



The Role of Independent Repair in a Circular and Regenerative Economy

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Abstract

The focus on the transition to a circular economy has contributed to a growing research interest in repair. This paper investigates the role of independent repair, which consists of individuals, organisations, or businesses engaged in the repair of products without formal authorisation of the brand owners of these products. Repair—and independent repair in particular—is critical in achieving a paradigm shift that is anchored in regenerative sustainability. Especially in the electrical and electronics equipment sector, independent repair is challenged by difficult or expensive access to spare parts and repair information. This paper focuses on the independent electronics repair sector in Oslo. We implemented twenty-five semi-structured interviews with repairers working in commercial independent repair shops, focusing on challenges and opportunities in independent repair. They repaired a wide variety of products: mobile phones, desktop computers, laptops, tablets, cameras, printers, e-mobility batteries, remote-controlled cars, drones, and white goods. The thematic analysis of the interviews revealed three main findings. The independent repair sector employs different business models and strategies to tackle the challenges related to accessing affordable and quality spare parts. Secondly, independent repair fills the gap between expensive authorised repair, mostly covered by warranty or insurance, and discarding a broken product. Thirdly, independent repair has contributed to a circular spare part economy, both locally and on a global level. In the discussion, we address how repair can be understood as a regenerative practice, as well as how policy and regulation of repair, both on an EU and national level, supports or undermines independent repair.

Keywords Business models · Electronics · Policy · Regeneration · Regulation · Spare parts

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Introduction

From a Circular Economy to a Circular and Regenerative Economy

In our modern world of interconnected flows across borders and rising inequalities, the circular transition must adapt, looking beyond resource use and efficiency alone. For a balanced outcome, it must examine its links with wider environmental issues and social equity. [1]

The notion of the circular economy (CE) is a contested concept and has a multitude of definitions [2]. Advancements in the circularity of products and materials are slow. According to the Circularity Gap Reporting Initiative, only 8.6% of the world is circular: “This means that between the ‘COP25 in Paris’, 2015, where the Paris Agreement was formed and COP26 in Glasgow, 2021, 70% more virgin materials were extracted than what the Earth can safely replenish.” [1, p. 8]. The same report states that 70% of four relevant greenhouse gas emissions (CO₂, methane, nitrous oxide, and fluorinated gases) are related to material handling and use. More efficiency in materials recovery is therefore of utmost importance.

The focus of the circular transition on resource efficiency carries several risks [3]. Zink and Geyer introduced the concept of circular economy rebound [4], arguing that “circular economy activities, which have lower per-unit-production impacts, also cause increased levels of production, reducing their benefit”. Another risk is a weak relation between circular economy and sustainable development [5]. According to Geissdorfer et al., only 12% of the circular economy definitions contain the term sustainable development [6]. Current circular economy reporting does not distinguish between sustainable and unsustainable circularity of materials, nor does it address the importance of extending the lifetime of products and materials [7, 8]. Barrie et al. [9] discuss the so-called circular divide as a result of circular resource control by industrialised countries that extract resources from less-industrialised countries. With increased domestic circularity, the first will be able to make important gains from recirculating materials, whereas the second will lose the economic benefits from extracting resources and exporting them.

This paper focuses on a less prominent but indeed crucial characteristic of the circular economy, namely regeneration. In a circular economy, regeneration is sometimes understood as circular natural flows [10]. “[A] product (e.g., a printer or an oven) is regenerated when new parts substitute for old or defective ones as in repair, refurbishing, remanufacturing, and upgrading” [11]. The Ellen McArthur Foundation mentions regeneration as the third principle of the circular economy [10]. Regeneration is described as contributing to nature or giving space to nature.

In this paper, we understand regeneration as a paradigm shift that goes beyond the circular economy. Regeneration is understood as a holistic and living systems perspective, in which the focus is on the evolution of the whole system of which we humans are a part [12, 13]. This shift means moving from sustainability and efficiency to sufficiency and regeneration or regenerative sustainability [13], and from a human-centred perspective to a living system perspective. Kate Raworth’s *Doughnut Economics* [14] presents such a holistic systems perspective and is based on the notion that an economy needs to be regenerative by design. Such an economy is not only circular, but also distributive, and generous: “giving back to the living systems of which we are a part” (p. 185). In a

circular and regenerative economy, the lifespan of products is expanded; local innovation and business models flourish; collaboration rather than competition is promoted; the extraction of raw materials is halted; and, most importantly, species thrive together [7, 15].

Repair

The focus on the need to transition to a circular economy, in particular in academia and by policymakers in Europe, has contributed to a growing research interest in repair, e.g., [16–19]. Repair plays a central role in the circularity of material flows by extending the lifespan of products. In an economy that is regenerative by design, repair is better understood as a sociomaterial practice [20, 21], reconfiguring the relationship between people and things. As such, repair becomes central in the transition to a regenerative circular system. It sustains and extends what is already made (materials, products), and helps mitigate the damage already done to the planet [22–24] through its capacity to restore, reconfigure, and remediate.

This paper investigates the role of independent repair, which consists of citizens and non-profit organisations (repair cafés, restart parties, etc.) as well as (usually small) businesses engaging in the repair of products without formal authorisation by the brand owners of these products. Independent repair can include original and non-original spare parts and tools. In the next section, we present some background literature on repair and its regulation that has provided context and direction to this study. In the “Research Approach” section, we present our research approach, which combined semi-structured interviews and thematic analysis. In the “Results” section, we present the outcomes of our study, and in the “Discussion” section, we discuss repair as a regenerative practice and if and how current regulation can support independent repair. This is followed by concluding remarks in the final section.

Background

Understanding Repair

In their oft-cited paper, Graham and Thrift [25] describe maintenance and repair as that what keeps modern societies going. They foreground the politics of repair: what gets repaired and what is not and what repair work is visible and what repair work is made invisible. The authors also discuss the environmental politics of repair. They highlight the fact that products are increasingly designed in such a way that maintenance and repair are made difficult or outright impossible, and, secondly, that products have accelerated production and consumption cycles. Repair is thus more than a set of tools and techniques to extend the lifespan of a product or system, it is also a reflection of market structures and economic strategies.

The focus on repair has generated research on different aspects of repair. Cultural and political understandings of when something is broken, and why, has become an important line of inquiry in repair research, e.g., [26–30]. Gender and repair are another focus [31–35]. The understanding of repair as a sociomaterial practice is especially found in community repair research [20, 21, 36, 37]. There is also a growing body of research on consumer practices and repair, e.g., [17, 38–41].

	<u>Past-oriented</u> (purpose similar)	<u>Future-oriented</u> (purpose different)
<u>Sustaining</u> (materials the same)	Reconstruction/ Restoration	Reconciliation
<u>Transforming</u> (material different)	Remediation	Reconfiguration

Fig. 1 A categorisation of forms of repair [39]

In a literature review of recent repair research, McLaren et al. [42] identify four categories of repair. Repair as reconstruction/restoration refers to repair that focuses on returning its subject to its original functioning and purpose, using traditional materials to achieve an authentic appearance. Repair as remediation retains a focus on the original purpose, but relaxes conditions on material and appearance, potentially thereby improving functioning. Repair as reconciliation on the other hand deploys original materials or components to a new end, focused on repairing the social relationships involved. It is future-oriented. Repair as reconfiguration might involve both new materials and novel purposes, and thus has the greatest potential to be both transforming and future-oriented (see Fig. 1).

There is not a large body of research on the particular challenges and opportunities of commercial independent repair, but this is changing due to a greater focus on the right to repair [43–46]. Many studies focus on mobile phone repair. This is probably the result of the fact that the mobile phone is a widely sold electronic device with a high economic value, combined with the high visibility of mobile phone shops [18, 47, 48]. There are also several studies of informal independent repair in Africa and Asia, e.g., [49–53].

Designed for Repair?

The reparability of a product is also dependent on its design. Some electronic products are designed with reparability as a central design characteristic, such as the Fairphone smartphone¹ or the Framework laptop.² Other products are designed in such a way that they effectively hinder independent repair, e.g., [54–56]. Some manufacturers use highly specialised screws, glue, soldering, or welding, preventing the opening of a product or the removal of broken parts. iFixit, the online platform providing free repair manuals for a wide variety of products, mentions Apple’s Macbook Pro laptops [57] and Samsung’s Galaxy series of mobile phones [58] as particularly difficult to repair because of glued components. Other barriers to repair are the lack of availability of spare parts, repair manuals, and

¹ <https://www.fairphone.com/en/impact/design-2/> (accessed 30 March, 2023).

² <https://frame.work/about> (accessed 30 March, 2023).

diagnostic tools. Parts pairing [59–61] has emerged as a technique used by manufacturers to directly prevent unauthorised repair. In parts pairing, a part gets a unique serial number which is paired to the device through software. This prevents the repair of products with used, non-original, or refurbished parts, even original parts from a similar device. Only an authorised repairer can re-establish the link between the new part and the device. According to iFixit [60], parts pairing is found in mobile phones, washing machines, game controls, televisions, cars, etc.

Regulating Repair

Repair has not been high on the policymakers' and legislators' agendas for very long. In the linear economy, repair is largely irrelevant. Business models and strategies are based on repetitive sales of cheap, short-lived products. Repair is often more expensive than throwing away and buying new. Outside of legal consumer guarantee periods, most consumers are unlikely to pursue repair. Moving to a circular economy that aims at reducing production and consumption and extending product lifetime requires repair to become a core business strategy, and law has a strong role to play. Several barriers currently limit the development of repair, and thus of more repair-based business models. These barriers can be said to fall into three main categories: access, competitiveness (including affordability and convenience), and mainstreaming (such as consumer attitudes and preferences) [44]. Some barriers are found in the law (for example, several IP laws prevent some repair activities), but the law can also be a tool to remove barriers.

In the last few years, a right-to-repair (R2R) movement has emerged in civil society, which has been pushing for the development of policies and regulations in favour of repair in the European Union (EU) and at a national level. Such policies generally aim at allowing citizens (and independent repairers working for them) to repair their products and ensuring access to necessary spare parts, repair manuals, and tools. These policies target different stages of a product's life cycle, in particular design, manufacturing (in particular of spare parts), and consumer rights.

At the EU level, the first step has been to include repair in product design. In 2019 and 2021, the Commission adopted ecodesign requirements (in line with the delegation of powers in the Ecodesign Directive (2009/125/EC)) for specific product groups, including refrigerators, washing machines, and dishwashers [62]. These requirements mandated producers to provide spare parts for a specified period: essential spare parts should be available after purchase for a period of 7 to 10 years depending on the product. The manufacturer should also ensure the delivery of the spare parts within 15 working days. Moreover, ecodesign requirements also specify that spare parts should be replaced with the use of commonly available tools and without causing permanent damage to the appliance but say nothing about updating software throughout the lifetime of a product (i.e., causing failure that cannot be remedied through repair).

It should be mentioned that the regulations distinguish between professional and non-professional repairers (or end-users). Non-professional repairers are typically consumers and common citizens engaged in non-profit and educational initiatives such as repair cafés. However, the regulations do not explicitly spell out what the distinction is between professional and non-professional repairers. Thus, independent repairers may risk falling into a grey area and potentially have to prove that they indeed fall into the first category. In Norway, a governmental regulation established the minimum requirements for qualifications of electrical professionals [63]. The regulation does not

however cover communication devices such as mobile phones. The distinction is important because professional and non-professional repairers are not guaranteed access to the same range of information and spare parts. For example, non-professional repairers are guaranteed access to spare shelves for a refrigerator, but not to spare parts for the electrical components of a refrigerator, which are guaranteed only to professional repairers.

On 30 March 2022, the Commission put forward a proposition to replace the Ecodesign Directive with an Ecodesign for Sustainable Products Regulation (ESPR) [64]. The proposed ESPR, which is currently discussed by European legislators, is expected to have a significant impact on repair. Indeed, reparability is to become an essential element of future ecodesign requirements along with notable durability and upgradability. In addition, on 20 March 2023, a proposal for a Directive on common rules promoting the repair of goods (Right to Repair Directive) was presented [65], which provides more rights to consumers, both within and beyond the legal guarantee. Within the legal guarantee, repair is to be the preferred remedy, except when it is more expensive than replacement. Beyond the legal guarantee, several new rights and tools are established including a right for consumers to claim repair for products that are technically repairable under European Union (EU) law (article 5), and an obligation for producers to inform consumers of their obligation to repair (article 6).

Consumer law, and in particular the regulation of legal guarantees, is a quite suitable way of promoting repair. According to a report by Eurobarometer, 77% of Europeans would rather fix a device than buy a new one [66]. Currently in EU law, legal guarantees enable consumers to remedy defects occurring at minimum during the first 2 years after purchase [67]. In some European Economic Area countries, that period has been extended. For example, Norway has, already since 2007, extended that period to 5 years for all products that are expected to last longer than 2 years, such as cell phones [68]. As a result, Norwegian consumers may claim remedy, i.e. repair or replacement, for defective products for a much longer period than most European consumers.

In spite of its crucial role in promoting repair, legislation does not always support repair strategies and can even turn out to be a key barrier to repair [69–71]. This is in particular the case with IP law as illustrated by a recent case from the Norwegian Supreme Court [72]. Independent repairer Henrik Huseby, who imported refurbished iPhone screens from China, lost his case against Apple, who had confiscated his screens. The court found the allegations of trademark infringement by Apple legitimate, in spite of the clear sustainability benefits of repair services provided by independent repairers [73].

Research Approach

Our research approach consisted of three methods. The first step was to create an inventory of independent commercial repairers of electrical and electronic goods in Oslo. We found that many small independent repair shops are not registered as such, so we needed to identify the shops ourselves, based on shop signs and internet searches. The second step was the implementation of semi-structured interviews with repairers. The third step was a thematic analysis of the interviews. The research was part of a project including an interdisciplinary team composed of three master's students, one PhD candidate, one postdoctoral researcher, and one professor that took place over 3 months in the summer of 2021.

Data Collection

The data collection started by mapping out the most populated areas of Oslo and therefore more likely to have repair shops. The decision was thus made to use Ring 3—the Norwegian National Road 150—a bypass road in Oslo, as the outer geographical limit for inquiry. All the independent repair shops that we visited were thus situated within Ring 3. To identify the repair shops in this area, each of the participants in the project was allocated a part of the city that was easily accessible to them, especially by proximity to where they lived.

Each participant noted the addresses, website and/or physical address, and contact details (if available) of the repair shops sighted or identified through an internet search. We also specified the electrical or electronic goods that were repaired by the shops.

The second stage of data collection was the actual visits to the repair shops and an interview with the shop owner or a repairer working there. The visits and interviews were conducted by the three master students. To ensure more effectiveness and not crowd the shops, which were often quite small, the visits were conducted in pairs so that only two would conduct the interview at a time. The composition of the pair varied for each interview. The person who did not join the visit was later tasked to transcribe the collected interviews and other observations.

The interviews were semi-structured. Ahead of the interview, the project team developed a guideline for the interview, including a list of questions to steer our interviews. All questions were related to the main research inquiry into the role of independent repair shops in a sustainable circular economy. Questions therefore fell into four main categories: (1) the history and development of the shop; (2) focus objects of repair in the shop; (3) level of circularity of spare parts that are bought, sold, and disposed of; (4) obstacles and challenges faced as repairer/shop. Each of the above categories comprised several more specific and concise questions on the topics.

The semi-structured interview form was chosen to allow for the line of questioning to adapt to the contexts of each shop, shop owner, or interviewee, and to react to their answers and specific interests and concerns. As a result, the data collected pertained not just to the technical repair of electronics, or business management, but also to the life stories, personal experiences with repair in Oslo, opinions, beliefs, and expectations of the people we interviewed.

Data Analysis

The interviews were analysed with the thematic analysis method [74, 75] and consisted of three steps. The first step was assigning codes or keywords to the transcribed interviews with the repairers. In the second step, similar codes were collated into initial themes. The third step consisted of a review of the themes with their codes, making sure the codes were mapped to the appropriate theme, and consolidating two or more initial themes in a new theme (see Table 1). The coding of the data was informed by our main research interests, the challenges and opportunities of independent repair and the role of independent repair in a circular economy. Our analysis thus had a deductive orientation; the interview data were approached by pre-existing research questions guiding the analysis [74].

Table 1 Example coding (number of the interview in brackets)

Codes (examples)	Initial theme	Final theme
<p>I reuse parts from other phones (#1) Yes, I keep old screens for parts (#2) We also use parts from old phones (#4) We reuse some of the parts to repair batteries or make new batteries (#20) We reuse parts from cameras we can't repair (#21) I use parts from devices that can't be repaired (#23) For parts we cannibalise other machines (#27) When a customer comes with a broken screen, we send it to China and we buy back refurbished screens (#5) We don't buy refurbished after this lawsuit in Norway. We buy OEM parts, original equipment manufacturer (#11) We refurbish screens (new glass) and then we have an original again (#13) We buy parts from [company name]. They also refurbish and sell them with warranty (#19) We mainly use refurbished 3rd party parts (#22)</p>	<p>Reuse of parts</p> <p>Refurbished parts</p>	<p>Circular spare parts economy (local and global)</p>

Table 2 Interviewees and what they repair in the shop

#	Repairs	#	Repairs	#	Repairs
1	Mobile phones	12	Mobile phones	21	Photo cameras, large printers
2	Mobile phones	13	Mobile phones	22	Laptops, PCs, printers, mobile phones
4	Mobile phones	14	Mobile phones, iPads, laptops (Mac)	23	Laptops (mainly Mac's)
5	Computers, tablets, mobile phones	15	Mobile phones	24	Laptops and PCs
7	Mobile phones	16	Mobile phones	25	Household appliances
8	Mobile phones	17	Mobile phones	26	Remote-controlled devices (drones, cars, boats, etc.)
9	Mobile phones	18	Mobile phones	27	Household appliances
10	Mobile phones	19	Laptops and PCs		
11	Mobile phones, laptops, PC's	20	Batteries		

Results

We identified more than 60 repair shops both physically and through internet searches within the Oslo Ring 3 area. A few shops were temporarily or permanently closed, others without functional contact information, while some were in fact not electronics repair shops upon closer inspection. It should be noted as such that this article does not account for the overall and accurate number of independent electronics repair shops in Oslo. The findings of our research are based on those repair shops that we visited and the owners and repairers we interviewed.

Number of Interviews

Data was collected from a total of 27 interviews with repairers in 27 repair shops spread around Oslo (#1–#27). Most shops we identified were mobile phone repair shops. We did not interview all repairers in all mobile phone repair shops, because after several interviews with mobile phone repairers, we had reached saturation, i.e., we started to receive similar kinds of answers.

Of the 27 repair shops, 22 were independent repair shops. Three repair shops (#10, #14, #15) were owned by the same owner and offered together a mix of independent and authorised repair. That means that—as we explain below under the “Business Models and Strategies” section—independent repair shops fill gaps of need even in the internal operation of authorised repair shops. Two of the repair shops were Apple-authorized repair shops (#3, #6). These interviews were not taken into consideration in the thematic analysis. See also Table 2.

Profile of Informants

All repairers we visited and interviewed were men. They mentioned they had only male colleagues at the repair shops. We did not ask about the ethnicity of the people we

interviewed; however, due to their preferred language of use during the interviews and their stories of how, where, and when they started to repair electrical and electronic equipment, we were able to determine key information regarding their background.

Ten of the interviewed repairers were “ethnic Norwegians”.³ Most of them told stories of picking up an interest in repair as young boys, tinkering with household electronics at home before professionalising their hobby. Repairers with an immigrant or refugee background were over-represented in our study. Although they had an interest in repair as a hobby, they had other more overbearing reasons for joining or staying in the independent repair sector. They were more inclined to continue to use skills acquired in their home countries, especially in the context of employment and language challenges in the Norwegian job market. One of the repairers mentioned he had several repair shops in Pakistan already, and that it was easy for him to do what he knows he is good at. A repairer from Syria said he was educated in Information Technology and Engineering, but could not get a job elsewhere, so he joined the independent repair sector. Most of the repairers had a formal education in IT or engineering. A few are self-taught through trial and error, YouTube videos, and online courses.

The repairers with an immigrant or refugee background also mentioned the fact that in their home countries, the norm was to repair, not to discard, when a product was broken. A repairer from the Middle East said that anything would be repaired in his home country, even a flat iron, while in Norway, it would probably be thrown away. He suggested that maybe it is because people in his country cannot afford to throw away and buy new things, so it is normal to repair everything.

Results from the Thematic Analysis

In the thematic analysis, we developed three main themes: (1) business models and strategies, (2) role of independent repair, and (3) independent repair and the circular economy.

Business Models and Strategies

It is all about the producers. They make phones that break; they make money, we make money. It is a business model. (#13)

The first theme is about business models and strategies. The interview data shows that independent repairers work with different business models to create a viable business (see Table 2). Access to spare parts, in particular affordable and quality parts, is one of the main challenges for the independent repair sector.

The price of a spare part is important. When a repair is too expensive, customers may refrain from repairing their product and opt for buying a new product. Repairers often offer spare parts in different price ranges. For the repair of broken smartphone screens, probably the most common repair in Oslo, repairers can offer a range of products, such as copies, original equipment manufacturer (OEM), refurbished, and original parts. OEM parts are produced in the same factory as original parts, but do not carry a brand logo, whereas

³ The authors are aware this is problematic term to use because we did not ask the interviewees about their ethnicity or ethnicities. We use this term solely to identify repairers who do not have an immigrant or refugee background.

original parts do. Refurbished parts are a combination of original components that were not broken and non-original component(s) to replace the broken component(s). For example, an OEM iPhone screen is the same as an Apple iPhone screen, but without the Apple logo on the connectors. A refurbished iPhone screen is an original iPhone screen with a new glass layer.

The independent repairers use different strategies to buy spare parts. If they do not have the part in stock and the customer wants a quick repair, they use a Norwegian supplier. The majority buys their parts in bulk from suppliers abroad because that is cheaper. Finding good suppliers is a challenge. As one repair mentioned, “It is difficult to find a good supplier; I don’t like Chinese ones.” (#9) On the other hand, several repairers mentioned buying parts from China. China also seems the main supplier of refurbished parts (see Table 3).

The location of the repair business can also be part of a strategy. Some repairers mention that it is difficult to do complicated repairs when they have a shop in which customers can walk in at any time, notably with other requests than repair. Therefore, some small repair businesses have a repair shop without a storefront (#1, #9). Small repair businesses with a side income (money transfer, second-hand products, accessories) refrain from doing complicated repairs, because they have more customers coming into the shop for non-repair business (#18).

Some repairers see a bright future for independent repair: “As long as Apple charges big money, we will have customers” (#8) or as another repairer mentions, “There is a future for us. Apple will not make things that can’t be broken, because then they will lose” (#18). Even so, several of the small mobile phone repair shops mention the difficult times during the corona lockdowns. Especially shops depending on walk-in customers were worried about the future of their repair shop: “The future is not good for small shops like these. A lot of friends had to close their shops” (#4). Another mobile phone repairer mentioned:

I think this business will die because whenever a new phone comes out, the repairers are afraid. They often cannot fix new features and parts of the phone. For example, when they changed to fingerprints and face recognition for unlocking the phone, we cannot fix that. Or now the displays change lights from bright to darker, we also cannot repair that (#9).

A laptop and computer repairer mentioned, “Less people are coming in with broken stuff than 3–4 years ago. People have insurance and then you get 80% of the new price. Most people buy new” (#19).

The price of repair is central for independent repairers. Many of their customers choose independent repair because it is cheaper than authorised repair. Several repairers mention the 25% VAT on repair and spare parts as making repair expensive: “Well, there is a discussion going on about making repair services VAT free, which would remove the requirement to add 25% tax to the total cost of the services. That would be nice for the customers” (#1) and “Taking the VAT away is a win–win situation for repair: cheaper for customer and more work for us” (#19).

The 25% VAT requirement is also an impediment to selling refurbished products, such as mobile phones and washing machines: “I have sent letters to the government some years ago. We have to pay VAT when we sell second hand goods, while people on Finn⁴ don’t pay VAT” (#21) (see Fig. 2).

⁴ Finn.no is an online marketplace for peer-to-peer selling or giving away used goods.

Table 3 Business models and strategies by independent repairers (number of interview in brackets)

Business model	Description	Strategy for spare parts
Single owner (A)	Small repair shop with 1–3 repairers (#5, #8, #9, #20, #21, #22, #24, #25, #26, #27)	Buy cheaper spare parts abroad (#5, #8, #9, #22) Use parts from broken devices (#20, #21, #24, #27) We send broken screens to China and buy back refurbished screens (#5, #8) We make our own parts when they are not available (#20) I buy from Norwegian companies (#24, #25, #26)
Single owner (B)	Small repair shop with 1–3 repairers with specialisation, such as experience and good reputation (#1), warranty on repairs (#13), very quick repairs (#16), cheap repair (#4), and iPhone repairs (#7)	I buy spare parts in Europe because they deliver faster (#1, #13) Reuse parts from old phones (#1) We buy in bulk from China (#4, #13) We import refurbished iPhone screens (#7) We refurbish screens with new glass (#13, #16) We buy Huawei and Samsung original parts in Norway and Apple copy parts in Sweden (#16)
Single owner (C)	Small repair shop with 1–3 repairers with different services, such as sales of second-hand phones (#4, #18), money transfers (#17), sales of accessories (#18), and home visits for repair (#23)	We travel to Dubai to buy spare parts (#4) I get my parts via my contacts in England, Sweden, and China (#17) We use refurbished screens (#18)
Mix authorised/unauthorised	Owner has a mix of unauthorised and authorised repair shops (#10, #14, #15)	We buy from suppliers in other European countries and China (#10) We buy original parts from the Netherlands and copies from China (#14)
Chain	Two or more repair shops with the same name and same owner (#1, #12, #19, #23)	We buy bulk from China (#11) We buy parts abroad, that is cheaper (#12) We buy parts from a Norwegian company (#19) We use parts from devices that can't be repaired or buy them on E-bay (#23)
Purchasing consortium	Several shops with the same name, but with different owners (#2)	We buy parts in bulk (#2)



Fig. 2 White goods repair in Oslo

Besides the 25% VAT requirement, the main challenge the interviewed repairers face is access to spare parts, in particular quality spare parts as well as affordable spare parts. One of the repairers mentioned that the spare parts he ordered to repair Apple products were confiscated at the border. The design of the devices they repair is another major challenge. Repairers mention the use of glass and glue hindering the opening of the device and the

use of parts pairing to prevent repair. The low quality of some products is also mentioned as a challenge for repair.

Role of Independent Repair

Today, the big companies are pricing their own repairs too high, which makes it more attractive to just replace old phones rather than repair them. (#1)

The second theme is about the role of independent repair in the repair sector. We found that independent repair fills the gap between expensive authorised repair and discarding a product. While authorised repairers mainly repair products covered by warranty or insurance, independent repairers repair what is not covered and do repairs that are not available at authorised repairers, such as the repair of the motherboard. One authorised repairer in a mixed independent/authorised repair chain mentioned:

Some of the phones are designed that you cannot fix them well. Like iPads (...) Apple doesn't really fix them. (...) if something is wrong with the tablet, they just change the whole tablet to the new one. (...) Because everything is glued inside. (...) So some of the devices are not made to be fixed. (...) Apple Watch (...). I think mostly from Apple, they have some devices that are not meant to be fixed. Also like AirPods, like that, yes (#14).

Most repairers mentioned that authorised repair is more expensive than unauthorised repair and that this is the main reason why people use independent repair. Several repairers compared the costs of authorised repair or use of original parts versus unauthorised parts: "A new screen costs 3000 NOK⁵ at Apple, but we charge 1500 NOK" (#4). Another repairer mentioned: "If you have an iPhone 6 worth 1000 NOK and Apple asks 1200 NOK for a new screen, you come to us and pay 500 NOK" (#18). Also the prices for identifying a problem differentiate between authorised and unauthorised repair. While Apple starts with 993 NOK, one of the repairers we interviewed asks for only 350 NOK (#23).

There are also fewer authorised repairers than unauthorised repairers in Oslo. For example, Apple offers nine locations for smartphone repair in Oslo and Samsung offers two. Large electronics shops also provide authorised repair. In comparison, there are already nine unauthorised smartphone repairers in one street in the centre of Oslo alone (see Fig. 3).⁶ Several of our informants mention that they can do a repair faster than any authorised repairer. They mention doing repair on the spot, while in some cases of authorised repair, the customer or repair shop must send the device to a larger repair facility. In addition, some of the informants stated they are willing to do more intricate repairs than authorised repairers.

Independent Repair and the Circular Economy

So what we are focusing on is to reuse, to prolong their life, to avoid over-recycling, which is what is happening here. (#20)

⁵ NOK stands for Norwegian Crowns (norsk kroner).

⁶ The repair shops were mapped on an interactive map: <https://tinyurl.com/4dfhfuyy>



Fig. 3 Street sign for mobile phone repair in the centre of Oslo (Translation: “Hi! We are your local mobile phone repairers. Oslo repairers make your stuff last longer. If you and all Europeans use their smartphones one year longer, we save the planet 2.1 million tonnes of CO₂ emissions per year. This is the same as removing one million cars from the street”)



Fig. 4 Cannibalised spare parts from photo cameras

The third theme is about the role of independent repair in a circular economy. Independent repair contributes to the circularity of products, but we also found that independent repair has contributed to a circular spare part economy, both locally and on a global level. The lack of availability and the price of spare parts have created circularity in spare parts. Several repairers use or cannibalise parts from non-repairable products to repair others (see Fig. 4). We found this strategy in the repair of mobile phones, computers, cameras, batteries, white goods, and remote-controlled devices. The repairers always have a stock of old devices available. This enables them to offer customers repairs that are not possible or are too expensive in the authorised repair sector. Independent repairers involved in mobile phone repair are part of a global spare part circularity. While a few repairers refurbish screens themselves or they know someone who can do it for them, the majority send broken screens to refurbishers in China and buy refurbished screens back for their repairs in Oslo.

Using refurbished broken parts and used parts in repair lengthens the lifespan of a product and is often the most sustainable repair option in terms of keeping materials in circulation and reducing greenhouse gas (CO₂e) emissions. There are no overall numbers for independent repair, but community repair networks, part of the independent repair sector, maintain databases calculating the waste and CO₂e emissions prevented thanks to their activities. For example, Restarters show that over the years, they fixed 34,213 electrical or electronic devices and prevented 1.1 million kg CO₂e emissions and 100,803 kg materials from being discarded.⁷ In 2022, the global network of repair cafés prevented more than 500,000 kg of

⁷ <https://restarters.net/about> (Accessed 19 August, 2023).

materials from being discarded because of successful repairs and thus prevented 1.3 million kg CO₂e emissions.⁸

At the same time, the repairers mention that newer products become more difficult to repair. For example, the use of cannibalised parts or refurbished parts is made increasingly difficult because of parts pairing: “Apple is problematic, they use a lot of security measures on their stuff. Serial numbers need to match. They don’t allow 3rd parties to repair. Samsung is starting to do the same” (#11).

Discussion

In the discussion, we will explore two themes related to the role of independent repair in the circular economy. We will focus on the notion of regeneration, and how policy and regulation, both on an EU and national level, can support independent repair.

Repair as Regenerative Practice

In the literature review, see the “Understanding Repair” section, we mentioned four categories of repair: reconstruction and remediation (past-oriented) and reconciliation and reconfiguration (future-oriented) [42]. We could identify the first two categories in all our interviews. Most repairers were involved in the reconstruction/restoration of a device towards its original state. When original spare parts were not available or too expensive, as is most often the case in independent repair, the repairers were involved in remediation. They bring the product back to its original functioning, using different materials, such as used or cannibalised parts, refurbished parts, or copies of the original parts.

As for the two other categories of repair that are future-oriented, we found examples of both forms among the independent repairers. While repairing something back to its original state and function can be called “past-oriented repair”, future-oriented repair is considered a site of innovation and future orientation, such as repairing for a more socially and environmentally sustainable future.

Repair as reconfiguration can be understood as a site of innovation and of future orientation, in terms of a more sustainable future [42]. In the interview with the e-mobility battery repairer (#20), the issue of reconfiguration became especially clear. Broken batteries from e-scooters were used to repair e-bike batteries or reconfigured to charge and drive a small electric car (see Fig. 5). The repairer and his team only work with batteries that otherwise would go into the waste stream. Through repair, the repairers found ways to innovate batteries by using 3D printers to design new batteries, such as larger batteries for e-bikes or for the electrification of a small gasoline car.

Repair as reconciliation is described as deploying original materials or components to a new end, focused on repairing the social relationships involved. We found a related type of repair, which used both new, used, and refurbished materials, but was also focused on creating and repairing social relationships towards a more sustainable future. Repair can have this regenerative quality of giving back through repair. It is based on the entanglement of the social, environmental, and material in repair, which is mentioned in the community

⁸ https://www.repaircafe.org/wp-content/uploads/2023/07/Jaarverslag_2022_print.pdf (Accessed 19 August, 2023).

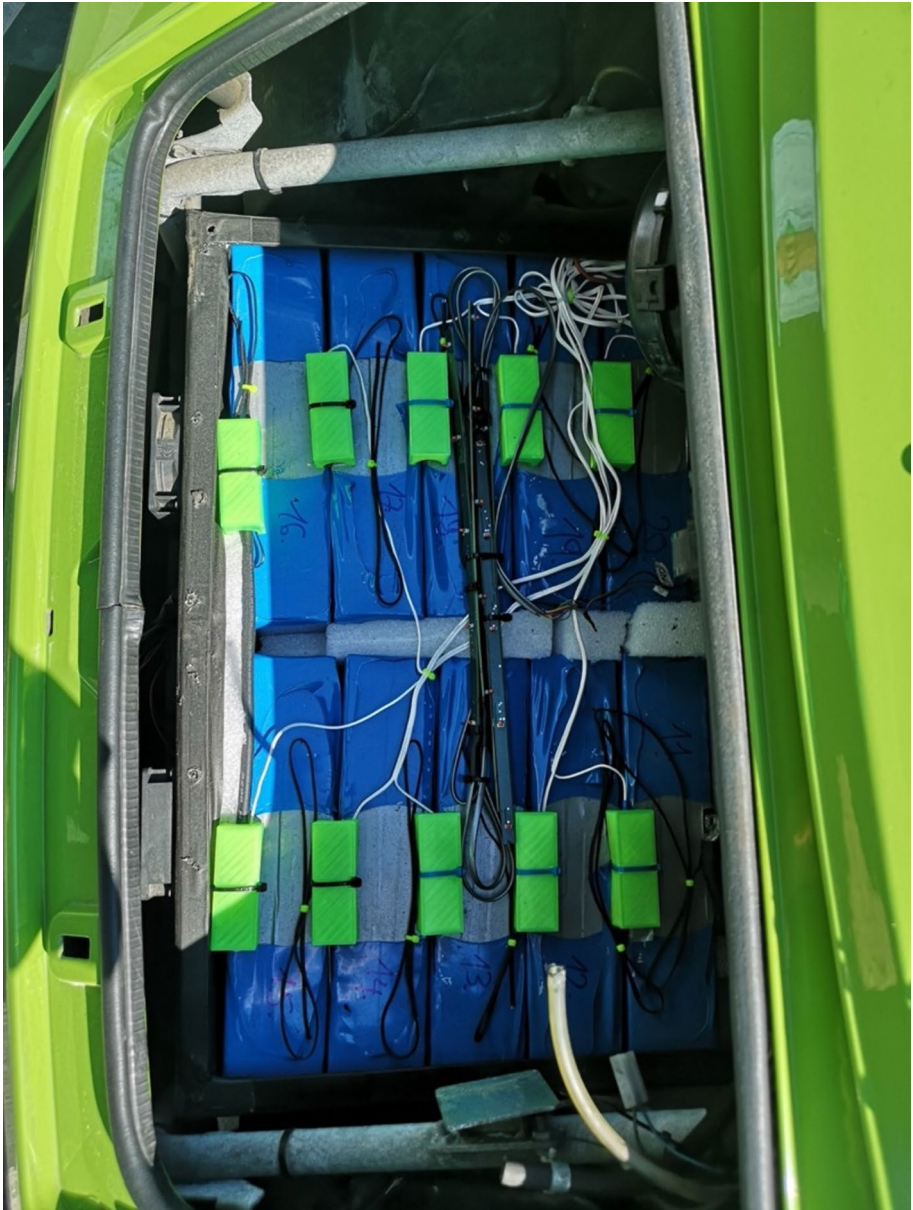


Fig. 5 Electrification of small car with discarded e-scooter batteries

repair literature [20, 21, 36, 37], and for which we also found some examples in commercial independent repair.

One example was the repairer/owner of a large white goods repair shop. All white goods under repair were discarded⁹ or brought in from recycling companies. In cooperation with Oslo municipality, most of his employees were people without documented skills or education. They would receive training in repairing white goods and could leave the company with a certificate of apprenticeship. The owner of the company explained it as follows:

So for me it's very important that not only circular economy, but that we use not only people that are... people that have the knowledge. To take it from the social aspect is very important. [...] this environment and this social, my passion is for this one and then just because as I was saying, I saw my father coming to Norway, and it wasn't... [...]. He came here, he couldn't work. He could work, he could repair stuff, but he didn't know the language. So, he got some help, he applied for this job at Electrolux. He got the job, and I was thinking myself: he got the job, here we are, why not help somebody else? So, like him, if you're 45 or over 40, it's very difficult to learn the language, but you want to work. If you don't work, you come outside of the society then people will point at you: 'You don't like to work. Why you don't like to work?'. Because they don't know the language. They don't know about this society. They get stuck inside of the house. (#27)

This regenerative quality of giving back through repair was also found in an interview with a mobile phone repairer. Electronics repair is a regulated business but excludes mobile phones. Everyone can call themselves a mobile phone repairer in Norway. Therefore, we met several refugees and immigrants among the independent mobile phone repairers. A recent refugee from Syria mentioned that without speaking Norwegian and documented skills and education, working in his friend's repair shop was a way to find his place in Norwegian society, to meet people, earn some money, and contribute to the country that was becoming his new home for him and his family.

In the circular economy literature, repair is often described as a stage in the life cycle of a product. Rather than a stage, repair should be understood as a whole system characteristic. Repair is more than bringing a product back to its original state or function. As a system characteristic, repair can be understood as ongoing, in the form of maintaining and repairing of what is in use and, through this, by strengthening product attachment [20, 38], prolonging the lifespan of the things around us. Repair is also about giving back. Its capacity to restore prevents waste, and through repair, we can learn how to reconfigure, redesign, and innovate unsustainable products.

This systemic quality of repair became also clear in some of the practices of the independent repairers. For example, the white goods repair shop and the battery repair shop worked with products that were already discarded and ready for recycling. Products were brought back into the circular economy. Sometimes they needed some repair to function again or were used to keep other products in the circular economy by cannibalising them. In the case of the batteries, they could become very different products. Mobile phone repair is another example. Because of the lack of original spare parts, independent repairers

⁹ The repair shop had a deal with one of the main white goods chains in Oslo. Whenever they installed new white goods in a household, they would take the discarded ones with them and deliver them at the repair shop. This saved the white goods chain recycling costs and the repair shop had free second-hand white goods, which were often in good shape or could be used for spare parts.

cannibalised broken products for spare parts, or they refurbished broken parts [76]. These solutions enabled them also to lower the repair costs, making repair more affordable and attractive for their clients. For example, one case study shows a washing machine repair shop had a threefold economic benefit when reused spare parts are used for repair [77]. The reuse of parts in repair also results in a lower ecological footprint than if they had used original parts [78].

The Need for Regulation

From the point of view of regulation, the interviews raised several issues, including those that are already on the legislative radars of the EU or Norway, but also some that are not. The main topics were consumer warranties, taxation, economic incentives for consumers, and brand owners' behaviour.

With regards to consumer warranties, several repairers mentioned that Norway has a stricter law on legal guarantees than most other countries as it provides 5 years instead of the minimum period of 2 years established by EU law [79]. Some mention that brands do not like that as it forces them to reconsider their business models. This may be true though it appears so far that, with Norway being a very small market, the effect of this policy on brand owners is in fact quite limited. However, it is clear that strengthening legal consumer warranties at the EU level would be much more impactful. Increasing guarantee period is not mentioned at this point by the EU legislators, but changes are nonetheless on the way with the prioritisation of repair over the other remedy that is replacement.

Two other concerns were raised that were not directly addressed in the legislation. Firstly, legal guarantees only apply to new goods, and repair does not give rise to new guarantee periods. Early discussion on the preparation of the proposed R2R directive indicated that the European Commission might include provisions to address this lack, but the proposal contains nothing in that regard. Secondly, consumers are regularly cautioned that having recourse to independent repair will not fall under or even void the commercial warranty, a voluntary service normally offered by the seller or the producer. Such restrictions may be legal unless they contravene consumer law. This means that commercial warranties cannot restrict rights provided by law under the legal guarantee regime. However, warnings by producers or sellers that non-authorized repair may void warranty are often ambiguous and may lead to consumers being afraid to perform repairs themselves or going to an independent repairer even within the legal guarantee period [44, 69]. Here, the law is quite clear: EU consumer law states that a commercial warranty does not replace the legal guarantee, and that those offering them must inform the consumer that this will not affect their right to the legal guarantee [67]. Thus, it appears to be more an issue of lack of communicating legal aspects regarding product usage and maintenance, as well as of consumer behaviour than a lack of the law itself.

The second topic that was largely raised by the interviewees is that of taxation. Many of them raise it as a major obstacle to their business, but different concerns emerge. The first one is the VAT that applies to repair services in Norway and makes their business less profitable and the services less attractive to consumers. The calls by civil society and businesses to remove the VAT on repair have never materialised and repairers are still struggling to remain relevant [80]. Like most taxation issues, this is a matter of national competence, and it is not expected that the EU will legislate on the matter. The second concern regards the other taxes that small businesses must pay and that too often make their repair services less competitive for consumers than buying new ones.

In particular, labour costs are high in Norway and repair is a labour-intensive service. On the other hand, products and materials are not taxed in a way that reflects their environmental and social impacts. As a result, repair services are often not competitive or attractive against the sales price of new products. This can and should be addressed through legislation.

The third topic that many interviewees pointed out is somewhat related to the previous and concerns prices of services in comparison to that of sales of new products, and the wealth of Norwegian consumers. Many interviewees were concerned that repair was bound to remain a niche in Norway simply because people can afford to buy new stuff, whereas in other countries everything would be repaired to save money. Generally, the price of repair is deemed uncompetitive for several reasons beyond those mentioned above with regard to taxation: spare parts are too expensive, repair is seen as too complicated or even unsafe, and people want “the best” and “the newest” notwithstanding the cost. The issue of the price of spare parts is one that is essential and should indeed be regulated if repair is to ever become more mainstream. Neither the proposed R2R directive nor the proposed ESPR contains proposals to address this issue although it would be expected that the EU tackles it. However, one of the interviewees rightly points out the need for public authorities to promote awareness about repair, its benefits, and consumer rights.

Finally, several interviewees mentioned issues with brand owners, especially related to the fact that they are not authorised repairers. As one of the repairers put it: “I think, there should be the law that some designs have to be stopped. Because it’s clearly against the customer. I mean, it’s clearly for the profit of the company, so automatically, who is delivering that profit to that company? Customers!” (#23). Not only do independent repairers face problems accessing spare parts, but are now also under threat of being sued for the way they conduct their business following the Huseby judgement (see above) [72]. These are typically issues where legislation is standing in the way of independent repair and thus of supporting the CE transition [40]. Another example of a legal barrier is a case from 2018 where independent repairers brought a claim to the General Court of the EU arguing that the refusal of Swiss watch manufacturers to supply them with spare parts constituted abusive conduct. The General Court dismissed the claim and stated that, although the manufacturers likely held a dominant position, it had been proven that not all effective competition would be eliminated by their conduct (in particular Articles 101 and 102 TFEU) [81]. Since competition between authorised repairers and the possibility for new repairers to enter the repair system remained, competition law had not been infringed. Thus, the mere fact that many independent repairers would be effectively knocked out from the after-market was not in contradiction with EU law [40]. The appeal to the CJEU was removed following the repairer association’s decision to discontinue the appeal. Generally, barriers to repair found in particular in competition and Intellectual Property law remain to be challenged by EU or national legislators.

Conclusions

The interviews with independent commercial repairers in Oslo enabled a deeper understanding of their motivations, challenges, and business models. We found that independent repair fills an important gap between expensive authorised repair, which is mostly covered by warranty and insurance, and the discarding of broken products. Independent repairers

describe themselves as providing cheaper and faster repair, as well as repairs that authorised repairers are not offering. Independent repair prevents electronic and electrical equipment from prematurely entering the waste stream.

Different business models can be found in the independent commercial repair sector, from small mobile phone repairers depending on walk-in customers to a chain mixing independent and authorised repair and a purchasing consortium. As long as brand owners produce products that easily break and offer expensive repair, there will be a market for independent repairers. However, not all independent repairers are optimistic about the future of their business. Obstacles in accessing spare parts, increasing parts pairing, and the cost of repair and parts affects the number of customers and thus their income.

Some interviews showed the role repair can play in giving back to the living systems we are part of. It can reconfigure design, inform new design, create new relationships with people and products, prolong use, and prevent waste. This regenerative aspect of repair enables a new understanding of the role of repair in a circular economy, from a stage in the CE to a characteristic of the whole CE system.

In our study, the products under repair are not sustainably sourced, manufactured, and transported, nor are they designed for reparability. Extending their lifespan is often the most sustainable option. As one mobile phone brand mentions, “The most sustainable mobile phone is the one you already own”.¹⁰ It is therefore important to acknowledge and support the central role independent repair plays in keeping these products in use. Repair needs to be available and affordable. This is possible if independent repairers have access to the schemata, spare parts, and tools that enable repair and if there are monetary incentives for product owners to repair their broken product.

Better policies and regulation will play a central role in promoting maintenance and repair, and notably independent repair, and to move the transition to a CE along. Several approaches are needed to achieve more access, more competition, and overall mainstreaming of repair, in particular 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. The EU has started addressing some of those challenges through its sustainable product policy, in particular the proposed Ecodesign for Sustainable Products Regulation and the proposed Right to Repair Directive. Yet, many of the issues known to impair repair and raised by the interviewees are not or insufficiently addressed by existing and proposed legislation.

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¹⁰ <https://www.fairphone.com/en/2019/05/20/the-most-sustainable-phone-is-the-one-you-already-own/>

Declarations

Ethics Approval and Consent to Participate Not applicable.

Consent for Publication All three authors have read and approved the final version of the article.

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