You repair what you sow

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You repair what you sow:

A study on the definitions of, and policies proposed for realising right-to-repair.

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Abstract

E-waste is one of the largest environmental hazards of the modern era. As more products are thrown away, more hazardous chemicals and pollutants are put into both the landfills and water systems, some of which is drinking water for not just people but also animals and plants. Repairing these devices allows them to have a longer lifespan which minimises e-waste. The RtR movement has sought to make repair a more viable option for consumers, requiring producers to supply more spare parts, manuals, software updates, etc. Despite the increase in repair right both in academia and government the definition of Right-to-repair is seldom defined to a satisfactory level, accounting for the nuances of the movement. Moreover, repair policies have yet to make an impactful change on consumer behaviour.

This study utilises an integrated literature review of 44 articles focused on right-to-repair discussions OECD countries, found through searches of three different search engines, to review, criticise, and synthesize to generate a definition and discuss necessary changes needed to further repairability. The study finds an applicable definition of the terms Right-to-repair encompassing three primary areas, legislation, information, and economic, as well as identifies relevant actors and areas of repair needed to change not only consumers ability and willingness to repair but also the producers' obligations towards repair.

Keywords: Right-to-Repair, Sustainability, Manufacturer, Consumer, Policy, Definition.

List of Abbreviations

A-G	– Energy label
CD	– cost degradation
DIY	– Do it yourself
EESG	– European Economic and Social Committee
EU	– European Union
EULA	– End-user licencing agreement
ILR	– Integrated literature review
IoR	– Index of Repairability
IP	– Intellectual property law
IR	– independent repair
LSY	– lifespan in years
OEM	– Original Equipment Manufacturer
RtR	– Right-to-repair
SDG	– Sustainable Development Goals
TPM	– Technological Protection Measures
U.S.	– United States of America
UL	– useful lifetime
VAT	– Value-added tax

Populärvetenskaplig sammanfattning

Elektroniskt avfall (e-avfall) är en växande oro runt om i världen som släpper ut farliga kemikalier och föroreningar både i soptippar och vattendrag och stör ekosystemens funktioner. E-avfall genereras när enheter som telefoner, datorer, diskmaskiner, kylskåp osv. kastas bort antingen på grund av att de går sönder eller när konsumenterna väljer att kasta sin fungerande enhet för att köpa en nyare modell. Reparation är ett sätt att begränsa mängden e-avfall som kastas bort, vilket ger konsumenten möjlighet att laga sin enhet istället för att köpa något nytt. Men idag är reparation inte genomförbart på grund av begränsningar både av lagar och producenten, t.ex. pengar, vilja, osv. Producenten begränsar ofta möjligheten att sälja reservdelar och manualer för att utföra reparationer själva, vilket gör reparationer svårare och dyrare att utföra, och lagar har införts för att se till att producenten är skyddad från andra aktörer som önskar att kopiera eller återskapa deras enheter. Right-to-repair (RtR) är en rörelse som fokuserar på att säkerställa konsumenternas rättigheter när det gäller reparation, tillhandahålla delar och manualer, och säkerställa en mer reparation-vänlig upplevelse för konsumenterna. Trots detta har RtR sällan definierats fullständigt, vilket gör det svårare för både lagstiftare och akademiker att korrekt diskutera effekterna av eventuell lagstiftning. Denna artikel syftar till att definiera begreppet, med beaktande av olika relevanta aspekter som upptäckts under forskningen. Genom en integrerad litteraturöversikt har denna artikel granskat, kritiserat, och syntetiserat 44 artiklar för att förstå vilka ämnen som är centrala för rörelsen.

Resultaten indikerar att RtR främst rör sig kring tre teman eller ämnen, lagstiftning, information och ekonomi. Dessa tre utgör de nödvändiga områden som behöver förändras för att ge konsumenterna rätten och förmågan att reparera sina produkter. Lagstiftningen utgör en stor del av begränsningarna och skapar avgränsningen för vad producenterna kan och inte kan göra. Information behövs för att vägleda konsumenternas inköpsbeslut och indirekt vägleda producenterna om vad som är viktigt att tänka på när man tillverkar enheter. Ekonomiska aspekter har visat sig vara den avgörande faktorn för om något repareras, då om reparationen av en produkt är för kostsam eller tidskrävande är det lättare att helt enkelt köpa en ny produkt.

Studien fokuserar också på effekterna av olika policys relaterade till information och ekonomiska incitament. Man har funnit att information behövs utöver bara etiketter, istället är det också nödvändigt att lära ut detta i skolan för att ändra samhällets tankesätt gällande reparation. Ekonomiska incitament används idag men har inte visat sig vara så effektiva som de skulle kunna vara.

Studien behövs för att vägleda framtida akademi och lagstiftning i en nödvändig riktning, genom definitionen av relevanta intressenter, nödvändiga ämnen att beakta och syftet med förändringarna.

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1. Introduction

E-waste is one of the largest environmental hazards of the modern era and the issue is growing ever bigger. In 2019 the amount of electronic waste (e-waste) was closer to 53 million metric tonnes (mt), with the United Nations (UN) predicting the total amount of e-waste for 2023 to be 61.3 mt (WEEE forum, n/a), and being expected to continue to grow to over 75 mt by 2030 (Weick & Ray, 7/2 2023). Moreover, e-waste is rising five times faster than e-waste recycling is capable of handling it (United Nations Institute for Training and Research, 2024). The issue with e-waste is that the products seldom have been used to their full functional lifetime and are oftentimes discarded prematurely. This is not always due to the marketing prowess of the original equipment manufacturer (OEM) but can instead be caused by different forms of obsolescence (Svensson-Höglund et al., 2021), either due to actions by the OEMs or by the individual themselves (Scott & Weaver, 2014) (see table 1).

Table 1. Different forms of obsolescence.

Design barriers. Svensson-Höglund et al. (2021: 5)	
Functional obsolescence	Developing software only designed for newer products.
Premature obsolescence	Usage of low-quality materials to shorten a products functional lifetime because of durability failure.
Planned obsolescence	Intentional shortening of products lifespan in design.
Relative obsolescence. (Scott & Weaver, 2014: 4-5)	
Psychological obsolescence	The product no longer giving satisfaction either symbolically or aesthetically.
Technological obsolescence	The products technical function no longer give satisfaction.
Economic obsolescence	The product no longer offers value equivalent to the cost of ownership.

In 2018 the UN set up the sustainable development goals (SDGs) of which goal 12 concerns 'Ensuring sustainable consumption and production patterns.' To accomplish this, what is needed is an economy which focuses on circularity, where the goal is to limit or stop buying products made by virgin materials, and

instead decouple economic growth from environmental harm. Where once something is bought it can be used for longer through different 're'- applications.

Often referred to as the seven R's are different 're'- applications that can be done to extend the length of time in which an item can be used. The R's are *rethinking* what we buy, if it is necessary etc., *refusing* to buy something that is not truly needed, *reducing* the purchases one makes, *reusing* what one has, *repairing* the item when necessary, *regifting* things which may find a better place somewhere else, and lastly *recycling* items which are no longer useable (Kreider, n/a).

The focus of this paper will be on that of repair, as it, in relation to e-waste, can limit the number of devices and appliances that are being thrown away by simply exchanging a broken part instead of the entire device. It may sound easy enough, but often the wish to repair is met by reluctance as OEMs may limit the amount of parts and manuals available, may increase the cost of diagnostics and repair, or may simply refuse sighting disproportionate costs to simply giving away a new product.

1.1. Timeline of Repairs.

The act of repair has long been part of the human experience, being a practical necessity when the breaking of the handle on one's axe would not deter the simple fashioning of a new handle (Perzanowski, 2022: 50). Similarly, baskets and pottery were oftentimes repaired, and have been throughout history.

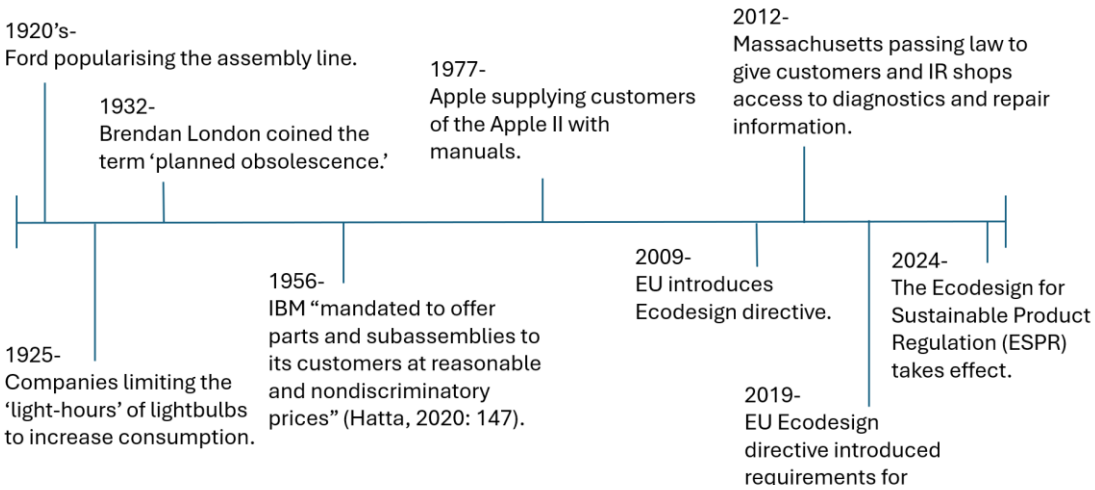

Figure 1. Timeline of 20th and 21st century attitudes to repair.

While staying within the 20th century, repair has been a paradoxical topic for consumers and OEMs alike. As industrialisation introduced the ability for interchangeable parts allowing for the swapping of parts, when necessary. Overtime the assembly lines eventually became so effective that it became in the businesses interest to work against repairability (Perzanowski, 2022: 49). For example, Hatta (2020: 146) refer to the words of Ford in which he states, "We want individuals who buy one of our products never to have to buy another [and that] you can take a 10-year-old car, and with parts that are available today, make it into a car for today with very little expense." Despite this, Ford later followed in the footsteps of his competitors and began evading competition though the creation of a network of dealerships and repair services in the 1920s. Setting into motion what is today a standard of not only the automotive industry but any industry that creates products what are deemed worthy of repair.

Despite this example of early anti-repair measure, repairs could still be conducted regardless of the OEM's attempts to limit them. However, one measure that would be exemplified during the Great Depression (1929-1939), was that of *planned obsolescence* as it was argued necessary to restart the economy. Lightbulbs of that time ware capable of 'light-hours' of upwards of 2500+ hours but were artificially lowered to 1000 hours by the prominent manufacturers from Germany, Netherlands, France, Hungary, the U.K., Japan, and the U.S. in 1925 (Krajewski, 2014) to create demand in the market, creating profits and increasing sales.

It was around this time the term planned obsolescence was first coined. Bernard London, in 1932, argued for the taxation on consumers who insist on "disobeying the law of obsolescence [by] using their old cars, their old tyres, their old radios, and their old clothing much longer than … expected" to boost consumption (Perzanowski, 2022: 56). Instead having the government of the U.S. assign every product with a "lease of life" that would be "retired, and replaced with fresh merchandise" after its time was up, thus forcing the consumer to keep consuming. For those not willing to part with their goods a tax would come into place. London called this plan 'Ending the Depression Through Planned Obsolescence' (Perzanowski, 2022: 57).

In 1956, IBM became the first company to be accused of, and charged with, unfair practices that violated U.S. antitrust laws, requiring IBM to change their ways to allow consumers to repair their own machines by providing their consumers with, among other things, spare parts (Grinvald & Tur-Sinai, 2019; Roy & Sen, 2023). Despite this, many companies did factor repair into the equation of selling devices. During the 20th century much of the technological innovation was the result of tinkering and repairs, making devices better through improvement. The 1977 Apple computer came supplied with manuals

in case any issues arose during its lifetime. Over time there has been a growing reluctance of OEMs to supply consumers and IRs with spare parts, manuals, diagnostics, etc.

What is understood to be the beginning of the contemporary 'Right-to-repair' (RtR) movement was started in 2012 as Massachusetts passed a law focused on giving customers and independent repair shops access to diagnostics and repair information that were up-until-then only available at authorised repair shops (Kahane, 2022). Later becoming a memorandum of understanding amongst the automotive OEMs, supplying the same information outside the requirements of the law to the entirety of the U.S.

2022 saw a further step in the direction of RtR with the EU adopting the Ecodesign for Sustainable Product Regulation (ESPR) requiring electronics manufacturers to ensure prolonged usability of electronic products through repairability, upgradability, durability, and reusability (European Commission [EC], n/a.b). By requiring OEMs to supply parts and information, and ensuring certain levels of durability like drop tests, the framework will help to minimise e-waste.

Comparing Apple from 1977 to today one will find two drastically different approaches to repairability. Some of the changes is in-part due to the advancement of technology, such as the water resistance through adhesives, however such changes have brought with them the evolution of measures meant to purposefully lock out both the consumer and independent repair shops. For example, the usage of specialty screws that could only be unscrewed through a special screwdriver created by the OEM, or the serialisation of parts and lock-out chips making it impossible to change any part of a phone, even when it is a genuine product of Apples, outside of their in-house repair shop. Further changes that have sought to make repairs impossible is that of soldering, where parts are things such as the SSD- or RAM-cards have been permanently attached to the motherboard of a device making it almost impossible to change, instead demanding the purchase of a new product.

Today the act of tinkering, of technological innovation, are being argued against by the OEMs, as divulging trade secrets through manuals and spare parts would – according to the OEMs – stifle innovation. Similarly, the act of repair is being argued to be too hazardous as the chance of exchanging a battery or screen on a phone could result in harm coming to the consumer through puncturing of the skin dealing with broken screens or a punctured battery resulting in fires. However, as proven by the makers of Fairphone, the only limits are those imposed by the manufacturer. The changing of a screen or battery can be done by anyone without more than a screwdriver if the phone is manufactured to that standard.

1.2. Research purpose and questions.

The 'Right-to-repair' is a growing movement focused on issues concerning the costumer's ability to repair. The aim is to allow for a more circular economic structure through the modification of existing legislation and implementation of new policies as well as changes in how OEMs interact with and towards issues such as spare parts, manuals, software, and information sharing to create a culture beyond that of wear and tear. While the paper will look at the effects policies may have regarding consumers interactions with repair, it is first important to define the term 'right-to-repair.' In so doing, properly identify the two most important aspects of policies, *whose* rights are we referring to when talking about repair, and *what kind* of repairs are focused upon? To do so the following research question has been created:

1. What does the 'right' to 'repair' mean?

After establishing the definition of what RtR is, the paper continues by discussing which policies prove to be most applicable in the case of consumers right-to-repair. This will be done by answering the following question:

2. What policies have been introduced/proposed to promote RtR, and potential effects on consumers?

The paper is structured as follows: section 2 will discuss the relevant methods being used to answer the stated research questions (RQ), and outline the methods used in finding the relevant material for the papers analysis. In section 3 the results will be presented, being separated into two subsections to account for the two RQs. Section 4 will discuss the results, also in two subsections, and section 5 contains the concluding.

2. Method

To answer the RQs this paper utilised an integrated literature review. The integrated literature review (ILR) focuses on generating new frameworks and perspectives through reviewing, criticising, and synthesising literature relevant to the topic which in turn is done by "examining the main ideas and relationships of an issue and providing a critique of existing literature" (Torraco, 2005: 361). The results will divide the field of RtR into the identified themes found in literature. This will allow the paper to delve into aspects not otherwise possible compared to other forms of literature reviews, such as a structured literature review.

This paper takes a normative approach, often suitable where the aim is to critique the status quo, particularly in relation to issues where certain actors exercise considerable power in a system. As such, the thesis criticises the current workings of OEMs for their reluctance regarding repair and consumer rights. This will be especially pertinent in the Discussion section. This aligns with O'Byrne (2022) as he argues that sustainable science often needs to take sides to move society towards sustainability, and that this can be done through objectively grounded normative claims. This thesis will allow for critics and discussions regarding certain claims and arguments pertaining to the fairness of RtR, considering the uneven power struggle that exist between the OEMs and consumers (and IRs). O'Byrne (2022: 19) establishes an approach for sustainable science, which:

> (i) focuses on the analysis of concrete cases; (ii) paying attention to the social practices that produce environmental problems and the theories that support those practices; (iii) examines alternative theories, and (iv) justifies a normative position by identifying the most comprehensive theoretical understanding of the particular case.

This, in my view, functions for this paper as it (i) focus on a concrete case (RtR), (ii) documents different stakeholders' relationship with repair, (iii) exemplify companies trying to create change, and (iv) establishes an uneven power struggle justifying normative discussion.

2.1. Search terms and execution.

Prior to the finalisation of the search terms, searches were made to determine which terms resulted in the inclusion of meaningful material. Ultimately, while certain combined terms, i.e. 'circular economy' AND 'repair' did guide the direction of the searches in meaningful ways in terms of which articles were shown, it did simultaneously result in an unreasonable number of articles. As such the term "*Right-to-repair*" was at last used as it both captured the relevant words and central concept of the study. This does, knowingly, not account for all relevant articles on the topic. It does however give a reasonable summation of the field for the objective of the study.

The geographical focus is OECD countries as these nations and regions are the leading actors on the topic. Similarly, the searches primarily focused on academic (review) articles published between 2015 – January 2024, but may include articles or other material when considered relevant. The articles also had to be available in English. As the search was conducted on LUBsearch, Scopus, and Web of Science (WoS), many of the resulting articles could be found on all sites. The sites, respectively, produced 145, 49, and 63 articles, totalling 257, however the total of unique relevant articles (based on titles alone) produced a total of 71.

After reading the abstracts, articles not applicable to the topic of RtR, or which fell outside the given criteria, was removed, bringing the total down to 51. During this process, some articles were detected that did not contain 'right-to-repair' in either the title or abstract but were still found to be of relevance to the topic at hand, these articles remained. After this, larger, relevant, sections of the articles were read (introduction, discussion, and conclusion) for relevance, further shortening the list of articles.

To supplement these articles, the snowball technique was used in conjunction with articles given by the supervisor, and further searches were made on Google scholar using the same search term to further widen the possible findings. An additional seven articles were found. The final number of articles used in this paper was 44.

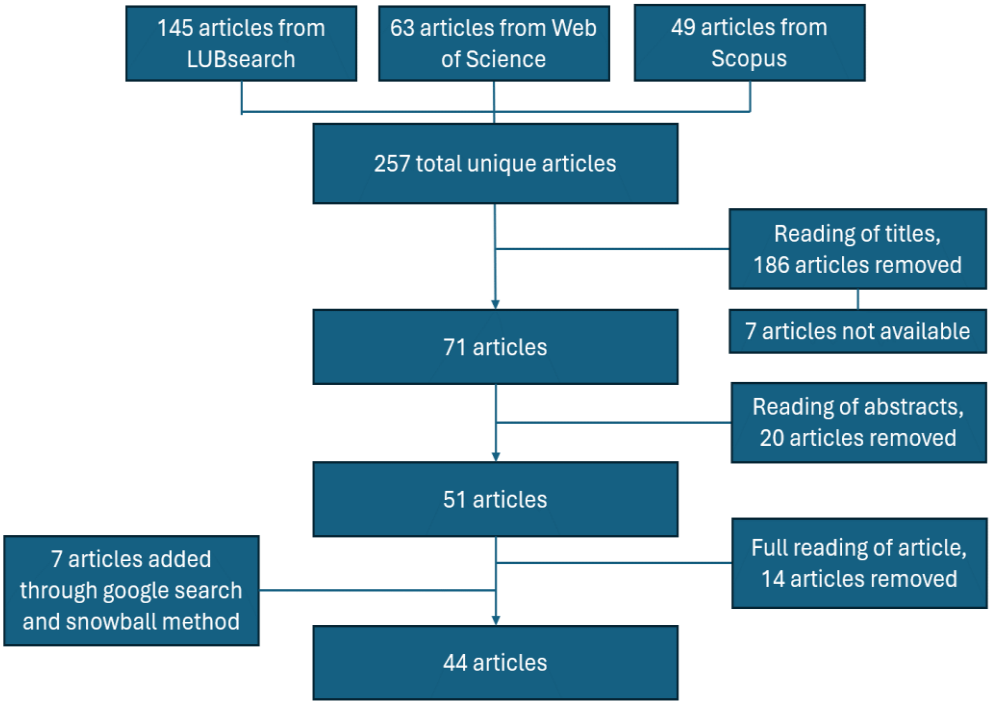

Figure 2. Flowchart of article selection process.

2.2. Ethical reflection.

The method used does not inherently pose any ethical dilemmas as it does not directly interact with people. However, in synthesising ideas from various authors it is important to present the concepts, ideas, and perspectives, in an accurate way. I have endeavoured to do so to the best of my ability.

The normative approach explicitly advocates for consumer rights, an alignment often shared by the literature reviewed, although not as explicit. This partiality comes from a longstanding interest and focus on concepts of justice and fairness, similar to those of John Rawls' concept of the 'original position,' which presents a hypothetical thought experiment of equality. Through this framework, this paper aims to contribute and engage in positioned and critical perspectives thought necessary within social and sustainable science.

3. Results

Under this heading the results of the review will be presented; section 3.1 will outline consumers repair capabilities since the start of the 20th century, section 3.2 will focus on the first RQ and highlight the results related to the concepts 'right' and 'repair'. Relevant subsection will further deepen the discussion surrounding the at-hand topic. Section 3.3 resolves to answering the second RQ related to policies to promote RtR for predominantly the consumer.

3.1. What is Right-to-repair?

The task to define 'Right-to-repair' has yet to be completed, none of the studied articles have clearly defined what RtR is. A briefing by the European Parliament on RtR called it a 'vague concept' (Šajn, 2022). While some articles have shown promise and come to a limited definition, most either leave it completely up to the reader to piece together a definition from the reading of the articles, or give a basic understanding of the concepts, who is in focus, what it relates to, etc.

There were four articles that in some way presented definitions for aspects of RtR. Baker et al. (2022: 268) who defined it as "the act of allowing consumers to modify or repair computer devices themselves or take it to a third-party center of their choice." Ozturkcan (2023: 2) referred RtR to "the concept that if you own something, you should be able to fix it yourself or have it fixed by an expert of your choosing." Barros and Dimla (2023: 925) broadly referred to RtR as the concept "allowing end users, business users, and consumers to freely repair [smartphones] in case of failure." Meanwhile, Aymerich Matarin et al. (2022: 105) defines repair as "the process of returning a faulty product to a condition where it can fulfill its intended use."

Wiseman and Kariyawasam (2020: 140), utilised the Australian governments definition of the term 'repair' (Section 72(5) of the Designs Act of 2003), which defines repair as:

- restoring and replacing a decayed or damaged component part of the complex product to a good or sound condition;

- replacing incidental items at the same time as a damaged component part is being repaired or replaced
- carrying out maintenance on the complex product by replacing component parts during a routine maintenance program.

Beyond the articles one can look towards the EU standard for a definition, defining repair as the "process of returning a faulty product to a condition where it can fulfil its intended use" (Dalhammar, Milios, & Richter, 2021: 22).

3.1.1. '*Right*' to Repair.

'*Right*' invokes different responses depending on which area of study one finds oneself in. Among lawyers and legislators, a 'right' is something very official and definitive. Oftentimes, the literature surrounding RtR speaks of rights in this manner, of presenting policies which focus on extending further applications to the consumer while limiting the ability of the OEM to in turn limit the consumers and independent repairers' ability to repair. However, when delving into the question of what constitutes a right one should, as was brought forth by Rosborough (2020), consider the moral implication as well. Rosborough argues, among other things, for the right-to-repair by implicating the otherwise denial of agency brought by not allowing consumers the ability to make such decisions themselves and instead relying on the OEM for the ultimate decision-making, stating that "the 'right' to repair must not be conflated with the ability to do so." In accordance with the argument surrounding the moral right-to-repair, the discussion around autonomy and agency does come into question. Having the autonomy to repair could be removed if devices were to be made repair-proof, thus removing the burden of repairs further extending our autonomy to focus our attention elsewhere. Moreover, while "autonomy must not be equated with agency" (Rosborough, 2020: 46), arguing that autonomy can give relief from the burden of repairing our devices it does simultaneously induce the discarding of such devices. As those devices never become important to us, never having been taken care of or repaired by the owner, distances it from the identity of the owner. Instead, as Rosborough (2020: 46) goes on to state: "by becoming agents and 'masters of our own stuff', we become not merely those who 'consume', but also those who create, invent, use, participate and find solution for the benefit of others." If we interact with our devices beyond their use for us, they help us create a more profound sense of self. By taking care of what we own we become more

in tune with the world around us; by fixing what is broken instead of simply using it until it breaks then getting a new one, we can gain a better understanding of ourselves and what effects we have on the environment (Rosborough, 2020).

As previously stated, most of the literature reviewed in this paper discusses the right-to-repair through the lens of legislation in which a definitive point must be reached regarding which 'right' should befall the consumer, independent repairers', or OEM. One should, however, also take into consideration the moral and philosophical aspects of such as decision. Should the person who buys the devices in question have the right to do whatever they want with it? Should the OEM producing the device have a moral obligation to supply the consumer or IR with parts, manuals, diagnostics, etc.?

For whom?

This section focuses on identifying the actors (consumers, IR, OEM, the environment) RtR is aiming to support. Moreover, the results indicates that the actors are not isolated players but are benefitted by the cooperation with others. Thus, arguments will be presented both for and against the changing repair rights in relation to better the ability to repair of some actors.

All articles position the consumer as the central actor for which further development of repair rights should be extended. As presented previously, apparent similarities between two of the five definitions as they make claims towards a choice of primary actor, being the consumer, and their ability of the consumer to choose who, including DIY, to repair their devices (Baker et al., 2022; Ozturkcan, 2023; Barros & Dimla, 2023).

To establish the consumer as the central actor, not only within the repair industry, but within the economy once again. As the prevailing understanding of the economic system puts the consumer as the final decision maker, beholden of the purchasing power, it would be of logically sound argument if they simultaneously have all possibilities to exercise such powers. As pointed out by Rosborough et al. (2023: 344), while providing the end-user with a level of efficiency and ease otherwise not seen throughout history, manufacturers have been granted an "unprecedented control over *how* and *by whom* those products and devices are used, maintained and repaired;" and due to the profit incentive provided to the OEMs, despite the public interest in repair and maintenance, relinquishing of such powers are not given voluntarily. To further more sustainable practices, the focus would logically be on ensuring the benefits of the consumers, as most literature suggests.

Van der Velden (2021) and Brandley and Persson (2022) both goes a step beyond the individual and argues for the benefits of community repairs, finding that community repairs offer further depth into circular economies, further

creates understanding and knowledge of the benefits and limitation of the current product design, gives the repairers a new understanding of the value of their products through the continued usefulness of personal devices and can be said to connect to the moral argument surrounding agency made by Rosborough (2020). Furthermore, she finds that community repairs can have a positive influence surrounding gender roles in tech, something that is otherwise predominantly occupied by males. Not to say that a change in legislation can or will not lead to social infrastructural changes, where, if done with the consumers ability in mind, devices are swappable to the extent that there is no need for middlemen or IR. Instead, in a similar fashion to Fairphone, the consumers can purchase the broken part and replace it themselves. This would, however, limit the skillset required of the IR to harder repairs, but can also result in the elimination of their jobs and skills in its entirety, as it would either increase the ability of repair for the consumer, or decrease the complexity of the product. However, such changes take time and is somewhat idealistic to imagine for both consumers and OEMs. As already mentioned by Ozturkcan (2023: 1) there is a need to include both consumers and IR within the legislation, making it available for both parties to have access to parts and manuals.

Beyond positioning the consumer as a central figure, the articles go further into detail discussing the different ways in which the OEMs currently operate. From using technological protection measures (TPM) to discourage or eliminate repairs outside of the OEMs in-house repairs which in turn can then increase the prices further discouraging the prospects of repairs (Montello, 2020). Also arguing that while the hardware of the device is the property of the consumer, the software allowing that hardware to prove useful is the ultimate property of the corporation (Wiens, 2015).

Throughout the research only one paper discusses how "fair repair legislation is not fair for manufacturers", suggesting that legislators instead look to solutions that provide measures more workable for the industries affected by the legislation (MacAneney, 2018: 333). This is not to say that MacAneney (2018) argues purely against RtR but finds the need to limit which policies are put in place to keep OEMs able to still retain their information without sharing it freely, which could arguably result in copying, further resulting in subsequent security concerns and copyright infringement.

Jin et al. (2023) found that if RtR legislation resulting in a lowered independent repair cost were to be enacted it could result in a lose-lose-lose situation between the manufacturers' profits, consumers surplus, and environmental impact. Making OEMs produce longer lasting devices would allow them to market their products with a higher price, which oftentimes includes a lowered cost for in-house repairs. This would simultaneously result in consumers purchasing fewer devices per year reducing the ultimate profits

of the OEMs, making it more expensive for consumers to buy a new device when needed (Jin et al., 2023). This ultimately offsets the cost saving from the repairs done to the consumers devices as the savings would have to go towards buying a new device when the old one reaches the end of its lifespan (Jin et al., 2023). On the other hand, if OEMs were to make devices cheaper to produce it would be beneficial for the consumers wallet but would have negative environmental impacts through the overconsumption of cheaper goods (Jin et al., 2023). This is not to say that RtR legislation can expect to become environmentally damaging, but it does put into perspective the importance of drafting conscious legislation focused on the benefits of both consumers, manufactures, and the environment.

In summation, RtR is predominantly meant for the ultimate benefit of the consumer. To that end, the need to include IR is similarly important as it allows those not interested, capable, or willing to repair their own devices to have such work done for a limited fee. Furthermore, part of the argument is to allow for more competition between the in-house repair option given by the OEMs and the independent repairs to ultimately lower the cost for the consumers.

Laws & Legislation.

This section goes over different laws and legislation meant to give OEMs creative freedom, but which has instead become ways to circumvent the rights of the consumers and IRs to give themselves the upper hand. Beginning with going over different aspects of intellectual property law and ending with a short exemption which currently allow for some leeway for the consumer and IRs.

The most discussed topic from the articles reviewed was that of law, legislation, regulation, etc. Specifically, the topics around intellectual property law (IPL), and its subcategories, such as trademark, design patents, and trade secrets, etc. Moreover, other laws, such as End-User Licencing Agreements (EULA), and consumer law and guarantees (see table 2).

Table 2. Laws and their current uses.

Major laws related to repair	Laws as they are currently.	References.
Intellectual property law (IP)	- **Copyright** is used by OEMs to limit access to manuals, and to justify TPMs. - IP rights are not absolute, especially when considering competition laws. - Copyright favours RtR. This is disputed by Mirr.	Brown, 2020; Carrier, 2023; Grinvald & Tur-Sinai, 2019; Grinvald & Tur-Sinai, 2020; Mirr, 2016; Reynolds, 2023; Rimmer, 2023; Rosborough et al, 2023; Samuelson, 2022; Turiel, 2021; Widla, 2023

Major laws related to repair	Laws as they are currently.	References.
	- **Trademarks** prevents authorised parts from being used in unauthorised repairs. - OEMs, i.e. Apple, uses trademarks on internal parts to limit the resale of said parts. - Trademarks are used beyond the laws intended mean, i.e. aimed at preventing customer confusion and distinguishing between companies and models.	Carrier, 2023; Grinvald & Tur-Sinai, 2020; Montello, 2020; Reynolds, 2023; Tischner & Stasiuk, 2023
	- **Trade secrets** meant to protect information is seldom enforceable when given to external parties. - Reverse engineering is legal but does not hold economic value beyond repair. - Confidentiality agreements may remove trade secret status.	Carrier, 2023; Gomulkiewicz, 2022
	- **Design protection** protects "new, original, and ornamental design[s]." - It predominantly applies to the external aspects of a product. - Internal parts may not be explicitly covered under this law.	Carrier, 2023: 1184; Gomulkiewicz, 2022; Grinvald & Tur-Sinai, 2020; Reynolds, 2023
	- **First Sale Doctrine** (FSD) removes OEMs distribution rights of a work after it is sold. - Consumers can resell the item after purchasing it. - FSD allows the use and repair of unpatented parts within patented products, required that it extends the product lifespan. - Repairing patented components without authorisation is illegal. - OEMs utilise "must fit or match" components to restrict access to parts, effectively monopolising their part and repair. - Selling refurbished products, including those with trademark logos, is protected under the FSD.	Ghosh, 2023: 1098; Grinvald & Tur-Sinai, 2020; Montello, 2020; Pihlajarinne, 2020
Consumer law / guarantee	- In Australia, consumers can seek repair, refund, or replacement after the OEM warranty expires. - In the EU, sellers may refuse repair in favour of replacement, citing cost or time concerns.	Rimmer, 2023; Terryn, 2019

Major laws related to repair	Laws as they are currently.	References.
End-User Licencing Agreement (EULA)	- EULAs has stronger enforceability and imposes restrictions beyond copyrights reach, especially with embedded software. - EULAs can limit distribution of TPM tracking and manual sharing, regardless of possible copyright law revisions. - EULAs have been used to disallow unauthorised hardware/software use and restrict second-hand sales.	Montello, 2020; Mirr, 2016
Liability (in terms of safety concerns for consumer)	- Safety concerns regarding repairs by consumers or IR are often cited to justify keeping repairs in-house. This, however, lacks substantial evidence.	Carrier, 2023

Repair is a global issue that, beyond the EU, demand national solutions. Australia has as of 2016 temporarily allowed repairers to copy and share repair information without infringing on copyright (Manwaring et al., 2022). In addition, recommendations have been made to allow repairers to copy and share TPM circumvention devices as well (Manwaring et al., 2022; Rimmer, 2023). Meaning the selling of such parts is not done in a competitive market, instead being sold by the OEM. Furthermore, allowing OEMs to prevent the creation of such parts, despite it being discontinued. Moreover, if a product is reconstructed beyond the products design constituting a new product it will infringe on the design patent.

OEMs argue that repair done outside of the authorised repair networks of those same OEMs could result in complications for both the consumers and OEMs (Montello, 2020). They maintain that if the consumer chose repair elsewhere, or does it by themselves, it could be done with subpar parts resulting in a subpar experience for the consumer, or even breaking the device all together. Moreover, if it was a DIY it could result in damages done to the consumer through a broken screen or damaged battery. Regarding the OEM, such actions bring up the question of liability – should the OEM be held liable if the phone breaks after being repaired outside of their network? OEMs oftentimes argue that IRs are less capable than the OEMs repair networks (Carrier, 2023), this is, however, not necessarily true as IRs (1) have gone through the same training and certification process, (2) do the same, if not more, repairs as those of OEMs, (3) might be former OEM repairers, (4) are not required to have immense experience for the most common repairs (Carrier, 2023: 1182; Rosborough, 2022b). Moreover, regarding consumer

repair, it could be said that the difficulty of repairs is due to deliberate design choices of the OEMs, as other companies have managed to sell devices much more capable of repair while still providing much, if not the same, level of features (i.e. Fairphone and Framework).

Despite the liability concern, repairs are not always a given if consumers go to in-house repairs. The EU consumer has the choice of repair or replacement within the guarantee period, however, the manufacturer, seemingly, has the final say as if they find repair to be a disproportionate cost in either time or money, they can simply replace the device (Terryn, 2019). Terryn (2019) instead argues for a hierarchical structure in law, in which repair is prioritised over replacement.

Beyond the cases of liability and guarantees, OEMs oftentimes use IPL, with all its subcategories, to argue that changes to the legislation regarding their property rights will result in them having to give up trade secrets, and essentially give away their copyrighted, trademarked, and patented material. As they stand today, these same rights are in a sense being misused. Copyright laws are used to allow for both preventing the distribution of manuals as well as a justification for TPMs (Carrier, 2023; Rosborough, 2020). Trademarks, in the case of Apple, is being placed on every part of their phones, including internals, making any part used in repairs done to those devices (unless bought through the OEM) illegal. This, according to Carrier (2023) and Montello (2020), goes beyond the purpose of the law which instead is meant to prevent confusion for the consumer when purchasing a product. Trade secrets is used to keep information of the devices hidden, however, the act of reverse engineering (i.e. taking the device apart and looking at its construction) is legal, although time consuming. Patent law, yet again, is only ever really meant for the externals of a device, regarding the products "new, original and ornamental design[s]" (i.e. not internal parts) (Carrier, 2023: 1184). However, the U.S. is allowing the registration of patents for product parts, which in turn makes the manufacturing the sole provider of those parts and make it illegal for anyone to manufacture even after its discontinuing (Rosborough, 2022a).

A further route for OEMs to take is through their EULAs, which has been used to prevent consumers from going to IRs by revoking warranty claims. Despite it being illegal in the U.S. 90% of companies were found to violate the law (Montello, 2020). It also functions to prevent consumers from utilising unauthorised hardware and software in conjunction with the device (Montello, 2020).

Despite these laws there is one aspect which manufacturers are less able to circumvent, the exhaustion or first sale doctrine. The exhaustion doctrine finds that after a product has been sold the OEM has no true say in how the product is meant to be used, it can be sold and/or repaired (with unpatented parts) (Ghosh, 2023). These extents to refurbished parts, even those bearing

trademark logos (Montello, 2020). The exhaustion doctrine is, however, not all encompassing and can only be applied to certain defences and does not limit the ability of OEMs to use the laws given to them to sue. It might only be applicable if the judge accepts the doctrine, and such limitation towards repair is often interpreted narrowly (Svensson et al, 2018).

The law around software is comparatively underdeveloped within repair, and while it should require new laws to better incorporate this newer aspect of everyday life often relies on law meant to protect against physical things. The rights to distribute and sell is exclusive to the OEM, as per copyright law. Moreover, due to security locks, third-party repairers are required to 'hack' into devices that block access to the operational software of a product. Trade secrets also guard software source code, considered valuable information, from discovery under reasonable measures. Software is harder to patent, but may still be protected under design patents. The only law which protects software is the EULA (see table 2).

To summarise, the legislation put in place to allow OEMs to innovate without being at risk of intellectual property infringement, are meant to benefit both the OEM and consumers. OEMs however have used these same legislations to create disadvantages towards the consumer regarding repairs. Their insistence with withholding information and access to not only manuals and parts, but also software, have created an unsustainable market in terms of both value and environment.

Information as a right.

In this part the results indicate the beneficial information has on consumers associated with repair. Discussing the benefits and shortcomings of two prominent examples of repair indexes currently in use. Moreover, this section discusses which types of labels consumers find more beneficial to their purchasing habits and choices, giving context to future labels.

When it comes to RtR, a legislative change does not have a direct correlation with the change of behaviour of the consumer (Brown, 2020). Instead, what is needed to better nudge the behaviour of the consumer is to further inform the public not only of their rights, but also of the repairability, availability of parts and manuals, and difficulty of repairs (Perzanowski, 2021). In so doing the consumer has the opportunity to learn more about the product properties and integrate this information at the time of purchase; e g choosing to buy a more durable and repairable product. As such some of the literature has focused on the educational aspects of the RtR movement. There are arguably two main aspects to this topic, labels and education. Fishlock et al. (2023) utilised project-based learning (PBL) in an engineering class to educate students on the possibility of creating repairable products, bridging a gap in

knowledge regarding the environmental aspects of education. Through this process they found an overwhelmingly positive response to PBL. It is however difficult to know the true outcome of the experiment, but it does showcase the possibility of implementing similar educational strategies in at least higher education. Arguably, such strategies could be used to guide future generations in the direction of becoming more considerate consumers. It also furthers the educational structure, helping to create a paradigm shift towards more sustainable teachings.

Beyond the educational aspects, most of the literature on the topic focused on information through labels (Barros & Dimla, 2023; Brown, 2020; Tischner & Stasiuk, 2023; Dalhammar et al., 2022). While there are two score systems for repairability, the French Repair Index and iFixit (Barros & Dimla, 2023), other forms of labelling, such as energy, be it obligatory or voluntary, are more prevalent around the world. The French index of repairability (IoR), introduced in 2021, is structured around five criteria (1) documentation, (2) ease of disassembly, (3) availability of spare parts, (4) price of spare parts, and (5) product specific sub-criteria *or* update and remote assistance (Dalhammar et al. 2022: 24; Barros & Dimla, 2023: 927). The biggest limitation around this system is the equal weight each criteria has. When scoring for repairability, an OEM can increase the overall score by, for example, making spare parts available, but simultaneously having a high price for said spare parts or having the availability and price be fair but having the phone be hard to disassemble. Thus, giving the consumer, a false sense of repairability. There are easier fixes for this problem. As suggested by Dalhammar et al. (2022: 24), the introduction of 'must meet' criteria or 'critical' and sub-criteria crates a closer balance between the different criteria allowing for a more accurate picture of the repairability. As can be seen in the Ecodesign directives and obligatory energy labels for smartphones in the EU (EC, n/a.b).

IFixit in contrast addresses the repairability of a device and does not address the last three criteria at all, and only partially addresses the first criteria of the French IoR (Barros & Dimla, 2023). The repair in question is however centred around the layman's repair, i.e. DIY, pairing the score together with a list of strengths and weaknesses, something that the French IoR does not cover (Barros & Dimla, 2023).

Evidently, while steps have been taken in informing consumers of the repairability of their devices there are aspects which can and should be worked out. Furthermore, the efforts that have been made on a governmental level are largely exclusive to France. Further legislation is needed to better change the industry. As argued for by Dalhammar et al. (2022) it would be more beneficial if such legislation is established further up in the international hierarchy. As the creation of multiple different IoRs would create confusion amongst OEMs, and would, in the case of Sweden for example, not prove very useful as due to

Sweden's population size. Being around 1/7th the size of France does not create much power in terms of bargaining power when it comes to creating legislation aimed at OEMs of such size and reach. Instead, what is suggested is to establish such legislation on an EU level as it would create both a market standard and make it easier for OEMs to follow regulations.

Ramirez and Boulbry (2016) found that between similarly priced products, those that were labelled had between a 20–44.7% increase in simulated purchases. Utilising four different labels, namely lifespan in years (LSY), useful lifetime (UL), energy (AG), and cost per year (CD) (EESC, 2016: 64-65), the study examined the differences between different forms of products from washing machines to jeans, seeing how differences in age-groups, price classes, and genders played a role in purchasing habits (EESC, 2016: 67-69). What they found was that younger people were more likely to factor in the information of the labels. Labels proved to have an effect regardless of price range, but more people chose to buy items when they were either under €900 or between €1,500 to €3,500 and found labels to have an impact regardless of gender. Moreover, certain labels were found to have a better recognition rate, with lifespan being recognised 82% of the time followed by AG (66%) and CD (60%) (EESC, 2016: 76). Milios and Dalhammar (2023) came to similar conclusions regarding lifetime labels, finding them to be the most preferable.

It is also important to consider the implications mentions of durability, repairability, and other similar terms have or may be understood contextually. For example, Milios and Dalhammar (2023) explains that due to the never-ending releases of phone and laptop models coupled with their technological advancements, the durability of such products may be seen as unnecessary. Regardless, durability is a positive factor for consumers when purchasing a products, oftentimes it proves more important than repairability as consumers trust the OEMs warranty for such matters.

Certain examples of similar AG labels that have already been implemented on EU levels is the energy label regulation. The regulation currently gives information related to annual energy consumption, noise levels, and an overall energy efficiency class, which was rescaled in 2021 due to increases in efficiency from OEMs (EC, n/a.a; Barros & Dimla, 2023). A 2019 Eurobarometer study found that 93% of consumers recognised the energy labels and 79% considered it when buying energy efficient products (EC, n/a.a). Moreover, the directive also changed requirements regarding the repairability of certain household appliances, such as washing machines, dishwashers, fridges and freezers, and electronic displays, to include requirements regarding ease of replacement of spare parts, extending the availability of key parts and manuals to a minimum duration of 7-10 years depending on the product.

The ability to inform the public cannot be said to exist within the U.S. As discussed by Brown (2020: 239), there are guidelines made by the Federal Trade

Commission (FTC), such as the label being "clear, prominent, and understandable" while also distinguishing "between benefits of a product, package, and service" and refraining from making claims that are overstating the environmental benefits or attributes and that avoid making comparative claims in order to "avoid confusion about the comparison." However, when it comes to the actual labels, the system is primarily run on a division of required and voluntary basis, which creates problems when comparing labels as different criteria create different values while simultaneously not being provided on a national scale (Brown, 2020). While this diminishes recognition of the labels it ultimately does not affect the purchasing habits of the consumers. The most prominent examples within the U.S. are Energy Star, EnergyGuide, and Electronic Product Environmental Assessment Tool. With most labels being voluntary, it makes it harder for consumers to gain the needed knowledge to make proper decisions, and with such labels being used seemingly arbitrarily it make it unclear if the product in question either was not tested or did not pass the standard (Brown, 2020).

To summarize, steps are being taken to better inform the individual regarding the affect their purchases have on both the environment and their wallet. Labels can both provide better, more accurate information to the consumer regarding the products they buy, but also shift the priorities of the OEMs to provide more repairable or energy efficient products as otherwise the consumers may look elsewhere.

3.1.2. Right to '*Repair*'

'Repair' in the context of RtR is oftentimes centred around legislative changes that in one way or another extend the lifespan of an item. For most of history repairs were purely physical, attaching a new handle to a tool, replacing a leg on a table or chair, or replacing a gasket on a car. However, with the introduction of both smart technology and software, *repair* has come to include far more complex array of things. Furthermore, with such complexity, the ability to repair also becomes much more difficult than exchanging the leg of a table. The repair of tech is often deemed to be beyond the capability of the consumer of said technology. Thus, to make repairs more achievable for the consumer the repairs must become simplified. One way in which this might be done can be by redesigning the device to account for a higher ease of disassembly, i.e. modularity.

Table 3. Strategies for repair.

Strategies for repair	Explanation	Benefits	Limitations	Examples
Modularity	To exchange or upgrade parts of the product when broken.	Ease of disassembly, and upgradability.	Creates more e-waste than part restoration, but less than current global trends.	Fairphone. AIAIAI. Framework.
Repair	To restore a part of the product to its original condition.	Less material uses.	Take longer time. Requires a higher skillset.	Soldering. Sewing.

Repair is a term colloquial not used as an alternative to modular. Instead, repair functions as an umbrella term that, in this case, includes modularity. Repair is not often discussed as more than a term, being seldom defined within the literature, apart from the occurrence in Wiseman and Kariyawasam (2020: 140) who utilised the Australian governments definition.

It is no question that extending the lifespan of a device is beneficial to the environment, at least so long as it holds up with the energy efficiency of newer models. Amend et al. (2022: 1) found that the "*users of modular smartphones are more likely to use repair instructions*" and "*modular smartphone design increase positive experience with repair instructions*." Furthermore, complementary products and service innovations have proven fundamental in promoting the lifetime extension of products within the tech industry, so long as they are implemented and managed successfully, one needs to look no further than the modularity of stationary PCs and AIAIAI, and repairability of Fairphone. There is a very slim margin of error to change the perception of repairability for technical products, if done incorrectly the idea of repair-friendly may attach negative connotations resulting in opposing.

The focus of the subsequent sections is the "repair section" of RtR. The first part on physical aspects of repair, second part on software 'repairs.'

Parts & Manuals.

This part posits the primary barriers towards RtR concerning the acquisition of parts and manuals. By using examples from existing businesses working with and towards better repair, those barriers are argued to be created for the purpose of limiting repair.

In a study done by Rosklada et al. (2023) in which experts within the field were asked about the difficulties around repair the two most agreed upon areas

were the lack of spare parts and lack of clear and complete manuals. It is of utmost importance to make such aspects of repair available to both the consumer and independent repair shops. Some of the largest barriers are the cost of diagnostics and repair, unavailability of repairing service, and the consumer's time for repair (Svensson et al., 2018). This is primarily done for the OEM to retain the business of the consumer, as this ultimately is the key driving force of the producer (Montello, 2020). As such, even if the consumer goes to the authorised repairer, being perhaps the only option, the cost of the repair may be too high to justify extending the life of a device that is older than a couple of years, or the time it takes for the repair to be conducted may be to long for the consumer to spend without the device. Being, for example, without a washing machine while having three young children does present certain challenges. It is then of importance, to better guide consumers towards repair, to create a more open access to repair (Svensson et al., 2018). To do so, access to repair needs to be created through the removal of preventative barriers, both legal and non-legal, after which barriers related to cost must be changed to make repairs more competitive which can in turn create a mainstream repair society through a systematic approach focused on guiding consumers towards repair instead of discarding (Svensson et al. 2018, figure 1).

As has already been mentioned (*laws & legislation*), the OEMs do give a multitude of reasons as to why parts, manuals, and diagnostics cannot be provided in the way that would favour most consumers, mostly having to do with trademark, trade secrets, consumer safety, and copyright.

In summary, while much can be said for the behaviour of OEMs regarding the availability of parts, manuals, and diagnostics, it is still possible to create a system in which parts and manuals are available and products are created to incorporate repair as an integral part of the experience. Moreover, with many legislative measures sweeping across the globe creating obligations for OEMs to supply consumers and IRs with repair parts and instructions, the direct dependence on OEMs for (in-house) repair is becoming less problematic.

Software.

What will be discussed here is the applicational aspect of software: how it is important to ensure the prolonging of software support to both ensure the usefulness of a device and maintain the engagement of the consumer.

As new devices are entering the market every year, there is a need to make sure that the consumer is not exchanging their devices "voluntarily", but instead wait until it is truly necessary to trade in for a new one. As discussed by Scott and Weaver (2014), the concept of relative obsolescence can be divided into three primary types; a) psychological; b) technological; and c) economic. Software plays a central part in ensuring the continued use of devices as

through continued updates software can bring aesthetic satisfaction, functional abilities, and maintain the devices economic value to the consumer.

This is not to say that updates are always welcomed, as can be exemplified by both Apple and Microsoft. Apple has over the years been both fined and found guilty of purposefully slowing down their devices to, in their words, extend the battery life of their devices, by updates; however, doing so without explaining it to their customers, nor giving their customers the ability to opt out of the update (Montello, 2020). The guilty verdict came during a case from 2017 (Lawler, 2023) and in 2020 were fined €25 million by the French government (Dillet, 2020). Moreover, a study focused on the Windows 11 update has concluded that when the update goes into effect in 2025 some 240 million PCs will become e-waste as the discontinued support for Windows 10 also includes security updates: computers unable to upgrade to Windows 11 risk security breaches. Microsoft has set very strict requirements for the Windows 11 update, e.g. a motherboard which requires a TPM chip. While updates do serve a purpose, the "planned obsolescence" of these types of actions are negative (Eaton, 2023; Caddy & Jessop, 2023).

Then there is the question of if it is fair to force companies to continue updating the software of their products. Many companies argue that while the hardware is the property of the consumer, the software is still property of the OEM. Gomulkiewicz (2022: 961) suggest a reframing of the idea around software repairs, identifying three measures to engage with updates, namely: "(1) *revert* to prior versions of a software product; (2) *refuse* updates; and (3) *receive* repairs for a certain period of time." The issue with software, according to Gomulkiewicz (2022), is that it oftentimes is automatic, not necessarily an up*grade* from the consumers point of view and may allow consumers to persist with software updates they find appealing. The third point does tie into the question of fairness for the OEMs, as OEMs find incentive in moving consumers onwards towards newer versions as opposed to having them remain on older versions which needs to be updated for security reasons which would cost the OEM in labour to maintain outdated software. The period in which a software update is being supported by further security updates is currently problematically short, especially within the phone industry, oftentimes covering only the warranty period. Gomulkiewicz (2022) goes on to suggest that legislation should mandate or nudge OEMs to better disclose which rights the consumer has regarding the three previously mentioned suggestions. This could perhaps entail that the OEMs give the timeline for the products software updates ahead of time to allow the consumer to make better decisions.

In conclusion, software is an integral part of repair and should be addressed in RtR legislation. Furthermore, the fining of companies when they use updates to induce "obsolescence" is a step in the right direction. As it sets a precedent for possible future measures.

The need to consider prolonged support of software (and/or security) updates is possibly the most important aspect of software today. To make sure that consumers can engage with their devices for longer periods of time is of utmost importance in securing a more circular future.

3.1.3. Barriers of repair

While reading the literature four main themes arose regarding the barriers RtR faces. These themes have been divided into two main areas of focus, rights (information and laws), and repair (parts and manuals, and software). These barriers are meant to create difficulty for the consumer when they attempt to repair. As Svensson et al. (2018: 2) found, the consumer, when faced with a broken product, can resolve it through one of four main ways: 1) go to the seller/OEM and either exchange or repair it from an authorised repair service; 2) do it themselves; 3) go to an independent repairer; or 4) throw it away and buy a new product. What most often determines such a decision is availability of spare parts, manuals, and cost of repair, or in other words, the convenience of repair (Svensson, 2018). These determinant factors also function to limit the number of options the consumer truly has, for example, if there is a limit on spare parts and manuals, the consumer is unable to do it themselves or go to an independent repairer. The consumer is thus forced to either go back to the OEM or throw it away and buy new. Moreover, as was shown in table 1, there are forms of obsolescence, by/from both the OEMs and consumers, that determine the probability of repair. Oftentimes they are grouped into external (OEMs) and internal (consumers) aspects, i.e. planned-, premature-, and functional obsolescence, and psychological-, technological-, and economic obsolescence.

3.1.4. My definition of Right-to-Repair.

RtR contains a plethora of different aspects, all interlocking to become, if implemented, a fundamental change in the way policies is written and structured. Having looked at many different parts concerning both the rights and repair aspects of RtR, the final definition given for the term is:

> The allocation and distribution of funds, resources, and information, through legislative intervention, towards independent parties, be they people or businesses, to encourage repair, of both hard- and software,

to maximise the lifespan of products to support sustainability objectives and help consumers economically.

3.2. Policies to propose repair rights for consumers.

This section aims to answer the second RQ, discussing the possible effects policies that have or may be introduced to benefit particularly consumers in their attempts to repair. The focus will firstly be on establishing the psychological aspects which make consumers more favourable towards repair. The two subsequent sections focus on policies within the two major areas which most likely affect the consumers stance on repair: economic incentives, and information. Beginning with economic incentives, of three current incentives within primarily three European countries are discussed: the value-added tax (VAT) deduction of Sweden, the fund system in France, and the subsidies in Austria. The second subheading, partially covered in *information as a right* considers how information can affect the consumers to choose more repair friendly devices. As this has already been covered in part, this section will not be equally in depth as that of economic incentives. But first, what are the psychological aspects to repair?

Marikyan and Papagiannidis (2023) find that repair, as with many aspects of life, is a social issue. It is dependent on the opinion of others, both in closer social circles and the broader environment, how we interact with repair. Through our tendency to mimic social conduct to become part of a group, Marikyan and Papagiannidis (2023) argue that individuals are more willing associate themselves and create an image of an environmentally conscious consumer. However, the paper also finds that environmental concerns and activism are not influences when it comes to consumers decision-making, most likely due to the indirect connection sustainability must repair in the eyes of the consumer (Marikyan & Papagiannidis, 2023). Consumers wish to be part of a social circle which may influence them to become more environmentally conscious, but the decision to repair is not made in accordance with sustainable thinking, instead it is purely dependent on the wish to be part of a group.

Moreover, while repair may be of interest to the consumer, their intent to repair weakens when the, oftentimes, increased costs of repair become apparent, as such decisions "often take the form of rational cost-benefit analysis (Marikyan & Papagiannidis, 2023: 16). Furthermore, consumers are, according to Marikyan and Papagiannidis (2023), dependent on their beliefs

about legislation. That is to say, the consumer, while seeing the benefits legislation may bring towards their right-to-repair, don't think it is not enough to change their behaviour. Marikyan and Papagiannidis (2023), has thus found three important aspects to consider when planning policies, 1) repair is not about sustainability but rather about monetary expenses; 2) repair is dependent on larger social structures, more than the individual's belief; and 3) legislation is not enough to persuade change in behaviour, other factors are needed to make change happen.

This if further supported by Parajuly et al. (2023) which present three primary aspects that influence the consumers engagement with repair: 1) intent to repair is dependent on "attitude, perceived behavioral control, and social norms;" 2) techno-economic settings, i.e. ability to repair both technically so well as economically; and 3) intervention strategies.

Regarding the first point, attitudes and behavioural control is seemingly dependent on separate contexts. Within the context of repair cafés and communal repairs, attitudes towards repair are a driving factor, i.e. one must be open to repair to engage with it in public spaces. Simultaneously, when it comes to repairs at home the driving force is perceived behavioural control, i.e. the perceived ability, or skill set, to perform repairs (Parajuly et al., 2023).

The second point considers the general ability to repair: is it possible to find parts and manuals and are the repairs costly. It is here structural changes are needed in the form of legislation. To create better possibilities to engage with repair. This, in part, connects to the third point. Forcing companies to design devices which are more repair friendly (Parajuly et al., 2023). An example here of a policy that could drive such change could be the 2027 EU requirement regarding removable batteries.

To summarise, the primary factors concerning repair are behavioural, economic, availability of parts, and the designing of more repairable devices, i.e. convenience. The subsequent sections will primarily focus on the first two aspects, creating an understanding around repair which may in turn change its social norm, and establishing repair as an affordable option to wear – tear – buy new.

3.2.1. Economic incentives.

In this section I go over the most prominent examples of economic incentives currently and indicating possible issues and effect they may have on consumers repair habits.

One of the most determinant factors regarding repair is cost. Often cost stands in the way of repair for both the consumers and OEMs, as the OEMs oversee the availability of parts, and their cost, making it too expensive to

replace parts at an IR shop; and in terms of their in-house repair, they may increase the price to the point were buying new is preferable and cheaper. Moreover, as previously mentioned, OEMs can site cost as an excuse to not repair.

Table 4. Summary of the incentives and their functions.

Incentive	Description
Subsidy	Voucher lowering cost of repair by upwards of 50% (max €200) /person/year.
Fund-based funding	Portion of price on sale of new product goes to repair fund. The funds subsidies a share of the cost for later consumer repairs.
VAT reduction and income tax deduction	VAT lowers the tax of certain items when repairing them to between 5-14%. Income deduction lowers tax by higher margins and for devices more often regarded worth repairing.

To circumvent this, countries have created economic incentives to get consumers to engage with repair. As documented in Dalhammar et al. (2022) and Etzinger and Reimann (2023: table 1) there are three primary examples currently used as economic incentives: subsidies, VAT reduction and income tax deductions, and fund-based funding. All are utilised primarily within Europe. The subsidies function through a voucher system in which the consumer submits a request for deduction of repairs by 50% (maximum €200) at the point of sale (Piringer & Butler, 2022). The best example of this system is in Austria where it was implemented and expanded to cover the country within two years. The system is funded through a Covid-relief fund, but could, as with the case of France and their fund-based funding (see table 4), be funded through the sale of electrical appliances where the OEM puts a portion of the sale into a state-administered fund which is "used to reimburse consumers directly for part of the repair costs" dependent on the type of product, where the repairer applies for reimbursement for the amount discounted, often between €10-€45 (Etzinger & Reimann, 2023). The Austrian vouchers, and the French fund, only work at certain repair shops which are part of a network across each nation. To be part of this network in Austria the shops must meet certain requirements, such as "having a maximum price for initial diagnosis

[and] providing warranties for repair" (Dalhammar et al. 2022). These requirements can be seen as anti-competitive as all shops are not able to participate in such a network. However, it does give the consumer the best form of security of both price and warranty that their devices will be fixed and stay that way regardless. Since being made national in 2022, the Austrian Environmental Ministry has redeemed more than 560,000 vouchers, surpassing the expected number of 400,000 by the start of 2026 (Symons, 2023).

Moreover, being required to contribution to such funds may incentivise producers to sell products with better life expectancy. It also results in the consumers being more likely to invest in higher quality repairs and parts when subsidised (Dalhammar et al., 2023).

The VAT reduction on repair is part of an effort to incentivise repair through a reduction in the tax on certain products, and is used by a host of different European nations (Etzinger & Reimann, 2023). Dalhammar et al. (2023: 18) found five explanations as to why the VAT reduction has seen less that promising results in countries such as Sweden:

1. Public is unaware of the tax relief.
2. It does not lead to a reduction in cost, but an increase in margins for repairers.
3. The reduction is not significant when compared to labour costs.
4. The price and quality of the product primarily determines the willingness to repair – not the price of repairs.
5. Swedes are reluctant to repair those types of products.

The same cannot be said for income tax deductions, as consumers are more knowledgeable about them and more willing to repair those types of products (i.e. electronic products). Similarly, such deductions are more align with the cost of labour to become of importance, as it can account for upwards of 50% of the labour cost compared to a reduction from 25% to 12% in Sweden (Dalhammar et al., 2023; Etzinger & Reimann, 2023).

In summary, the awareness of economic incentives is dependent on the incentive. While vouchers have seen a widespread use in Austria, the VAT system in countries like Sweden has been less able to capture the attention of the consumers. Reasons given for this are definite things to consider if new initiatives are ever pursued. The types of products which are being subsidised and the amount of money given to cover repair need to be in line with the values of those wishing to repair. Moreover, as previously mentioned regarding repair indexes, it could prove more viable if incentives were made available through international structures and funded by international means, such as the EU.

3.2.2. Information as policy.

As discussed previously regarding the importance information has in relation to the consumers decision-making and the OEMs necessary shift in priorities with regards to labels (*information as a right*), this section instead focuses on the effects information may have on the purchasing habits of consumers and which other forms of information may be necessary to change consumers behaviour more effectively.

The biggest determining factor in terms of willingness to repair, according to Rosklada et al. (2023), is consumer awareness. Specifically, the lack of knowledge regarding the impact of repair, its moral implications, which rights the consumer has, and the importance of prolonging the lifespan of the product. Coupled with the desire for new products and a lack of engagement and popularisation of repair (Rosklada et al., 2023), information can prove to be a highly effective tool for changing such behaviour if accompanied by motivation and comprehension (Hernandez et al., 2020). It is then important to not only provide the information but to also educate the population on matters of repair and its effects.

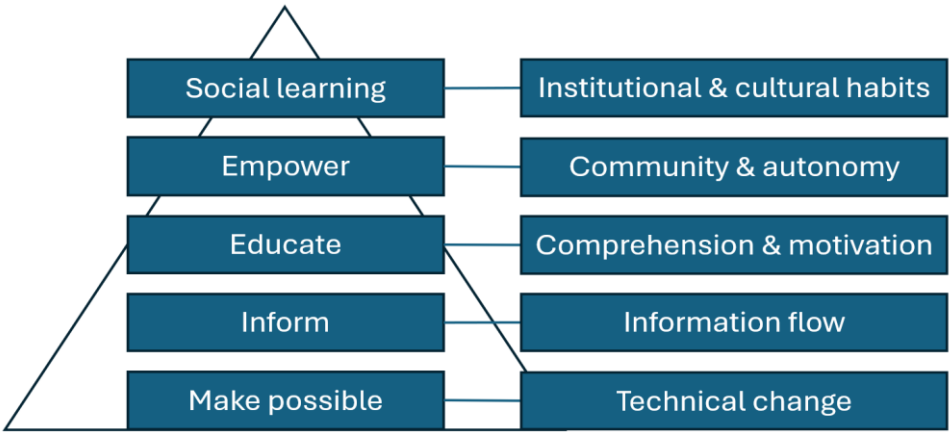

Figure 3. Possible policy approaches to repair behaviour (Hernandez et al., 2020: figure 2).

Fishlock et al. (2023) found a strong, positive, engagement with repairability among engineer students. To allocate resources towards engagement with repair within grades lower than engineering, i.e. low-, middle-, and high school, may allow further engagement in later parts of life. Moreover, it may increase the self-assuredness for consumers to attempts repairs on their own, i.e. comprehension, normalising behaviour and social norms and cultural habits around repair, providing support for what Parajuly et al. (2023),

suggested shapes both the perceived behavioural control around repairing items at home as well as the communal abilities for repair.

In terms of direct information, the study done by the EESC (2016) showcased the effectiveness labels can have in terms of influencing purchasing decisions, with an increase in consumer choice regardless of which label content it pertained to. Important to note is the way such information is presented, as the energy label used closely resembled the EU energy label, which were both most recognised and proved most effective in influencing purchasing decisions. This may, according to the EESC, be an effect of consumers having had time to get used to the label, coming to understand its meaning. However, the most understood label, in terms of its content, was lifespan, displayed in months and years, as opposed to a similar label showcasing other units showcasing larger quantities, which were found to be harder to mentally picture, e.g. 10 000 hours or 500 cycles. Similarly, displays indicating annual costs of a product were found to be both the least understood and worst performing (EESC, 2016).

Moreover, as previously mentioned, France's and iFixit's IoRs provide a sufficient basis upon which further legislative and regulatory applications can be made. Their application would, however, prove more useful becoming part of supranational union legislation as that would both create recognition towards the labels, as well as create a unified system under which both customers and OEMs can rely for both information and structure.

To summarise, information is an important factor in promoting sustainable actions, be them repair or otherwise, but is not able to change behaviour alone. To change behaviour, one needs to view repairs (in this case) in their surroundings and interact with it in a positive setting as well as better understand the effect it has on both the individual so well as the environment. As such there is a need to educate people of the impacts repair has, and this should be done in both schools and while purchasing products. As for labels, they prove appropriate to give the consumer context as to the product's reliability within the lives of the customer, ensuring longevity of the product for an extended lifespan through repair.

4. Discussion

> Man cannot be freed by the same injustice that enslaved it.
>
> - Pierce Brown, Red Rising, 2014.

The continued growth of e-waste marks a dangerous path for humanity in dealing with its problematic relationships with controlling and destroying nature with little to no regard to the effects such actions will have.

The results indicate three thematical areas of importance (1) legislation, (2) information, and (3) economy, as can be seen in the formulated definition. This further creates a threefold of blame with (i) (inter)national government(s) only now starting to pass legislation meant to give back rights to their citizens having allowed corporations to lobby damning legislative changes in the past, (ii) corporations working against the rights of their consumers, and (iii) consumers remaining short-minded and illogical in their decisions making and with their purchasing power.

OEMs have, over the last century and a half, lobbied their way towards total domination of resources and information within their fields. Creating boundaries within which consumers must navigate with overlapping laws meant to make it impossible to repair, which in turn makes it impossible to enact environmental and economic change. One of the most basic but also fundamental aspects within the Right-to-repair movement is that once someone has bought something that in the future might need repair, they should be able to do it. They bought it, they own it, why can they not do whatever they want with it? The existence of laws, such as the design patents, is understandable from the OEMs perspective, but when considering that the item in question no longer belongs to the OEM but is the rightful property of the person who bought it, it makes little to no sense to not allow them to do whatever they want with it.

The governments that push for more environmental responsibilities and stricter regulations have also allowed this to happen and persist, thus ultimately failing in their responsibilities towards future generations and the safety of both their citizens and the environment. Being created to govern, to create laws under which everyone and -thing is held to the same standard, helping to enact change. Being voted for by the citizens of their respective countries, their work

is to benefit the people, not the producers. Democracy is the rule of people, not companies.

Beyond the companies and governments of the world, to better motivate consumers to repair more comprehensive measures are needed. While Europe and the EU are making progress to lower costs of repair, the same cannot be said for the rest of the world. As Hernandez et al (2020: 7) discusses, "motivation is a fundamental issue in the case that products have to be repaired" and such motivation can arise from, among other things, economic incentives. Moreover, the lack of emotional and economic attachment to products, which can be improved through repair, is currently low. As products are purchased and discarded to attain newer versions, and those versions are equally flimsy, unrepairable, and as destructible as the previous model it is no wonder why repair is a difficult attractor. Furthermore, as previously discussed by Parajuly et al. (2023) the techno-economic ability to repair is indeed significant, if structural changes are made with regards to system perspective of repair it is likely to change consumers repair behaviour, more so than individual interventions, i.e. if repairs are made available both in terms of material and economic availability, e.g. parts increase and costs decrease, repair can become more attainable. Such changes may also increase the second-hand market for computer and phone parts which may bring down the price to become more competitive and affordable (Gonzales et al., 2022).

Many of the arguments made by OEMs against RtR is seemingly dependent on the assumption that proposed legislation while being a disruption to the status quo of these OEMs, instead are being made on the presumption that the current way is the ultimate way. Essentially arguing that obligations towards availability of both parts and manuals will exist within the same production structure that is in place today. The battery law passed by the EU which will go into effect in 2027 is an excellent example of why such a presumption is wrong, as it will force the OEMs to change their designs or their devices will not be allowed to be sold within the EU, which makes up a substantial part of the revenue of the tech industry. The argument that such a change is beyond the ability of the tech industry would be ignorant. Yet, a similar, if not the same, argument is being made when the discussion around parts is being pursued. To claim that change is not possible is ignoring the massive change that has already happened within the last 20 years. The possibility is there, it is only the reluctance and comfortability within the current broken structure that makes the OEMs not wanting change. Who is to say that the change will not result in mutually beneficial changes for both the consumer, manufacturer, and in turn the environment.

Based on personal experience such access is not an alien concept. It is being implemented by companies leading the way towards a more sustainable tech industry. Companies like Fairphone who make smartphones/headphones

that can be fully taken apart by the consumer when needed to change anything independently: the battery/USB-C port/screen/cameras; all to minimise the need to change devices as soon as one-part breaks. Moreover, they work with distributers to guarantee that the supply chain is free from conflict mining, and using as much recycled plastic as possible. Furthermore, they guarantee a minimum of eight years of software updates (aiming for ten years) and five-year warranty. Framework, another company who make laptops that are fully modular and hardware swappable, are also showing the benefits of changing the game to become the "go-to" company for modular computers. Another example is AIAIAI, a Danish headphone and speakers' company, who produce modular headphones that allow for the replacement of all parts of the headphones allowing for a change in both sound, comfort, and functionality. This also allows for the replacement of specific parts instead of the entire headphones. Another example concerns Fairphone's headphones which, instead of focusing on modularity in the same way AIAIAI does, are instead centred around repairability, to allow for changing of parts when needed instead of when desired. They also focus on the environmental aspects of modularity, using recycled plastics. These companies started with different strategies but share the same ambitions to both minimise the amount of e-waste produced each year and to help consumers save money by swapping the necessary parts instead of the entire device (Fairphone, 2024; Framework, 2024; AIAIAI, 2024).

While there is an argument to be made regarding the security and copyright infringement, the inclusion of manuals and spare parts at reasonable prices and for more reasonable periods of time does not necessarily need to result in security risks or copyright infringement. Repair-specific manuals can, if structured intuitively in addition to a repair-friendly device (Taffel, 2023), be simple step by step instructions negating the need for complete information and possibly even allowing for the upgradability of those same devices, creating a system in which smaller devices can work like larger stationary PCs, or the Framework laptop. To say that full, secret divulging, manuals containing every bit of information about the device is needed for the layman's repair is both unnecessary and arguably an exaggeration of reality.

5. Conclusion

The duality of the paper has focused on first establishing the fundamental aspects of the RtR movement, considering for whom it is meant, which laws and legislation affects the effectiveness of the movement, and different aspects of repair that needs to evolve beyond their current ways, i.e. information, availability of parts, manuals, diagnostics, etc., and the extension of software updates. Legislation is central to almost every aspect of RtR, as such there are plenty of changes that can increase the ability to repair, such as (a) limiting the application of trademarks to only account for external aspects of a device, (b) create exclusions for copyright and design patents regarding aftermarket repairs, (c) ensuring stronger consumer laws and EULAs related to repair priorities, (d) prioritising repair over other measures during warranty periods, (e) creating laws specifically meant for software, ensuring that software does not slip through the cracks of contemporary legislation. Through this a definition of RtR was created focused on encompassing all relevant aspects and themes discussed in the paper:

> The allocation and distribution of funds, resources, and information, through legislative intervention, towards independent parties, be they people or businesses, to encourage repair, of both hard- and software, to maximise the lifespan of products to support sustainability objectives and help consumers economically.

The second focus of the paper was on policies effects on consumers repair habits, specifically on economic and informational incentives. Economic incentives prove to be the biggest determinant factor of repair, being incentivised only if the product is considered valuable enough to warrant repair. Moreover, incentives prove most useful when accounting for a larger portion of the repair, as can be seen by the failings of the VAT system in Sweden. Instead, what is needed is a network, preferably across nations, of vouchers or similar discounting measures towards set prices. These repairs then have access to necessary parts regardless of affiliation to the OEMs.

Propper information has immense habitual and enforcement abilities for both consumers and OEMs as it creates clarity for consumers in their

purchasing while simultaneously incentivizing OEMs to make more repair-friendly devices or otherwise risking exclusion from consideration of consumers. This should be furthered through legislative means.

More research is needed into different measures and incentives that may influence consumer habits. Most urgently there is a need to expand the possibility of existing incentives, seeing if they may have an application in other nations, and perhaps across nations. For example, the voucher system of Austria could be placed in a nation like Sweden where repair is less popular to see if repairs increase. Moreover, research around labels specifically measuring repair should be investigated to see the influence it may have on consumers.

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