forced through regulations or if they see it as a potential for increasing their own profits. Other regulatory initiatives, not

necessarily directly related to the design of products, could greatly contribute to more sustainable consumption of e-products. Examples of such initiatives could include changes to the WEEE-directive, leading to more emphasis on higher levels of the waste hierarchy. Another example could be regulating the cost of repairs, e.g., through reduced taxes. This is a change that has already been established in other countries such as Sweden. Here, citizens are able to receive tax deductions for a fraction of the cost of repairs corresponding to the repairers salary. Besides this, the VAT on repairs of certain types of products is reduced by 50% (Gaarslev, 2016). We have seen from our analysis that cost is among the main barriers for increasing the number of repairs, and that salary is the primary factor leading to high cost of repairs. We therefore believe that similar initiatives in Denmark could potentially lead to substantially more repairs and simultaneously generate new jobs.

As a last reflection on the project, we will note that the outcome of our research has been greatly influenced by the theoretical and methodological approaches we have chosen to apply. The process has to a large extent been focused on identifying adaptive resources among the local actors on Bornholm and to investigate potential ways of coordinating these resources in a response to the challenges of the e-waste problem. Other theoretical and methodological approaches may be equally valid but yield different findings and conclusions. As an example of another potentially valuable approach would be to investigate the barriers for increased repair and reuse through a perspective of social practice theory and conceptualize solutions based on changes to the 'materials', 'competencies', and 'meanings' on which the social practices are based (Spurling et al., 2013).

Another example of how the findings could have been different relates to the environmental assessments of ReStore. In the conceptualization, we have only assessed environmental impacts in CO_2-eq i.e., impacts on climate change. As stated in Chapter 1.1, Sustainability definition, we do not only account for CO_2 reductions but aim not to exceed any ecological limits defined by the planetary boundaries. However, besides reading about which environmental impacts increased repair and reuse of e-products entail, we have not made any further calculations upon e.g., ocean acidification, ozone layer depletion, or chemical pollution. To do so, application of a more comprehensive tool, such as a Life Cycle Assessment (LCA), is necessary. Curran (2015) defines LCA as "a holistic, cradle-to-grave environmental approach which provides a comprehensive view of the environmental aspects of a product or process throughout its life cycle." (p. 1). So, by applying the framework of LCA, we could have made more, and better assessments of environmental aspects related to ReStore. However, completing a full ISO standardized LCA is not a simple task as it is a very intensive process as a matter of time, and requires furthermore several data we necessarily could not access.

CHAPTER 9

9. Conclusion

As we have now seen, rapidly growing consumption of e-products and the accompanying e-waste generation constitutes a massive environmental concern. Extending the life of e-products is a viable strategy for reducing their detrimental environmental impacts, while also generating both economic and social value, thus establishing a basis for more sustainable consumption. However, achieving this vision in practice is in no way a trivial task.

With the project described in this thesis, we have sought to develop a concept for increasing repair and reuse of e-products in a local context of Bornholm. We have presented the social-economic business model of our concept, ReStore, which represents an approach to accommodating the different barriers we have identified throughout our empirical research. The concept furthermore represents an answer to our research question:

> *How can we develop a **scalable social-economic model** based on principles for **circular economy** in order to **prolong the lifespan of e-products**, thus creating both economic, environmental, and social value?*

While we realize that the concept needs further detailing before implementation is feasible, we argue that it represents a valid approach to working towards the vision of more sustainable consumption of e-products.

Our analysis has shown that the current streams of e-products marketed on Bornholm and e-waste generated can underpin a larger business model centered around repair and reuse. Thus, it is not the stocks and flows that hitherto have prevented e-products from being treated the most optimal way according to the waste hierarchy. As the analysis has emphasized, it is rather a matter of anti-programs by which implementation of various interessement devices are crucial in order to mobilize the identified local actors.

Furthermore, the analysis has shown that the existing practices on Bornholm are embedded in a global regime of e-products, which is subject to a highly stabilized trajectory of development. It is therefore clear that interventions in the very local context will not in itself lead to substantial changes to the overarching regime. However, we have utilized Bornholm as a protected geographical niche which we believe represents a suitable environment in which innovative concepts can emerge and mature. We will argue that the principles on which ReStore is based can be scaled and adapted to larger geographical areas, thereby increasing the overall effect of repair and reuse activities. Furthermore, if ReStore is upscaled significantly, we believe it can exert pressure on the larger regime, forcing powerful regime actors such as producers and the collective schemes to adopt more sustainable practices. Such changes to the practices of central regime actors would constitute a socio-technical transition, thus dramatically increasing the overall sustainability potential.

The research and findings presented in this thesis will be handed over to BOFA, who from here on will be the concept owner. We believe that the approaches and ideas presented here can be of value and guide future BOFA projects, thus contributing to the vision of the waste-free island.

It should be noted that the concept is still linked to a series of uncertainties, which we have described in the previous section. Additional work is therefore needed, some of which will be related to our own further research, and some which will be the responsibility of BOFA, should they decide to carry the project forwards. Examples of further work will be outlined in the following section.

CHAPTER 10

10. Recommendations for further research

As a final contribution of this thesis, we wish to provide some recommendations for further work and research, which we believe will be necessary for a successful implementation of ReStore. Although continuous work should be done to improve and adapt the concept, to ensure that it meets the needs of local consumers at all times, we will argue that some additional research should be conducted in order to further develop ReStore while it is still in the conceptualization stage.

Firstly, as we have previously discussed, the potential for interessement of Johann is still linked to a high degree of uncertainty. Therefore, we will argue that BOFA should seek to identify meaningful constellations through dialogue with Johann. If it should not be possible to arrive at a partnership in which Johann is sufficiently incentivized and willing to manage ReStore on a day-to-day basis, BOFA should look for other repairers with similar capabilities that may take on the role proposed to Johann.

Secondly, there is the matter of warranty which we have identified as highly influential in increasing consumers' willingness to repair and reuse. Further research should be conducted on the extent to which warranty is feasible and whether it is equally important for all types of products and repairs.

Lastly, the feasibility of ReStore's business model relies heavily on the preferences and practices of consumers. As we have previously mentioned, our knowledge about the inclinations of the local citizens of Bornholm is largely based upon our survey responses and extrapolation of data from other geographical areas. We can therefore not be sure that our knowledge on this matter is sufficiently representative. Although our findings can to a wide extent be backed up by findings from document studies, the concept of ReStore should be qualified by additional research on the local market for repair and reuse of e-products. One approach to this could be the application of social practice theory (Spurling et al., 2013) to build a firmer understanding of drivers and barriers related to the established practices of local consumers.

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