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The emergence of electronic repair practices in Circular Craft Centres

The barriers, enablers and opportunities for e-repair in Circular Craft Centres in the Netherlands

Master thesis – Metropolitan, analysis, design & engineering

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Abstract

This study examines the practice of electronics repair within Circular Craft Centres (CCCs), identifying barriers, enablers, and opportunities to support the adoption and scaling of repair practices. The current throwaway consumer society has led to increased waste and e-waste production. This is leading to considerable environmental and human health risks because E-waste is inadequately managed. To counter the problematic developments of the throwaway culture, we need to transition to a circular economy (CE) where resources are reused through strategies such as repair and recycling. Currently there are systematic barriers that prevent the uptake of repair practices in society. Creating a need to gain insights into the complex dynamics of repair practices and what is needed to stimulate their uptake in various forms in society (Yuan, 2023).

CCCs are collaborations between second-hand shops and recycling points, focused on increasing circular practices through repair and reuse. Despite increased interest in CCCs and their potential role in the CE and the efforts of implanting them nationwide, CCCs remain largely understudied. This thesis thus aims to explore the current practices of repair in CCCs and the influences of their embeddedness in the CCC and the broader repair system. CCCs face a lot of practical barriers for the repair and reuse of electronics. This research seeks to address this by examining how CCCs can optimize and upscale electronics repair practices and work towards CE objectives. Therefore, this research aims to answer the following question: What are the current practices of e-repair in Circular Craft Centres (CCCs) in the Netherlands, and how can the growth and scaling of these practices be supported? To address this, the study first seeks to understand the current e-repair practices in CCCs. It then examines the barriers and enablers that influence the potential for scaling these practices. Finally, the findings are used to design tools and services that support CCCs in expanding their e-repair efforts and strengthening their role in a circular economy.

Social practice theory (SPT) was used as framework to analyse the practice of e-repair within CCCs and identify barriers, enablers and opportunities of the adoption and upscaling of the practice. Data was collected through interviews with CCCs and a co-creation session. The results were analysed using SPT concepts such as material, meaning and competences. The findings reveal significant barriers to e-repair in CCCs such as regulatory restrictions, access to spare parts, poor-quality electronics, and low profitability of repaired electronics. These barriers originate in broader systemic regulatory, economic, and cultural contexts. Addressing these barriers requires reforms to align regulations with CE goals, and cultural changes through awareness campaigns and increased accessibility to repair facilities.

A practice-based design approach was employed to design services based on the barriers, enablers and opportunities that were observed. The co-creation session was used to initiate ideas for how to improve e-repair and reuse in CCCs. The barriers, enablers and opportunities were translated into design guidelines. These were used to brainstorm ideas for services and tools. Throughout the process various design tools, such as mind mapping, reverse brainstorming and a decision matrix, were used to develop the final idea. The final idea is the *repair hub plan*, which outlined services and tools that CCCs can provide to citizens. These services and tools are aimed at stimulating citizens to engage in e-repair by providing free access to tools and knowledge. The plan contains several services, namely a free workspace where citizens can try repair and a tools and electronics rental service for free or low prices. The CCC can also give e-repair workshops and collaborate with educational facilities to exchange resources. CCCs can also hive out repair yourself kits, which challenge customers to repair a broken second-hand electronic product and win a small price. The designed services aim at using the CCCs social and collaborative nature and goals to create a repair hub through which a community of e-repair can emerge, stimulating the upscaling of the e-repair practice.

Keywords: Circular Craft Centre, Social Practice Theory, Electronics, Repair, Circular Economy

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1. Introduction

In this chapter, the topic of this thesis will be introduced by explaining key components, stakeholders and the relevance of the topic in terms of social and environmental impacts. Then the objectives and questions of the research are outlined. Finally, a brief overview of the rest of the thesis structure will be provided.

In the face of a growing throwaway culture, the repair and reuse of electrical and electronic equipment emerged as essential practices to transition toward a circular economy (CE). These efforts however remain underexplored especially within novel circular initiatives such as Circular Craft Centres (CCCs), which are collaborations between second-hand shops and recycling points, focused on increasing circular practices.

Fifty years ago, it was common practice to repair things when they broke. Careful use, upkeep and repair was used to extend product lifetime. However, due to increased prosperity as well as significant transformations in systems of provision and daily lives, this habit of repair has disappeared. Instead, what is broken is thrown away and replaced (McCollough et al., 2018). This throwaway society has negative environmental impacts such as a higher need for raw material usage and extraction, higher amount of emissions from the production of newly manufactured goods and more toxic waste from disposed products (King et al., 2006). Municipal waste in OECD countries, of which the Netherlands is one, has increased by around 40% between 1980 and 1997 (OECD, 2019).

Waste Electrical and Electronic Equipment, also known as e-waste, is one of the fastest-growing waste streams worldwide. This is leading to considerable environmental and human health risks because E-waste is inadequately managed. The way in which we produce, consume and dispose of e-waste is unsustainable as E-waste ends up in landfills or incineration, resulting in the loss of valuable materials, increased greenhouse gas emissions, and health risks from toxic substances (Forti et al., 2020). In 2019, the world generated over 50 million metric tons (Mt) of E-waste and it is expected to grow to over 70 Mt by 2030. In 2019 less than 20% of this was recycled properly, leaving the rest unaccounted for in informal or environmentally harmful places (Forti et al., 2020). The production of electronics relies on scarce earth materials, of which the mining process has significant environmental impacts (Nayar, 2021). In our current linear economy, in which we inadequately dispose of E-waste, these materials are lost. To counter the problematic developments of the throwaway culture, we need to transition to a circular economy (CE) where resources are reused through strategies such as repair and recycling. The idea of a CE is that products and materials are kept in use for as long as possible, reducing the need for new resources and minimizing waste. The CE is a sustainable economic alternative to our current linear model (Ellen Macarthur Foundation, 2013). The CE uses strategies such as reuse, repair and recycling to keep materials in a cycle, also referred to as R-strategies. Reuse extends the life of products with little additional resources. Repair addresses malfunctions, making a product functional again, often by replacing parts, and with the goal of extending the products lifetime. Recycling is the most sustainable option after a product is no longer fit for reuse or repair, as it tries to reuse the materials from a discarded product in a new product. However, recycling costs a lot of energy due to the manufacturing of new products (PBL, 2024).

Repair is an important strategy to extend the lifetime of electronics and thus minimize E-waste. However, repair has become an increasingly declining practice, due to, among others, difficult to repair electronics, declining repair knowledge and high repair costs (McCollough, 2009). As Jaeger-Erben et al. (2021) notes, repair is often hindered by systemic factors that lock both consumers and service providers into non-repair structures. Netherlands Environmental Assessment Agency (*Plan bureau for the leefomgeving*, PBL) has recently found that only 30% of Dutch citizens have reported engaging in repairing devices, despite 75% expressing willingness to do so (Koch & Vringer, 2023). This shows there is a large potential for increasing repair practices, thus there is a need to explore how repair can be more widely executed. Jaeger-Erben et al., (2021) recommend fostering

the availability and affordability of repair services and look for ways to boost the competences of consumers. In this thesis we explore the role of a novel circular initiative, the CCC within this current repair system in the Netherlands and what it has to contribute to promote repair in society.

In the Netherlands new collaborations have started forming between recycling point and second-hand shops, with the goal of increasing the circularity in the waste disposal system. Through these collaborations it is possible to save more products from being disposed in the recycling point and instead repair and reuse the products and sell them to new owners via the second-hand store. These collaborations are being referred to as CCCs and they should combine at least the following five building blocks: waste collection site, thrift store, repair workshop, education, and the social domain. One of the main goals of the CCCs is to ensure that goods and materials stay in use longer and unnecessary dumping and incineration are prevented. However, they also have educational and social goals, regarding teaching citizens about repair and reuse, changing consumer mindset and providing employment opportunities for persons with distance to the labour market (circulair ambachtscentrum, n.d.). People with distance to the labour market are individuals who experience significant barriers finding and maintaining employment. These individuals might lack skills and education, language, have health related-issues or have language barriers. Examples are individuals with a disability, refugees or a formerly incarcerated individual.

This concept of a CCC has been gaining momentum and municipalities are looking for ways to become more circular and minimize waste production in their cities. In 2019 Rijkswaterstaat started a programme to stimulate and subsidize the creation of a nationwide network of CCCs to stimulate knowledge exchange and guidance for setting up a CCC. There thus seems to be a lot of attention for the potential impacts of CCCs to foster circular practices in their own organisation but also among citizens. However, these emerging collaborations are still exploring how to work towards their new circular goals while also managing their organisation. Due to their novelty, there is not much known or secure about their potential impacts or business case (circulair ambachtscentrum, n.d.).

Especially for the product group of electronics additional steps towards circularity have been under explored. This research seeks to address this gap by examining how CCCs can optimize electronics repair practices and work towards CE objectives.

1.1 Problem statement

Repair is a higher-level circular strategy, meaning it reuses more materials, and less energy compared to other R-strategies. It thus has a significant role in minimizing waste and E-waste in the transition towards a CE. Despite this, repair is critically understudied in academia (Niskanen et al., 2021). Yuan (2023) conducted a semi-systematic literature review, in which it was found that the technical disciplinary perspective dominates the repairing research and that consumers are often depicted as passive actors who are restricted by provisional infrastructure. Papers that do recognize the significance of consumers often fail to capture the interconnections between material and social factors. Social practice theory (SPT) could be used to research repairing practices as routinized patterns embedded in the social and material frameworks. This perspective has been underexplored in literature and could lead to insight on the complex dynamics of repair practices and what is needed to stimulate their uptake in various forms in society (Yuan, 2023).

Decreased use of repair practices is mostly driven by structural, cultural, and logistical barriers that hold back both consumers and repair service providers. As discussed by Jaeger-Erben et al. (2021), there is a critical need to foster repair skills and undo the systemic barriers that prevent the integration of repair within circular spaces like CCCs. Limited research has been conducted on the specific challenges and opportunities of commercial independent repair, meaning repair by citizens and non-profit organisations (repair cafés, restart parties, etc.). However, this is changing due to a greater focus on the right to repair (Van Der Velden et al., 2023). Of these studies most have focused on mobile phone repair because this is a widely sold electronics device with high economic value. It is thus valuable to explore the practices of repair within a more organised setting and from an organisational perspective such as the uptake and scaling of repair practices in CCCs.

Despite the increased interest in CCCs and their potential role in the CE and the efforts of implanting them nationwide, CCCs remain largely understudied. Some studies investigate the initial roadblocks and impacts. Particularly regarding electronics repair in CCCs there is a remaining gap in research. This gap is both from an academic perspective and a practical standpoint, as CCCs are exploring how to set up electronics repair. Current literature on second-hand stores highlights the broader importance of second-hand spaces in sustainable consumption (Gregson & Crewe, 2003; Kuppinger, 2023), but it does not address the nuances of integrating repair into these settings. It is thus important to explore the current practices of electronics repair in CCCs and the influences of their embeddedness in the CCC and the broader repair system.

1.2 Research aim and objectives

This study aims to explore the practice of electronics repair within CCCs, identify barriers, enablers and opportunities through using SPT based analysis, and propose a tool or service to support the adoption and scaling of these practices for the CCC context. Barriers here is used to refer to influences that discourage the uptake of e-repair in CCCs. Enablers is used to refer to influences that encourage the uptake of e-repair in CCCs. Opportunities are used to refer to new elements or ideas that could potentially encourage the uptake of electronics repair is CCCs. For the purpose of this thesis, the repair of electronics will be referred to as *e-repair.* SPT is utilized in this research because in contrast to conventional more individualistic approaches, SPT decentralizes individuals and instead explores the impact of wider social, financial, and provisional contexts on practices (Hargreaves, 2011; Shove et al., 2012b). The aim of the research is not to determine or measure influences on the practice, but it is to explore the dynamics of these influences, their interconnections and their role in shaping the practice.

The broader aim of the research is to generate knowledge and insights that can contribute to minimizing waste and e-waste by supporting the transition to a CE. It seeks to adjust the throwaway economy and culture to one that embraces repair and reuse. Furthermore, it aims to explore and support the role of CCCs in this transition.

The focus of the research is the e-repair practices within CCCs in the Netherlands. Because of the broader goal of minimizing e-waste, the scope often extends beyond e-repair to include related reuse practices, reflecting their interconnectedness. The repair practices are embedded within the organizational context of CCCs; therefore, this research adopts an organizational and management level perspective. This focus aligns with the novelty of repair practices in CCCs, as managers play a key role in determining how these practices are implemented and scaled. This research will thus focus on the barriers, enablers and opportunities experienced in the management and execution of the repair practices in CCCs.

The following research questions and sub questions are meant to guide the research to achieve the previously outlined objectives:

Main Research Question:
What are the current practices of e-repair in Circular Craft Centres (CCCs) in the Netherlands, and how can the growth and scaling of these practices be supported?

Sub-questions:

- R1: How are electronic repair practices emerging in CCCs?
- R2: What barriers and enablers influence the adoption and scaling of e-repair practices in CCCs?
- R3: What are the possible roles of CCCs in the current and future ecosystem of e-repair?
- R4: How can designed tools or services support the adoption and scaling of e-repair practices in CCCs?

The remainder of this thesis is structured as follows. Chapter 2 presents an overview of the relevant literature regarding (e-)repair practices and the broader context of the (e-)repair ecosystem. Chapter 3 provides an overview of the theoretical framework, focusing on the use of SPT and design theory to analyse the practice of e-repair and design tools and services. Chapter 4 outlines the research methodology, discussing the data collection processes, analysis methods and the limitations and ethics of the research. Chapter 5 presents and analyses the research findings, highlighting the barriers, enablers, and opportunities identified in the e-repair practices. These inform the design process outlined in chapter 6, which discusses the design guidelines, initial ideas and final design. Chapter 7 offers a discussion of the findings, connecting them to the broader literature on circular economy and repair practices, as well as reflecting on how the findings inform the design. Additionally, it provides recommendations for future research, policy and practical applications within CCCs. Finally, Chapter 8 concludes the thesis by summarizing key insights, the services and tools developed and reflecting on the implications for both theory and practice.

2. Literature review

This chapter provides an overview of the existing literature on (e-)repair practices and explores key factors influencing (e-)repair in order to contextualize the research and identify research gaps. The broader context of (e-)repair practices is explored through literature on repair ecosystems, history and the current state of repair practices. The chapter aims to create expectations for the aspects that might come up as barriers and enablers of repair during the research. Through the exploration of the broader context of repair in this chapter the stage is set for understanding the complex socio-material setting in which the practice of e-repair operates, thus making it easier to contextualize the later findings of this research.

2.1 Repair practices

Van Der Velden describes repair as a socio-material practice (2021). Socio-materiality is about how people and things, like tools or technology, work together and affect each other. In repair for example your knowledge and actions influence how we look at tools and use them, as well as how we view a broken product. Another take on repair was introduced by Graham and Thrift (2007, p. 6) who describe maintenance and repair as that what keeps modern society going. They explain that "the world is involved in a continuous dying that can only be fended off by constant repair and maintenance." This natural decay that happens to materials on earth, leads to maintenance and repair which itself can be a vital source of variation, improvisation and innovation. However, Graham and Thrift (2007) argue that products are increasingly being designed to be more difficult to repair. They also note that production and consumption cycles are becoming more rapid. This shows that repair reflects broader market structures and economic strategies and is not just about using tools and techniques to prolong the life of a product or system (Graham & Thrift, 2007).

As stated before, limited research has been conducted from a social practice perspective on the practice of repair and e-repair. Additionally, social research that has been done on repair is largely about individual repair and its challenges. There is a gap in the research regarding the way these practices show up in a more organisational setting and what barriers they face in facilitating repair. Van Der Velden (et al., 2023) has done research on independent repair in Norway, which includes repair cafés and small repair shops. This is an example of a research about the difficulties experience when facilitating repair. Barriers mentioned are regulations, costs and accessibility of spare parts and repair information. As little research has been done about the organisational practice of repair, we look to the studies on individual repair to see what aspects and barriers of the practice have been explored. Even though the primary focus of this research is not on individual repair and reuse efforts by citizens, insights into their repair behaviour may lead to valuable expectations for repair activities within CCCs. Additionally, CCCs play a role in educating citizens on circular practices and aspire to offer services that help promote more sustainable consumer behaviour. For these reasons it is important to understand citizen relation to repair practices and what are deterring and inspiring factors for them to engage in these practices.

2.1.1 Costs

McCollough et al. (2018) investigated the factors that are responsible for the transition into a throwaway society in America. An important factor weighing into the decision to repair a product is the cost differential between replacing and repairing a product. The costs of newly manufactured products have gone down, while wages of repair workers go up. This creates a cycle of replacement being chosen over repair, which decreases the need and for repair services and thus increase costs further. Additionally, cheaper products are replaced for new ones more quickly due to the cost of repair outweighing the price of a new product (Scott & Weaver, 2014).

The cost of repair thus is an essential predictor of repair behaviour (Okada, 2001). Economic context seems to play an important role in in people's willingness to repair (Sonego et al., 2022). Borthakur & Govind (2018) found that in order to maximize product lifetime, the low-income group has the highest willingness to repair (93,7% of respondents). During economic slumps the search for repairs is higher and to save money are more likely to attempt repair themselves (Laitala et al., 2021; Scott & Weaver, 2014).

High cost seems to be the biggest reason to not repair a product (Bovea et al., 2017; Pérez-Belis et al., 2017). Cost is seen as not only the price of repair, but also the invested time. Borthakur & Govind (2018) found that 68.1% of their respondents consider buying a new product in the face of the repair cost. The perceived costs of repair are indirectly influenced by material and social setting, such as the availability of repair services and social support Jaeger-Erben et al., (2021). From a repair service perspective repair is also hindered by the low price and poor quality of new products, as this makes it difficult for repair to be profitable (Laitala et al., 2021).

2.1.2 Convenience

Another factor is the ease to repair a product (Sonego et al., 2022). Consumers find having products repaired or attempting repair themselves to be time consuming, inconvenient, costly and frustrating (Scott & Weaver, 2014). When it comes to individual repair the levels of knowledge and skills to repair of consumers are decreasing, making it more difficult for consumers to attempt repair (McCollough, 2009). Additionally, products are increasingly designed to be disposable and not repairable (McCollough, 2009). Electronics specifically are often complex, build with low repairability and thus hard to repair for individuals with little repair competence. The alternative of going to a repair professional is becoming less convenient due to the decline or repair shops and facilities (McCollough, 2009).

2.1.3 Time & effort

Performing repair takes time and this impacts the perceived costs of repair. It either means investing your own time to try a repair or time without the product, which can be seen as an inconvenience to people (Svensson-Hoglund et al., 2021). People are willing to invest 15-30 minutes on average into fixing the device (Flipsen, 2019). The number of steps people are prepared to take depends on the problem and the situation. However, the probability of success is more important than the number of steps (Bouma, 2018)

2.1.4 Repair information

There is a lack of information regarding electronic products such as a repair manual, common failures or information on where to go for a product repair. This leads to barriers for consumers and missed opportunities for simple repairs as there is a lack of knowledge in the consumer (Sonego et al., 2022). Producers of the products often are not transparent with information regarding product repair. Manufacturers sometimes offer their own repair service and then deny the supply of parts to non-official repairers (Türkeli et al., 2019). Additionally, due to product design, there are difficulties with diagnosing the problem and disassembling products (Vanegas et al., 2018).

2.1.5 Emotional attachment

An aspect that normally is said to have great influence on a citizen's willingness to repair is their attachment to a product. People form attachments to products in various ways such as nostalgia, invest money and invested time and care for a product (Korsunova et al., 2023; Mugge et al., 2005). Attachment thus is a potential predictor for individual repair or going to a repair service or shop. As the CCCs work with products that have been donated, and thus there is no owner with attachment to the product it will be interesting to explore how the dynamic between repair and attachment shows up.

2.1.6 Tools and parts

Both self-repair and non-authorized repair service are undermined by the low availability of spare parts and tools. Spare parts not being readily available has a significant impact on the time needed for repair and potential inconveniences that form a barrier to repair (Korsunova et al., 2023). In addition to being poorly accessible, spare parts and tools are often expensive (Den Hollander, 2018). This is partly due to underproduction of spare parts by manufacturers, which can be seen as a practice related to planned obsolescence (Godfrey et al., 2022). Korsunova et al., (2023) concludes that accessibility of spare parts should be a priority for facilitating both professional repair and self-repair.

2.1.7 Skills

Burger states that it seems that there is a higher skill level needed than is often recognized by the CE literature (Burger et al., 2019). The European standard (*Material Efficiency*, n.d.) subdivides different repair skills in knowing how to localise the fault, physically getting to the fault, safe tool handling, minimizing risk for breaking the product in the process, the repairer and the environment. These repair skills have been decreasing in our consumption society. People do not have the right knowledge, competences and experience with repair or in other cases convenient repair infrastructure (Jaeger-Erben et al., 2021; Svensson-Hoglund et al., 2021). This raises the barrier to consider repairing a device. Additionally, on professional level, the amount of repair workers is decreasing (McCollough, 2009).

2.1.8 Obsolescence

Electronics are increasingly treated as consumables (Sabbaghi et al., 2017). Repair café volunteers expressed that “the concept of manufacturer ‘in-built obsolescence’ is a real issue, across a wide range of electrical/electronic products” (Charter & Keiller, 2014, p. 2). Premature obsolescence means that the products or the market around are designed to limit the lifetime of a product (Magnier & Mugge, 2022; Henry et al., n.d.) This can either be by designing a product to have a short lifetime (*planned obsolescence*), through low repairability and not having access to spare parts (*indirect obsolescence*), through a product no longer being useful or compatible with newer technologies (*compatibility obsolescence*) or through making a product seem outdated by rapid release of new trends, technologies and trends (*perceived obsolescence*) (Henry et al., n.d.). A product may be perceived as obsolete, regardless of its technological state, and the purchase of a new one feels justified (Sabbaghi & Behdad, 2018).

2.1.9 Regulations

Generally, for repair of electronics certain regulations apply. These legal mechanisms such as intellectual property, contracts, consumer laws, tax laws, and chemical laws can really limit participation in repair practices (Svensson-Hoglund et al., 2021). In the Dutch legislation for e-waste processing the CENELEC-standard is used. This is a European standard for the processing of disposed electronics and e-waste. Companies that process electronics therefore must operate according to these standards and must have a CENELEC-certificate. To receive this permit, a company must meet certain requirements and must be examined by an independent auditor (Stichting Open, n.d.). According to the Dutch Human Environment and Transport Inspectorate repair of electronics is allowed outside of the CENELEC-certificate. However, disassembling is not allowed without the CENELEC-certificate. In practice, dissembling is often part of a repair process. Which entails that all repairs requiring disassembly are not allowed without CENELEC-certificate. Additionally, it is not allowed to harvest parts from electronics without the certificate. These regulations do not count for individual repair, making it possible that voluntary repair services such as repair cafés do not have a certificate and are allowed to dissemble electronics (Ministerie van Infrastructuur en Waterstaat, 2024).

2.2 Context of repair practices

2.2.1 Repair ecosystem

The concept of a CCC is quite new and little research has been done on these emerging networks between second-hand stores, recycling centres and repair work. Some research has been done in the Dutch context, mostly reporting on the so far measured impacts of the CCC's. One report states that the avoided environmental costs of waste processing and production are often way higher than the environmental costs of upcycling these materials by CCCs (Impact Institute, 2022). For products with a mixture of materials, such as electronics, the impact is even greater (Impact Institute, 2022). Some research has been done about the social activities that take place at CCC's and on the relationship between residents and the CCC (Panteia, 2019; Seminck, 2022). However, no research could be found that explores the particular challenges of electronics re-use within a CCC or applies SPT to a CCC context. As there is no official translation for the term, no literature was found about international equivalent of the Dutch CCC.

Second-hand stores are one of the main collaborators that form a CCC, thus it is valuable to see what research has been done in this area. Second-hand cultures and economics have only recently gained attention in the social sciences (Kuppinger, 2023). Important research was done by Gregson & Crewe (2003), who examined the British landscape of charity and retro/vintage shops in the 1990s. They stress that "second-hand worlds matter" and talk about how value is created in second-hand markets, how this is different from first hand spaces and how the second-hand space reflects movements of ethical, green or sustainable consumption (Gregson & Crewe, 2003). Within research on second-hand stores, most attention has been paid to studying the consumers of second-hand products, focusing on their motivations and attitudes towards the store (Darley & Lim, 1999; Evans et al., 2022; Roux & Guiot, 2008). Roux and Guiot (2008) found that price sensitivity, need for uniqueness, frugality, predisposition to nostalgia among others had a positive relation with second-hand buying. A large portion of literature about second-hand stores, is solely focused on clothing. No studies were found looking into specifically electronics at second-hand stores. No studies specifically research the role of repair within second-hand and thrift stores. There are studies that highlight the significant role of second-hand stores in the recycling, upcycling, repairing and reusing of goods. Such as Kuppinger (2023, p.1), who addresses that thrift stores are places of "incidental sustainability that do not loudly advertise their work but quietly help thrifters pursue more ecological lifestyles and help cities divert huge quantities of materials from landfills and incinerators".

Evidently, little research has been done on CCCs and their inner workings and potential. Additionally, there is also a lack of studies looking into the current handling of donated electronics in CCCs and second-hand stores, and its possibilities for more repair and reuse.

2.2.2 Circular strategies

The concept of CCCs is part of the aim of the Dutch government and many Dutch municipalities to transition to a circular economy (Circulair Ambachtscentrum, n.d.). The need to transition to a circular economy has become a focus for academia and European policymakers, stimulating an increased research interest in circular practices. PBL (2024) has created an adaption of the circularity ladder or R-ladder model, which is a hierarchy of circular strategies based of their resource-savings and sustainability (Figure 1). The higher the number of the strategy the more energy and resources are required in the process of getting a product back to its use state. Lower strategies thus are most sustainable and thus desired. This model is used as a guide by Dutch governmental agencies when planning the transition towards the circular economy. To transition to a circular economy, these strategies are applicable to many companies and organisations. They therefore are also valuable to CCCs, and their aims to repair and reuse donated goods. In addition, they have a role in educating

citizens/consumers on these strategies and how to integrate them in their lives. CCC Waardering in Zwolle, also use versions of this R-ladder model and the strategies defined in it (Schut, 2019).

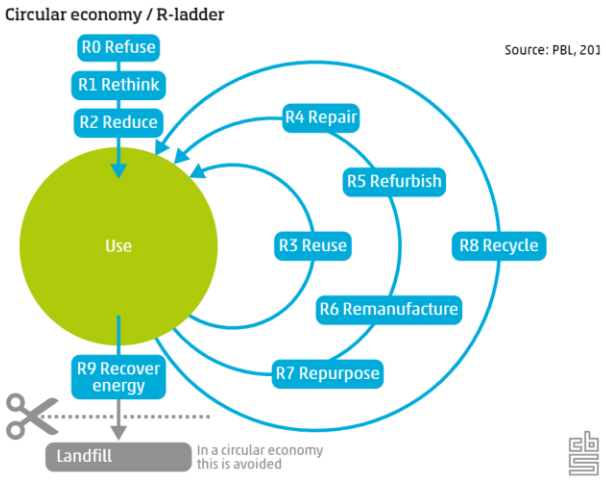

Figure 1 Circular economy model with R-strategies defined by PBL (CBS Statistics Netherlands, 2020)

2.2.3 Current state of repair

Due to the need to transition towards a circular society, there has been regained interest in the practice of repair. Such as the growth of the "right-to-repair" movement (Godwin, 2021). This movement focusses on the legal right of consumers and independent repairers to be able to repair the products they buy. Meaning products should be designed to be repairable and they should have access to spare parts and repair manuals.

There are multiple actors who carry out repairs: the producing companies or their licensed repairers, independent repairers, profit and non-profit organizations, community groups, and private people (Bradley & Persson, 2022). In their research Bradley and Persson (2022), state that companies are trying to control repair by making products difficult to repair independently and lobbying for restricted repair rights. Repair is now increasingly handled from corporate service centres or by specifically licensed repairers, instead of independently at a shop or at home (Bradley & Persson, 2022).

Van Der Velden et al. (2023) investigated the role of independent repair by doing surveys and interviewing repair shops and found that the independent repair sector fills the gap between expensive authorized repair and discarding a product and they have contributed to a circular spare part economy on a local and global level. They highlight some barriers that need to be overcome to achieve more access and overall mainstreaming of repair, such as: "better product design; more access to spare parts, tools, and manuals; increased affordability; strengthened consumer rights; addressing consumers and brand owners' behaviours; taxation; and the removal of existing legal barriers (Van Der Velden et al., 2023, p. 22)." Independent repair has been declining, McCollough (2009, p. 619) illustrates that in America "the Current Employment Statistics (CES) division of the BLS estimated that in 1967, there were 9136 shoe repairmen in America but by 2004, the CES reported only 2825 shoe repairmen". The decline of independent repair is problematic because it decreases accessibility to an in-between option between expensive authorized repair and disposal.

Community repair is a fairly recent development. It formed due to environmental concerns, lack of (affordable) repair opportunities, and critiques of the consumer society (Van Der Velden, 2021). Community repair is a citizen-driven, locally organized public event, in which volunteer repairers and people with an object in need of repair are matched (Charter & Keiller, 2014). A well-known example of community repair is the international repair cafés. Findings from Charter and Keiller (2014) work, suggest that volunteers at Repair Cafés are most

strongly motivated to take part because of what they can do for others, namely their desire to help others live more sustainably, to provide a valuable service to the community and to help improve product repairability and longevity. Repair cafés aim to work against the current trend of declining repair skills and knowledge among young people, by repairing together with the consumer.

A CCC would most likely fall into the category of profit and non-profit organizations. Little research has been done on different forms of profit and non-profit organisations in repair and how they contribute to the repair ecosystem. This research will address this gap in the literature by focusing on CCCs and their repair and reuse efforts.

2.2.4 History of repair

In order to understand the current role and shape of the repair and reuse in our society, it is insightful to look back at how these practices have evolved throughout history (Kuijer, 2017). Anthropological and historical research indicates that repair has been used for other purposes than in response to the crises of overproduction and growing climate concerns (Isenhour & Reno, 2019). For a long time, people used to own only what they needed, and took care, mended and repurposed their possessions. However, as economic prosperity grew in the 1970s people could afford to buy more stuff. Lower-income groups, often excluded from the expanding consumer economies, had little choice but to continue buying second-hand items or using hand-me-downs. Here the association was created and promoted by industry that using old, worn-out, or second-hand items was a sign of poverty or being old-fashioned. This led to a decline in the trade of used goods, though it never completely disappeared (Kuppinger, 2023). Old and unwanted possessions that were once repaired and reused, are now redefined as garbage and disposed of so new stuff can be bought (Martínez, 2017). This has led to decreasing practices of reuse, repurpose, repair and the associated skills (Kuppinger, 2023).Berry, Bonnet and Isenhour (2019) found that in the northeastern United States, many continue practices of repair and reuse because of values of thrift, the desire to preserve high-quality or sentimental items, and the practical need to save money. They suggest that any effort to promote reuse would benefit from looking beyond purely economic rationales to attend to matters of place, sociality, and market relationality (Berry et al., 2019).

2.2.5 Consumption second-hand electronics

Consumers have alternative perceptions and attitudes towards buying second-hand goods than first hand goods. In his research on factors that influence the decision when buying second-hand products, Alam (2015) found that in case of electronics in the decision-making process, price was considered first, then risk and lastly brand. Some more research has been conducted on what motivates consumers to buy second-hand goods (Jibril et al., 2024; Rodrigues et al., 2023). However, little research seems to be done on the considerations of consumers when buying these products. To gain insight, research on the factors influencing the purchase of refurbished goods can be examined. (Agostini et al., 2021; Alyahya et al., 2023). In this research, price and perceived risk also have been found to influence the purchase of these second-hand electronics.

2.2.6 Donation of electronics

When a product is broken or a consumer has decided it is no longer useful to them or wanted, they have the option of disposing the product or redistributing it by re-selling or donating. Redistributing products extends the lifetime of the product and is therefore favourable when it comes to environmental considerations. Several studies have been conducted on consumer disposal and redistributing behaviour, and what factors influence their decision-making (De Ferran et al., 2020; Fortuna & Diyamandoglu, 2017; Sarigöllü et al., 2021). Fortuna & Diyamandoglu (2017) found that people tend to choose disposal methods that are convenient and require low effort. They go on to say that the type of disposal method selected relies on the perception of the reuse potential of the product. This perception however is not always reliable, as people have been found to use self-

favouring reasoning to justify actions that deviate from internal moral standards when it comes to sustainability choices. This phenomenon is called moral disengagement (Kilian & Mann, 2020). To illustrate this, when someone wants to dispose their old microwave after buying a new one, it is better for the moral conscience to donate it than to dispose it. A person could use self-reasoning behaviour to justify that the old microwave is still fit for reuse. This then taints their ability to assess the reuse potential of a product. De Ferran et al. (2020), found that there are varying motivators for each type of redistribution behaviour. Donating is associated with among others practical, social, altruistic and ecological motivations.

2.3 Conclusion

The literature shows that repair practices are shaped by a variety of interconnected aspects, including economic considerations, accessibility of tools and parts, skills, emotional attachment and regulatory frameworks. These aspects might be observed during the exploration and analysis of the e-repair practices in CCCs. In the current repair ecosystem, there are various providers of repair: induvial repair, community repair, organized repair, independent repair and licenced repair. However there still seems to be a need for consistent, affordable and accessible repair options. In this thesis it will be further explored what role the CCC has and should take in this ecosystem. While a lot of research has been done on individual repair, there remains a gap regarding organizational repair practices, particularly in the context of second-hand stores and CCCs. We have seen that research on repair has mostly been done from a technical or consumer perspective, and there is a lack of social science research that considers the complexities of everyday life. This has informed the theoretical framework for this research which will be established in the next chapter.

3. Theoretical framework

This chapter will elaborate on the theoretical framework and how it is relevant to answer the research questions. For this study, a combination of social practice (SP) theories and concepts is used to guide an analysis of the e-repair practices that occurs in CCCs in the Netherlands. First, these theories will be introduced and their relevancy to this research will be discussed. Afterwards the conceptual framework will be introduced, which applies the theories in a framework that will guide this research. Theories of practice have been used across various disciplines but have mostly been applied to behaviour and consumer studies (Hargreaves, 2011). Practice theory is suited for doing in depth, context rich analysis of practices. This fits the aim of this study which is to understand what CCC's do in terms of e-repair and what is holding them back from doing more. For this study we hold the view that to create meaningful change in repair practices it is necessary to understand the current practices to a deep contextual level. SPT is suitable for this because in contrast to conventional more individualistic approaches, SPT decentralizes individuals and instead explores the impact of wider social, financial, and provisional contexts on practices (Hargreaves, 2011; Shove et al., 2012b). An objective of this study is to design recommendations to improve e-repair and re-use in CCCs. For this purpose, we draw on the work of Spurling and McMeekin (n.d.) and Kuijer (2017) who developed approaches for using practice theory as an analysis and design method.

3.1 Defining repair practices

This study focuses on e-repair practices within CCC's. The practice of repair can be defined as the repair and maintenance of a product for the use in its original function. It is one of multiple R-strategies, which aim to reduce resource consumption, waste, and environmental impact by promoting circularity. Repair and reuse are often interconnected, as they serve the common goal of extending product lifetime. In this study, I examine how e-repair takes shape in CCCs and explore ways to enhance its impact. The focus of the study is thus on e-repair. However, due to limited e-repair practices being performed, reuse of electronics is sometimes discussed alongside repair. As the practices in the CCCs are connected in their aim to extent product lifetime.

In a CCC, reuse happens when products are successfully resold to customers. Direct reuse of an electronical device is the most resource efficient and thus sustainable way for a CCC to process the incoming electronics. When a product is not directly resalable other strategies are utilized such as repair. These steps require more time and materials, making the process less sustainable than direct re-use, but more sustainable than recycling. Recycling also happens within CCCs; however, this is outside the scope of this research.

3.2 Social practice theory

Circular strategies have mostly been studied from a technical, economic or consumer behaviour perspective. In these studies, individual citizen choices and agency are considered as the main drivers in creating circular change. However, these actor-centred models have little acknowledgement of the provisional structures and socio-material complexities of everyday practices (Greene et al., 2024). In this thesis, SPT was chosen to guide the study of electronics repair practices in CCCs. SPT uses practices as the unit of analysis to study human behaviour by focusing on how these are embedded and materialized through practices (Schadenberg & Folmer, 2022)**.** The SPT framework can guide the analysis of the meanings associated with second-hand electronics and how they influence consumer behaviour, as well as how the material conditions of these centres (e.g., availability of tools for repair) affect the likelihood of engaging in the practices (Beatson et al., 2020). To create meaningful contributions to electronics repair practices in CCCs, it is important to do a context rich in-depth analysis of the current practices. SPT has proved useful for doing explorative research that can help identify barriers and opportunities for changing practices (Shove et al., 2012a) and develop strategies for these changes (Speck & Hasselkuss, 2015). These theories are used to guide the analysis of the electronics repair practices in

order to find opportunity points for change. This study contributes to theory by integrating social practice into a different spatial setting, the CCC, and thus applying it to a more organisational and technical setting and exploring whether the insights might lead to meaningful design recommendations.

3.2.1 What is a practice?

SPT is about people in their everyday lives and the practices, or doings, they are engaged in. For example, they cook, eat, sleep, take care of children, shop, play football, and work. People find significance in their practices, often describing them when discussing their daily lives (Røpke, 2009). A practice is described by Reckwitz (2002, p. 250) as "a routinized way in which bodies are moved, objects are handled, subjects are treated, things are described, and the world is understood". The groundwork of SPT has been laid by among other (Giddens, 1984), who viewed practices as a continuous process in which individuals perform daily tasks and routines based on practical consciousness whilst at the same time creating social structures within society.

When engaging in a practice typically a range of materials is used, such as equipment, tools, materials, and infrastructures. SPT therefore uses material elements to define practices, making it relevant to study (circular) consumption or other material focused practices, such as repair and reuse. Reckwitz (2002, p. 253) shows the materiality of practices with the following example: "in order to play football we need a ball and goals as indispensable 'resources'". Likewise, Shove et al. (2012a), highlights that a ball does not make the game. An idea of playing, people to play with and a measure of competence are also needed. Thus, there are other elements that form a practice. There have been many versions of these practice-elements described by sociologist. However, they all describe the following three elements that have been condensed in Shove's version: materials, meanings, competences.

- ***Materials*** include all the physical aspects of performing a practice, including things, technologies, tangible entities, and the stuff of which objects are made (Shove et al., 2012a). This also includes specific buildings where a practice is carried out or the human body (Holtz, 2014). In case of electronics repair materials can be tools used for repair or a work bench.
- ***Meanings*** indicate understanding, belief or emotion that are associated with the practice, or practice elements. These include symbolic meanings, ideas and aspirations (Holtz, 2014; Shove et al., 2012a). In case of electronics repair, an example is the expectations and biases consumer have about second-hand electronics.
- ***Competences*** refer to the skills and knowledge that is needed to perform a practice (Shove et al., 2012a). An example is knowing how to use a screwdriver. This illustrates how one element such as knowledge can be linked to materials, in this case a tool. A distinction can be made between tacit and explicit knowledge.
    - ***Tacit knowledge*** is learned through experience, practice, and socialization (Nonaka, 1998). This kind of embodied knowledge is acquired through repeated performance and cannot be learned solely from written text or other people. An example of tacit knowledge is walking.
    - ***Explicit knowledge*** is learned through written or verbal form and shared among people (Nonaka, 1998). This knowledge comes in the form information, facts and rules.

Shove's version of the elements lends itself to empirical and explorative research. However, it might cause some simplification of the intricacies of practice theory (Shove et al., 2012b; Spaargaren et al., 2016). Figure 2 is an illustration of the practice elements and how they are linked together to form a practice.

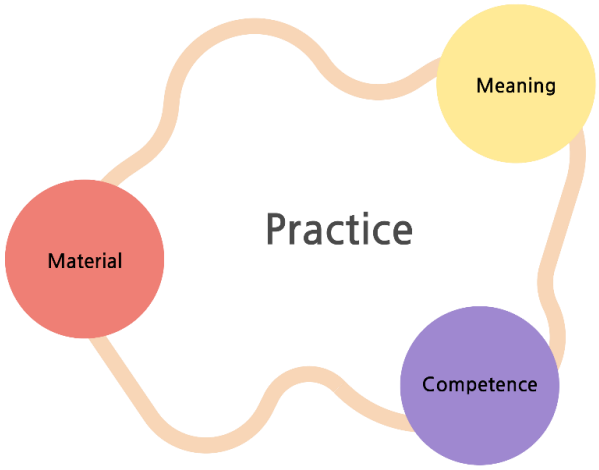

Figure 2, social practice theory elements model, adapted from (Shove et al., 2012a)

To form a practice, it is essential that elements are linked together: “it is the presence and integration of all three of these elements in the moment of performance that a practice is realized (Maller, 2015, p. 58)”. In Figure 3, created by Shove et al. (2012a), it is shown that the elements of a practice can already exist separate without links between them. This is called a proto-practice. Once links between the elements are formed a proto-practice becomes a practice. Finally, the practice might evolve or disappear breaking links between the elements creating an ex-practice.

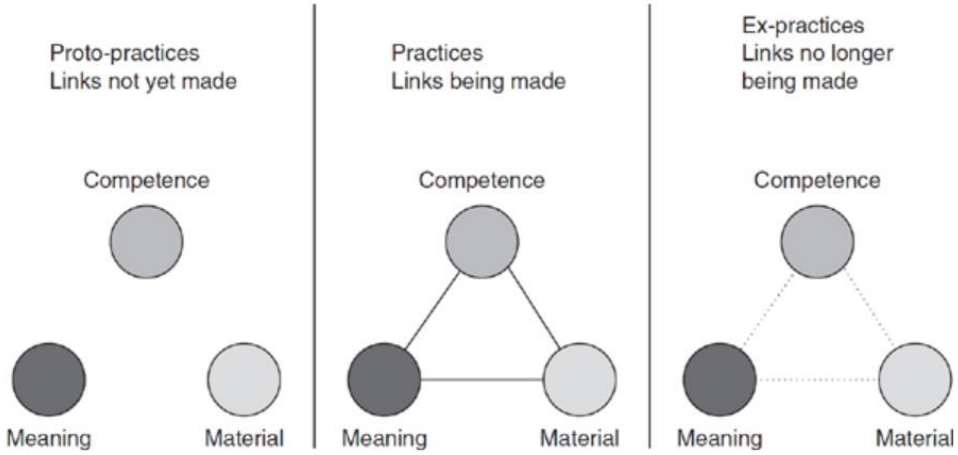

Figure 3, model showing different stages of practices (shove et al., 2012)

3.2.2 Zooming in and zooming out

To really study practices, it is important to study both the local material elements of a practice as well as its trans local connections to societal phenomenon and organizations. Nicolini (2009, p. 1392) has developed an approach of “zooming in and out” which enables the understanding of “both the conditions of the local accomplishment of practice and the ways in which practices are associated into broad textures to form the landscape of our daily (organizational) life.” When “zooming in” Nicolini’s (2009) approach focusses on “saying and doings” and the active role of tools and materials. This means there is a focus on the materials used, the

practice elements, and the performative actions that are used in the practice. The “zooming in” approach will be used to get a better understanding of what the practices of e-repair look like in CCCs.

When “zooming out” the focus in on trailing connections. Because “activities never happen in isolation, so that practices are always immersed in a thick texture of inter connections” (Nicolini, 2009, p. 1407). These connections can be studied by “focussing on the local and translocal effects produced by chains and assemblages of situated practices”, which Nicolini (2009, p. 1409) calls practice networks. By looking at connected practices and societal and organizational contexts, the broader influences on the practices of e-repair will be explored.

3.2.3 Connected practices

Practices often do not exist alone but are dependent on and connected with other practices. The practice of repair for example is depended on the practice of donation. The practice of repair exists of sub-practices such as testing products, identifying the fault(s) and disassembling. Shove et al. (2012c, p. 14) defines two kinds of connected practices. Bundles of practices which are “loose-knit patterns based on the co-location and co-existence of practices” and complexes of practices which are “stickier and more integrated combinations” of practices. Practices are often connected through shared elements. Thus, practices use the same materials or are connected by a shared meaning. Just as with the figure for practices (Figure 3), Shove et al. (2012), describe three formations of connections between practices that, illustrated in Figure 4, in which practices exist but without being integrated, one in which practices are provisionally linked by ties of co-existence or co-dependence, and one in which connections are no longer sustained.

In this thesis, I will explore which other practices are connected to the practice of e-repair. Attention will be paid to how these practices are linked to each other, if they are dependent on each other, what elements they share and what effects this has on the practice of e-repair within CCCs.

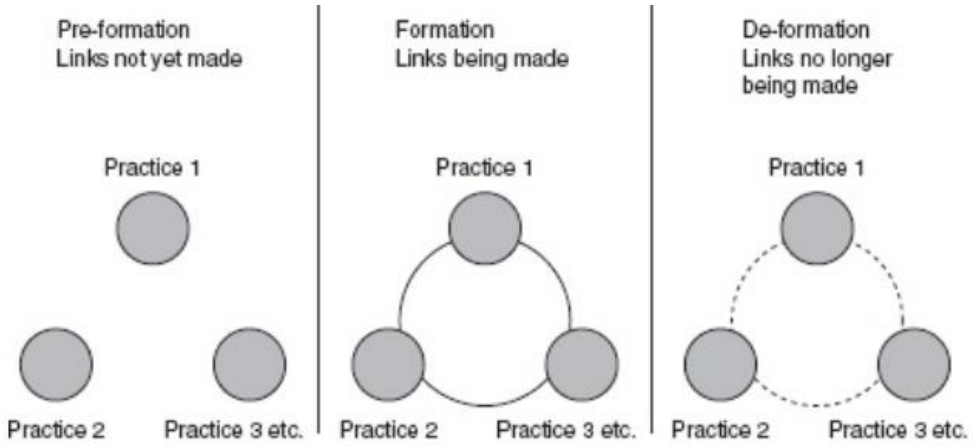

Figure 4, The pre-formation, formation and de-formation of connections between practices (Shove et al., 2012)

3.2.4 Organized practices

Schatzki (2002) has developed a version of SPT, known as site ontology, which has been widely applied by organisation sciences. Due to Schatzki (2002) incorporation of rules and its focus on situated and organised practices, this theory is suitable for application in a more organized environment (Loscher et al., 2019). This research also states that there are saying and doings in the form of voluntary bodily movements (Schatzki,

2002). These are the actions that can be observed while a practice is performed. These sayings and doings are created through four "organising principles", which are:

- **Teleoaffective structure**: A normative structure composed of prioritised goals, end projects, and appropriate emotions.
- **Practical understanding:** The bodily ability to perform activities within practices and the sense for appropriate reactions in a practice.
- **General understanding:** Shared senses of things, including values, aesthetics, morals, and the cultural appropriateness of activities.
- **Rules:** explicit prescriptions, procedures, and principles of proceeding.

These principles are connected to a specific site and the attached goals and legislations; thus, they have a part in shaping the practice. An example is that in an organized setting such as a CCC the practice of repair comes with the goal of earning profit, which would be a teleoaffective structure, that influences how the practice is conducted.

3.2.5 Practitioners

In SPT, the people who perform the practices are called carriers or practitioners. In a practice-based approach, people are decentralized from analysis. However, they still play a critical role as active agents in practices. Through their linkages to the practice elements practitioners largely shape the performance of practices. The organised setting in the CCC in which this practice emerges, impacts the way the practitioners engage in the practice. As a large group of practitioners are the employees who perform the practice as part of their job, this might influence the elements of the practice such as the meanings associated with repair in the CCC. Another practitioner group is the managers of the CCCs who influence whether and in what way the practice is carried out. And lastly, the citizens and customers of the CCCs who engage in donating, buying electronics, and potentially learning about repair through the CCCs. This might influence their motivations and competences, as these are not purely individual but linked to their work and the setting of the practice.

3.2.6 Communities of practices

Lave and Wenger (n.d.), argue that involvement in communities of practice is an essential way for people to learn. Communities of practices are created overtime and through collective learning and creating practices that are sustained through a pursuit of a shared enterprise. According to Lave & Wenger (n.d.) communities of practice are defined by three dimensions: What it is about, how it functions, what capability it has produced. In this thesis it will be considered whether a CCC is or can be a community of practice and whether this can help (re)emerge and scale the practice of repair, through involving citizens and consumer in the practice and letting them learn through these experiences.

3.2.7 How do practices change?

Practices are inherently dynamic, they can disintegrate or re-emerge due to technical, social or cultural development (Warde, 2005). They can evolve or be performed in a new way or for a different purpose. Practices change or disappear if links between the elements are being created or broken down (Shove et al., 2012c). Old practices and their elements can be "fossilized", so that little knowledge of the practice persists into future generations (Shove et al., 2012c). Yet, there is potential for the resurgence of these practices, drawing upon their historical foundations to reclaim relevance. This might be the case for repair. Once common, the practice of repair has slowly disappeared from our current society. Now there is a need to revive this practice, adapting it to suit the demands of modern everyday life. SPT is thus suitable not only for analysing how practices have changed and shaped from the past until now, but also to explore how practices can be changed in the future and how these changes can be stimulated. Building on the different mechanism through

which practices change described by Shove et al. (2012b), Watson (2012) outlined the following three ways in which practices change:

Elements comprising the practice can change
A practice can change by the changing of one of its elements. This is most visible for the material element. For example, when a material is used in a practice, it is innovated due to technological advancements. Electronical devices have said to be increasingly designed in a way that they are difficult to disassemble and thus to repair. This material change has an effect of the practice of repair. New meanings and competences can also be integrated into the performance of a practice, overtime leading to a changed practice. Due to the increasing awareness of the impacts of the fast fashion industry and re-emerging trends in fashion, second-hand shopping for clothing has regained popularity. This change in how people regard second-hand clothing shopping has changed the practice of second-hand shopping, such as more vintage stores specifically catering to demand for second-hand fashion. However, in most cases of evolving practices it is difficult to point to one element but it is rather that "the things, meaning and competencies of a practice co-evolve, with innovation in relation to one sort of element reconfiguring the relations between elements such that spaces open up for innovations elsewhere" (Shove et al., 2012b; Watson, 2012, p. 491).

Carriers of the practice can change
Even though practices are not defined by their carriers, they do have a central role in how a practice is performed and thus how it evolves over time. Watson (2012, p. 491) emphasizes the importance of considering these carrier roles in exploring shifting practices: "while human individuals can be decentralised from analysis, it is nevertheless necessary to recognise people and their unique capacities and active involvement in the dynamics of practices". For practices to exist over time and keep being performed it depends on recruiting new carriers. Carriers will develop their opinions and skills over time, gradually evolving the practice. Two examples of this are provided by Shove et al. (2012a, p. 8) such as new techniques arising from the embodied experiences of experts when performances are constantly redefined or "it is novices who bring new ways of doing into being".

Way in which the practice bundle together
Practices can be connected to form bundles of practices that are interlinked and mutually dependent. These connections between the practices and their elements, cause the practices to influence each other. Meaning that a change to one practice, or practice elements, can have a ripple effect on the practices in its bundle.

3.3 Practiced based policy and design

Researchers such as Spurling and McMeekin (n.d.), and Kuijer (2017), have developed frameworks for how to use SPT to recommend policy or design.

Spurling and McMeekin state that current policy interventions perspectives of "technology fix" and "shifting consumer choices" are based on a certain understanding of the problem, how change happens and of possible solutions. Interventions are static and expected to have a simple causal effect relation to a problem, which is frequently not the case. Using SPT to analyse problems leads to a more in depth and systemic understanding of a problem, revealing new areas for interventions. They present three practice intervention framings that focus on the dynamic elements of a practice, outlined above, namely:

- ***Recrafting resource-intensive practices:*** In this intervention type, the practice is being changed via changes to its constitutive elements (materials, meanings, competences). The goal is to reduce the

resource intensity of a practice, not to challenge the scale or extent of a practice. Using this intervention type policy makers would aim their intervention on one of more elements of a practice.

- ***Substituting practices:*** In the intervention framing of substituting practices the aim is to create policy that discourages current unsustainable practices and enables sustainable practices as alternatives. Through finding a substitutable pairing of a sustainable and unsustainable practice the aim is to change "the ways in which particular 'needs' or 'wants' are met" (Spurling & McMeekin, n.d., p. 84). The intervention should intervene to shift the balance of competition between more and less sustainable practices.
- ***Changing how practices interlock:*** Instead of aiming an intervention at an element of the practice, an intervention is designed that aims to change an element of a connected practice. As an example: "rather than focusing on mobility practices in their own right, the focus shifts to recrafting those interlocking practices, such as how households are provisioned, where children go to school, and how work and leisure are organised" (Spurling & McMeekin, n.d., p. 81).

Kuijer (2017) has studied the uptake of SPT in design literature and identifies different ways in which SPT has been deployed in design. One type of application of SPT in design research, is using it as a conceptual framework for analysing situated performances of practices, instead of focusing on products, users or interactions, practices are used as the unit of analysis.

Inspiration is taken from these design approaches to develop a methodology that leads to the development of design recommendations and a tool or service that helps enhance the practice of e-repair in CCCs. This study mainly draws on the first two applications of SPT in design as analysis tool that leads to the identification of opportunities for desirable change. During the design process a participatory approach is taken. Participatory design (PD) is a design theory focused on actively involving stakeholders and end users as co-creators in the design process. This approach facilitates the creation of solutions that are relevant to their contexts (Sanders & Stappers, 2008).

3.4 Conclusion

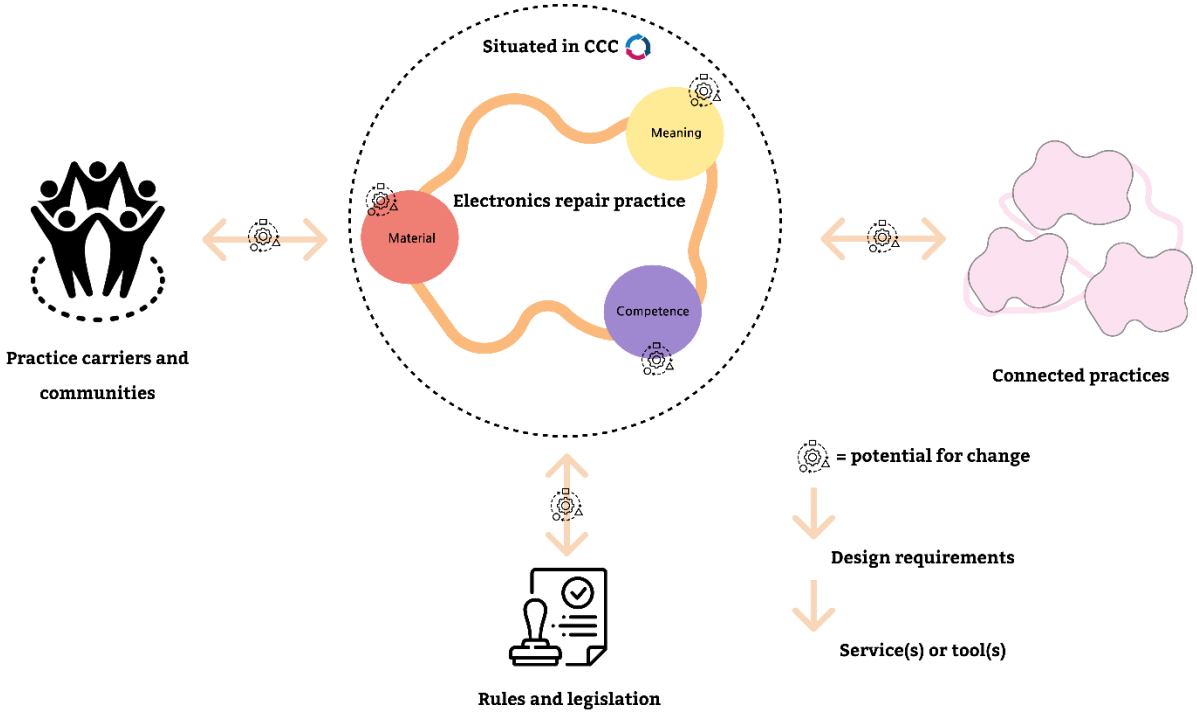

Figure 5, conceptual framework, adapted from (Lens, 2024)

To define how the theory mentioned in this chapter will be used to execute the research, a conceptual framework was created out of the before mentioned theories (Figure 5). Central to the conceptual framework are the practice elements materials, meanings and competences. As described by Kuijer (2017), through exploring and analysing the elements that emerge within repair practices and their connections to each other, barriers, enablers and opportunities for change will be identified. These are pointed out in the figure as areas that have potential for change. As mentioned by Shove et al., (2012a) and Watson (2012) practices can also change through their connections to other practices and their carriers. Thus, these areas will also be analysed and explored to find barriers, enablers and potential change opportunities.

The practice carriers involved in the CCC are the CCC employees, CCC managers and the citizens who donate electronics, buy second-hand goods or visit the CCC for other reasons. When considering how the carriers of the practice can change the practice, attention will also be paid to communities of practice and what they could contribute to the re-emerge of repair competences through community learning. Other connected influences on the practice, such as societal conditions and trends, will also be taken into account in the analysis of the practice.

As seen in Figure 5, the practice of e-repair in our case is situated within the setting of a CCC. This will largely shape how the practice of e-repair emerges. A CCC is an organisational setting, which is a more structured environment for a practice to be performed in, making it more likely to be influenced by management rules and regulations. Additionally, an organisation can be seen as a community rather than a group of individuals. To account for this theory such as communities of practice and the concept of rules were included in the

conceptual framework (Lave & Wenger, n.d.; Schatzki, 2002). The effect of rules and regulations on the CCC will be analysed to find potential for change.

The barriers, enablers and opportunities identified have potential for changing the practice. They show where the problems of setting up e-repair lie currently and what the conditions are that actually stimulate e-repair. The barriers, enablers and opportunities will be translated to design guidelines that will be used to guide the design process and check the suitability of a design for the current practice and the CCC setting.

This chapter has outlined the key theoretical and conceptual ideas behind this research and explains how they have been tied together to form a conceptual framework. This framework will be used to guide the data collection, analysis and interpretation. The methods that have been chosen to execute these steps will be outlined in the next chapter.

4. Methods

In this chapter, the methodology and methods used in this research will be discussed. First, the foundation of the research will be introduced through the research paradigm. Following this, the methods used in the research, including interviews and co-creation, will be explained, along with information about how they were conducted and who participated. Then, the process of the thematic analysis will be described, followed by an outline of the design methods and process. Finally, the credibility, ethics and limitations of the research are discussed.

4.1 Research paradigm

The goal of this research is to conduct an initial exploration of the practice of e-repair in CCC and its barriers, enablers and opportunities. SPT is used because it is an explorative context rich analysis method. This research is guided by a qualitative, constructivist and relativist paradigm, which aligns with SPT. This approach is based on the belief that practices like electronics repair and reuse are shaped by social interactions, everyday experiences and socio-material structures. SPT finds that to understand these practices, we need to explore the experiences and relationships that shape them. A qualitative approach fits this study, as it allows for the exploration of the subjective experiences, meanings, and social processes that underlie these practices (Boeije & Bleijenbergh, 2019). This research has a constructivist epistemological view, meaning it assumes that reality is socially constructed by individuals who interact with one another to create meaning (Glaser & Strauss, 2017). This aligns with SPT in the emergence of meanings in practices that have been created by the carriers who experience and connect certain motivations and expectations to the practice. This research has a relativist ontological view, meaning it assumes that there isn't just one reality but multiple realities and that these are different perspectives that vary between people and cultures (Smelser & Baltes, 2019). This connects to SPT as practices are formed through repeated performance. These performances can vary in the practice elements that emerge. The study also has a pragmatic orientation in its aim to provide practical contributions to the practice of re-use and e-repair. The found barriers will inform the design of tools, services, or recommendations to enhance the opportunities in re-use and repair practices in CCC's.

4.1.1 Research design and link to theoretical framework

A qualitative research design was chosen to facilitate research that explores the complexities and contexts practices of electronics reuse and repair within Circular Craft Centres (CCCs) (Boeije & Bleijenbergh, 2019). The full research process is outlined in Figure 6. Data has been collected through in-depth interviews with representatives of the CCCs and with companies, initiatives and organizations that are part of the broader context of CCC and e-repair. Interviews were conducted because they allow for elaboration and a more detailed response, which will help to understand the full contexts of the studied practices (Alamri, 2019). The interviews were structured using SPT concepts outlined in chapter 3, such as zooming in and out (Nicolini, 2009) of practice elements and bundles (Shove et al., 2012b). The method of co-creation was chosen because it allows for a collaborative setting in which different perspectives come together in an in-depth analysis of a topic. This creates a participatory design process that leads to solutions that are specified for the context of the stakeholders (Sanders & Stappers, 2008). It also creates a fruitful environment for creativity and problem solving, due to the interactions between various participants (Pearce et al., 2022). The data collected from the interviews and co-creation session, including transcripts, notes, and visuals, were analysed using thematic analysis to uncover key patterns and themes (Braun & Clarke, 2006). This inductive analysis approach facilitates the discovery of new insights and leads to a deeper understanding of the subjective experiences of participants. Throughout the analysis, SPT elements (material, meaning, competences) were used to categorize and

interpret the data. Additionally, connections between practices, as well as regulations and practitioners were identified.
The insights gathered from the interviews and co-creation on barriers, enablers and opportunities for e-repair were translated into design guidelines and initial ideas. Various brainstorming techniques were used to create and develop ideas (Design Council & Technology Strategy Board, n.d.). Additionally, the design guidelines were used to check and improve the design in line with the results from our SPT analysis.

This study is focused on the analysis of e-repair and re-use practices. The design is merely an application of the gained knowledge and an effort to not only understand but also improve practices. Therefore, an iterative design process, with feedback cycles is not part of this study.

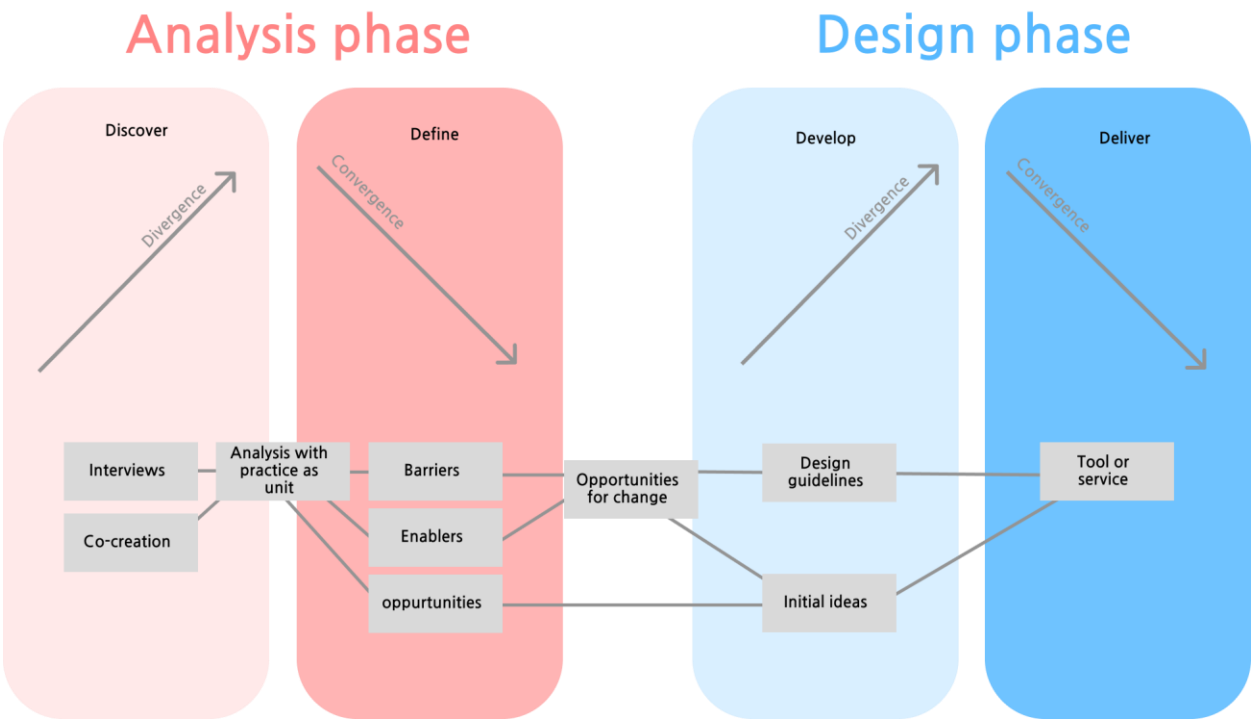

Figure 6, figure outlining the research process and methodology.

4.2 Data collection and analysis

4.2.1 Interviews

Interview participants

The CCC's were selected via purposive sampling (Coyne, 1997; Sharp, 2003). The interactive map with an overview of CCC's on the website of *Circulair Ambachtscentra* was used (*Overzicht Circulaire Ambachtscentra*, n.d.) to select CCC's. On this interactive map (Figure 7) a distinction is made between CCC's in four different development stages: Stage 1. Directing (*Richten*): exploring possibilities for starting, Stage 2. Structuring (*Inrichten*): the craft centre is under development, Stage 3. Executing (*Verrichten*): the craft centre is being tested in practice, Stage 4. Advanced (*Gevorderd*): the craft centre is operational (*Overzicht Circulaire*

Ambachtscentra, n.d.). The interactive tool holds information about the building blocks and product groups that are worked with within a CCC. However, these descriptions are not always up to date.
At first only CCC's were contacted that are in stage 4 and had specified to work with technology. However, because of low availability and response, CCC's in other stages were also selected. Studying CCCs at various stages might have led to more insights in barriers, enablers and opportunities around repair experienced at different development stages of the CCCs. However, no specific attention was given to the stages during the analysis of the findings. Contact with CCC's was taken up to schedule a meeting via phone and email. Visiting the CCC for a meeting was preferred, as this allowed to get a more comprehensive view of the processes, activities, people and products that are part of the practices at the CCC. In total 7 CCC's were interviewed (Table 1). Of the seven representatives that were interviewed five were employees of the second-hand store, one from a recycling centre and one from a second-hand shop preparation centre.

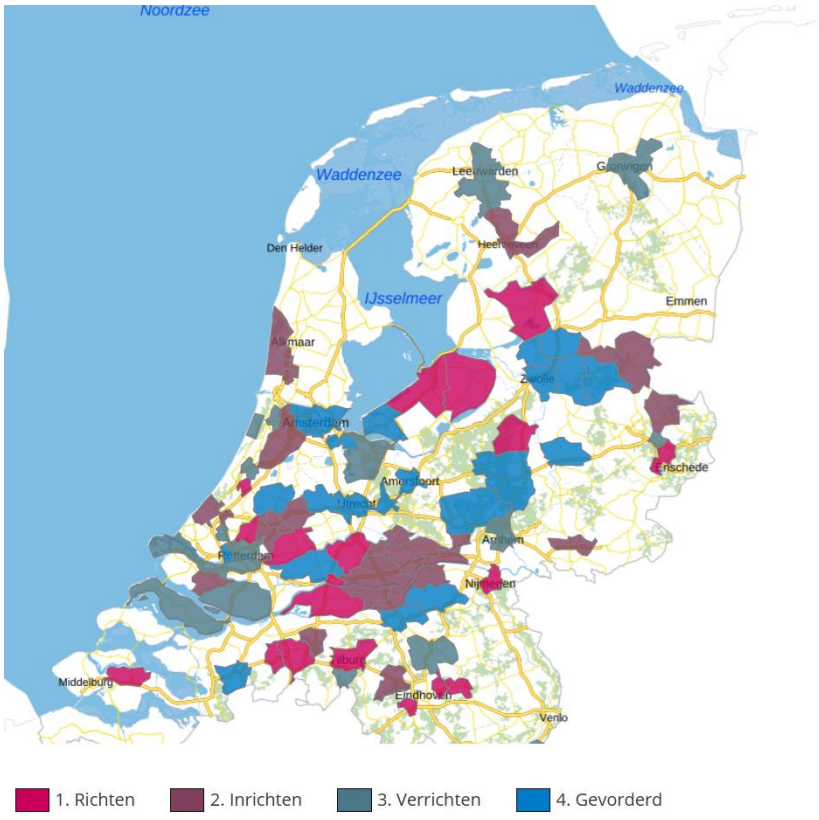

Figure 7. Screenshot of interactive map containing information on the CCCs and their stages of development (*Overzicht Circulaire Ambachtscentra*, n.d.).

Table 1, details about interviews with CCCs

Interview number	Name CCC	Place	Date	Development stage	Role of interviewee	Representative of
I1	Stichting de Kringloper Roosendaal	Roosendaal	29 - 5	4. Advanced	Manager Craft Centre	Craft/preparation centre
I2	Foenix	Apeldoorn	6 – 6	4. Advanced	Manager collection point	2nd hand shop
I3	Stichting Restore Ede	Ede	7 – 6	3. Executing	Manager	2nd hand shop
I4	Het Goed Schiedam	Schiedam	18 - 6	2. Structuring	Team Lead	2nd hand shop
I5	Kringloopcentrum Amersfoort-Leusden	Amersfoort	20 - 6	4. Advanced	Communications	2nd hand shop
I6	Vindingrijk Den Bosch	Den Bosch	21 - 6	4. Advanced	Manager	2nd hand shop
I7	Duurzaamheidsplein Oss	Oss	26 -6	4. Advanced	Manager	Recycling centre

Other interviews

Other interviews were conducted with companies, initiatives and organizations that are part of the broader context of CCC and e-repair. These interviews were initially selected via purposive sampling (Coyne, 1997; Sharp, 2003), and more interviews were gathered through snowball sampling (Biernacki & Waldorf, 1981). These interviews were mostly conducted online. In total eight of these interviews were conducted (Table 2).

Table 2, details about interviews with other stakeholders

Interview number	Name Company	Date	relevance to the study
I8	Natuur en milieu Overijsel	30 - 4	Interviewee works for Natuur and Mileu Overijsel on the implementation of the CCC is in Zwolle
I9	Rijkswaterstaat	7 - 5	Organiser of the national programme promoting Circular Craft Centre's
I10	Repair café	4 - 6	Network of voluntary neighbourhood initiatives that provides small scale support with repairing electronic devices
I11	Road2work	10 - 6	Dismantling hall for electronics and social workplace that makes an effort to reuse and repair more electronics
I12	Municipality of Utrecht	17 - 6	Interviewee works for the municipality of Utrecht on circularity
I13	Lansingerland	24 - 6	Interviewee works for the municipality of Lansingerland on setting up a CCC
I14	BKN	3 - 7	National Association of thrift stores in the Netherlands. BKN represents the interests of Dutch thrift stores and understands their needs and challenges.
I15	Open	3 - 7	Organization made responsible on behalf of electronics manufacturers for the collection and recycling electronics.

Interview approach and execution

Semi-structured interviews were conducted with both CCC's and other relevant organizations and experts. This structure was chosen because this is exploratory research and thus it could not anticipate in advance which answers, topics and themes would be important for the CCC's and experts. According to (Spotswood et al., 2015), using interviews has been recommended for conducting practiced-based research because its discursive interaction between researchers and participants creates a suitable manner for exploring the structure of connections between the elements of a practice. Semi-structured interviews leave room for diving into certain important aspects that come up in an interview (George, 2022). The flexibility of this format is also valuable when you want to get a broad sense of a subject, as is the case when wanting to understand a practice.

A topic list and interview questions were prepared in advance according to the research question and theoretical framework. The topics included were partly based on the concept of SPT, such as materials, meanings, competence and bundles of practices. Additionally, questions were included with the purpose of uncovering barriers, enablers and opportunities through a SPT framework. During the interviews, the questions and discussion order were adjusted according to the context of the participant. Additionally, there was flexibility during the interviews to explore new emerging topics. After a couple of interviews, the topic list and questions were reviewed according to the course of the previous interviews.

In general, the topics discussed during the interviews included: the interviewees views on CCC's, network and partnerships, what they currently do regarding the repair of electronics, barriers and needs for scaling- up electronics re-use and repair, what materials, knowledge and skills is needed, the employees, the clients and their role in repair and views regarding second-hand and electronics. The topic and question lists can be found in Appendix B: Interview topic and question lists (p.98).

Expert interviews

The topic list of expert interviews or with companies and organizations that are part of the broader discarded electronics processing, were tailored to the specific interviewee and their relevance to the research. Most of these interviews were conducted online and they took about an hour in total. The interviews were mostly conducted online via Microsoft teams, which was also used to record and transcribe the interviews.

Interviews with CCCs

The interviews with CCCs were conducted in person. The interviews were made up of partly of interview with the contact person in an office setting and partly of a tour through the CCC with additional explanations, observations and opportunities to talk to employees. The interviews took between one to two hours and were recorded on a mobile phone with a recording application. During the first two interviews a different recording application was used, due to the malfunctioning of this application, these first two recordings were lost. Extensive notes were written down from those interviews to have data on these CCCs. For this reason, no direct quotes are included from CCC I2 and I3. Occasional notes were also taken during interviews. It was explained to participants what the research was about, why the interview was being recorded and how the recording would be processed. Permissions was always asked and granted before starting the recording. The recordings were transcribed with Turboscribe software (TurboScribe, n.d.). Due to the noisy background whilst doing the tour, the transcription software was not always accurate. The most important sections of the transcriptions were therefore manually adjusted, or the audio file was used as reference during the analysis of the interviews.

Informed consent and privacy

At the start of an interview, the participants were given an explanation of the objectives and aims of the research, the reason for recording the interview and information on how the recording would be processed. Permission was always asked and granted before starting the recording. The participants were either asked

with what name (Personal name, company name) they would like to be referred to or ensured that their name would not be used in the research.

Analysis of interviews

A thematic analysis of the interviews was conducted. During a thematic analysis, the researcher searches for patterns and themes in the data. This inductive approach is suitable for exploratory research as it facilitates the discovery of newly emerging topics (George, 2021). To familiarize with the data, the interview transcripts were printed and read. Then initial codes were generated based on the patterns in the data. Extra attention was paid to find links to the theoretical framework, such as material, meaning and competence, connected practices, rules and practitioners. Furthermore, the research questions were kept in mind, meaning there was a focus on barriers, enablers, opportunities and the role of e-repair in the CCC in the wider repair system. The data was searched for converging and diverging findings between interviews. These codes were manually applied and later transferred to a whiteboard application called Miro (Miro, n.d.). Miro was chosen because it is easy to map and move around data, making it possible to easily adapt your emerging themes. The creating of themes was done through an iterative process of sorting codes into themes, reviewing the themes and redefining the themes. Figma, an online whiteboard and visualisation program, was used to create the final models (Figma, n.d.). Direct quotes from interviews were analysed and used in the results section to illustrate the themes and barriers found.

4.2.2 Co-creation

Design and facilitation

The co-creation session was organized with the goal of bringing together diverse stakeholders from the field of e-repair and reuse to explore the challenges faced by CCCs regarding electronics reuse and repair and to brainstorm potential solutions. The session was designed to foster collaborative problem-solving by leveraging the collective expertise and perspectives of participants. The session was conducted online using Miro, an interactive virtual collaboration platform (Miro, n.d.). Miro was chosen for its capabilities to facilitate real-time collaboration through visual tools such as journey maps and brainstorming templates. Miro was used to design and set up the exercises which can be found in Appendix C: Co-creation exercises and answers (p.108). The co-creation session was structured into three main exercises, each designed to build on the previous one, guiding participants from identifying needs to mapping influences and finally generating creative solutions.

Participants

A broad range of stakeholders involved in e-repair and reuse, including policymakers, circular economy experts and representatives from CCCs, circular electronics initiatives and government organizations. Eighteen invites were sent out from which five participated in the session. The session was attended by a mix of participants, including a representative from Rijkswaterstaat, that works on the national program about CCC's, a representative from (BKN), which is the union of Dutch second-hand shops, a representative from Natuur en Milieu Overijssel, that works on the CCC in Zwolle named Waardering, a representative from Foenix CCC Apeldoorn and a Master student writing his thesis on e-repair and CCC's. This diversity created knowledge exchange between participants and brought about a comprehensive analysis of the challenges and opportunities in the field.

Co-creation exercises

Exercise 1: Journey map

The first exercise aimed to identify the needs of CCCs by mapping the process of handling electronics from collection to re-use or recycling. Using a modified journey map template in Miro, participants collectively identified pain points, barriers, and needs at different stages of this process (Appendix C1. Exercise 1).

Exercise 2: Influence map

This exercise focused on identifying internal and external influences on the needs of CCCs and through this identifying the difficulty of meeting these needs (Appendix C2. Exercise 2). Participants were asked to map out influences on the needs found in exercise 1. Then they were asked to vote on these needs to determine which were most critical and which were most likely to be addressed successfully. The tree needs with the most votes were used in the next exercise.

Exercise 3.1: Brainwriting

The purpose of this exercise was to quickly generate a wide range of ideas to address the prioritized needs identified in Exercise 2. Participants had 3 minutes to individually brainstorm ideas for each need and then build on each other's ideas in a silent, written format (Appendix C3. Exercise 3.1). This method enables quick idea generation without spending too much time thinking about potential drawbacks, which allows for more creative ideas to emerge.

Exercise 3.2: Reverse brainstorm

This exercise aimed to push creative boundaries by asking participants to think of ways to make the identified problems worse and then reverse these ideas to uncover potential solutions (Appendix C4. Exercise 3.2). Participants were divided into two teams, each focusing on a different need. They first brainstormed ways to make the problem worse and then reversed these ideas to create solutions.

Data collection and analysis

Miro was used during the session to capture all participant inputs, including the notes on the journey maps, influence maps, and brainstormed ideas. To analyse the data of the first two exercises, a thematic analysis was conducted. This inductive approach was used to find patterns in the data and organize the qualitative data in a manner that contributes to the understanding of the complex practices in CCCs. The collected data was coded and than categorized into themes using Miro, these themes were reviewed and redefined until they felt representative to the data. Concepts of SPT were used during the categorizing of the data to align it with the theoretical framework. Exercise 3.1 and 3.2, which are the brainstorm exercises were analysed and searched for the main ideas and their expected impact. The results of the analysis of the co-creation session were summarised in a report and shared with the participants.

Feedback survey

The session was followed up with a feedback survey to gain insights into the effectiveness of the co-creation process and the relevance of the ideas generated. This information is valuable to assess the relevance of a co-creation sessions for the process of scaling up re-use and repair practices in CCC's. The survey can be found in attachment (Appendix D: Survey on co-creation (p.110)).

Of the five attendees of the co-creation session, four filled out the feedback survey. Overall, the feedback was positive. The attendees thought the session was valuable and it helped them gain a better understanding of the challenges and opportunities of e-repair and re-use within CCC's. When asked what the attendees found most valuable about the session, they all mentioned that they valued talking about these challenges and their experiences with other people who have different perspectives on them. The attendees seem to think the session helped slightly with working towards improvements to e-repair and reuse in CCC's. They did express that a point of improvement could be to come to more concrete ideas or agreements.

4.3 Designing tools and services

The design process was inspired by the outlined approach to practice-based design by Kuijer (2017). As suggested by Kuijer, SPT is used in this research to explore the "design problem" with the practice as the subject. This analysis leads to potential point of change, which inform relevant areas of intervention. Kuijers (2017) approach was combined with various ideation techniques to initiate, develop and finalize a design. Shove et al. (2012) & Watson's, (2012) theories on how practices can change and evolve were used in the ideation phase to brainstorm ideas that can evolve the practice.

An overview of the steps in the design process of this research can be seen in Figure 8. As explained earlier interviews and co-creation sessions were used to gather data on the practice of e-repair in CCCs. The gathered data was analysed using a thematic analysis and concepts of SPT to explore the practice further. This analysis led to the identification of various barriers, enablers and opportunities in the current practice that could form potential point of change. From these findings guidelines were created that should inform the design of services or tools that stimulate the further emergence of the e-repair practices in CCCs (1). The barriers and enablers identified through the SPT analysis were synthesized into design guidelines by identifying common themes and connections, then rephrased to inform what a design should aim to achieve in order to serve as a fitting service or tool within the practice's situated context. From the interview data opportunities were identified that were used to inspire initial ideas (2). Other ideas were developed during the co-creation session, where the participants went through analysis, identification of needs and ideation based on those needs. The initial ideas were further developed through utilizing brainstorming techniques (3). For each of the ideas a reverse brainstorming exercise was executed, and a mind map was created mapping the potential features of the ideas and their impacts (Appendix E: (p. 114)). Then the guidelines were applied to see how the ideas could be adjusted to better fit the guidelines. The reflections of this were included in the mind map. To work towards one final idea, a decision matrix was used to evaluate and narrow down the ideas (4) (Elmansy, 2023). A decision matrix is used to define the criteria affecting the decision-making process in a number of choices in hand, and it is based on the Multiple-Criteria Decision Analysis (MCDA). It works by establishing criteria which the ideas are scored on. The criteria are weighed, and this weight is multiplied with the score of the idea for that criterion. All scores are summed up to form a score from which can be seen which idea best fits the overall criteria established. The result of the decision matrix has been incorporated into the design chapter (See chapter

6.3). The criteria used in the decision matrix were based of the design guidelines and the weights were set based on the impact of the criteria on the feasibility and significance of the criteria. The ideas with the highest score were evaluated to see what elements they have in common and how these aspects can be incorporated into the final design (5). A set of ideas was chosen and developed further by reviewing what potential impacts the suggested services and tools could have on the practice. Based on these reflections, additional ideas and changes were made to create a cohesive package of ideas. The final design is presented in chapter 6.4 Final design.

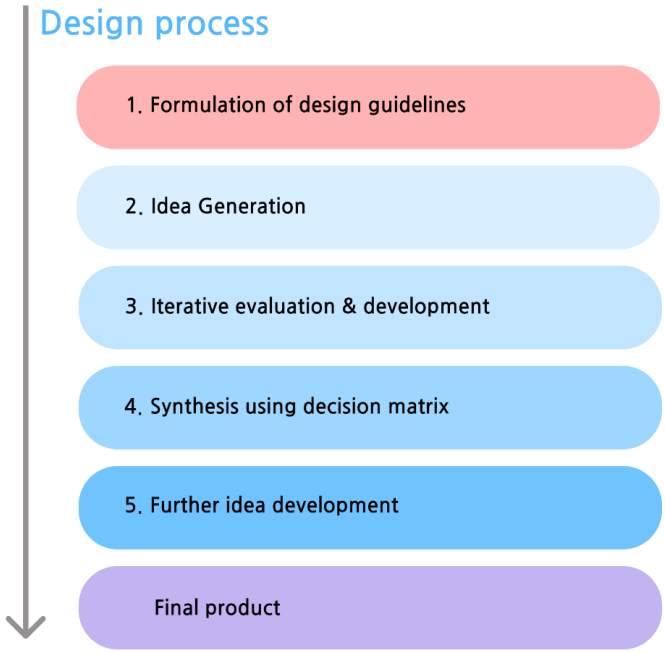

Figure 8, overview of design process

4.3 Credibility and transferability

The credibility of this research is increased through the use of methodological triangulation (Denzin, 2017). Meaning multiple methods were used. During the research data was gathered on e-repair practices in CCCs through both interviews and a co-creation session. The results will be compared with existing literature on SPT and repair to validate findings and highlight novel contributions. By writing a detailed methodology chapter I hope to make my research transferable to other contexts. Practice theory itself lends itself to be used in other contexts. By also elaborating on limitations of this methodology in the discussion, the research acknowledges the context in which the result should be understood. In this research, I have tried to execute in a more organized context and on a relatively novel practice. The lessons learned from this will be shared in the discussion so they can be used to improve methodologies for similar contexts.

4.4 Use of AI

During this thesis ChatGPT was used as a tool to help create plans and set-ups for chapters, brainstorm and improve grammar. Use of ChatGPT requires careful considerations of the risks of generative AI and an awareness of how to use it safely. To ensure academic integrity, all outputs generated by ChatGPT were critically reviewed, edited and validated against existing literature. An AI tool, Microsoft Designer was also used to generate images to illustrate the features of the final idea (Microsoft Designer, 2025).

4.4 Methodological limitations

Data collection

There was a limited amount of CCCs actually engaging with e-repair. Thus, the choice was made to contact the most advanced CCCs as they were more likely to explore the practice of e-repair. Additionally, more advanced CCCs have more flexibility and resource to be able to participate in interviews and a co-creation session. This may have led to a bias for the perspective of more advanced CCCs.

Interviews

Due to technical issues with the recordings, two interview recordings were lost. Notes were written down when this was discovered, 2-3 days after the interviews. This may have led to biases in the notes written down by the interviewer. Additionally, there were no direct quotes of these CCC. Thus, these CCCs might have been less well represented in the final analysis and results.

Co-creation

A co-creation session was held as part of the data collection. Even though beforehand there was a clear goal and idea behind the integration of the session as part of the thesis, using the results from the co-creation session among the result of the interviews was difficult. This was because the participants of the co-creation were almost all previously interviewed. Therefore, in the analysis part of the co-creation session there was a lot of overlapping findings. The added value should have come from having these participants interact with each other and in this way mix perspectives and come to deeper analysis. However, due to the online setting and limited time, the discussion between participants were limited.

Data analysis

To make sure interviewees could express themselves well the interviews and co-creation were held in Dutch. The analysis of the data was thus also conducted in Dutch, results and quotes were later translated. This has possibly led to issues of interpretation, or lost nuances or contextual meanings that are captured in language.

Thematic analysis was used to analyse the data collected through interviews and the co-creation. While this is a valuable method for identifying patterns and insights within qualitative data, it is inherently subjective. Thus, the themes identified in this study are influenced by my interpretations as a researcher (see researchers bias). This creates bias, as other researchers might have highlighted different aspects of the data.

Design process

The design process undertaken in this study misses some significant design stages of typical design methodology. Practical constraints such as limited time and methodological choices such as the use of SPT, required prioritization of the analysis and ideation phase, over an iterative feedback phase. As a result, the final design was not evaluated by stakeholders, which is a limitation of the process. A decision matrix was used to mitigate bias during decision making processes, however the design process and the synthesis of the design guidelines remains influenced by personal interpretation.

Application of theory

As not much prior research has been done on CCCs it was challenging to define what theoretical concepts would work well with the setting. The SPT theory was useful to structure an in-depth analysis of the practice. However, due to the limited amount of e-repair being practiced in CCCs and the organisational setting, sometimes applying SPT correctly into this setting was difficult. For instance, SPT data collection typically involves in-depth interviewing with the practitioners of the practice. Since most CCCs either do not engage in e-repair or do so to a very limited extent, there were limited direct practitioners to interview. Additionally, CCCs often work with people with a distance to the labour market, which can make conducting interview more

challenging. Therefore, in this study interviews were primarily conducted with CCC managers rather than repair practitioners. This resulted in a broader, more strategic perspective rather than detailed insights into the practical enactment of repair behaviours. This however does fit the current state of e-repair, as managers are the ones navigating the barriers to e-repair and they give direction to the CCC adopting or scaling e-repair practices.

Researcher's bias

The researcher's assumptions, perspectives, or background can influence and lead to bias in the study's design, data collection, and analysis. Acknowledging and addressing the researchers background and reflecting on how this influences the research can help ensure more reliable and transparent findings.

As a researcher, my positionality and experiences have inevitably influenced this study. For my interviews I travelled to a lot of places where I had not been before. It was one of my first times doing these interviews on my own and this came with some feelings of insecurity. This might have led to me being shyer and more hesitant in asking questions and following my script. These reflections show the difficulties of managing societal power dynamics during interviews (Braun & Clarke, 2013).

My background and personal interest in sustainability and circularity motivated my exploration of e-repair adoption in CCCs. My interest in the topic and enthusiasm to get a look behind the scenes at CCCs, has definitely shaped my interviews and data collection. On the one hand it created a positive dynamic, which engagement the interviewees share insights. However, my enthusiasm may have also influenced the interviews, as I sometimes directed discussions by expressing my own opinions and ideas or deviating from the script due to a natural curiosity about the topics being discussed. Another challenge was maintaining a focus on e-repair during interviews, which was partly due to the limited e-repair activities in CCCs but also influenced by my interest in understanding the broader workings of these centres. This highlights that interviews are fundamentally social exchanges, influenced by the dynamics of human interaction.

My academic background is multidisciplinary, with a focus on sustainability and urbanism, and my previous experience has been mostly in quantitative research. As a result, it took time for me to fully grasp SPT. Additionally, I found that language plays a crucial role in sociological research, particularly in the communication of findings. Since I am less used to this, it was sometimes challenging to navigate, which may have influenced the data analysis and presentation.

4.5 Conclusion

This chapter has outlined the methodological approach used to execute this research. To align the methodology with the explorative and context rich nature of SPT, qualitative methods, such as interviews and co-creation, were used to collect in-depth insights. Then a thematic analysis was carried out, leading to insights on the potential points of change in the practice of repair in CCCs. These results then were used as starting point for an iterative design process, leading to a final toolkit. Limitations in the performance of e-repair in CCC shaped the research content to be more on the management of e-repair in CCCs. The following chapter discusses the results derived from this methodology.

5. Results

In this chapter the results of the data collection and analysis will be presented. First, the overall process of e-repair practices in CCCs will be discussed, to create an overview of the setting and different steps that are part of this practice. In the next section, I zoom in on the practice by analysing the materials, meanings and competences observed in the e-repair practice. Then, I will zoom out to discuss how the practice of e-repair is connected to other practices and what external influences affect the practice of e-repair in CCCs. In this subsection I observe barriers, enablers and opportunities which are summarized in tables after each subsection. The analysis of the results is focused on sub questions 1, 2 and 3, thus aiming to understand the practice of e-repair and how it is influenced by its context. Whereas in the next chapter the results will be built on to answer sub question 4, by designing tools and services based on the results.

5.1 Overview of electronics processing in CCCs

Most CCCs that were interviewed were a collaboration of a second-hand shop, recycling centre and social domain. The presence of education and repair were more variable per CCC. Vindingrijk Den Bosch is an example where they had a lot of repair specialists such as a bicycle workshop, wood workshop and sewing space, where they upcycle furniture and clothing. CCC Foenix in Apeldoorn provides education via their repair café in their second-hand store. The repair café was originally used to help citizens repair their broken products and repair them together, thus stimulating citizens to engage and learn about repair and obtain repair skills. The visitors could book an appointment online, to increase accessibility to the service. However, the repair café in this format had to be closed due to Foenix not having a CENELEC permit. As mentioned before, other repair cafés that are run by volunteers and are not part of an organisation are allowed to do repair without permit. Currently repairs are still done at CCC Apeldoorn but only if they are simple and external or if the customer buys and brings along the right parts. CCC Ede is also working on collaborating with technical schools to provide materials and experience to students, while getting some workers in return.

Figure 9, Repair café in the CCC Foenix in Apeldoorn (Own picture)

5.1.1 Practices involved in processing of electronics in CCC's

During the interviews with representatives of CCC's several activities and actions were mentioned in relation to the repair of electronics. The activities described were testing, assessing, cleaning, repairing, pricing and the selling of electronics (Figure 10). These activities are bundled together to form a network that is the process of the reuse of electronics within CCCs. The e-repair practice in CCCs is thus connected to other practices through the interactions between their materials, meanings and competences, which are further analysed in section 5.3.1.

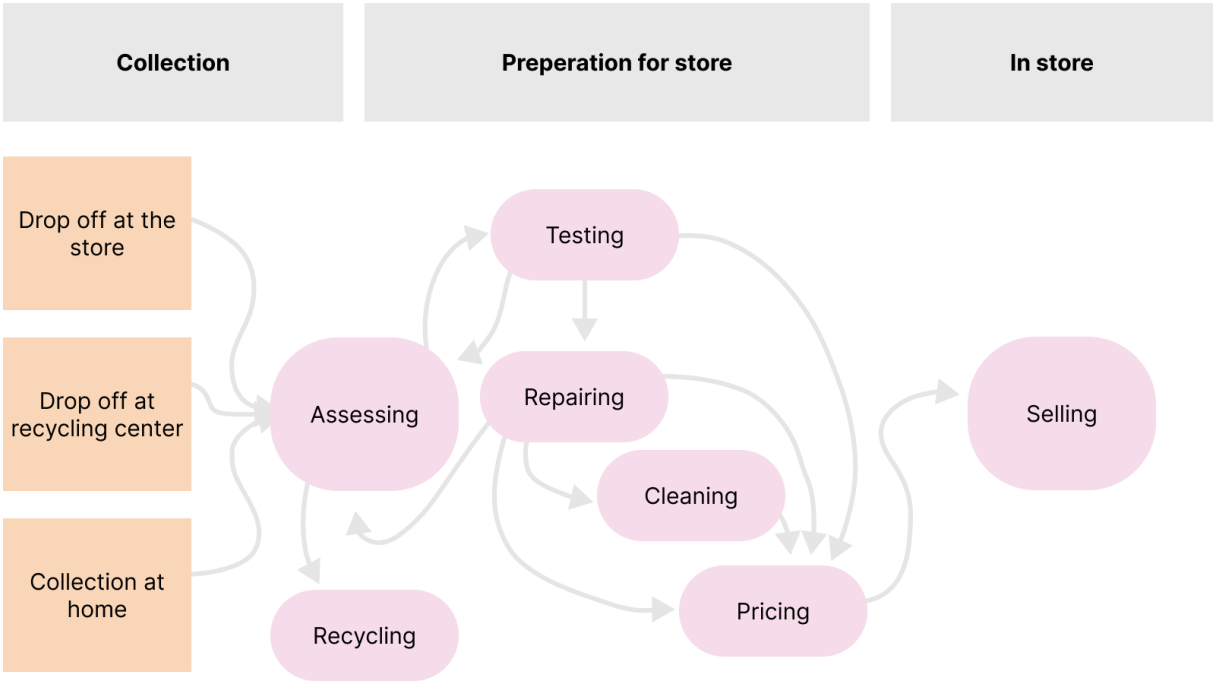

Figure 10, Diagram showing the process of the collection and preparation of donated electronics before reaching the store.

Collection

There are several common manners for electronics to arrive at the CCCs. First, there is the option of drop-off at the second-hand store. All CCC's that were interviewed offer this option. In most cases a staff member is stationed at the re-use container to assist and assess the products that are delivered. Second, there is the option of drop-off at the CCC container at the recycling centre. This container is in some cases staffed by someone from the CCC. Most CCCs also offer free home collection of reusable products.

Assessing (at collection)

When electronic devices are collected, they are, in most cases, assessed by an employee to see if the product is still appropriate for donation. At Restore Ede they work with a system with stickers (Figure 11). These stickers help the employees track the issues of the product and what should happen with the product.

Figure 11, This figure shows a sticker used by Restore Ede to indicate whether an electronical device still works.

Recycling

When decided by an employee that a product can no longer be reused, it goes to a demolition centre via Wecycle or Stichting Open. These demolition centres take apart incoming devices and try to sort materials and create clean material streams for efficient recycling. The demolition centre road2work operates with manual labour by employees with a distance to the labour market (e.g. individuals with a disability, refugees or a formerly incarcerated individual) to reach a high level of recycling. They also try to re-use and repair and repurpose certain product categories. An example is the repurposing of old laptop screens in gambling machines (I11).

Preparation for store

Testing

Most electronic devices get tested by means of the plug-in test. This is simply plugging the device into the socket and seeing whether its carriers out its intended purpose. Some devices are tested more thoroughly, e.g. letting a washing machine carry out a full program or keeping a screen on for a certain amount of time.

Assessing (during preparation)

When a device does not pass the plug-in-test, an employee needs to decide whether it can be and is worth repairing. Here a lot of factors are considered, such as the estimated value and quality of a product, the repairability of a product, access to tools and spare parts, if repair is possible without the CENELEC permit and the costs of repair time versus expected selling price (I1 t/m 7, I9, I14).

Repairing

Repair has been found to only be a small portion of the electronics reuse practices that are carried out in CCCs. This is due to many barriers to repair, such as permits and parts, and the large amount of electronics received by CCCs (I4). Some CCCs do small repairs that are allowed without CENELEC permit and that do not take much effort.

Cleaning

Cleaning has two functions within the electronics reuse process. Sometimes it is actually the solution to fixing a broken product, as is the case for many coffee machines (Apeldoorn). However, mostly cleaning is important for the image of selling second-hand products. Second-hand products for a long time have been assumed to

be dirty and dusty. CCCs have been trying to change this image by making sure all their products are clean and representable (I4, I5, I1).

Pricing
Products that are ready to go into the store must be priced. This is a task that requires knowledge about the quality and popularity of brands and products. Some CCCs have pricing schemes to guide their employees during this task (I4).

In store
Selling
Electronics that have gone through the preparation process and have been cleaned and repaired are ready to be resold to the customers of the CCC.

5.1.2 State of e-repair in CCC's
In most CCCs, e-repairing activities were limited. This is due to some difficulties navigating barriers, which will be discussed throughout the results and discussion sections. The extent of e-repair in CCCs includes testing whether electronics are broken, investigating the cause of the malfunction and replacing external parts. More extensive repairs are not allowed without a CENELEC permit, which none of the CCCs own.

However, there are more factors that influence how e-repair practices is shaped or why and how they have not yet shaped. These barriers play a significant role in shaping the current practices of e-repair in CCCs. Consequently, in the following subsections, the elements shaping repair practices will often emerge in connection with barriers or as descriptions of missing elements necessary for establishing or scaling up repair practices.

5.2 Zooming in: practice theory elements
This section zooms into the practice of e-repair within CCCs, focusing on the local realities of the practice. This is done by discussing the material, meaning and competence elements present in the practice. Each subsection will present an analysis of an element and related barriers, opportunities and connections to the other elements, which will be summarized in *the points of potential change* at the end of each sub-chapter.

5.2.1 Materials
In this subsection, the materials elements of the e-repair practice in CCCs will be observed and analysed based on the interview and co-creation data. Materials elements in a practice include all physical aspects such as technologies, tangible entities, and the stuff of which objects are made. This also includes specific buildings where a practice is carried out or the human body.

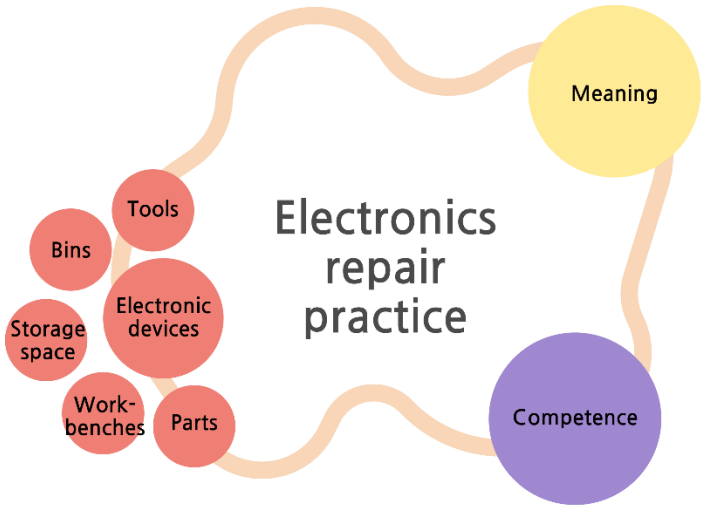

Figure 12, Figure showing materials elements of electronics reuse (Own image)

Electronic devices as core material element

In the e-repair and reuse processes of CCCs, donated electronics are the main material elements. They thus shape and constrain the repair practices. Donated items range from home appliances to ICT and audiovisual equipment. Interviewees express that they notice trends toward smaller (I11), lower-quality (I1) devices designed with limited durability and repairability. These characteristics of the donated items shape the performance of repair in CCCs. The lower repairability makes potential repair more difficult and lower quality of electronics makes them less profitable to resell. The representative of CCC Roosendaal spoke about how nowadays electronics are cheap and available everywhere as an explanation for the following behaviour:

"Last week, I saw something like a leaf blower but for snow. I had never seen it before. At some point, someone must have thought, 'Shall we buy that?' But how often do you really need it? It was still quite new. All sorts of things like that show up, you know. The strangest equipment comes in, and then they have to look up what it is when it comes in. And it's almost unused. People see or hear about it and think, 'This is useful.' But it's not necessary; it's not useful." (I1 - CCC manager Roosendaal)

As illustrated by the CCC Roosendaal manager, ill-considered purchases of trendy and possibly unnecessary electronics contribute to an inflow of barely used, low-value electronics. This shows that the meaning of worth and usefulness of electronics are connected to the material characteristics of devices.

Spatial dimensions: layout and locations CCCs

In most cases the testing and repairing of electronics happens backstage at the second-hand shop. Although in Roosendaal there is a separate preparation facility apart from the second-hand shop (I1). The second-hand shops are often located in an industrial zone and almost all CCCs that were interviewed were next to a recycling point. These material elements of location and layout influence the way the practice of repair can emerge within that spatial setting. It influences the accessibility to visitors and the opportunities for collaboration (I1, I4).

"We also have a store right in the middle of the city centre. And there you see a lot of students. They eagerly snap up the clothing. Also, the vintage clothing—we do sell that too. And I see it being snatched up eagerly. So you mainly notice it with students. When students live nearby, the store runs really well. But yes, you have to be able to get there, indeed." (I4 - Schiedam)

From this quote it is visible that location can be significant in shaping visitor demographics, the sales of the store and possibly visitor engagement. Schiedam's city centre store attracting a student clientele, suggests there is a connection between location, accessibility and the social practices of repair and reuse.

Material e-repair elements: tools and parts

During the research, a couple of material elements were observed to have emerged within the handling of electronics prior to and preceding optional repair of an electronic product. The materials seen include tools, spare parts, and storage facilities, which are necessary for transporting, sorting, testing, and repairing electronics. An example is a transportation tool that was designed specifically for transporting electronics, as they are delicate and prone to damage during transport. Road2work noticed all electronics coming in damaged and thus without reuse potential. To solve this, they created special bins to categorize and transport electronics safely (I11, Figure 13). Similar bins are used to sort and categorize electronics based on their reuse potential or product group (Figure 13).

Figure 13, Examples of bins developed by road2work (own image)

Testing and repair spaces for electronics are often limited in size, with workbenches and basic tools enabling plug testing (Figure 14). This limited size can lead to prioritization of smaller goods due to issues with handling large products such as refrigerators. The “repair” spaces for electronics suffice now in the current situation where repair is limited. In a future where legislation change, and opportunities arise for CCCs to develop their e-repair, new demands for the workspaces might arise. In the current situation interviewees seemed uncertain about what material elements were necessary next to in general “tools and spare parts” and need for sufficient storage for incoming items and adequate workspace for safe and efficient operations. Accessibility problems regarding tools and spare parts do seem to have a notable impact on how the practices of e-repair are currently performed.

Figure 14, Photo of electronics workspace at Apeldoorn Foenix (Own image)

What also emerged as an issue for the repair of electronics, when discussing the current repair practice and future possibilities, is the accessibility of spare parts and tools for repairing electronics. Employees often have difficulties identifying and sourcing the correct parts for electronics due to a lack of standardized and accessible information about devices. It thus takes extra time and effort for employees to order new parts (I1). When spare parts are identified, their cost presents another barrier, as CCCs typically operate on limited budgets regarding e-repair, restricting their ability to purchase new parts and tools (I1, I2, I6). For instance, at CCC Schiedam, an employee highlights this financial and logistical challenge:

"People often think that we can repair something, but you need to have the right parts. How do you get them? There are so many different devices. You would need to have a wall full of all the same parts here, which would also cost a fortune" (Schiedam).

This shows that the material constraints of the practice are linked with constraints in the competence element. The limited knowledge that is currently available in this practice, causes difficulties with gathering the material elements necessary to carry out the practice. The economic context of high-priced spare parts and low-value second-hand electronics, causes financial constraints for CCCs trying to repair electronics.

Some interviewees expressed that ideally, they would reuse parts from other donated electronics (I2, I6). However, without a CENELEC permit, CCCs are not allowed to harvest and reuse parts of electronic devices. This is also the case for external parts for which no disassembling is necessary. This forms a big barrier for CCCs as it takes away the possibility of having affordable access to parts, while also reusing and being circular. These legal constraints emphasize the systemic barriers to developing sustainable repair practices within CCCs. Aside from affecting the practical side of the practice, this barrier also has consequences for the morale of the employees. In Apeldoorn they had set up repairing services without being aware of the CENELEC regulations. Finding out about the regulations and stopping their repairing activities has frustrated the employees because of the limited possibilities and options in their work (I2; Groot & Tooker, 2024). These regulations thus do not only shape the practical and material elements of a practice but also undermines the meaning and morale associated with the work. For employees, these regulations affect the agency and meaning they experience in their work, which can affect their motivation (I14).

CCC in Roosendaal does buy some spare parts such as remotes, charges, batteries or software licenses. For Roosendaal it seems to be an economic assessment, about investment and expected selling price. At CCC

Apeldoorn, they have a different approach. Their principle is not to buy new things, this includes spare parts. However, when offering their repair café service, a new part is often required. In these cases, they ask their costumers to order the part and bring it along to their next visit (I2). Another innovative idea of Apeldoorn was to use 3d printers to print spare parts or specific tools (I2). In practice however, it said that 3D printing was not yet used much for the purpose of e-repair.

In multiple interviews there were mentions of the opportunity of making more distinguishable streams of electronics. For example, filtering not only for whole working products or not working products, but filtering for reusable parts, like a good quality battery, or a part of a vacuum cleaner (I6, I4, I5). With the current legislation this has little additional benefit for the CCCs, however in the future this could lead to useful resources, or extra sales. An example of such a potential stream is explored in Schiedam:

"If we can't repair it, we'll put it in the store at a low price as a fixer upper" (I4).

At het Goed Schiedam, they have thought of another way to handle high-quality broken electronics, that they cannot repair themselves. Broken electronics are being sold for a cheaper price, clearly labelled as broken and to-be repaired by the buyer. This creates an opportunity for reuse or repair that works around the current restrictions faced by CCCs.

From this analysis of the material elements of the practices of e-repair, the following points of change were identified:

Table 3, summarizes the potential points for change gathered from the material element

	Potential points for change: Materials
Barriers	***CENELEC permit*** These regulations prevent the CCC from doing internal repairs or retrieving and selling parts of a product. ***Access to tools and parts*** Repair is only allowed with new parts, which are often expensive and hard to access. Thus, limiting CCCs in their repair work. ***Space constraints*** All work in a CCC requires space for storage and sorting. Setting up a e-repair workspace, will require extra space. ***Declining quality and repairability*** Electronics are produced more cheaply and designed with lower durability and higher complexity. Making repair more difficult and less financially attractive. ***Economic context*** Due to limited budget for repair of electronics within CCCs it is not worth investing in new spare parts to repair donated electronics.
Enablers	***Collaborative spatial layout*** Setting up a collaboration between a second-hand stores and recycling centres is easier when they are located close to each other. ***Transport solutions*** When locations are not close to each other electronics need to be transported, this needs to happen without breaking the products. Specialized bins help achieve this.
Opportunities	***Filtering more streams*** Better categorizing electronics based on their reuse potential, by filtering for reusable components, could lead to more reuse of electronics devices. ***Bring own parts repair*** Customers can bring their own parts for repair services offered by CCC. This allows CCCs to help customers and educate them on e-repair, while also keeping down costs. ***3D printing*** An innovative approach such as 3D printing parts and tools, to make repair easier, is a good example of creative ways to make repair possible.

5.2.2 Meanings

In this subsection, the meaning elements of the e-repair practice in CCCs will be observed and analysed based on the interview and co-creation data. Meaning elements are understandings, beliefs or emotions that are associated with the practice or practice elements. These include symbolic meanings, ideas and aspirations. Due to the practice of repair not being performed at many CCCs, the meanings discussed in this subsection are not always directly connected to repair practices. However, the meanings discussed in this section are connected to the creation of an environment and circumstances wherein repair is enabled or not.

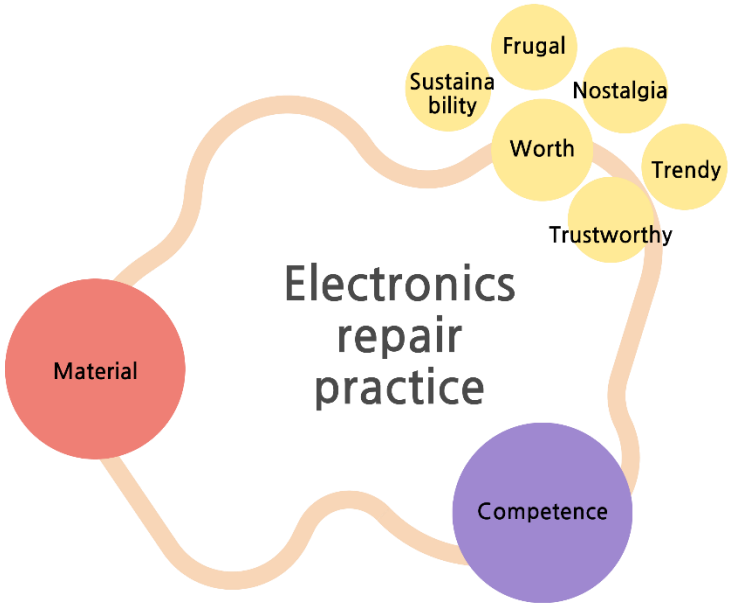

Figure 15, Figure showing meaning elements of electronics reuse (Own image)

Factors influencing value of electronics

The practice of repair in CCCs is partially shaped by the meanings that people attach to electronic devices. These meanings influence people's decisions about keeping, repairing or disposing their products. The manager of CCC Den Bosch highlights that people are more likely to engage in repair or preservation when a device holds personal or nostalgic value, indicating that emotional meanings can act as motivators for prolonging a product's life:

"But that's the point, people need to have some kind of connection to a device, or they need some sort of extra motivation. Maybe it's something nostalgic, or it's from their family, and then they're motivated to keep it. Otherwise, you'd just buy a new one, if, let's say, that particular device doesn't have anything important about it."- (I6, Den Bosch)

During the interviews in relation to donation and collection, it often came up that an electronic device needs to be in good enough condition or have a certain worth to be resold. The judgment of this worth is done partly by citizens who decide whether they want to donate an electronic device and partly by the employee of a CCC who decides whether they want to take it in. There were a multitude of meanings that seem to be able to influence a device worth in this practice. These meanings are not intrinsic to the devices themselves but are constructed through interactions between individuals, material characteristics and broader societal norms.

Examples described by interviewees are emotional worth such as nostalgia, which is created through time and interactions between the individual and the material (I6). Worth can also be created through material aspects such as quality, functionality and condition of an electronic device (I1, I4). Additionally, worth of a device can come from societal influences, such as brands and trends (I1, I4).

The influence of perceived value for repair

Most CCCs are non-profit organisation, thus they want to earn enough to sustain the organisation. E-repair is a time-consuming process and thus often the costs of repair outweigh the potential revenue from selling the repaired items. During the preparation of electronics for store they are tested and, in some cases, cleaned and repaired. This process seems to be a constant estimation of the worth of a device compared to the time invested. As expressed by CCC Roosendaal:

"Well, with a record player, for instance, if the belt is broken and we have one in stock, we'll replace it. But it also has to be worth the effort. I mean, to be honest, if it's an item you're pricing at 3.95, you can't spend hours on it. But if it's a nice microwave and it's missing something, like a knob, then we'll look for that. So, things like that, yes." (I1, Roosendaal)

This is a good example of how the employees weigh the worth of a product to the effort it will cost to be able to sell it. In this example they also consider how difficult the repair will be. Other aspects such as this are considered in these decisions such as quality and uniqueness of a device (I2, I3, I4). An even more detailed explanation of these economic considerations is illustrated in the following quote of the manager of CCC Den Bosch:

"You're adding hours to the product group that costs relatively little. If someone spends 45 minutes checking a stereo system, which then sells for 40 euros, during that same 45 minutes, someone at the textile sorting line might have sorted 20 items of clothing, each worth around 3.50 euros. So, in terms of total revenue, you're already far ahead with clothing. You're constantly looking for that balance." (Den Bosch)

In this quote a clear equation is made of time invested versus profit earned and how this compares between different product group. The manager of CCC Den Bosch, states here that electronics are almost always a product group that will costs more money to repair than that is earned back and that it is relatively inefficient profit wise compared to categories such as textiles. However, money earned by the profitable groups can be invested in the groups that cost money. In this way it is possible to finance e-repair.

A large part of the electronics received by CCCs is still working. Due to the economic interest and the costs of repair, it becomes a more effective for CCCs to focus on re-using the working electronics instead of repairing the broken ones (I5).

"Because we receive so many items, we can keep the store stocked with the working ones. So, it's not worthwhile for us to do that" (I4- Schiedam).

As stated in the quote there is not enough incentive for CCCs to start repairing the broken electronical devices, especially when being discouraged by other barriers. This results in repair being reserved for particular cases, where the value of the product is high enough for the employee to invest time in the repair and expect to earn it back by selling a working product. This value is assessed by employees and in most cases the assessment of this value is not standardized, but rather an individual assessment made by an employee.

"If there happens to be something among them that is a very good brand or very popular, we'll see if we can repair it" (I4 - Schiedam).

Multiple factors can lead to a product being seen as valuable. This can be a good or popular brand as seen above, but could also be uniqueness, vintage or nostalgia. These aspects of a product and how they are valued by people can thus be an enabler or a barrier for e-repair in CCCs.

Preconceptions about second-hand electronics

CCC's notice that customers have preconceptions about second-hand technology. Electronic products related to personal hygiene tend to not sell well because people perceive it as un-hygienic (I4, I2).

"For example, that a lot of electric hair straighteners and curling irons come into the Dutch market, but there's really no market here in the Netherlands to sell those. However, in some other European countries, it's different. It's really country-specific. So, they don't have a problem using a second-hand curling iron or straightener." (I14- BKN)

As can be seen is this quote these preconceptions are also dependent on and influenced by broader cultural and societal norms. People have a certain perception of when something is dirty, and this perception differs per country and culture. These norms and values influence what the customer buys and therefore what the CCC is able to sell. Another concern of customers is the expected lifetime of a second-hand electronic device (I6, I5).

"Electronic devices, people say, 'No, better not,' because the device is already five years old. Yeah, what if it breaks down again soon? That's also the most frequently asked question. A fridge—how much longer will it last? Well, I don't know. But there are certain things you just can't check." (I6 - Den Bosch)

Customers consider older products to be less reliable because they expect them to have a shorter expected lifetime and thus break sooner. To compensate for this liability, products are sold for lower prices. Short term guarantees are given to create security for the customer that a product is not broken.

"People need to see that, oh, it can be reliable, or it's not a big deal because you're buying it cheaper. But there are enough products where you don't have that wear and tear at all. Actually, there should be something like that for these too, where you can say, these are devices that aren't subject to wear and tear. People should be much more informed about that." (I6 - Den Bosch)

The spokesperson of BKN suggest here that there should be more awareness around which electronics are reliable to buy second-hand. An example could be that most sewing machines from the seventies are made of metal, and thus often last longer than sewing machines produced now, which are mostly created from plastic. In electronics and especially ICT, there are consent technological advancements.

"Yes, no good camera, no good screen, lower quality, and that is sometimes true in some areas. But on the other hand, a lot of things can be solved with software nowadays. The slow performance is also just part of the trend. Wanting to have the newest phone is, of course, still somewhat of a status symbol, I think. Whereas, for example, shopping at vintage stores has also gained a certain status in society. But that's not the case yet with vintage phones." (I14 - BKN)

As seen from this quote, customers are persuaded into wanting the newest trends, which are often not found at the thrift store. This is a form of planned obsolescence, as customers are made to believe that devices without the latest technologies, will not be functional in modern society.

Life expectancy and having the latest trends are aspects that seem to influence the worth of a product in the customers perspective. This therefore also influences how well products can be sold by the CCC. When selling second-hand electronics, the motivations and beliefs of the customer affect the items sold, how they are sold,

and what they are worth. This then can form a potential barrier for e-repair, as low value means lower selling price, making it harder to invest in the repair of products.

From this analysis of the meaning elements of the practices of repair, the following points of change were identified:

Table 4, summarizes the potential points for change gathered from the meaning element

	Potential points for change: Meanings
Barriers	**Preconceptions about second-hand electronics** Customers often view second-hand electronics as unhygienic or unreliable, impacting their buying habits. **Repair costs versus profit** The high cost of repairing electronics often outweighs potential profit, thus CCCs prioritize reuse of working devices rather than repair. **Citizens take easiest path** When citizens discard items, they want it to be convenient. Thus, paying less attention to value or reuse potential. This makes it harder for CCCs to collect and repurpose functional electronics.
Enablers	**Employee motivation and social atmosphere** Workers at CCCs enjoy flexibility, social connections, and the meaningful work environment. This causes employees to remain working at the CCC. **Cheap and unique offerings** Second-hand stores often sell products for relatively cheap. This can include high quality items. They also sell unique items and vintage items not found at chain stores. This attracts an audience. **Store environment and image** Efforts to change the image of a second-hand store from old and stuffy, to clean and organized, improve customers perception of second-hand products. This causes a more diverse audience to shop at second-hand stores.
Opportunities	**Increasing convenience of donating process** CCCs are implementing better structures at recycling centres to guide citizens in making more conscious decisions about which items can be donated rather than discarded. **Enhancing the status of repaired electronics** Rebrand repaired electronics as desirable, high-quality alternatives to new products.

5.2.3 Competences

In this subsection, the competence elements of the e-repair practice in CCCs will be observed and analysed based on the interview and co-creation data. Competence elements in a practice include skills and knowledge that is needed to perform a practice. Knowledge can be required through repeated performance (tacit knowledge) or through written or verbal form such as facts and rules (explicit knowledge).

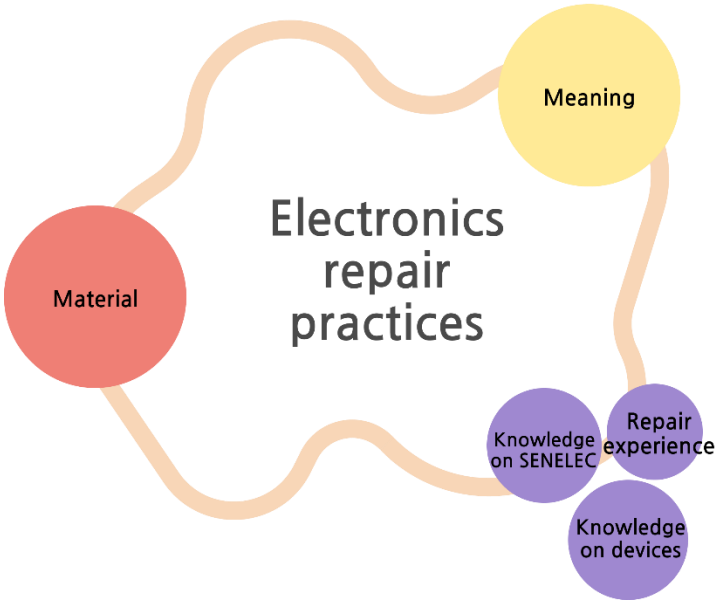

Figure 16, Figure showing competence elements of electronics reuse (Own image)

Assessment competence during donation & collection

Citizens that want to dispose of their electronics, might make different decisions about donating or disposing of an item than a CCC. For this reason CCCs have been paying attention to restructuring the recycle centre and having employees present to help guide people with the decision of where to bring their products. These employees either at the recycle centre or at the drop-off point at the store need to check whether something is worthwhile to resell. Often there are some standard requirements that employees can check, to help guide them to see if an electronic device is worthwhile in the eyes of the CCC. For CCC Schiedam these requirements are:

"The normal requirements from us are that items must be clean, intact, and complete. So, people, that's what the stuff must meet" (I4 - Schiedam)

This decision about whether a electronic device is worth donating is influenced by both objective and subjective aspects. If employees lack the needed knowledge, their decisions will be made based on subjective aspects. The motivation of an employee, whether they care about sustainability or frugality or they do not, this will impact the way they carry out their work. Due to the variety in workers and the duration of their employment, it is not likely that the values and interest of the workers are aligned. This is illustrated by the following quote from the team lead at CCC Schiedam:

"But if they have a temporary worker at the sorting station on a Saturday, yeah, they just throw everything away if there's a little dent in it." (I4 - Schiedam)

In terms of the practice of e-repair, this lack of coherent aspirations and motivation to extend the lifetime of products can be perceived as a barrier to upscaling repair practices, as there might be few employees who actively look for possibilities and opportunities to repair more electronics.

It is thus preferable for decisions to be made based on objective aspects. This requires employees to have knowledge on aspects such as the quality of the brand, the popularity of the product or its potential repairability. Currently most of this knowledge seems to be coming from the individual knowledge of employees and is transferred between employees (I2).

Some employees might have more prior knowledge than others impacting their assessment of the worth of a device. There is thus a connection between the competence and meaning surrounding an object. For example, some societal trends surrounding technology such as young people collecting vinyl, can also increase the worth of a product. Employees must be knowledgeable on these trends and what artists are popular to be able to assess and price these products correctly.

To counteract this individual knowledge gap and execute a more standardized assessment more information on electronical products, such as brand, build year and energy label would be beneficial. Manager of CCC's expresses this desire for more information and data about the donated electronics (I2). During the co-creation, the following comment were made about the collection:

"Missing knowledge at intake" (C1)
"Value assessment / is the device worth it" (C1)
"History of the device not always known" (C1)

There is a need for a system such as the one that CCCs use for books, that can help employees estimate the resell value (I6). A system such as this for electronics might contain information on repairability and access to spare parts based on the earlier experiences with these products by CCCs. There is research ongoing in Belgium that looks at the possibility of making a database with information about products, such as build year and material component. Additionally looking at whether it is possible to access this information based on scanning a code or taking a picture. A system such as this could help guide the employees (I2).

Repair knowledge

CCCs also expressed a need for certain knowledge about the material elements of the repairing process. The following needs were written down during the co-creation session:

"More transparent knowledge about how electronic devices are constructed and what you need (tools). Sometimes special screws are intentionally used in products." (C1)

"Need for employees with knowledge or a tool that can help with that" (c1)

"Knowledge among employees is necessary" (c1)

There is a need for information on the device, how it can be repaired, what tools to use and where to find its spare parts. Currently it seems that within CCCs there is tacit knowledge available, which is knowledge learned through experience. For example, employees with affinity and experience repairing audiovisual devices. However, there is not a lot of guidance for employees who do not have prior knowledge in terms of information, facts and rules. This type of explicit knowledge could help temporary employees to make a valuable contribution to repair.

It would be useful for CCCs and their employees to have more insights in what devices can be easily repaired and whether there are any special tools or parts necessary and where to find these. This information could be acquired by keeping track of which devices have been successfully repaired in the past.

More guidance knowledge about CENELEC

The regulations and laws around the repair of electronics in organizations is very complex. For an organization such as a CCC where e-repair is not a primary task, there is not enough time and budget to figure out these regulations. This need for more knowledge on the regulations was expressed in the co-creation session:

"Knowledge about the value of electronic devices and current regulations" (C1)
"Not everyone has the same knowledge about what is allowed or not without certification" (C1)
"Clarity about which rules apply with and without certification" (C1)

There is a need for this knowledge on the regulations, because without it the CCC and its employees are discouraged to do any repair, or they unknowingly break the rules, which could lead to sanctions for a CCC.

"And that's also because the regulations are really complicated. If you're talking about WELEBEX and CENELEC certifications, and how, especially with CENELEC, it's too extensive for what thrift stores actually do. It almost misses its purpose for electronics and actually discourages them from starting to repair electronics, even though there's a lot of demand for it and members see many opportunities. But they just don't do it." (I14 - BKN)

It is expressed by interviewees that regulations are too complex for CCCs and the e-repair work they want to execute. This is very discouraging for CCCs and inhibits them from adopting repair practices. More guidance on regulations or simplified regulations could support the CCCs.

Repair skills and experience

The specific skills needed for doing repair work are difficult to be determined for the interviews. Some interviewees talk about small repairs that involve replacing parts, cleaning or whipping devices (I2, I5).

"Sometimes there's something small, or something wrong, like the wrong plug—we do see that. But it's not like a hairdryer or a mixer gets opened up to replace something inside. That doesn't happen, so to speak." (I1 - Roosendaal)

In other words, repairs that can be trusted to not cause problems when sold to a new user:

"We work according to the plug-and-play system. There are two employees with an MTS (technical school) background whom we allow to perform small repairs that won't cause problems when used at home." (I6- Den Bosch)

As seen from these quotes, repairs are limited to small adjustments or external replacements. This is largely due to the CENELEC regulations keeping CCCs from doing more advanced repairs.
In most CCCs e-repair, if done at all, is not very organised but more an occasional extra, for when employees have time to spare, or a product has a special worth, or the employee has a particular affinity with the product.

The CENELEC regulations have halted the development of repair of electronics so far and therefore all CCCs repairing electronics are pioneering. This novelty and improvised nature of current e-repair in CCCs might be the reason for the skills and competences to not be clearly defined. CCCs themselves are still exploring what skills, competences and knowledge they need to be able to carry out repairs on a more regular basis.

In most CCC's employees working on the testing and repairing of electronics are not required to have a technical education or background. CCCs do express a clear need for more employees with technical education

of repair experience, especially when talking about potentially upscaling e-repair. An idea that is mentioned is the employing of a few more experienced and skilled repair workers who can be an educational source and leader for other test and repair employees:

"If I look at repair, I think there's a need for easier learning paths on topics like repair. So, what skills do you need? The craftsmanship aspect, where you really need someone who can take on the role of work supervisor and has in-depth knowledge." (I14 - BKN)

"you'll probably need a few more people who work somewhere longer and gain more experience, I think. Because if you're really going to repair things, then it might also be difficult... to only work with people who are temporarily employed. Yeah, you really do need someone... You'd actually need to create paid positions for that, I think. And it sounds really cool, you know, to have one mentor... and a few people who have time to learn the techniques. They can already learn that, it's great. So I do see possibilities here." (I5 -Amersfoort)

In this quote they also state it would be valuable to have employees who work on repair for longer so they can gain experience. In another interview with the union organisation of second-hand stores, it was mentioned that the limited repairs done, might be a reason for employees with repair skills to leave the CCC.

"If someone comes to work at a thrift store temporarily, or is in the process of integrating and has a lot of affinity with electronics, they may leave sooner because there just isn't much they can do in that area. So, you need someone who's really skilled and enjoys it." (I14 - BKN)

From this analysis of the competence elements of the practices of repair, the following points of change were identified:

Table 5, summarizes the potential points for change gathered from the competences element

	Potential points for change: Competences
Barriers	**Inconsistent knowledge and skills** CCC is a social workplace with many temporary employees. These employees might lack standardized knowledge to assess the value and repairability of electronics. This might lead to inconsistencies in decision-making and repair processes. **CENELEC requirements** Repairs are typically limited to small, external fixes due to the CENELEC regulations. To acquire a CENELEC permit, an extensive audit needs to be completed, which is too expensive and complicated for an organization such as a CCC. **Regulatory complexity** the CENELEC regulations on e-repair are complex, discouraging many CCCs from exploring e-repair. **Lack of base knowledge** Much of the repair knowledge is based on individual experience rather than formal training, making it hard for temporary or new employees to contribute effectively. **Minimal formal repair guidance** CCCs lack structured processes for evaluating, repairing, and reselling electronics, limiting the potential to scale repair activities.
Enablers	**Affinity and prior experience** Some employees have affinity or prior experience in electronics and repairs. These employees bring expertise and knowledge about electronic products. **Knowledge Transfer** Informal knowledge transfer between employees
Opportunities	**Standardized electronics assessment tool** Developing a centralized system or database for assessing electronics' value and repair potential could help CCC employees make more accurate and consistent decisions. There is a desire for more structured tools and databases, similar to the systems used for books, that could help assess the value, repairability, and spare parts availability for electronics. **Specialized Repair Staff** Employing a core group of skilled repair workers who could act as mentors would help transfer repair knowledge more effectively and support upscaling repair efforts. **Regulatory Guidance** Providing clearer, easily accessible information about the laws and regulations surrounding e-repair could encourage more CCCs to engage in repairs without fear of legal complications. **Customer Education** CCCs could play an educational role, offering repair workshops or contributing to public knowledge about repairability, thus increasing customer engagement with reused electronics.

5.3 Zooming out

This section zooms out on the practice of e-repair within CCCs, looking at its connections to other practices and the broader influences on the CCC and its e-repair practice. This includes the rules, management, societal circumstances and the opportunities of collaborations for CCCs.

5.3.1 Practices connected to repair

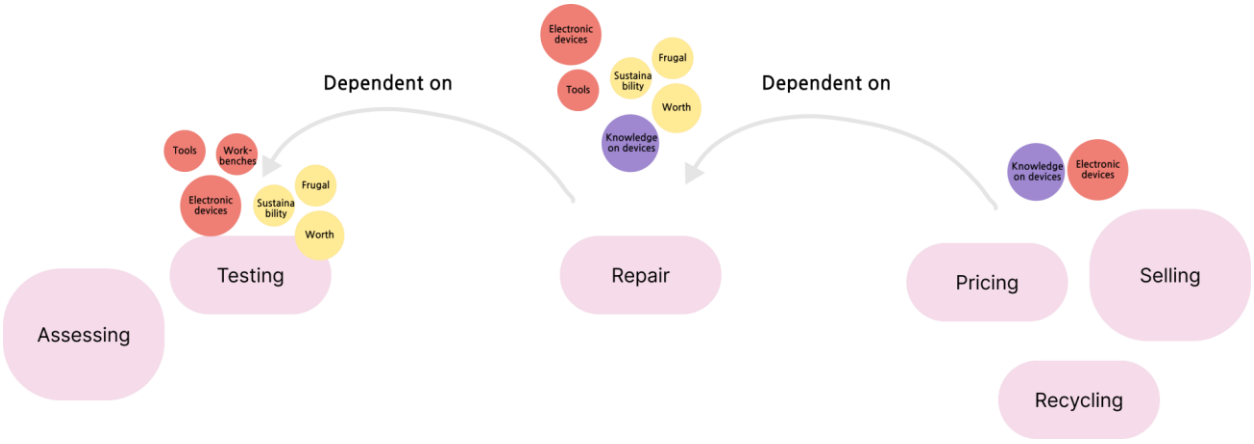

Figure 17, Connection of different sub-practices to the practice of repair

As discussed earlier, the practice of e-repair is connected to other practices, which together form the process of reusing electronics in CCCs (subsection 5.1.1). These connections can exist through dependencies and shared elements. Figure 17 shows how the different activities relate to repair and what elements are shared between them. One element that is shared among all these practices are electronic devices. Repair and reuse of electronics are focused on processing these electronics, and thus they are an essential element of each activity. In each of these practices the electronic device (Material) is altered or the way it is viewed (Meaning) is altered. This has an impact on the connected practices as these elements are altered and thus the practice is altered. All preparatory practices (testing, repairing, cleaning, pricing) are dependent on assessment. Because during the assessment it could be decided that a device will be disposed of, all other practices will not be performed due to the changes to the common elements of electronics. The practice of e-repair is thus dependent on the assessment and testing of the electronical device, as they happen prior to repair and determine whether repair happens at all. The practices of pricing and selling electronics are dependent on repair because the practice of repair and whether it is successful or not determines if a product can be sold and for what price. Worth is also a constant element in all practices. In sub-practices such as assessing and testing worth is assessed, during repair worth is increased, and during pricing and selling worth is established and earned. The assessment of worth during testing and increasing this worth during repair, influence the selling price that is established during pricing.

5.3.2 Organizational structure and character

CCCs have various forms of organisations which influence their available resources, goals priorities and what work they execute. Most CCCs exist out of a collaboration between a second-hand store and a recycling point. Second-hand stores are foundations that have social goals as their main focus, not profit. Profit is reinvested in the organisation to resell more donated items and create jobs for people with a distance to the labour market. Most CCC, thus do not have a big budget to experiment and invest in setting up new areas such as e-repair. Being a social workplace, is one of the core functions of a CCC and this has an influence on the way the organisation is managed.

"We are not ordinary companies, we are also inclusive companies, so that means that we work with people who sometimes can't just do anything, and we can't just change things around, but also that people are very central to that work process. Which also means when we talk about collection, right? You can't just implement something top-down or automize it, because no, that would mean a lot on the work floor and new work processes, and that's just, yeah." (BKN)

As expressed in the quote people are central to the work processes in CCCs. The social service employees can be refugees, reintegration, day activities, probation or people who have not worked for an extensive period due to psychological or physical issues. These employees often do not have a previous background or skills for working in a CCC and they require more guidance due to personal background or language and cultural barriers.

"But the obstacle is the language of the work processes and also the cultural differences and sometimes underlying psychological issues. Which of course are present if you've fled. You don't do that just like that, and then sometimes a six-month or a year-long process can be really good to build stable ground and trust, so that afterwards they can work with an employer who has less experience with that." (I14 - BKN)

CCCs are thus required to work differently from other organisations. They need to have a more personal and bottom-up approach in their work and this needs to be considered when restructuring work processes (BKN). As an example, it is difficult for a CCC to alter work processes to make them more efficient and standardised, because it takes longer for the employees to learn new process.

Motivations of employees

Employees express that they enjoy the atmosphere at the CCC. They enjoy the social connections they have at work, the flexibility, freedom and own pace and decision-making in their work (I1, I2). These motivations do have an impact on their engagement with the work. Flexibility is important for the employees, but this is difficult to combine with very structured work processes. The communications employee at CCC Amersfoort had the following to say about the work:

"Yes, I know that for many people, it's simply a nice place. Just low stress and a pleasant environment. For a lot of volunteers, it's indeed a kind of meaningful way to spend the day. And for people who may be even further removed from the job market, it becomes something necessary. Then they have something to do. So yes, it can really be all sorts of things. But I always find the vibe here really nice." (Amersfoort)

In this quote it is clear to see that there are multiple motivations that people can have to work at the CCC. It might be due to a trajectory that they are in; it might be the volunteer work aspect because they want to do some meaningful work, or they might be attracted to the social aspects of the work in a CCC. During interviews

other motivations such a frugality and sustainability were mentioned by managers. When asking employees working on electronics for their motivations the answer was often related to the good atmosphere and flexibility of the work. The values and motivations of employees have an effect on how they carry out their work, their work attitude and the decisions that they make. Someone who has frugality as a value and motivation for their work at the CCC probably views the donated electronics as more valuable than someone who is not frugal, and this can also result in the employee investing more time in cleaning and repairing products.

Ad hoc work processes and dependence on incoming staff

The practitioners, the employees of a CCC, bring prior knowledge, interest and affinity to the work. These experiences will impact the work the employee carriers out and the decisions this person makes. In a working environment where process is to a large extent standardized, there is less room for these experiences to impact the work. However, due to CCCs being places of social work their work process is more ad hoc, meaning the work and how it is carried out if very dependent on who is working and what they are good at or like to be involved in (Roosendaal, Apeldoorn). Het Goed in Schiedam says the following about this:

"So, you're often somewhat dependent on volunteers who happen to have the right knowledge and can then provide support in that area" (I4 - Schiedam).

The practices of repair and reuse in CCCs are highly influenced by the prior skills or affinities brought in through volunteers and temporary workers. During multiple interviews instances were described, where a particular genre of electronics was often picked up by a certain volunteer, often with affinity for audio equipment (I2, I4, I1l). This is at the same time a barrier and enabler. On the one hand, it is important for workers to enjoy their work and put their competence to use. However, on the other hand, the ad hoc work process lacks consistency and reliability when being dependent on individual expertise. Difficulties can also arise when key employees leave, and new staff might not have the same skills and interests.

The amount of work and kind of work that is carried out is dependent on the employees and their affinities and competence. Because CCCs do not choose the people who are deployed to them via social service, there might be temporary workers who over or under preform:

"Some people can do everything, see everything, and solve everything. And others think, 'Yeah, I won't do that.' You know, that's something you can't really teach" (I1- Roosendaal)

Due to this dependence on the incoming social service workers, it is not certain that employees will have the preferred skills for reuse and repair practices, such as described by the manager of recycling point Oss:

“There are no more bicycle repairmen. So they have the infrastructure, sort of. And they really want to do it, but not the right people. And that's because it's often based on, what's it called, social workers. That's right, yeah. Other people who are distanced from the labour market or volunteers.” (I7 - Oss)

Due to the constant rotation of these employees, it is difficult to educate the staff and maintain knowledge. Currently employees might have some prior tacit knowledge. However, with fast rotation of employees it is also important to build explicit knowledge. When upscaling repair there would be a need for more fixed employees, that can be educated or have prior technical knowledge.

5.3.3 No good business case for e-repair

As explained earlier CCCs are not focused on making profit, however they do need to earn enough to sustain the organisation. Thus, they are required to make economically attractive choices. A large part of the electronics received by CCCs still work. Thus, it is more effective for CCCs to focus on re-using the working electronics instead of repairing the broken ones (I5). This is illustrated by het Goed Schiedam:

"Because we receive so many items, we can keep the store stocked with the working ones. So, it's not worthwhile for us to do that" (I4 - Schiedam).

Therefore, there is not enough incentive for CCCs to start repairing the broken electronical devices, especially when being discouraged by other barriers.

E-repair is a time-consuming process and thus often the costs of repair outweigh the potential revenue from selling the repaired items. Often repair is reserved for particular cases, where the value of the product is high enough for the employee to invest time in the repair and expect to earn it back by selling a working product. This is illustrated by het Goed Schiedam:

"If there happens to be something among them that is a very good brand or very popular, we'll see if we can repair it" (I4 - Schiedam).

This assessment is found to be made by many CCC's, an example is Roosendaal:

"For example, with a record player where the V-belt is broken, and we have those in stock, we do repair it. It has to be worthwhile. Honestly, a small appliance priced at $3.95 is not worth spending hours on. But if it's a nice microwave and something is missing, like a knob, then we'll look for it. So, we handle things like that" (I1 - Roosendaal).

Limited budget for e-repair, combined with low profitability of second-hand electronic and high cost for repair do to labour and expensive second-hand parts, result in CCCs not being hindered in their adoption of e-repair.

5.3.4 Rules and regulations

The practice of repair in CCCs is largely restricted by regulations. CCCs need to have a CENELEC permit, if they want to do any repairs to the internal parts of electronics. The permit also prohibits them from disassembling a device to retrieve spare parts. CCCs without the permit are not allowed to keep second-hand spare parts and they cannot use a spare part from one device in another device (I1). This even counts for reusing a second-hand fridge drawer in another fridge.

"Yes, sometimes we take off loose parts, and we're allowed to do that. But we are not allowed to remove the motor and then store it and use it as a different motor. Not the big things" (I1- Roosendaal).

To get the permit a company or organization has to go through an extensive process. In addition, keeping the permit requires a periodic audit. Recycling centre Oss, has the permit, and their manager had the following to say about the process:

"It was quite an intense three days. Because then someone really comes in to measure everything. Yes. All the processes are completely analysed. Yeah, my work here depends on people. It definitely doesn't all go exactly by the rules. And then you have to do it perfectly for three days straight. Then that person will deliberately take note of everything. But we made it through again. But it really goes into detail about what you have to do. So, in the end, a huge manual comes out of it."

As part of these audits, all kinds of documents need to be handed in outlining the work process and its safety measures. For CCCs that have limited budget and are social workplaces these requirements are near impossible to meet. In CCCs the CENELEC permit is really seen as big obstacle for setting up e-repair. Without the permit CCCs are really limited in the repairs they can do. However, obtaining a permit for second-hand stores and CCC's are not seen as an options do to the difficult audit process. For these reasons multiple parties are collaborating and lobbying a CENELEC light. The idea is that this would be an altered version of the CENELEC permit, that has less difficult requirements, and more specific allowances and disallowances for second-hand stores or CCCs that want to do e-repair.

5.3.5 Education in CCC and their role as a community of practice

One of the five building blocks that make up a CCC is education. Education is incorporated in CCC in multiple ways. Especially education on repair is important, as less citizens, especially young people, know how to do repair. This is confirmed by the representative of repair Café:

"People who really have good repair knowledge are, unfortunately, often older. And unfortunately, younger people have much less of it. So, we need to make sure that this knowledge is passed on in time."

First there is the education of their own employees. As mentioned before, second-hand stores and CCC work with people with a distance to the labour market. As a social workplace they often offer education to their employees to help prepare them to start working for other employers.

"And then it's only for a few months when it comes to return-to-work programs, for example. They do acquire the skills to perhaps start somewhere else afterward with a better starting qualification. So, we don't see that as a loss or wasted investment. Yes, maybe we train them for a few months and then they move on. But of course, we also have to deal with the flow-through function of the thrift store." (I9 - BKN)

This education might vary from language courses for refugees, to education on digital skills and repair skills. CCC Den Bosch is part of the municipality and earns subsidies for its function in educating employees to transition them to the labour market. Thus, they offer a broad range of courses:

"We have training programs where we help people learn the Dutch language. Arithmetic skills, digital skills, reading, writing… but also just courses for professional diplomas. It's actually a very large educational centre." (I6 - Den Bosch)

Secondly, second-hand stores and CCCs collaborate with educational facilities. Some examples are the trajectories for students who dropped out of school to get a second chance on their exams or the giving away of materials to technical schools (I3, I7). Multiple CCC's also expressed to be interested in more substantive and long-term collaboration with a technical education program. Such as altering technical education to focus more on repair versus production and students being able to get practical experience by helping out with repair of electronics in a CCC.

5.3.6 Collaborations

Apart from collaboration with education facilities, CCCs often have multiple other collaborations and projects to increase their impact. An example of this can be seen in a project at Restore Ede, where bicycles are repaired and donated to a charity that distributes them to children from underprivileged families. A notable example of a collaboration regarding e-repair, is the one between the home appliances manufacturer Bosch Siemens group (BSH) and CCC Roosendaal. The representative of CCC Roosendaal says that due to BSH not employing enough mechanics, this collaboration allows BSH to get early defect washing machines refurbished. CCC Roosendaal buys the defect washing machines and repairs and tests them according to the instructions of Bosch Siemens

and sells them with a renewed 2-year guarantee from BSH. This collaboration gives CCC Roosendaal access to the necessary spare parts and they get instructions and guidance from the BSH group on how to carry out repairs. This access to parts and instructions, is difficult without such a collaboration. The representative of Roosendaal says this about repairing other brand washing machines:

"Yes, our mechanic can do something. And we do order new parts. But if you have a different brand, it's not so easy for us to order. You see, if it's Bosch Siemens, we can order all of that." (I1 - Roosendaal)

When observing these collaborations, it is interesting to pay attention to what makes collaborating so valuable for CCCs. Collaborations are a way for CCCs to get access to tools and information by more experienced partners, who have more expertise on a certain topic. This is the case for the Bosch Siemens collaboration. There is also a type of collaboration where the CCC can externalise work to more an appropriate partner. This is the case for some product streams of road2work. Such as consoles and Dyson vacuums which goes to specific partners who can repair and sell them (I8).

Collaborations thus often seem to be an exchange of material resources, knowledge and expertise between partners.

During interviews and the co-creation session ideas for future collaborations were mentioned. CCCs expressed that they would like to collaborate with manufacturers, to make repair more accessible and deliver "feedback to the manufacturer" (C1). Such collaborations could help exchange knowledge about common defects and ways to improve the repairability of devices, as well as provide support for CCCs through "access to data on products and parts" (C1).

Another collaboration mentioned is with independent e-repair shops. This would be a good partner for expertise of repair and possibly to outsource some repair work. Potential is also seen for creating networks of small-scale local collaboration.

Table 6, summarizes the potential points for change gathered from the connected context

	Potential points for change: Connected context
Barriers	**Regulatory constraints** • CCCs are restricted from disassembling, repairing internal parts of electronics and retrieving and using second-hand spare parts without a permit. • Obtaining and maintaining the CENELEC permit is costly and time-consuming, involving detailed audits, which many CCCs cannot afford or manage. **Social work management** • A substantial portion of the CCC employees are social service workers, volunteers, and temporary workers who do not always have knowledge on electronics or repair skills. • High turnover rates and limited expertise make it difficult to maintain the level of technical skills needed for e-repair. • Due to the social work nature of CCCs, work processes are ad hoc, leading to inefficiencies and dependency on specific employees' skills. Additionally, it is difficult to change work processes “quickly” **Economic sustainability** • Repair of electronics is often not profitable for CCC’s due to high investment of time (and materials), and low resale value • CCC thus prioritize reusing electronics over repairing, as this is more convenient and profitable • Repair is done in particular cases, where an electronic product is worth the investment of repair
Enablers	**Collaboration** • Partnerships with organizations like Bosch Siemens Group provide CCCs access to spare parts, technical instructions, and expertise for specific products, enabling more effective repair. • Collaborations with educational facilities such as technical schools could increase repair knowledge among younger generations and provide CCCs with extra and skilled temporary workers **Education** CCCs provide education to their employees, such as language and repair skills, creating a pathway for skill-building within their workforce.
Opportunities	**Collaborations** • More partnerships with manufacturers, similar to Bosch Siemens group (BSH) • Potential collaboration with independent e-repair shops could bring in external expertise and create outsourcing opportunities for complex repairs. **CENELEC light** Discussions around creating a "CENELEC light" permit, tailored for second-hand stores and CCCs, could reduce regulatory burdens and allow for simpler, more feasible repairs of electronics. **Educating citizens** Educating citizens about repair through community-oriented initiatives, such as repair cafés, offers the opportunity to extend repair skills to the public and promote a culture of repair.

5.4 Conclusion

This chapter has explored and analysed the practice elements of e-repair in CCCs. The process of repair in CCCs is connected the activities of testing, assessing, cleaning, repairing, pricing and the selling electronics. The extent to which e-repair is performed in CCCs is limited and exists of testing whether electronics are broken, investigating the cause of the malfunction and replacing external parts. CCCs encounter various challenges when adopting e-repair. This is represented by the shortcomings observed in the material, meaning and competence elements of the practice. Constraints in the build quality of electronics and the availability of spare parts and repair knowledge form barriers to up-scaling e-repair. The low reselling value of second-hand electronics makes it difficult to make e-repair financially viable. Another prevalent barrier is the CENELEC permit, that CCCs need to own in order to disassemble electronics. The barriers to e-repair in CCCs seem to outweigh the identified enablers and opportunities. Moreover, many enablers function as a compensation to existing barriers rather than independent drivers of repair. An enabler of e-repair in CCCs is the knowledge of employees with personal affinity for e-repair. Opportunities are presented in the social nature of the CCCs and their potential for situated learning and education on repair. More opportunities can be found through collaboration with educational facilities and manufacturers as this can create new access to resources and knowledge. The next chapter will outline the process of creating a design based on the barriers, enablers and opportunities observed. Additionally, it will present the final design idea. In chapter 8,

6. Design

This chapter introduces some in-between steps and results of the design process and some additional information on the goals and strategies behind the idea's (Figure 18). First the design guidelines, which are based on the barriers, enablers and opportunities, will be established. Then the initial ideas will be outlined. Next the results of the decision matrix will be discussed and reflected on in order to show how these have informed the final design. At last, the final design will be presented.

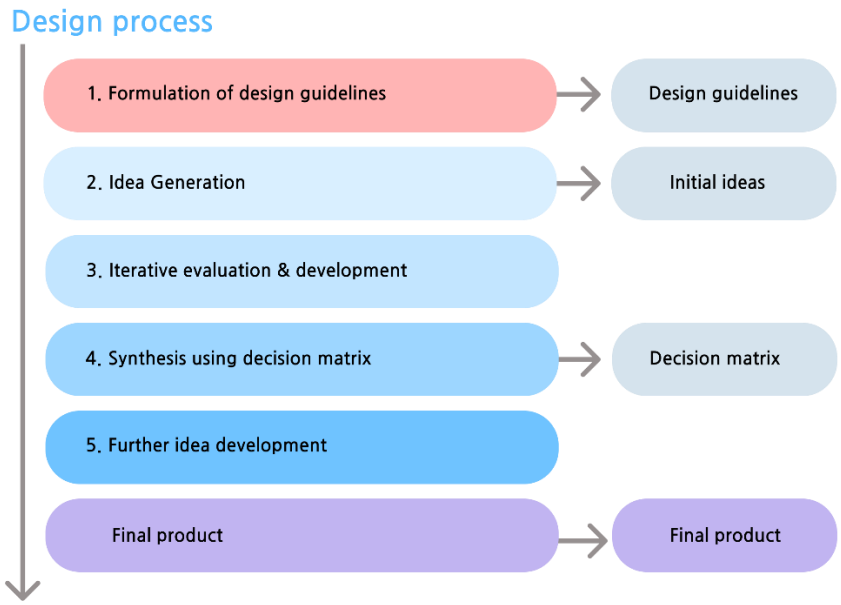

Figure 18, overview of design process with products of this process

6.1 Design guidelines:

The takeaways of SPT guided analysis of the interviews and co-creation outcomes were reviewed and translated into design guidelines to inform the design of tools and services that can stimulate CCCs in their e-repair efforts. This was done by looking at the barriers and enablers and seeing what a design should do to address these issues and opportunities. The guidelines are aligned with the practice dynamics, in order to understand in what way these guidelines intent to change the practice (Shove et al., 2012; Watson, 2012). CCC specific requirements and aims such as engagement and education of citizens and providing social work are also included in the guidelines. The design guidelines are showed in the following figure (See Table 7). The intent of the guidelines is explained according to the following categories:

- **CCC specific requirement**
  These are guidelines that have been established due to CCC specific circumstances that have to be taken into account when designing services or tools. These are for example that CCCs work with people with distance to the labour market and that this informs the type of work that is carried out.
- **Change through elements: material, meaning, competence**
  These guidelines are aimed at changing an element of the practice. Often the element mentioned in the guideline is constraining the emergence of the practice, thus the guideline aims at increasing

access to these materials and competences. Or changing meanings that discourage the emergence of the practice and substituting them with more encouraging meanings.

- **Change through practitioner community**
  These guidelines aim to broaden the practitioner community in the CCC. From only involving employees in the repair of electronics, these guidelines aim to include citizens, education facilities and possible other collaborators.
- **Connected practice**
  These guidelines are aimed at practices that are connected to the practice of repair, such as donation, assessment, or the selling of electronics. Changing connected practices can influence the practice of repair or reach the main goal of reducing electronics waste and disposal.

Table 7, design guidelines based on the potential point of change identified through SPT analysis.

	Guidelines	Intent of guideline
1	**Increasing repair and reuse of electronics** The design should stimulate more reuse and repair of donated electronics within the CCC, with the goal of less electronics disposal.	***Main goal***
2	**Social workplace and employee education** The design should work within the capacities and specialized employee circumstances of the CCC. Ideally supporting education and skill-building for employees, offering guidance on electronics assessments and repairs.	***CCC specific requirement*** ***Change through elements:*** *Material*
3	**Financial sustainability** The design should be affordable for CCCs, not cost more time and resources and help generate profit. Should add to the business plan around repair of electronics.	***CCC specific requirement***
4	**Access to tools, parts and materials** The design should enable easy access to repair tools, parts and materials or reduce reliance on expensive new parts and materials.	***Change through elements:*** *material* ***Change through practitioners***
5	**Efficient use of resources and space** The design should optimize use of resources and use of space for repair and storage. Or it should work effectively within limited CCC space.	***CCC specific requirement*** ***Change through elements:*** *material*
6	**Durability and repairability** The design should promote the repair of durable electronics and encourage more repairable product designs.	***Change through elements:*** *material*
7	**Positive perception of second-hand electronics** The design should help improve the image of second-hand electronics, making them more attractive to buyers.	***Change through elements:*** *meaning* ***Connected practices*** ***Change through practitioners***
8	**Change attitudes regarding repair** The design should help introduce people to the possibilities of repair and help change culture norms that shape the current thruway culture to a repair culture	***Change through elements:*** *meaning*
9	**Citizen engagement and education** The design should make electronics donation easier for citizens and educate them about repair and reuse to encourage them to actively reuse and repair instead of buy new	***Change through elements:*** *competence* ***Change through practitioners***
10	**Consistent work processes** The design should help CCC retain knowledge and create consistent and effective work processes that reduce the amount of disposed electronics.	***Change through elements:*** *Competence*
11	**Collaborations** The design should encourage collaborations that provide repair materials, expertise, or opportunities to outsource complex repairs.	***Change through practitioners*** ***Change through elements:*** *Material & competences*
12	**Regulatory compliance** The design should work within (or around) existing regulations. Or should include clear advice for alterations to the regulations	***CCC specific requirement***

6.2 Initial ideas:

During the co-creation session and interviews several ideas and opportunities emerged that can be used as starting points for developing ideas. By mind-mapping and using reverse brainstorming exercises the following ideas were developed. During brainstorming the intervention types outlined by (Spurling & McMeekin, n.d.) were used to initiate ideas based on SPT elements and their connection to the CCC, the community, other practices and further contexts.

1. **Database** – Collecting data about incoming electronics to create more consistency in decisions about whether to dispose, repair, or sell a product
2. **Repair at home kit** – Selling broken products with a repair guide and spare parts, for cheap price
3. **Altering collection** points – Small ideas such as compensation of donation of working electronics rather than disposing, moving testing of electronics to the collection points (also at recycling point) and requesting people to help with testing to push engagement.
4. **Rental tools and electronics** – Rent out second-hand tools and electronics to earn extra money and combat one-use purchases. For example, gourmet sets, disco lights and music boxes could be interesting for rental.
5. **Separate streams** – At collection points create more distinguishable streams of electronics and parts. So not only filtering working and repairable devices. But also filtering a device that has potentially useful parts.
6. **Positive image for electronics** – Multiple marketing and awareness tools such as letting customers write reviews about second-hand electronics bought at a CCC. To create trust and awareness for second-hand electronics.
7. **Learning pathways** – Teaching in incremental steps, making knowledge as accessible as possible, ensuring relevance and practical application on the job, and always providing easy access to information could address the lack of knowledge of employees.
8. **Workspaces for citizens** – Create workbenches with tools, that citizens can use if they want to attempt to repair an electronic device

6.3 Decision matrix

A decision matrix was used to generate insights on which ideas align best with the guidelines and have the most realistic potential to be carried out by a CCC and make a difference in the repairing practice (see Table 8) (Elmansy, 2023). The decision matrix works based on weighted criteria and score for each idea on these criteria. The criteria are based on the design guidelines (details in Chapter 2.4 4.3 Designing tools and services). Weights were distributed based on the influence of a criterion on the feasibility and the potential impact.

Table 8, Decision matrix criteria, weights, scoring and results

Criteria	Weight	1. Database	2. Repair at home kit	3. Altering collection	4. Rental tools and electronics	5. Separate streams	6. Positive image for electronics	7. Learning pathways	8. Workspaces for citizens
Regulatory Alignment	**0,15**	**4**	**3**	**4**	**4**	**2**	**4**	**3**	**2**
Impact on Repair and Reuse	**0,15**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
Financial Sustainability	**0,2**	**1**	**3**	**2**	**3**	**2**	**3**	**1**	**3**
Access to Materials	**0,1**	**3**	**2**	**3**	**2**	**3**	**2**	**3**	**2**
Cultural Change (Meaning)	**0,1**	**2**	**3**	**3**	**4**	**3**	**4**	**3**	**3**
Citizen Engagement and Education	**0,15**	**2**	**4**	**3**	**4**	**2**	**4**	**2**	**4**
Employee Support and Education	**0,1**	**5**	**3**	**2**	**2**	**2**	**2**	**5**	**2**
Resource and Space Efficiency	**0,05**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**2**
Total Weighted Score	1	**2,65**	**3**	**2,85**	**3,15**	**2,4**	**3,15**	**2,6**	**2,75**

6.3.1 Conclusions from decision matrix

The results of the matrix (Table 8) show that Idea 6 - *Positive image for electronics*, 4- *Rental tools and electronics*, have the highest score, meaning that they fit best to the chosen criteria and their assigned importance. Idea 6 and 4 have in common that they are both focused on citizens and are perceived to be financially sustainable. However, idea 4 tries to lower barriers to repair and through this engage citizens in repair. Whereas idea 6 is more focused on changing citizen perspective to increase the value of second-hand electronics. The highest scoring ideas seem to have in common that they work around regulatory constraints, there is a potential business case and there is an element of engaging citizens and changing repair culture. Idea 5 – *Separate streams* ranks the lowest. This seems to be due to low overall scores and low scores for heigh weight criteria such as financial sustainability and regulatory alignment.

6.3.2 Reflections informing final design

The process of setting up the weighted criteria and filling in the matrix, as well as the results of the matrix, led to insights about what elements should be present in the final idea. For the final idea it is important that it can work without being constraint by regulations. This element is important because it has a lot of impact on whether an idea is practically feasible. If an idea scores well in all areas expect for alignment with regulations, it means that it is a great idea, however it will probably not be possible to carry it out. Therefor losing its value completely. Secondly the final idea must be financially sustainable through potential profit or low costs. This criteria is also focused on the practical feasibility of the idea. It was observed that in the current e-repair practices financial considerations form a barrier to e-repair. Therefor it is important that the final idea is financially viable. Thirdly the final idea must focus on lowering barriers to repair for citizens and educating them about repair. This aspect fits the role of the CCCs as they have a social nature and goals. Additionally, through lowering barriers for citizens to repair, CCCs can positively impact the upscaling of e-repair. Without having to increase their own e-repair practices, which is difficult due to the regulatory, financial and resource barriers.

The final idea has combined multiple of the ideas that incorporate the elements discussed above to from a package of services and tools that can stimulate and enhance the emergence of e-repairing practices. This final idea is intended to be executed by CCCs. However, the services and tools that are in the final idea are intended for current customers of the CCCs and for citizens who want to learn about repair. The combined ideas focus on the engagement and education of citizens and using the potential of a CCC to function as a community of practice and provide situated learning. This is done through providing access to tools and knowledge. By focussing on citizen engagement, it is possible for the services of the final idea to largely work without complexities with regards to the CENELEC regulations. As this means no dismantling of electronics needs to be done by the CCC itself. However, it is still the case that many of the services could increase their impact if regulations would be more flexible. To account for the services being financially sustainable, the services and tools in the final idea range in the effort and organization asked from the CCCs. Some ideas have a potential business case. This, however, can form a trade-off of where profitability might interfere with consumer engagement in repair due to increased costs. In the next subsection the final idea will be presented in more detail.

6.4 Final design

Repair hub plan

Context, concept and aims

In the current throwaway society, the practice of repair has been seen to have declined among citizens. The once common practice of repair has been slowly replaced by disposing of and buying new cheaply manufactured products (McCollough et al., 2018). Repair skills and knowledge are no longer used and therefore are disappearing from the public. However, to transition to a circular economy it is essential to stimulate the public to repair instead of dispose of their devices. As previously mentioned, a study in the Netherlands revealed that while 75% of citizens expressed a willingness to repair devices, only 30% actually engage in this practice (Koch & Vringer, 2023). Literature suggests that people are hindered by factors such as high repair costs, lack of accessible repair services, and insufficient knowledge (Jaeger-Erben et al., 2021). This gap between willingness and action calls for interventions that make repair practices more accessible, affordable, and engaging for consumers. CCCs can play a role in this promotion of repair practiced among citizens. The interventions that are part of this plan are meant to contribute to the accessibility for repair to citizens and reintroducing people to repair.

Whilst CCCs have been focusing on repairing electronics themselves, currently there are many quite obstructive barriers that prevent them from actually being able to repair electronics as part of their working processes. Therefore, it might be more beneficial for CCCs to focus on fostering e-repair through education and engagement of citizens. Combining two of the goals of the CCCs to minimize waste and to contribute to education and awareness on the CE.

The final idea is a plan for the CCCs to stimulate citizens to engage in e-repair through multiple interventions and services. Instead of the CCCs carrying out external repair behind the scenes, the aim is to engage the citizens in this repair. Thus, creating a fun, social and positive experience of e-repair. Positive repair experiences have been found to increase the likelihood of someone repairing a device later on (Korsunova et al., 2023). The different services and interventions transform the CCC into a repair hub for citizens, a place or community where they can come for necessary repair materials and knowledge.

Plan features

A. Workspaces for Citizens:

The idea is to provide equipped workbenches at CCCs where citizens can repair devices. These workbenches would be free to use to promote easy access to e-repair. Some guidance and assistance to repair might be offered through specific product guidelines or working together with educational facilities.

Strategy: Addresses the constrain in the **material** and **competence** elements of the practice of repair for citizens by providing tools and guidance.

Figure 19, illustration of workspace for citizens (Microsoft Designer, 2025)

B. Tool and electronics rental:

Set up a service to rent out tools and second-hand electronics to reduce single-use purchases and increase accessibility to repair materials. Tools could be rented out for free or for a tiny fee, to make it accessible. Second-hand electronics, such as speakers, beamers or a gourmet set, which are often items bought for a one-time event, can be rented for higher fees.

Strategy: Aims to change the **meanings** associated with owning tools and electronics, promoting shared resources, and creating positive experiences with second-hand devices. Addresses the constraints in the **material** elements of the practice by providing tools and guidance.

Figure 20, illustration of tool and electronics rental (Microsoft Designer, 2025)

C. Workshops and training:

The CCC can offer repair workshops or trainings where the basics of e-repair are taught via experimenting with broken devices. In the end of a workshop people can take their repaired devices home. This could be a fun activity for a work team outing or a Teen birthday party.

Strategy: Aims at educating trainees on repair **competences** and shifting **meanings** toward valuing and enjoying repair, additionally creating positive repair experiences for trainees.


Figure 21, illustration of workshops and training (Microsoft Designer, 2025)

D. Repair yourself kit

Broken electronic devices that get sold in the CCC for free or really cheap that people can then attempt to repair at the free workbenches with the available tools and guidelines. To stimulate people to partake in this repair yourself, people can earn a small reward by attempting repair. Such as a discount on their next buy at the CCC or a coupon for a free tool/device rental. Additionally, people who successfully repair a product can be charged for the external parts they used for repair.

Strategy: Aims to make it more accessible for people to experiment with repair and through this shift **meanings** around repair towards enjoying repair and creating positive repair experiences. Additionally stimulating people to build repair **competences.**

Figure 22, illustration of repair yourself kit (Microsoft Designer, 2025)

E. Collaborations with education facilities

Collaborate with education facilities to exchange knowledge and materials. Students that study electrical engineering or similar applied studies could help the CCC and gain practical experience by guiding visitors in their attempts at repair. CCCs provide education facilities with broken electronics and other materials that could be used in their education programs. Lastly workshops could be given to students by the CCC, on basic repair skills and the importance of repair in solving sustainability challenges.

Strategy: Aims to exchange **materials** with knowledge and experiences stimulating **competences** in students and citizens.


Figure 23, illustration of collaboration with education (Microsoft Designer, 2025)

Strategy of the plan and features

The plan sets out to engage citizens in repair practices in the CCCs. Features A (*Workspaces for Citizens*) and B (*Tool and Electronics Rental)* focus on making the materials needed for repair available and accessible for people to use. This can help lower the barriers to repair for people who are already interested in trying repair, but do not have the money or space to explore the practice. Features C (*Workshops and Training*) and D (*Repair yourself kit*) aim to introduce new people to the practice of repair. This is done by creating a fun low-stakes social setting where people can explore and learn about repair with little risk. In this manner repair competences are made more accessible. Features B, C and D additionally aim to alter or substitute some existing meanings associated with repair and second-hand electronics. Feature B tries to alter the mindset of one-time use products and owning a product by letting people explore with cheaply hiring products. This also gives people an opportunity to test out second-hand or repaired electronics and formulate positive associations. Features C and D aim to change meanings around repair through creating positive repair experiences. This is done through making repair a social or positively challenging experience, with low-stakes and possible rewards. As said by Korsunova et al., (2023) positive repair experiences make people more likely to want to try repair again.

Feature E (Collaborations with education facilities) aims at stimulating broader and more systematic building of repair competence by working with education facilities. By collaboration with education facilities, education can be shaped according to the needs of a future circular society. Thus, including not only working with new materials, but also repairing and repurposing or reusing second-hand materials.

As currently most CCCs do not involve citizens in the repair process, all these features are aimed at including and engaging people in the e-repair practices to broaden the carriers of the practice. By involving new practitioners, new ideas and elements are brought into the practice (Shove et al., 2012c). Through engaging citizens and involving educational facilities and possible other collaborators, as suggested in feature E, a community of electronics practice can emerge. Thus, stimulating more significant type of learning through situated learning in a social environment (Lave, 1991).

Rules and regulations were found to be one of the most restrictive barriers to e-repair practices in CCCs. It is thus important that the plan and its features can function without a CCC needing a CENELEC permit. For features B and E this is not a problem. For features A, C and D the CENELEC regulations create limitations for the guidance and training that can be given. Physical training and repairing must remain on the external parts of electronics to avoid disassembly, however further instructions can possibly be given in a presentation format.

To reflect on the feasibility of the plan it is also important to take into account the work processes and employees of the CCC. The designed plan has features with differing levels of necessary new work processes. Features A and B requires mostly work in setting up the systems and materials. However, after set-up these features mostly need upkeep in material elements and administration. This should be easy work that can easily be assistant on by temporary employees. Features C and D require more constant work in the form of administration, giving trainings, and preparing repair kits.

For the plan to be successful it is also important that the plan is financially attainable for the CCCs. Features A and D do not bring in any profit. The aim is to provide these services for free, or with flexible prices that cover the resources used. However, not many costs are generated by these services, apart from the upkeep by employees. Features B and C could be used to bring in profit. The rental of tools should be offered for free, or low prices, to keep it accessible. The rental of electronic devices however can be used to earn profits on. Additionally, giving workshops to companies, is a way of earning profits.

6. 5 Conclusion

In this chapter the design process was outlined leading to a final design, which is was based on the design guidelines that came out of the barriers, enablers and opportunities found during the SPT analysis. Based on the guideline's ideas were formed, of which a selection was chosen to be combined in a package that forms the final idea. The final idea is the *repair hub plan*, which focusses on services and tools that lower barriers to e-repair for citizens through providing access to tools and knowledge. The plan contains a free workspace where citizens can try repair, tool and electronics rental for free or low prices, e-repair workshops, repair yourself kit and collaborations with educational facilities. The plan aligns with the CCCs goals of education and social impact. Through engaging citizens and involving educational facilities and possible other collaborators, a community of e-repair can emerge, stimulating the upscaling of the e-repair practice.

7 Discussion

In this chapter, the findings of the research will be linked back to the theory and literature and its gaps that were discussed in the introduction. The presented findings will be interpreted and linked to theory and relevant context. The research questions will be discussed, along with the design guidelines. The significance of the research findings will be highlighted and recommendations for future research, policy and practical applications within CCCs will be provided. Finally, I will reflect on my research process.

The objective of this research was to explore the current practices of e-repair in CCCs and to discover barriers, enablers and opportunities that are experienced in the setting up and scaling up of these practices. As established earlier, the transition towards a circular economy is a significant challenge in the current throwaway society. Municipalities are looking for the most circular and sustainable ways to deal with our disposed electronics. CCCs have been trying to decrease ecological impacts of the disposal of electronics by reusing and repairing electronics. These efforts however have not flourished due to various challenges setting up e-repair and reuse within CCCs, as seen in this research. Literature has shown that citizens increasingly lack the ability or the incentive to repair (Jaeger-Erben et al., 2021). Thus, the goal of this research was to find out what can be done to stimulate repair practices in CCCs, but also what role CCCs have in the larger scale repair system and in what way this can stimulate the repair practices in the broader society.

Few studies have focused on (e-)repair, and those that do often approach it from an economic, or passive consumerist perspective. There is a lack of research from a social science standpoint that considers the broader context and everyday realities that might influence the state of repair (Yuan, 2023). Using a SPT perspective is essential for this subject, as it examines how practices emerge, taking into account contextual factors such as societal trends, financial constraints and regulatory frameworks. Using SPT, the current practice of e-repair in CCCs were analysed to determine intervention points that could help inspire tools and services that support CCCs to repair more electronic devices and engage more citizens in these practices. Figure 24 presents the conceptual framework that guided the research analysis and that will be reflected on in this chapter

The following research questions are guiding this research:

RQ: What are the current practices of e-repair in Circular Craft Centres (CCCs) in the Netherlands, and how can the growth and scaling of these practices be supported?

- R1: How are electronic repair practice emerging in CCCs?
- R2: What barriers and enablers influence the adoption and scaling of e-repair practices in CCCs?
- R3: What are the possible roles of CCCs in the current and future ecosystem of e-repair?
- R4: How can designed tools or services support the adoption and scaling of e-repair practices in CCCs?

The following section are going to discuss the results found during the research and how they might be interpreted to answer the research questions.

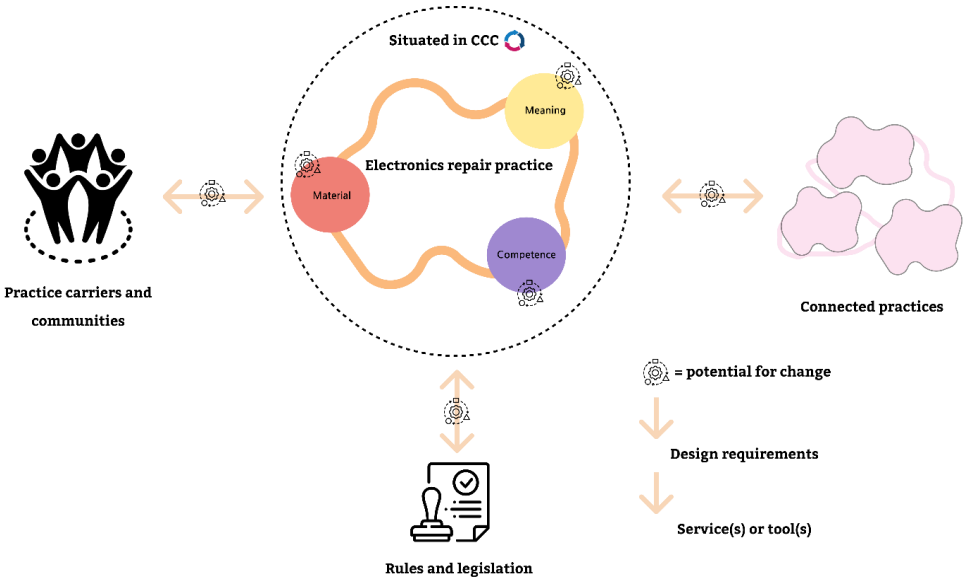

Figure 24, conceptual framework, adapted from (Lens, 2024)

7.1 The emergence of e-repair practices in CCCs

The concept of CCCs is very novel and these new collaborations and their aims and impacts have not yet been studied much from an academic perspective, despite the expectation that CCCs will contribute to the transition towards a CE. Moreover, repair practices have recently been studied from an individual, home repair (or repair shop) angle, but not focusing on efforts by second-hand shops and CCCs. As an organisation receiving large amounts of working and broken electronics, they might face different challenges in trying to reuse and repair these products and thus it is important to explore what challenges they face, how these relate to broader societal structures and what can be done to help CCCs fulfil their contribution to the CE.

7.1.1 Practice of repair or (non)repair

It was observed during this research that in most CCCs the e-repair practice does not reach a further stage than testing whether products are working. CCCs are discouraged by barriers and limitations that prevent them from experimenting with materials or investing in experienced employees to set up e-repair. Some CCCs were observed to be actively looking for opportunities to do more e-repair such as Apeldoorn (I2) and Roosendaal (I1). Others solely focused on streamlining donation of electronics and testing them properly, such as Amersfoort (I5) and Schiedam (I4). Due to a lack of advanced repairs in most CCCs, it was often difficult for the managers and employees, to talk in detail about the materials, meanings and competences needed for e-repair. As often these elements were only partially present.

These findings about the current status of repair within CCCs challenges the idea of e-repair in CCCs being a practice, as opposed to a proto-practice. As by definition of Shove et al., (2012) a practice is formed when the practice elements: materials, meanings and competences, are present and are linked to each other. For the practice of e-repair in CCC's, this is difficult to tell for the following reasons:

First of all, the elements materials, meanings and competences certainly seem to be present and linked. However, it is hard to distinguish if these elements belong specifically to the practice of e-repair, or more so to the connected practices of reuse of electronics in the CCCs. Additionally, many elements of the e-repair practice identified during the research, such as electronic products, tools, materials, perceived value, and repair knowledge, are either linked to barriers or represent missing components essential to the practice. This relates

to the work of Jaeger-Erben et al., (2021, p.10) who says the following: “Thus, our study of repair as a social practice is more likely a study of structures of non-repair, where human agents are locked in incompetence and repair-impeding settings”. Following this idea, this study might be more likely a study of the structure of non-repair of electronics in CCCs as during the research the missing elements and challenges were mostly discussed. It might thus be more accurate to say that this research is an exploration of the ways in which repair cannot yet be practiced in CCCs and what elements and context provide this non-repair. This practice of non-repair is illustrated in figure 25. The barriers mentioned will be discussed in more detail in section 7.2.

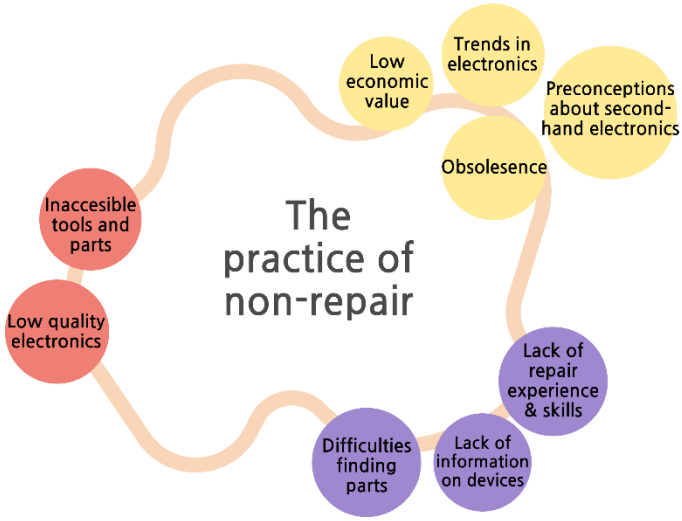

Figure 25, illustration showing the elements of the practice of non-repair.

The main material in the current practice of e-repair consist of donated electronics. The material characteristics of these electronics were found to create barriers to repair, as they often have low repairability and bad build quality, making repairs financially unattractive. This relates to the theme of worth and value, which plays a central role in e-repair practices in CCCs. The worth of an electronic device was found to be assessed based on characteristics such as brand, quality and physical state. This assessment of value influences the likelihood of repair. These findings align with previous research on individual repair practices, though a key distinction is that in CCCs, value assessments are made without personal ownership of the devices (Korsunova et al., 2023). Unlike in personal repair decisions, emotional attachment was not found to influence employees’ assessment of worth and repairability. However, it did emerge as a meaning associated with donation.
Additionally, financial considerations have been found to shape e-repair practices in CCCs. This finding is consistent with prior research on at home repair practices, where financial concerns influence repair decisions (Okada, 2001).

7.2 Barriers and enablers of adoption and scaling

Many of the barriers that were found to discourage the further emergence of e-repair practices in CCCs can be linked to broader influences from the situated or external context of the CCC. The inaccessibility of materials, meanings and competences seems to be linked to broader challenges that have been more widely experienced in the repair system.

7.2.1 Regulations

Multiple of the barriers observed in e-repair practices in the CCCs can be related to regulatory constraints. Without a CENELEC permit, CCCs are not allowed to harvest or use second-hand spare parts (Ministerie van Infrastructuur en Waterstaat, 2024). This creates material constraints for CCCs, as new parts are often hard to find and expensive. The CENELEC regulations restrict repair in CCCs. This influences the possibility for CCCs to educate employees on repair and develop and retain repair competences within their organisations. Lastly the restrictions have an effect on the meaning of the e-repair practices, through their discouragement of employees in their attempts to strive for circularity. A clear example of this is CCC Apeldoorn, where they set up repair services and used second-hand spare parts (Groot & Tooker, 2024). This is not allowed and the service had to be shut down. This demotivated the employees, as they feel restricted in the work they can do.

Despite increasing pressure to move away from a throwaway economy, current regulation in many ways do not support circular strategies and thus the transition to a CE (Van Der Velden et al., 2023). Legislation has been found to be a key barrier to repair (Svensson-Hoglund et al., 2021). In fact, in case of the CCCs the regulations hinder the efforts to repair electronics. In more recent years the right-to-repair movement has emerged, which has been pushing for the development of policies and regulations stimulating repair in the EU and at a national level (Van Der Velden et al., 2023). This has led to the EU adopting requirements for repair in product design (European Commission, 2022). These requirements force producers to make spare parts available and to ensure repair can be executed with commonly available tools. These are some first steps aligning policy with circular aims. However, lots of regulatory issues regarding guarantees, taxation and economic incentives for consumer remain (Van Der Velden et al., 2023).

It is important that the legislation is reformed to better fit the demands of these organisations and initiatives that want to play an active role in facilitating repair and promoting circularity. Without changes to this legislation CCCs remain very restricted in their abilities to adopt and scale e-repair practices. Rijkswaterstaat and BKN are lobbying on behalf of CCCs to change or create a light version of the CENELEC regulations (I9 & I14). This process should be continued as it is crucial for the CCCs ability to repair, but also to stimulate other novel e-repair and reuse initiatives that might arise. In the meantime, CCCs should look for other ways to promote the reuse and repair of electronics that are not reliant on changed regulations. CCCs could focus on supporting and introducing citizens to the possibilities of e-repair and lowering their barriers to repair.

7.2.2 Economy & finances

The current linear economic system leads to multiple barriers for CCCs in their adoption of e-repair. In the research it was observed that CCCs mostly have limited budgets. Compared to other product groups, electronics repair has high costs compared to potential profit. Financially there is thus little incentive to adopt e-repair practices. The trouble for circular initiatives to find a business plan or gain market share is seen more widely in the repair ecosystem (McCollough, 2009). Svensson-Hoglund et al. (2021), observed multiple business and industry related barriers, such as low profitability of repair, lack of design for repair and risks due to legal obligations and uncertainties. These barriers have also been found in the CCCs.
The budget for repair in CCCs is dependent on the potential profit of a product. This profit is low, due competition with low priced new products available. The low quality of incoming electronics was mentioned by interviews as a barrier to repair. This is a material impact of the linear economy. Where intentionally shortening lifetime in design (planned obsolescence) or designing products with low-quality materials and thus low product durability (premature obsolescence) is part of business strategies (Rivera & Lallmahomed, 2016). Electronics left at the recycling container are sold to recycling facilities and bring in money. Therefore, there is also not a financial incentive for municipalities and waste handlers to increase the amount of e-repair.

These examples illustrate that the current economic systems are in multiple ways discouraging repair of electronics and these barriers can also be recognized in CCCs. Adding to previous paragraph about legislation, these barriers need to be regulated by government and policymakers' tough legislation and incentives such as tax deductions (Svensson-Hoglund et al., 2021).

7.2.3 Culture

The barriers to e-repair adoption observed in CCCs can be linked to broader systemic challenges rooted in the culture of a throwaway society. As mentioned before the costs of e-repair outweigh the profits of selling repaired electronics in CCCs. High costs that are caused by previously assed links to regulations and economy. The other problem is consumers preferences for new products or biases against repaired products. Consumers have been found to not give equal value to refurbished and repaired items as they do to new, even if quality and lifetime are equal (Atasu et al., 2008).

Citizen's preferences and biases are caused by misinformation or lack of information (Svensson-Hoglund et al., 2021). Additionally, manufacturers stimulate and use the consumer assumptions through marketing strategies that are focused on novelty seeking (Jaeger-Erben et al., 2021). Examples of this are producing new trends in electronics, not updating software, or constantly bringing out better versions of a product so people feel their old product is no longer functional.

Additionally, repair practices have fallen out of cultural norms and have become less accessible due to lack of knowledge, inaccessible materials and high costs (Jaeger-Erben et al., 2021), stimulating the culture of disposability. Without the knowledge or experience to repair, consumers are less likely to view repair as an alternative to replacement.

These meanings are embedded in the throwaway culture and materialize in the preference of new over repaired or second-hand thus devaluing older or repaired products. This results in low profitability for CCCs trying to adopt e-repair practices. To target these meanings cultural shifts, have to be stimulated through awareness campaigns to target misinformation and regulations for manufacturers and advertising. Additionally, campaign about alternatives to consumption of new goods and the establishment of associated infrastructure and services can stimulate the forming of new meanings.

7.2.4 Lack of repair skills and knowledge

The findings indicate that there is a lack of consistent knowledge and skills on electronics in CCCs. This is due to the inaccessibility of information of electronic devices and repair guidance. Additionally, CCCs work with temporary employees, which do not always have prior knowledge or experience with repair or electronics. Currently, knowledge and skill gaps are overshadowed by more pressing regulatory and financial barriers, which also limit CCCs ability to train employees and development skills and knowledge. However, if these barriers are addressed in the future, CCCs would benefit from proactively building expertise in electronics and e-repair to support upscaling efforts.

7.2.5 Transition towards CE

As discussed earlier, although current regulations and legislation do not fully align with the goals of transitioning to a CE, progress is being made, e.g. the right to repair movement. It is hoped that future policies will better support the transition to a CE, thus creating more opportunities for CCCs. The CENELEC light lobby is one such promising development, which will enable CCCs to have more freedom in their repair and reuse of electronics and their spare parts. Additionally, interviewees noted a growing diversity in the customer base of second-hand stores, possibly driven by sustainability concerns and financial motivations during the recent economic inflation.

7.2.6 Social dimension, collaboration & community

The role of practice carriers and community, as included in the conceptual framework (Figure 24), is relevant for e-repair in CCCs, as a large part of what characterizes a CCC is its social nature. CCCs form a community where employees with a distance to the labour market are provided with suitable jobs and opportunities to learn new skills. CCCs already resemble a practice community when it comes to their workplace culture. There is potential to broaden this community by involving customers and citizens in e-repair practices trough the proposed repair hub plan. CCCs are already a collaboration between organisations, and they often seek collaborations with local sustainable initiatives. These collaborations might be promising in navigating current regulatory structures, providing more opportunities for innovation. Given their social and educational goals, CCCs are well-suited to focus on education and citizen engagement, a concept supported by theories of practice communities and situated learning (Lave & Wenger, n.d.), which emphasize the value of localized, hands-on experiences to stimulate learning. These opportunities will be further explored in the next section, and in the reasoning behind the final design.

7.3 CCCs role in the repair ecosystem

Looking at the current repair system there seems to be a gap between organized repair by manufacturers, expensive repair at repair shops, in-accessible home repair and buying new (Van Der Velden et al., 2023). To incentivise people to reuse and repair electronics there needs to be more in-between options that are in-expensive and accessible. Repair cafés form such an option and since the first one was set up in 2009 the concept has been adopted by citizen all over the world, expressing the demand for such facilities.

An additional gap exists regarding the disposed and donated electronics. Here there are parties interested in recycling for the reuse and profit of the materials in electronics. However, there is little interest in reusing or repairing these electronics, or their parts, which is preferred from a sustainability perspective.

As the recycling centres and second-hand shops are motivated to contribute to a more sustainable CE and receive a lot of broken electronics, they are in a good position to fill this gap in the repair system. However, the barriers that are experienced by CCCs trying to repair electronics, show this might not be feasibly realisable. The CCCs current role is mostly in the reuse of not broken electronics. Some CCCs try to increase their impact on electronics by doing small external repairs. However, the barriers experienced by CCCs have kept them from scaling their impact when it comes to electronics. Thus, it is valuable to reconsider the position of CCC in the repair ecosystem and evaluate where opportunities arise for CCCs to reach circularity goals in the current repair context.

There are multiple factors to consider about the potential e-repair services that CCCs can offer. Namely, the regulatory, economic and cultural barriers limiting repair possibilities, the social dimension of the CCC as an organisation and associated goals and the current gaps in the repair ecosystem. The CCC's mission emphasizes a social dimension of providing social work, education, and circularity rather than profit-driven activities. Transforming CCCs into commercial repair shops would likely conflict with their values and business models. Instead, the focus should remain on their ability to educate citizens about repair and inspire more sustainable consumption habits.

This can be materialized through CCCs providing services and tools for citizens to use to try and repair their own electronics, as incorporated in the final design (6.4 Final design). Providing these services can lower the barrier for citizens to engage with repair practices. This supports incidental sustainability, as Kuppinger (2023) describes in the context of thrift stores. CCCs could effectively contribute to more ecological lifestyles by exposing citizens to circular practices, stimulating the reemergence of repair practice among citizens. Rather than employees performing repairs themselves, CCCs are well-suited to serve as community repair hubs, due to their social and collaborative nature. It was observed that in the current e-repair practices citizens have not

been engaged. The CCC itself is already a network of different parties which should be extended to engage citizens to form a circular community. This has potential benefits for the education on repair skills, as learning in a community of practice can be seen as a wider experience than just tied to a specific task (Lave, 1991).

The lack of provisional structures for repair has been recognized in the literature as a key barrier to fostering a culture of repair (Svensson-Hoglund et al., 2021). CCCs could play a significant role through addressing this gap, by providing workspaces, materials and knowledge, to help increase accessibility to repair for citizens and reintroduce e-repair practices.

It could be beneficial for CCCs to seek collaborations that could externalise the repair of electronics. As currently most e-repair is not possible for CCCs, there might be opportunities for CCCs to collaborate with existing repair shops and ICT refurbishing businesses to optimize the amount of electronics that can be repaired or reused. With aims of transitioning to a CE, future policy and regulations might be adopted that stimulate e-repair initiatives (Svensson-Hoglund et al., 2021). In such an economy new business might arise the CCC could collaborate with and donate or sell their broken electronics to.

CCCs can also have a role in changing the current regulatory and financial context in which setting up e-repair initiatives is difficult. They can do this through being actively involved in lobbying and creating awareness among citizens, municipalities, politicians and manufactures. As broken and discarded electronics get donated or discarded at CCCs, they are confronted with the reality of the problems regarding electronics disposal and consumption. This makes CCCs an important agent to talk about the experiences and the problems they face in the current ecosystem and what changes are necessary to transition to a circular economy.

7.4 Reflections on design

For a design to be able to support the adoption and scaling of e-repair in a CCC, it needs to consider the barriers from both internal and external to the CCC, be creative in navigating these challenges and using the strengths of the CCC. SPT aided significantly in identifying the barriers and enablers and providing a foundation for ideation to transform and evolve the current practice. The final design has been created based on the potential points for change and guidelines that came out of the SPT analysis and were based on the dynamics of how practices change (Shove et al., 2012c; Watson, 2012).

The final idea exists out of several features targeting the so far less explored route to engage citizens in e-repair. This is done through services and opportunities the CCCs can offer and through this become a repair hub and community for citizens. Some of these features such as the free workbenches and tool rental aim at altering the elements of a practice, in this making the material elements more accessible. This is a type of intervention that is outlined by Spurling & McMeekin (n.d.). It aims to go beyond superficial solutions and targeting the underlying dynamics of the practice. Thus, by increasing accessibility to materials and knowledge, the intervention tries to alter the elements in the practice of repair (Spurling & McMeekin, n.d.). Another way of intervening is through the substitution of an unsustainable practice by a more sustainable one (Spurling & McMeekin, n.d.). The rental of electronics devices can hopefully serve as a replacement for buying cheap devices that will only be used for occasional uses, or even one-time. This feature thus aims to show citizens that there are other more sustainable practices for them that can replace their current ones. The repair kit included in the repair hub plan, is an intervention aimed at an interlocking practice. The practice of shopping is altered because the repair kit offers the chance to buy a broken product and repair it. Another way the practice can be evolved is through changes in the carriers of the practice (Shove et al., 2012c). Through engaging citizens, students (collaboration with education facilities), companies (workshops) new elements and ideas can be brought into the current practice, which can evolve stimulate its evolvement.

The feasibility of the design was increased by trying to include financially beneficial services. These services are the renting of electronics devices, the workshops and potentially selling parts as part of repair kit and free workspaces. These types of business plans are more often seen and suggested in circular business plans (Ferasso et al., 2020).

A weak point of the design is the implementation in the CCCs and the adoption by citizens. Due to the social dimension of the CCCs and their high staff turnover it might be challenging to implement the features. This might be especially true for the ones requiring preparation and upkeep, such as the rental of electronics and repair kits. The plan is supposed to engage and introduce citizens to repair. However, interventions such as the free working spaces will probably only attract people already interested or experienced in repair. To increase the chance of involving citizens with limited prior interest in repair, the workshops and repair kits can be aimed at specific groups to stimulate engagement.

As this plan is mostly focused on the engagement and education of citizens, it will probably not be as impactful on the physical problems of increasing e-waste disposal.

7.5 Reflections on conceptual framework

The conceptual framework introduced in subsection 3.4 provided a useful structure for analysing e-repair in CCCs, however certain concepts were difficult to align with the findings.

Economic constraints are significant in shaping the current e-repair practice in CCCs, however it is hard to position them within the framework. Economic factors are not explicitly integrated in the conceptual framework. It can potentially be seen as a material element of the practice. However, throughout the thesis it was more connected to the management of the practice and thus to rules and regulations. When looking at the barriers to upscaling e-repair, most were found as constraints within the practice elements themselves. However, these shortcomings were often caused by external conditions, such as regulations and financial limitations that lead to limited access to spare parts. Similarly cultural circumstances were found to influence the practice elements. The framework thus adequately captures the internal practice elements but could have better reflect the influence of external elements, such as policies, financial structures and cultural circumstances.

Shortcomings in competencies can be linked to management and practitioners. The CCCs already function as a community of practice, educating their employees trough situated learning. The potential for change in regarding practitioners and the community, as seen in the framework, is used in the repair hub plan. By involving a new group of practitioners, namely customers and citizens, in the CCC community, the aim is to scale the practice of e-repair.

The role of connected practices in this research was largely overshadowed by more pressing barriers, such as regulations and financial constraints. If e-repair was practiced in CCCs to a larger extent, the interactions between different practices might have played a greater role in scaling repair efforts. However, given the significant limitations on repair activities, these connections remained less relevant in the current context.

7.6 Reflections on research process

In this subsection I will reflect on the research process as it can provide valuable insights into the challenges encountered, the adjustments made, and the lessons learned while conducting this study.

One of the key challenges I encountered was working with SPT. The challenge was not with gaining an understanding of the theory, but mostly with having to apply it to my own subject. For someone with limit social science experience it was difficult for me to view the world through the SPT concepts and use the

appropriate language to analyse and describe the findings. The application was further complicated due to the limited examples of e-repair being carried out in CCCs, as e-repair is still emerging as a practice. Additionally, merging social science and design was sometimes hard to navigate as I was unsure where to place the emphasis. As it could either be on understanding and analysing the practice or on the design and development process. In the end I decided to focus more on the analysis and how this could inspire design and thus disregarding the phase of validating and testing the design.

The reality of the field was different from my initial expectation, requiring changes to research methods and focus areas. An important takeaway for me is that engaging with the field early on in the research process is preferable. It can be challenging to find the balance of being prepared enough to enter the field, but also not investing time in developing plans that might not be relevant to the real-world context. I learned that a research process is an iterative process that requires continuous refinement as new insights emerge.

Lastly, I had trouble integrating the co-creation session outcomes into the thesis for various reasons. Reflecting on the organization of the co-creation there were a couple of things that I could have done differently in order to improve the relevancy of the results. The co-creation session was set-up to discuss the whole electronics reuse and repair process in CCCs. This included collection and selling electronics. Due to the obstructive barriers to repair of electronics, ideas and conversations quickly strayed to reaching more reuse over increasing repair. The planning of the co-creation was very tight and therefore it was hard to start up discussions with the participants. This defeats some of the benefits of a co-creation session, namely having all stakeholders together to discuss and brainstorm solutions. Time could have been freed up by focusing solely on the brainstorm and design phase in the co-creation session. A large part of the co-creation session was an analysis of the barriers encountered in the CCC with regard to e-repair. However, as many of the participants were also interviewed about similar topics, this data could have been used as a starting point.

7.7 Overview of recommendations

This section will give an overview of the recommendations mentioned throughout the discussion. Current EU and national policy do not align with CE aims, with regulations such as CENELEC raising barriers to e-repair for organisations. In order for extensive e-repair, where disassembly is necessary, to be carried out by CCCs on regular basis, regulatory changes need to be made. As mentioned previously, Rijkswaterstaat and BKN are exploring the possibilities for creating a CENELEC light. As gaining a CENELEC permit is normally a too expensive and strenuous process for CCCs, the CENELEC light should be more accessible and consider the social nature of the work at a CCC. Furthermore, a process should be started to figure out what flexibilities are most beneficial for CCCs with regards to the CENELEC regulations. During the co-creation session the suggestion was made to carry out a pilot, to test a potential form of CENELEC light, to explore what a desired CENELEC light would entail. For instance, allowing CCCs to disassemble to harvest spare parts or create a list of repair procedures that CCCs are allowed to carry out. This could include specific product types or brands.

However, even if a CENELEC light would be established there are remaining financial and cultural barriers to repair in CCCs. To enable CCCs to adopt e-repair, policy should be created that makes repair financially viable for CCCs, such as subsidies for spare parts or tax-reductions for repair activities. Additionally, e-repair would become more financially interesting if the value of second-hand electronics increases. To stimulate this cultural perception should be shifted through public awareness campaigns.

CCCs should consider playing a role in this cultural shift by actively engaging citizens through the services and tools presented in the *repair hub plan.* By becoming a community hub for repair knowledge and skills, CCCs can help shift cultural perceptions toward e-repair and second-hand electronics.

Until the regulatory and financial condition improve, CCCs should explore alternative ways to repair more electronics. Through collaborating with repair businesses or manufacturers CCCs might find ways to outsource repair, by sorting and delivering repairable electronics to manufacturers or repair business. All the recommendations have been summarized in

Table 9.

Table 9, overview of the recommendations given throughout the research

Category	Recommendation	Who can take action
Regulatory changes	Develop a CENELEC light permit to allow CCCs more flexibility in repair work. Ensure the CENELEC light is affordable and accessible, considering the social nature of CCCs. Conduct a pilot program to test potential CENELEC light flexibilities (e.g., part harvesting, specific repair procedures).	*Policymakers, Rijkswaterstaat, BKN, CCCs*
Financial support	Introduce subsidies for spare parts and tax reductions for repair activities. Increase the economic value of second-hand electronics to make repair more financially viable.	*EU & National governments and policymakers*
Cultural shift	Launch public awareness campaigns to change perceptions of second-hand and repaired electronics. CCCs should engage citizens by becoming community hubs for repair knowledge and skills.	*National Government & municipalities* *CCCs*
Alternative strategies	Until regulations and financial conditions improve, CCCs should collaborate with repair businesses or manufacturers to outsource repairs.	*CCCs, Repair Businesses, Manufacturers*
Building e-repair expertise	Proactively build e-repair knowledge and skills by collecting data and setting up trainings	*CCCs*
Repair hub plan features: *Workspaces for Citizens*	Provide equipped workbenches at CCCs for free use, with guidance through product guidelines or educational partnerships.	*CCCs, educational institutions*
Tool & electronics rental	Rent out tools for free or low fees; second-hand electronics can be rented for higher fees	*CCCs*
Workshops & training	Offer repair workshops where participants learn by experimenting with broken devices	*CCCs*
Repair-yourself kit	Sell broken electronics cheaply, allowing citizens to repair them at CCCs using available tools and guides, with incentives for participation	*CCCs*
Collaborations with education facilities	Exchange materials and knowledge with schools; students help guide repairs and gain practical experience	*CCCs & educational institutions*

7.8 Future research

This study has highlighted several areas where further research could lead to valuable insights for the adoption of e-repair practices and wider transition to the CE. Additionally, there are more practical research areas that could be beneficial for CCCs to reach their circularity goals.

Following this research, a future study could evaluate the proposed repair hub plan. The features could be implemented in a pilot to gather stakeholder feedback, assess scalability and the potential impacts for community engagement and learning of e-repair competences. In regard to e-repair and CCCs a more practical study could look into potential collaborations for CCCs with industries that can reuse/repair or repurpose broken electronics.

As CCCs have not been studied much from an academic perspective, a study could look into the characterises of CCC, such as location, income sources, organisational structure and size, and compare these across different levels of repair implementation. This could lead to insights on what conditions enable CCCs to repair. There are other less explored areas of CCCs that could be beneficial to study. Namely, research with a focus on visitors and potential visitors, and what are their expectations and desired features in a CCC. Another area of research could be looking at the broader aims and goals of the CCCs to educate citizens on the CE and circular strategies and how to materialize these aims.

Further exploration of regulatory and economic barriers is needed to provide insights into policy interventions that enable e-repair initiatives and move from hindering to stimulating these initiatives. Specifically, it would be valuable to study regulations aimed at the stimulation of e-repair business models and targeting of unstainable strategies by manufactures. Specifically, a pilot of CENLEC light could be executed, to study the desired features and impacts of such a regulation on CCCs.

8. Conclusion

This study explored the practices of electronics repair within CCCs, identified barriers, enablers and opportunities through using SPT based analysis, and proposed a combination of services to support the adoption and scaling of these practices in CCCs.

This research has found that e-repair practices in CCCs are limited to great extent by constraints in the material, competence and meaning elements of the practice. Material constraints such as limited access to spare parts and poor-quality of electronics, are linked to regulatory and financial barriers. These barriers are possible through legislation that is misaligned with CE goals and an economic system that incentivizes manufacturers to discourage repair. Constraints in competences persist due to the lack of repair possibilities in CCCs, and limited access to repair knowledge via manufactures. Finally, the throwaway culture stimulates consumers to prefer new electronics over second-hand or repaired electronics, resulting in low profitability for e-repair practices. This limits CCCs budgets to invest in the materials and competencies needed for repair.

The constraints seen in the elements of the e-repair practices are caused by more systematic regulatory, economic and cultural contexts. This is also described by Svensson-Hoglund et al., (2021), who state that repair is hindered in the EU and U.S. by barriers in infrastructure & systems, business & industry and culture and markets. This implies that making e-repair possible in CCCs and similar initiatives will require significant regulatory and cultural shifts.

To make this happen, legislation should be more flexible to encourage e-repair initiatives. More regulations should be made for manufacturers to increase quality and repairability of products and inhibit design and advertisement that stimulate obsolescence. To stimulate cultural changes governments should stimulate repair infrastructure, education and campaign circular alternatives.

As the barriers prevent CCCs from repairing donated electronics, there might be a more suitable role for CCCs. They can help stimulate the cultural transition by engaging citizens in e-repair practices. Aligning with the CCCs social aims and nature, the CCC could function as a repair community, where citizens can engage and learn about repair.

During this research design guidelines (section 6.1) and a final idea (section 6.4) were developed. The repair hub plan focuses on lowering the barriers to repair for citizens by providing free access to tools and knowledge. The plan contains several services, namely a free workspace where citizens can try repair and a tools and electronics rental service for free or low prices. The CCC can also give e-repair workshops and collaborate with educational facilities to exchange resources. CCCs can also hive out repair yourself kits, which challenge customers to repair a broken second-hand electronic product and win a small price. These services are all meant to make repair more accessible for citizens and to introduce and educate citizens on e-repair competencies through community learning.

In conclusion, to transition to a CE and adopt and scale circular strategies, such as repair, systematic changes are needed including regulatory reforms, shifts in economic structures, and cultural transformations. While systemic barriers currently limit the adoption of e-repair practices in CCCs, these novel collaborations hold the potential to drive cultural change and promote e-repair practices through community engagement and education. In this way, using their social character and collaborative nature, CCCs can contribute to the systemic shifts necessary for advancing a circular economy.

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Appendices

A: Interview introduction

Introductie praatje:

Voorstellen:

Allereerst bedankt voor je deelname aan mijn onderzoek. Ik zal eerst mezelf voorstellen. Ik ben Sacha ik studeer stedelijke ontwikkeling aan de universiteit van wageningen en delft. en als afsluiting van mijn studie doe ik een onderzoek naar repareren van elektronisch afval in circulaire ambacht centra. Ik zal nog wat meer over mezelf vertellen omdat ik hetzelfde zo van jou ga verwachten. Ik ben 25 jaar oud, kom oorspronkelijk uit Breda, maar woon nu al 5 jaar in Utrecht.

Over het onderzoek:

Over het interview, wat kun je verwachten

Ik zal eerst vertellen waar mijn onderzoek over gaat, zodat jullie begrijpen waarom ik bepaalde vragen stel. Ik onderzoek namelijk de gebruiken rondom repareren van elektronisch afval. Dus hoe ziet repareren eruit? waarom doen we het? Wat is er voor nodig? enzovoort. Het doel van mijn onderzoek is om te begrijpen hoe het gebruik van repareren er uit ziet in onze levens en hoe we ervoor kunnen zorgen dat meer mensen gaan of laten repareren. Daarom stel ik vragen over jullie werk hier, hoe jullie hier terecht zijn gekomen en wat er allemaal bij komt kijken. Sommige vragen kunnen misschien een beetje simpel lijken, maar juist die alledaagse details zijn erg interessant voor mijn onderzoek. Ook zijn sommige vragen misschien wat persoonlijk, dit is om inzicht te krijgen in hoe het gebruik van repareren een onderdeel is van je leven. Ik wil je dus nogmaals herinneren dat als je een vraag liever niet beantwoord dit helemaal oke is.

- **Is alles duidelijk?**
- **Heb je nog vragen?**

Consent formulier tekenen

B: Interview topic and question lists

B1. Repair employees - topic list:

Algemeen:

- Wat is je leeftijd?
- Waar woon je? Waar ben je opgegroeid?
- Woonde je in een stad of in een dorp? En nu?
- Heb je opleiding gedaan? Welke opleiding heb je gedaan?

- Wat voor beroep heb je/ heb je gehad? Wat doe je nu? (Wat is / was je inkomen?)
- Woon je in een huur of koop huis?
- Heb je een partner?
- Heb je kinderen? Welke leeftijd hebben je kinderen?

Over werk:

- Context: hoe lang, hoe vaak, vrijwillig?
- Motivatie & betekenis
    - Hoe ben je bij het werk gekomen en wat maakt dat je blijft
    - Leuk en minder leuk aan werk
    - Specifiek circulair ambachcentrum?
- Levensstijl / persoon
    - Waarom past het werk bij jouw?
    - En bij je levenstijl?
- Werkzaamheden
    - Hoe ziet een dag op je werk er hier uit? Neem me mee, vertel me erover?

Mijn onderzoek gaat specifiek over elektrische apparaten, dus probeer bij de volgende vragen te bedenken dat het gaat over reparaties van elektronische apparaten

Elementen & dimensies:

- Reparaties
    - Hoe veel per dag
    - Wat komt veel voor
    - Welke problemen / producten kom je vaak tegen
    - Veel succesvol?
    - Met bezoekers? Samen of allleen?
- Reparatie proces
    - Wat zijn de stappen van een reparatie?
- Materiaal
    - Wat gebruik je?
    - Hoe kom je eraan?
- Vaardigheden
    - Welke vaardigheden heb je nodig?
    - Hoe kom je eraan?
    - Nog bijgeleerd?
- Werkplek
    - Wat heeft een werkplek nodig?

Barrières en mogelijkheden

- Barrières:
    - Wat maakt je werk moeilijk
        - Materiaal
            - beschikbaarheid
        - Te repareren object
            - Kwaliteit

        - Repareerbaarheid
    - Kennis/ vaardigheden
    - Bezoekers
- Mogelijkheden
- Circulair ambacht centrum

Zooming out:

- Voorbereiding/ afhandelen
- Gebruiken naast repareren
    - Wat als reparatie niet lukt? Wat gebeurt er dan?
    - Andere manieren van levensduur verlenging?

Outro:

- Wat vond je van het interview? Zijn er nog dingen die je kwijt wilt
- Zijn er vragen die ik niet heb gesteld die je denkt dat ik wel zou moeten stellen?
- Heeft u eventueel interesse om mee te doen aan de volgende stap van dit onderzoek?

Extra:

- Bezoekers
    - Hoe vaak met bezoekers
    - Wat voor soort mensen
- Duurzaamheid
    - Heeft het een rol in je werk?
    - Maakt het je werk meer waard
- Educatie
    - Leer je iets aan anderen?

B2. Repair employees - question list

Algemeen:

- Wat is je leeftijd?
- Waar woon je? Waar ben je opgegroeid?
- Woonde je in een stad of in een dorp? En nu?
- Heb je opleiding gedaan? Welke opleiding heb je gedaan?
- Wat voor beroep heb je/ heb je gehad? Wat doe je nu? (Wat is / was je inkomen?)
- Woon je in een huur of koop huis?
- Heb je een partner?
- Heb je kinderen? Welke leeftijd hebben je kinderen?

Algemeen over het werk:

Context:

- Hoe lang doe je dit werk nu al? (context)
- Hoe veel dagen werk je hier in de week?
- Hoe vaak krijg je te maken met klanten of bezoekers tijdens je werk?

Motivatie & betekenis:

- Hoe ben je hier (bij dit initiatief) komen te werken? (recruitement)
- Waarom ben je hier komen werken? (recruitement)
- Wat motiveert jouw om dit werk te doen? (motivatie)
- Waarom blijf je hier werken? (recruitement)
- Wat vind je leuk aan het werk?
- Wat vind je minder leuk aan het werk?
- Waarom doe je dit werk? Vind je het werk belangrijk en waarom? (meaning)
-

Levenstijl/ persoon:

- Waarom past dit werk bij jou?
- En past het in je levensstijl en waarom?
- Wil je dit werk nog lang blijven doen? Wat zou een reden voor jou zijn om te stoppen?

Werkzaamheden

- Hoe ziet een dag op werk er uit? Welke taken verricht je? Neem me mee in een van je werkdagen van afgelopen week?
- Repareer je alleen elektronische goederen?

Bij de volgende vragen wil ik graag antwoorden die te maken hebben met de reparaties van elektronische goederen:

Zooming in: elementen & dimensies:

Reparaties:

- Hoeveel reparaties doe je meestal op een dag?
- Is dit vaak alleen of met bezoekers erbij?
- Welke reparaties komen vaak voor?
- Hoeveel van de reparaties zijn succesvol? Heeft dit effect op je werk?

Reparatie proces:

- Neem me mee in het proces van een reparatie. Welke stappen voer je globaal uit?
- Welke acties voer je vaak uit tijdens deze stappen?
-

Materiaal:

- Welke materialen gebruik je vaak tijdens reparaties?
- Hoe kom je aan deze materialen?
- Welk gereedschap heb je nodig tijdens reparaties?
- Hoe kom je aan dit gereedschap?
-

Vaardigheden en kennis:

- Welke vaardigheden heb jij die maken dat jij dit reparatie werk kan doen?
- Waar heb je die vaardigheden geleerd? (Waren ze er al, waar komen ze vandaan?)
- Welke kennis heb jij die er voor zorgt dat jij dit werk kan doen?
- Waar heb je die kennis op gedaan? (Waren ze er al, waar komen ze vandaan?)
- Wat heb je nog bij geleerd sinds je hier bent gaan werken?

- Hoe schat je in of iets te repareren is?
- Hoe schat je in of het de reparatie ook waard is?
- Hoe weet je hoe je iets moet repareren?
- Hoe weet je hoe je iets uit elkaar kan halen?
-

Werkplek:

- Heb je specifieke eisen voor een werkplek waar je reparaties doet?
- Zijn er bepaalde tijden in de dag of week waarop je veel reparties doet?

Barriers & enablers:

Barrières:

- Wat maakt je werk soms moeilijk? Loop je weleens tegen dingen aan?
- Welke technische problemen kom je vaak tegen tijdens reparaties?

Te reparen product:

- Hoe beïnvloedt de kwaliteit van de ontvangen elektronische afvalproducten je werk?
- Zijn er producten die je vaak tegenkomt die moeilijk te repareren zijn vanwege hun ontwerp of staat?
- Wat maakt deze producten of merken uitdagender?
- Zijn er externe factoren die je werk moeilijker maken? (Bijvoorbeeld regelgeving, leveranciersproblemen, of economische omstandigheden.)

Materiaal:

  - Heb je altijd de nodige materialen beschikbaar? Of kun je eraan komen?
  - Hoe beïnvloeden de beschikbare middelen (gereedschappen, onderdelen) je vermogen om reparaties uit te voeren? (Zijn er specifieke middelen die je vaak mist?)

Bezoekers:

  - Ervaar je wel eens dat klanten of bezoekers onrealistische verwachtingen hebben over reparaties? Hoe ga je daarmee om?

Mogelijkheden:

- Wat zijn dingen die het juist makkelijk voor je maken om je werk uit te voeren?

Circulair ambachtcentrum:

- Wat zijn de voordelen van werken in een circulair ambachtcentra?

Extra:

- Wat voor vragen of verzoeken krijg je meestal van bezoekers?
- Wat vind je opvallend aan je interacties met bezoekers?
- Hoe zie je de rol van jouw werk in het bevorderen van duurzaamheid?
- Wat betekent duurzaamheid voor jou in de context van je werk?
- Werk je ook aan het opleiden van anderen in reparatievaardigheden? Zo ja, hoe?
- Zijn er momenten waarop je anderen hebt geholpen hun vaardigheden te verbeteren? Kun je daar een voorbeeld van geven?
- Wat is jouw rol is het totale reparatie proces?
- Zijn er andere mensen deel van dit proces en wat is hun rol?

Zooming out:

- Als je begint met een reparatie, zijn er dan dingen die je eerst voorbereid? / Zijn er dingen die je doet voordat je begint aan een reparatie?
- En als je kaar bent met een reparatie, zijn er dan nog acties die je onderneemt?
- Als je een product niet kan repareren wat doe je er dan vervolgens mee?
- Zijn er andere manieren naast repareren waarop je probeert de levensduur van een product te verlengen?

Outro:

- Wat vond je van het interview? Zijn er nog dingen die je kwijt wilt
- Zijn er vragen die ik niet heb gesteld die je denkt dat ik wel zou moeten stellen?
- Heeft u eventueel interesse om mee te doen aan de volgende stap van dit onderzoek?

B3. Managers – topic list

Algemeen:

- Waar woon je? Waar ben je opgegroeid?
- Woonde je in een stad of in een dorp? En nu?
- Heb je opleiding gedaan? Welke opleiding heb je gedaan?
- Wat voor beroep heb je/ heb je gehad? Wat doe je nu? (Wat is / was je inkomen?)
- Woon je in een huur of koop huis?

Zooming in:

- Circulair ambacht centrum:
    - Hoe zou je definiëren
    - Impact
    - Wat zijn de doelen/visie
    - Wie zijn de Partners
- Bezoekers
    - Doen jullie veel met bezoekers?
    - Wat voor bezoeker zie je veel
    - Wat voor soort bezoekers
- E-repair
    - Welke rol
    - Hoe gaan jullie te werk?
    - Wat zijn de stromingen
- Materialen
    - Welke materialen en gereedschap
    - Hoe kom je eraan
- Vaardigheden
    - Welke vaardigheden & kennis nodig
    - Hoe kom je aan mensen met de nodige vaardigheden
    - Zijn er manieren op de kennis aan te leren?
- Zooming out / andere gebruiken
    - Voorbereidingen voor reparatie werk
        - Is iets het waard om te repareren?
    - Afhandelingen
        - Garantie?
        - Werkt het?
- Betekenis /meaning
    - Waarom is reparatie belangrijk
    - Wat is het belang van circulair ambacht centrum
    - Waarom laten bezoekers reparaties doen?
- Dimensies
    - Wat zijn eisen aan werkplaats
    - Wanneer word er gerepareerd / is er behoefte aan
    - Invloed van Culture opvattingen en sociale normen op repareren
- Barrières en mogelijkheden
    - Wat zijn de grootste barrieres voor e-repair in CA?
        - Te repareren producten

        - Materialen
        - Externe invloeden (vergunningen, wetgeving)
        - financieel
    - En wat zijn de mogelijkheden?
- Werknemers / vrijwilligers
    - Zijn er genoeg? Met de juiste kennis?
    - Wat voor mensen?
- Bezoekers
    - Weten bezoekers het CA te vinden?
    - Wat voor mensen?
    - Manieren om andere mensen te bereiken?
- Outro
    - Wat vond je van het interview? Heb je nog iets wat je zelf graag kwijt wilt?
    - Zijn er vragen die ik niet heb gesteld die je denkt dat ik wel zou moeten stellen?
    - Heeft u eventueel interesse om mee te doen aan de volgende stap van dit onderzoek?

Vraag;

- **Geef een voorbeeld?**
- **Kun je dat omschrijven?**
- **Kun je mee daarin meenemen?**
- **Waarom?**
- **Hoe?**
- **Wat voor gevoel?**
- **Waar komt het vandaan?**

B4. Managers – question list

Algemeen:

- Wat is je leeftijd?
- Waar woon je? Waar ben je opgegroeid?
- Woonde je in een stad of in een dorp? En nu?
- Heb je opleiding gedaan? Welke opleiding heb je gedaan?
- Wat voor beroep heb je/ heb je gehad? Wat doe je nu? (Wat is / was je inkomen?)
- Woon je in een huur of koophuis?
- Heb je een partner?
- Heb je kinderen? Welke leeftijd hebben je kinderen?

Zooming in:

- Hoe definieer jij een circulair ambachtscentra?
- Wat zijn de doelen van circulair ambachtscentrum ...?
- Wat is in jouw ogen de potentie van circulaire ambachtscentra?
- Welke partners zijn betrokken bij circulaire ambachtscentra ... ?
- Wat is jullie visie van een circulaire ambachtscentra?
- Wat is de rol van elektronisch 'afval' binnen dit circulaire ambachtscentra?
- Wat zijn de stromingen kwa elektrisch afval in dit circulaire ambachtscentra?

Materialen:

- Welke materialen zijn nodig op e-repair uit te voeren?
- Zijn deze materialen beschikbaar? Hoe komen jullie aan deze materialen komen?
- Is er bepaald gereedschap nodig? Hoe kom je aan dit gereedschap

Kennis:

- Zijn er bepaalde vaardigheden en kennis nodig voor het uitvoeren van de reparaties?
- Hoe komen jullie aan werknemers/ vrijwilligers met deze kennis? (Hoe kom je überhaupt aan vrijwilligers)
- Zijn er manieren om deze kennis op te doen? En te leren aan nieuwe vrijwillgers?

Meaning:

- Waarom is het repareren van elektronische producten belangrijk?
- Wat hebben jullie gemerkt dat reden zijn voor bezoekers om apparaten te laten repareren?
- Wat voor soort bezoekers trekken jullie aan? Is dit een diverse of juist niet diverse groep?
- Wat wordt er gedaan om meer mensen te betrekken bij het circulaire ambacht centra?

Dimensions:

- Wat zijn vereisten en benodigdheden voor een locatie om reparaties aan elektronische apparaten uit te voeren?
- Wat zijn de voordelen van een circulair ambacht centra voor het repareren van elektronische apparaten?
- Wanneer worden reparaties meestal uitgevoerd?
- Hoe vaak worden reparaties uitgevoerd?
- In hoeverre beïnvloeden culturele opvattingen over consumptie en duurzaamheid de vraag naar e-reparaties binnen de gemeenschap?
- Zijn er sociale normen of gemeenschapsdruk die van invloed zijn op het gedrag van mensen ten opzichte van het laten repareren van elektronische apparaten?

Barriers & enablers:

- Wat zijn de grootste barriers voor e-repair in dit circulaire ambachtscentra?
- Wat zijn de grootste mogelijkheden voor e-repair binnen dit circulaire ambachtscentra?

Werknemers:

- Welke barriers ondervinden de reparateurs tijdens hun werken?
- Wat doe jij als manager om dit te verhelpen?
- Welke specifieke vaardigheden en kwalificaties worden gezocht bij werknemers die betrokken zijn bij de reparaties van elektronische apparaten?
- Zijn er bepaalde arbeidsomstandigheden of ondersteunende structuren die belangrijk zijn om het personeel gemotiveerd en efficiënt te houden?

Bezoekers:

- Word er hier samen met bezoeker gerepareerd? Hoe gaat dat? Word ze dan dingen geleerd?
- Word er nagedacht over mogelijkheden om bezoekers te betrekken bij e-repair in dit circulaire ambachtcentra?
- Welke segmenten van de samenleving zijn het meest geneigd om gebruik te maken van de reparatiediensten van het circulair ambacht centrum?
- Zijn er specifieke strategieën ontwikkeld om verschillende groepen burgers actief te betrekken bij het reparatieproces?
- Wat vinden bezoeker over het algemeen fijn aan het circulaire ambacht centra? En wat zou er in hun ogen ander moeten?
- Wat zou repareren bij een circulair ambacht centra toegankelijker maken voor bezoekers?

Zooming out:

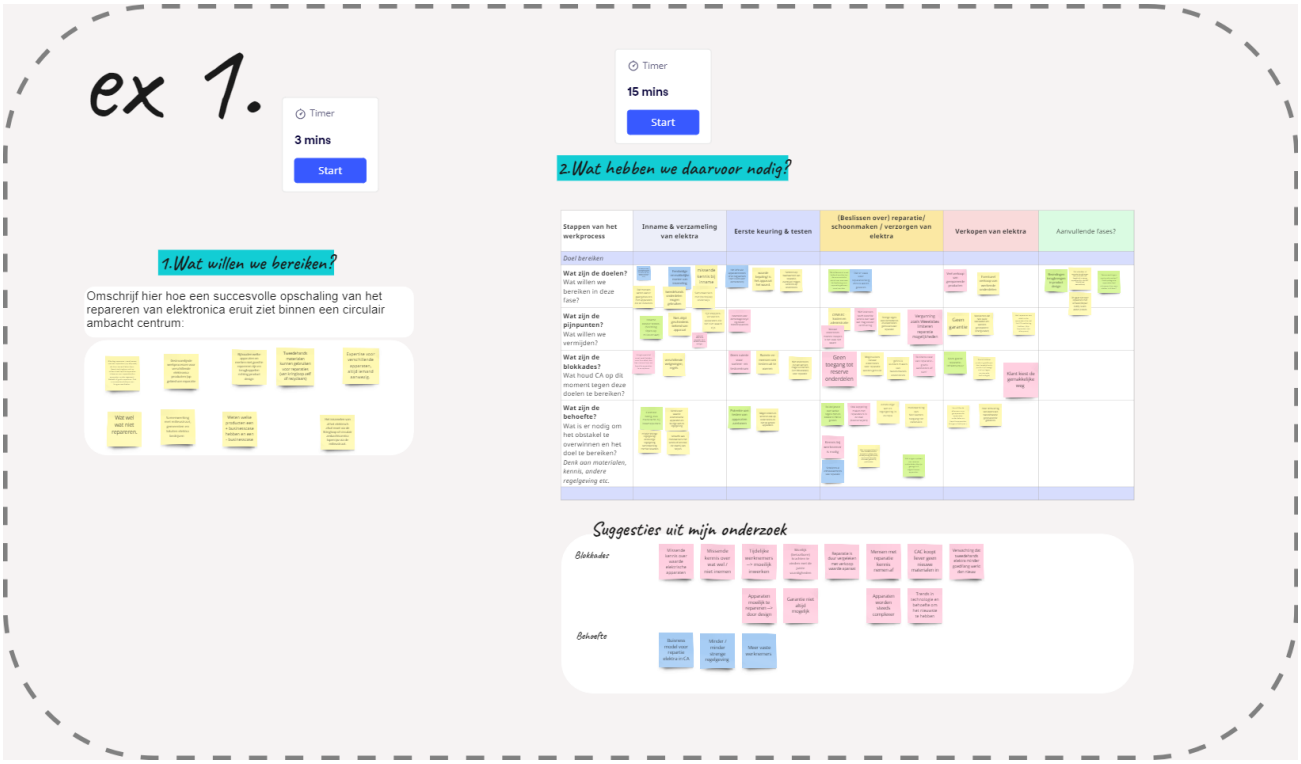
- Moeten repraties van elektronische apparaten voorbereid worden? Wat komt hier bij kijken?
- Moet er na het repapreren van elektronisch aparaten nog iet gebeuren? Wat komt hierbij kijken?
- Zijn er culturele en sociale invloenden op de vraag naar e-repair?
- Wordt er voorafgaand aan reparaties een diagnose gesteld van het probleem? Zo ja, hoe wordt dit proces uitgevoerd?
- Zijn er follow-up procedures na reparaties om te controleren of het gerepareerde apparaat goed functioneert en tevredenheid te garanderen?

Outro:

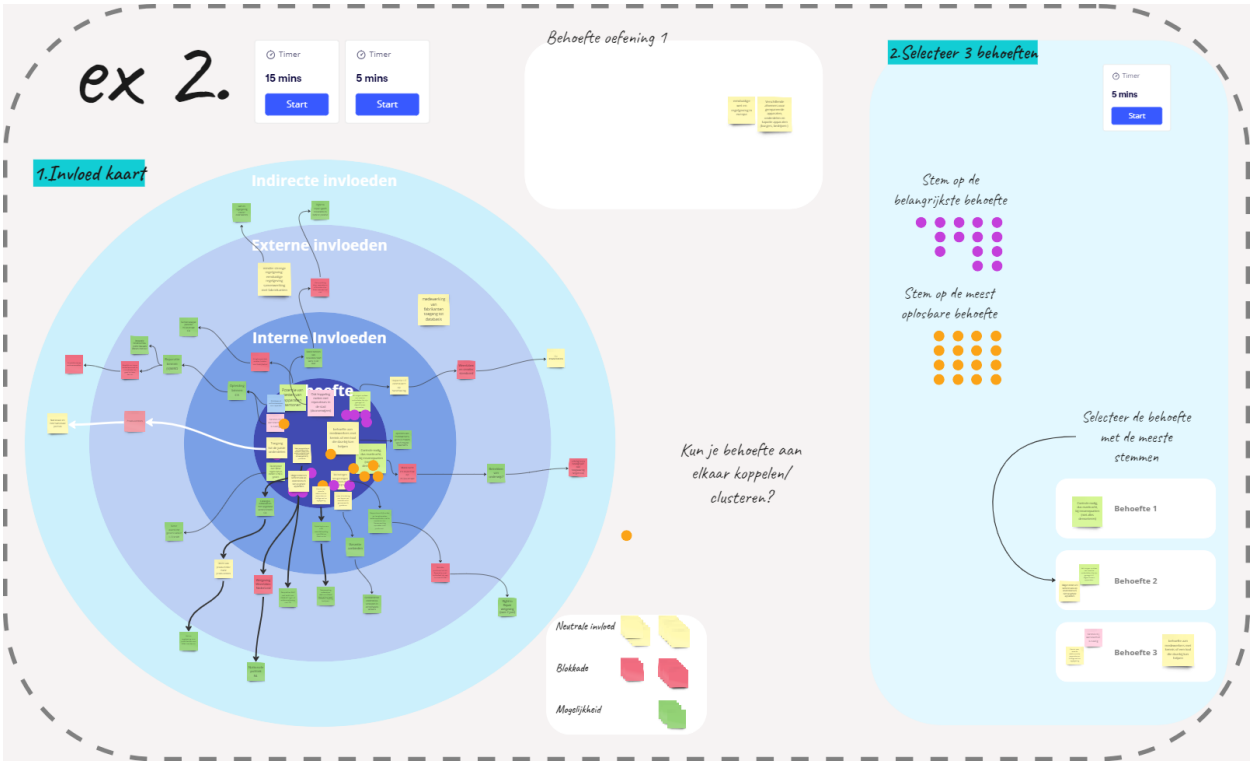
- Wat vond je van het interview? Heb je nog iets wat je zelf graag kwijt wilt?
- Zijn er vragen die ik niet heb gesteld die je denkt dat ik wel zou moeten stellen?
- Heeft u eventueel interesse om mee te doen aan de volgende stap van dit onderzoek?

C: Co-creation exercises and answers

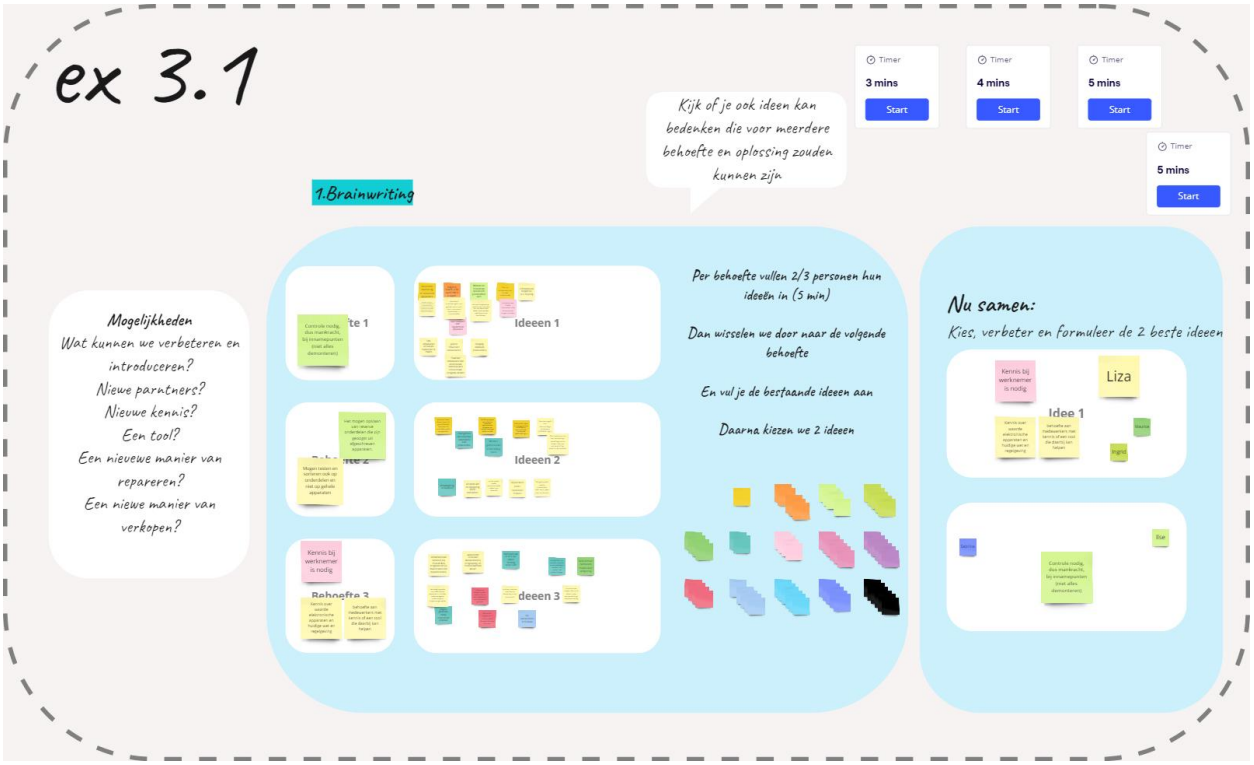
C1. Exercise 1



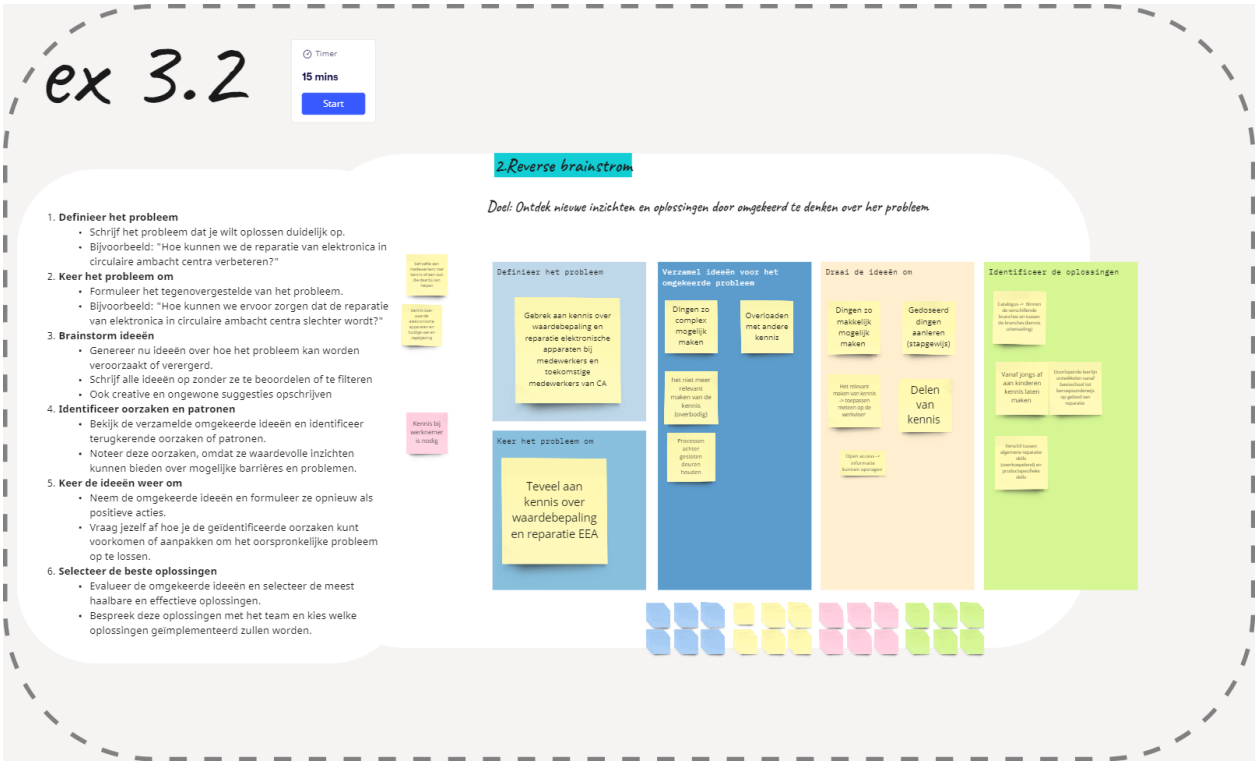
C2. Exercise 2



C3. Exercise 3.1



C4. Exercise 3.2



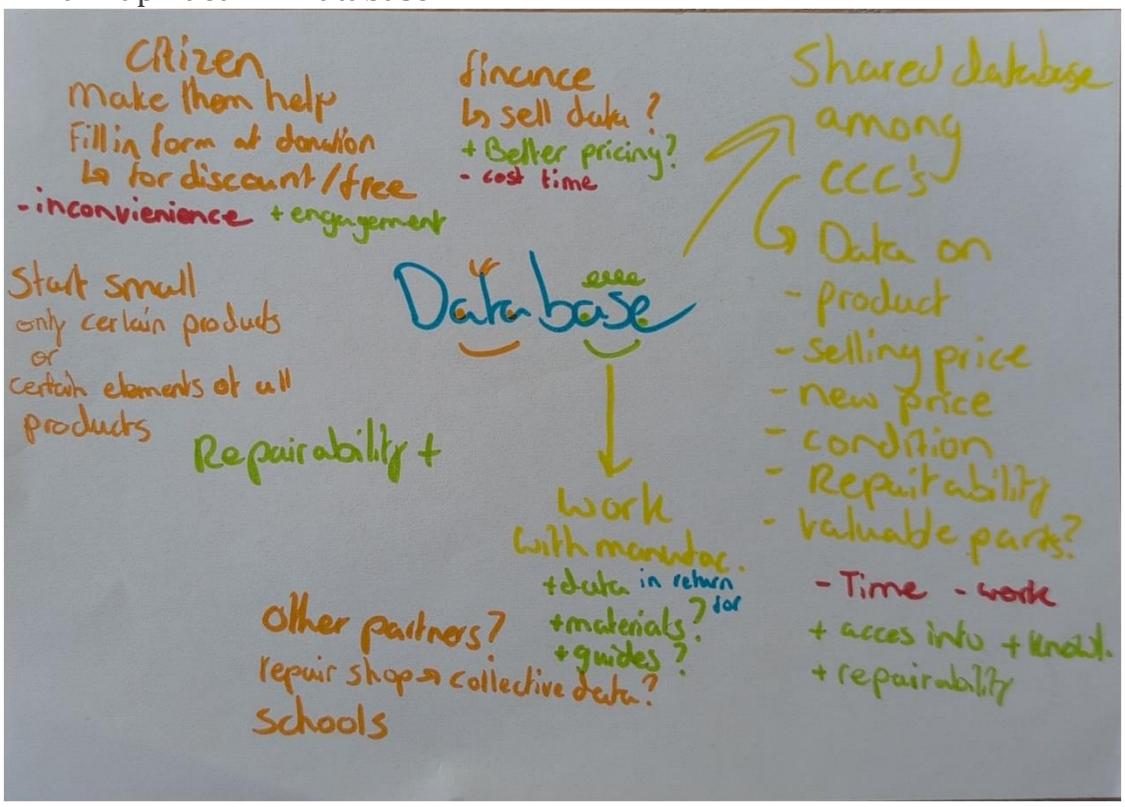
D: Survey on co-creation

Naam & bedrijf:	CCC Apeldoorn	Rijkswaterstaat	BKN	CCC Zwolle
Hoe waardevol vond je de co-creatie sessie in het algemeen?	4	4	4	4
Wat was het meest waardevolle aspect van de sessie voor jou?	Sparren met anderen over hetzelfde probleem, waar lopen we tegen aan, samen kijken naar oplossingen	Om met verschillende partijen zoveel mogelijk op het gebied van reparatie van apparaten in kaart te brengen	Verschillende visies en meningen horen over het CA	Ervaringen van anderen horen.
Vond je de sessie nuttig voor het begrijpen van de uitdagingen en kansen rondom hergebruik van elektronica?	4	4	4	4
In hoeverre denk je dat de sessie heeft bijgedragen aan het vinden van oplossingen voor het verbeteren van hergebruik en reparatie van elektronica in CAC's?	4	3	3	4
Welk idee of voorstel uit de sessie vond je het meest veelbelovend?	Pilot WEEELABEX light certificering	Het meer testen van apparaten i.p.v. meteen demonteren, lijkt makkelijk op te lossen	Het stapsgewijs aanleveren van skills om te repareren en het delen van kennis over de reparatie van EAAE	Meest laagdrempelig, is het inzamelen van producten die het wél doen. Ondertussen werken aan de condities om reparatie mogelijk te maken (light-certificering, BTW-verlaging, scholing etc.).
Heb je het gevoel dat de sessie je heeft geholpen om beter/meer samen te werken met andere belanghebbenden?	3	3	4	3

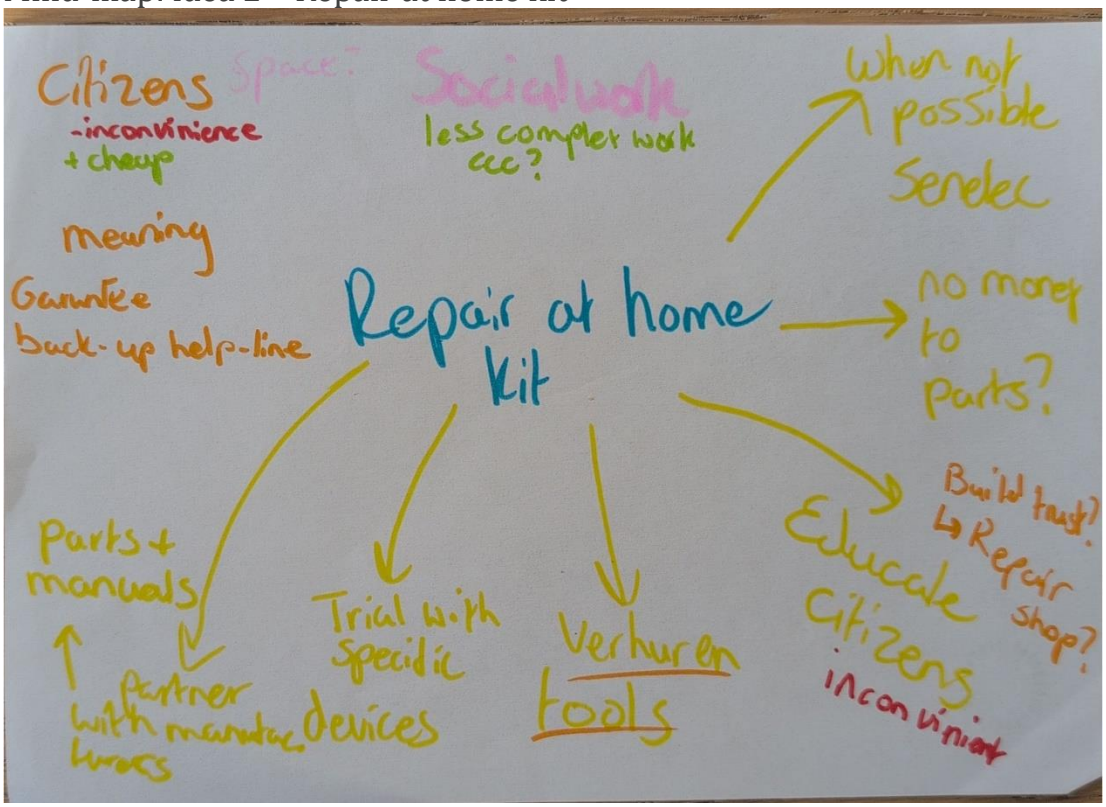
Wat vond je het meest geslaagd aan de sessie?	Duidelijke probleemanalyse	De voorbereiding zat goed in elkaar, het zag er heel netjes uit en werkte goed zo. En ik denk dat het onderwerp heel relevant is omdat veel CA tegen de reparatietak aanlopen en daar niet verder mee komen.	Het gezamenlijk brainstormen over oplossingen	Goed georganiseerd. Veel voorbereid waardoor het een gestructureerd gesprek was. Interessante manier om juist te denken hoe je het tegenovergestelde kunt bereiken, en dan terugredeneren. Dit heb ik nog niet eerder gedaan, leuk!
Wat had beter gekund tijdens de sessie?	nvt	Ik vond soms dat het concept van een Repair Café moeilijk in het format past, terwijl veel CA daar wel mee samenwerken (dat apparaten dus nog een eigenaar hebben)	Eventueel stimuleren van een follow up van de oplossingen, stimuleren van het maken van een vervolg afspraak (wie pakt wat op)?	Het bewegen richting een concreet idee binnen die tijdspanne is lastig.
Heb je nog aanvullende opmerkingen of suggesties?	nvt	Lastig is dat het grootste knelpunt (de certificering) iets is waar een traject voor loopt maar waar we verder niet echt invloed op kunnen hebben. CENELEC is trouwens de nieuwe naam van WEEELABEX (het is dus dezelfde certificering).	Het was heel fijn hoe je het proces begeleide en ons steeds meenam in de volgende stap. Ik vond het ook fijn om zo stapsgewijs de problemen in kaart te brengen, te prioriteren en te brainstormen. Dank voor het organiseren!	Succes verder!

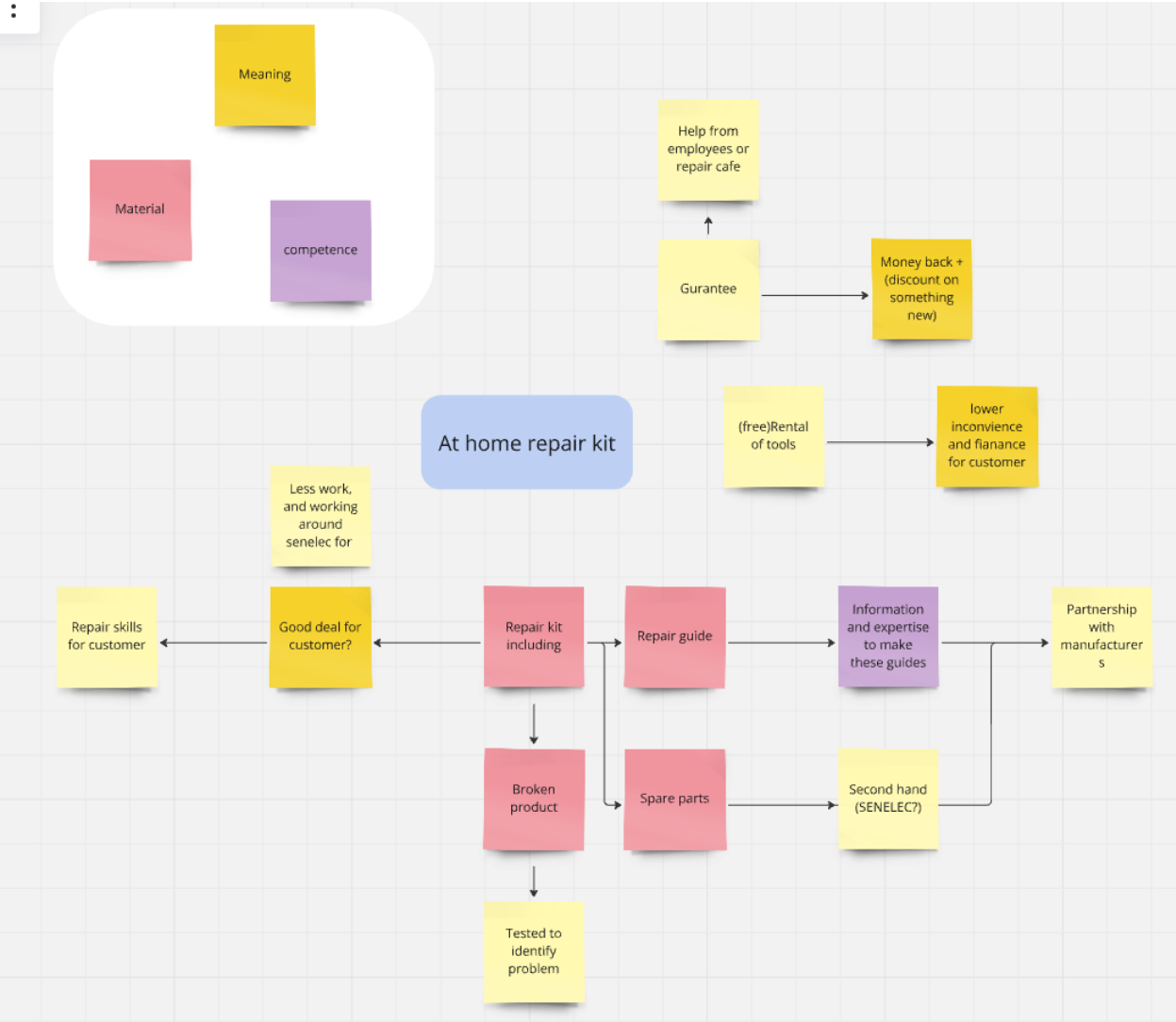
E: Design methods

Mind-map: idea 1 – Database

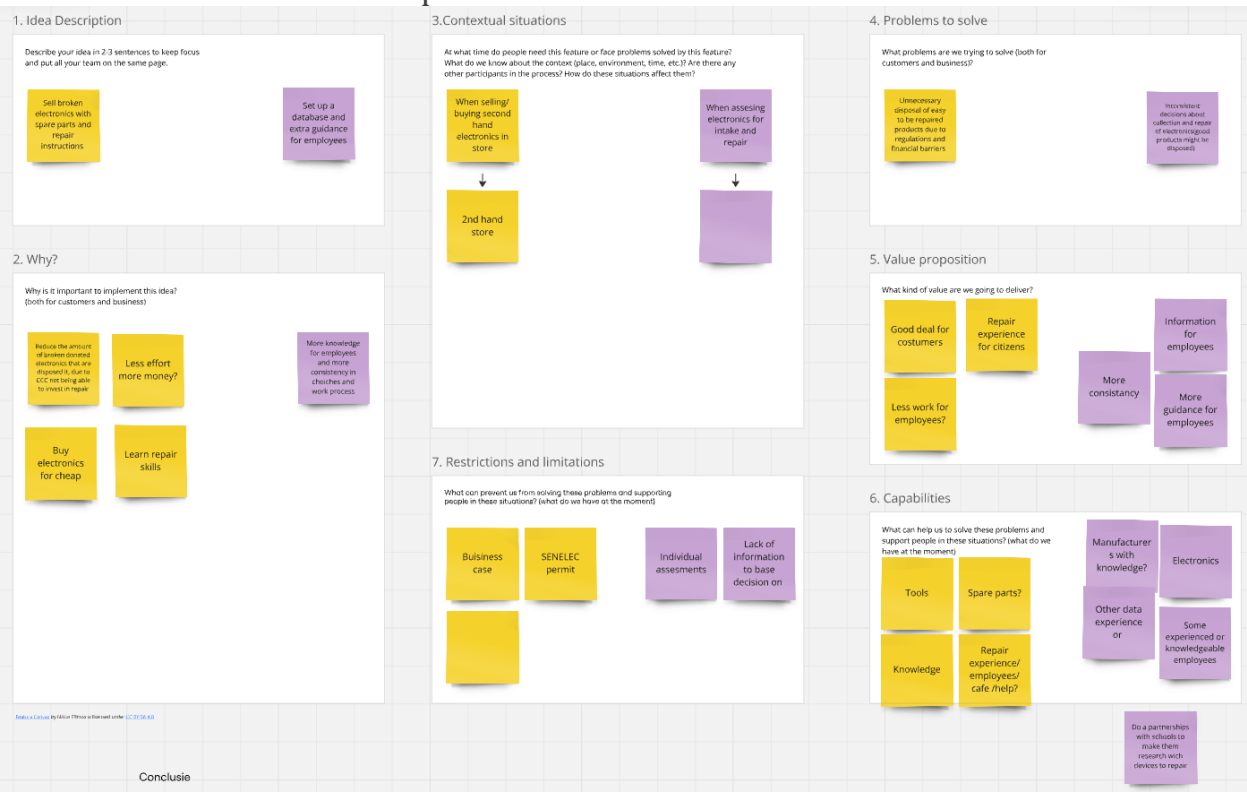


Mind-map: idea 2 – Repair at home kit



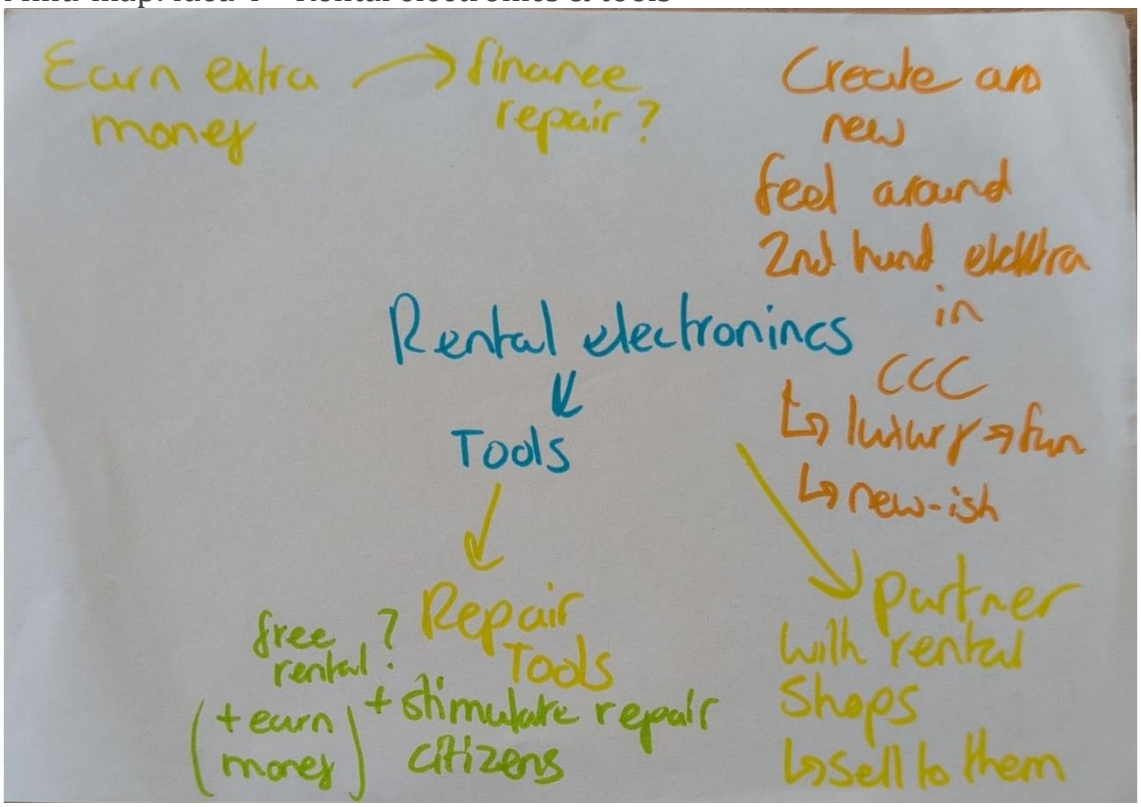

Meaning
Material
competence
Help from employees or repair cafe
Gurantee
Money back + (discount on something new)
At home repair kit
(free)Rental of tools
lower inconvience and flanance for customer
Less work, and working around senelec for
Repair skills for customer
Good deal for customer?
Repair kit including
Repair guide
Information and expertise to make these guides
Partnership with manufacturers
Broken product
Spare parts
Second hand (SENELEC?)
Tested to identify problem

Business-canvas: idea 2 – Repair at home kit

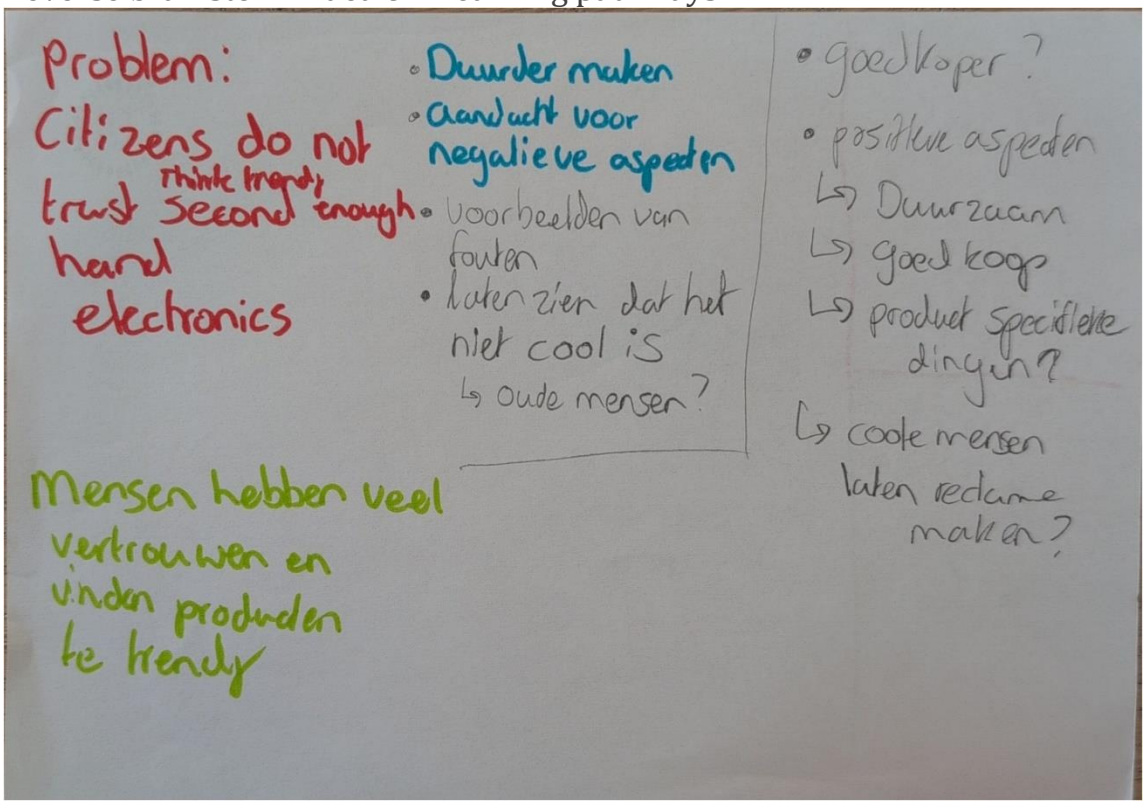


Mind-map: idea 3 – altering collection points

Mind-map: idea 4 – Rental electronics & tools



Reverse brainstorm: idea 6 – Learning pathways



Mind-map: idea 7 – Learning pathways