



Barriers, enablers and market governance: A review of the policy landscape for repair of consumer electronics in the EU and the U.S.



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ABSTRACT

Many strategies have been proposed to support the transition to a Circular Economy (CE). In most cases, circular design and product life-extension practices specify repair as an essential element. In both the EU and the U.S., policymakers are attempting to increase the amount of repairs made, through the introduction of recent EU Ecodesign regulation changes and proposed US Right to Repair legislation. This review explores the current policy landscape for repair services by first outlining legal and market barriers to stakeholder participation in repair activities, and which stakeholders are affected. The review reveals a wide range of fundamental obstacles to both supply and demand of repair, including Intellectual Property, Consumer, Contract, Tax and Chemical laws, along with issues of design, consumer perceptions and markets. Subsequently, the current and proposed policy solutions to address barriers and increase repair activities are reviewed. A comparative assessment of the EU and the U.S. is followed by a discussion on the current repair market governance structure, which is found to be primarily centralized (i.e. repair services concentrated with manufacturers), with possible implications for upscaling repair. New policy proposals challenge this governance. Introducing the concept of a Repair Society Framework as a market transformation tool, we comprehensively discuss the current state of repair and provide an outlook for research and policy in this area.

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1. Introduction

1.1. Electronics repair in the circular economy

The Circular Economy (CE) is still an emerging concept, based on the premise that the value inherent in materials and products ought to be sustained and recovered (European Commission, 2015). CE is also seen as an approach addressing broader resource and sustainability challenges (Dominish et al., 2018); CE has the potential to offer meaningful solutions to waste and resource efficiency issues by narrowing and closing material loops, and by slowing the speed at which materials and products complete their life-cycle. While the former two objectives rely foremost on eco-design and recycling, the latter is primarily accomplished through

designing longer-lasting products, reuse, upgrading, and engaging stakeholders in repair (International Resource Panel, 2018), (Cooper, 2005) - the focus of this paper.

Repair activities have been in decline for the last decades, indicated by e.g., a decrease in household expenditure on repair work (McCollough, 2009), (Cooper et al., 2018). An alternative is to promote a CE Repair Society, one in which repair is a cost-effective, convenient, and mainstream activity; its realization requires upscaling of repair services and activities. The goals and desired outcomes of such upscaling will affect the approaches to, and outcomes of the transition to a Repair Society. For example, an upscale motivated by enforcement of consumer ownership rights is achieved once all consumers are given the opportunity to engage in repair activities. In contrast, an upscale motivated by environmental protection and the realization of a CE requires a systems-perspective and more extensive interventions to create a wider demand, supply, and infrastructure for repair (International Resource Panel, 2018). An upscale with the objective to liberalize

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the aftermarket through equitable competition is believed to enable more opportunities for consumers to repair. However, increased competition within the repair sector can affect the marginal return on repair, and thereby the quality of the work that can be performed. This is less of a risk where repairers are organized in a way that allows them to distribute the cost of quality, which maintains the profit margins (e.g. repairers that operate within an OEM's authorized network). The risks for quality compromises are higher where such collaboration is not possible between repairers (e.g., independent repairers) (Banker et al., 1998). Effectively, price-based competition, without inter-firm collaboration, may come at the expense of quality. Such a development would not only lead to wasted resources, but also a potential confidence crisis among consumers. In this review, we define the upscale of repair as an environmental protection endeavour, which is both quantitative and qualitative.

To enable strategic policy decisions that successfully bring about an upscale of repair, governments need an understanding of the general challenges and opportunities of repair, and possible market governance structures. We focus particularly on the examples of consumer electronics and appliances to demonstrate barriers and solutions. Electrical and electronic products are also important in the context of the valuable resources used in their production and rising levels of e-waste that have led to increased focus on repair for these products (Balde et al., 2017).

The objective of this review is to increase the understanding of the role of policy in both creating and addressing barriers and opportunities for CE repair activities, and inform a "Repair Society" where repair is normalized. For this purpose we review the current market and legal barriers to consumer electronics repair and the policy solutions to mitigate these barriers, taking a systems-perspective, and comparing the EU and U.S. contexts. We outline barriers in Intellectual Property, Consumer, Contract, Tax and Chemical laws, along with issues of design, consumer perceptions and markets. Regarding market barriers, their inclusion is limited to those that can be addressed by policy. Subsequently, we identify solutions within these same legal areas, including Antitrust Laws and an overview of potential (voluntary) market solutions. Here, leading examples from EU-member states and U.S. states are brought up, both as examples of potential solutions and also as indications of where the markets are presumably heading; e.g., the provision in the 'Right to Repair'-bill regarding cars that was adopted in the state of Massachusetts (Commonwealth of Massachusetts, 2013) are now applied all over the U.S. through a voluntary agreement (Auto AllianceGlobal Automakers, 2014). In the final section, we compare and discuss the EU and U.S. repair markets, introduce frameworks in which the barriers and solutions are viewed within a system, including consideration for market governance.

1.2. Stakeholder participation and the repair society

The key stakeholders on a repair market represent the demand-side and the supply-side of the repair transaction, with roles and interests outlined in Fig. 1. On the supply side, we find Original Equipment Manufacturers (OEMs), Independent Repairers (IRs), and consumers performing repair themselves (do it yourself - DIY). The stakeholders on the demand-side consist of the individual consumers. The Governments set the market conditions. Ultimately, the planetary boundaries dictate the absolute limit to the activities on the repair market, requiring in particular circularity and long-term sustainability.

The demand and supply stakeholders' participation involves: a) being able and willing to conduct a repair transaction (selling or purchasing), and b) performing the repair. Participation in repair is

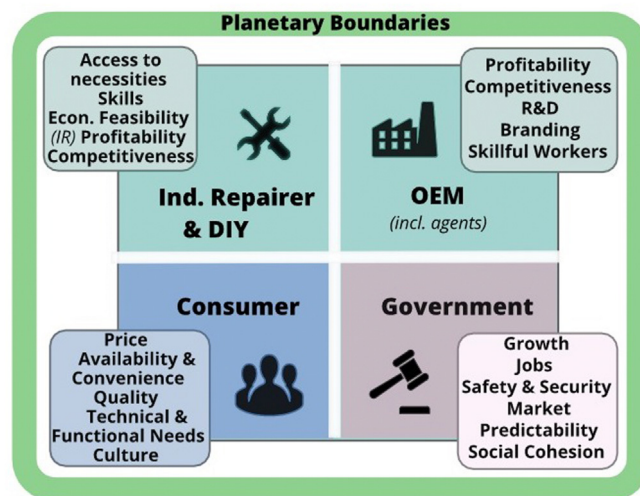


Fig. 1. Repair key stakeholders.

determined by several different factors that may be different for each stakeholder. When faced with a broken product, the consumer usually has four possible courses of action: 1) consult the seller, the OEM's repair division, or authorized repair service provider; 2) 'Do-it-yourself' (DIY) repair; 3) seek out an Independent Repairer; or 4) dispose of the broken device and purchase a replacement product (Yeh, 2016) (Svensson et al., 2018). Ultimately, this choice will depend on feasibility, financial appeal, and personal preferences. Hence, the consumer's final decision may be influenced by the price of the repair, access to repair, the location and duration of the repair service, the functionality of the repaired product, specific consumer needs, personal convenience, personal interest, and current fashions (Cooper et al., 2018), (Deloitte, 2016), (Lee-Woolf et al., 2016).

The supply of repair is complex, and one must distinguish between OEMs (and OEM-authorized repairers), independent repairers, and DIYs. To conduct the repair, access to the required tools, firmware, schematics, and spares is essential (hereby collectively referred to as 'necessities'), which are often controlled by the OEM of the product. Moreover, initial product design from OEMs proves crucial and, in the absence of specific legal rules, OEMs may have a strong influence on whether and how other stakeholders participate in repair. Independent Repairers and DIYs share many interests, such as the need to access necessities and have the repair be economically feasible. However, their relationship to OEMs can differ, and, unlike DIY, independent repairers must consider competitiveness and profitability. Through legislation and incentives (e.g. tax deductions), governments, foremost as policy-makers, have the ability to regulate product design and influence the competitiveness of repair services.

1.3. Scope, methodology and structure

This paper looks at the role of policy in the upscale of repair activities, viewed as key stakeholders' ability and willingness to participate directly in repair (i.e., transaction and the actual repair). We concentrate on features impacting the possibility of participation of willing stakeholders, while consumer perceptions and other stakeholder motivations are delimited to only brief overviews. This priority is made due to the fact that policy is deemed more relevant and immediate regarding ability to participate than willingness. The scope of this review addresses repair as a service, which includes the supply of refurbished spare parts; it does not include the sale of repaired or refurbished electronics. Further, while consumer

electronics are emphasized, examples of policy solutions regarding vehicles and farming equipment are examined when relevant.

Identification of barriers in Section 2 stems from a literature review searching major academic databases available through EBSCOhost search platforms and Google Scholar. The search began with searching legal barriers to repair. Keywords used included repair and barrier(s) and/or legal and/or consumer law and/or intellectual property and/or antitrust and/or copyright and/or patent and/or trademark, and/or contract and/or warranty and/or ecodesign and/or economic and/or consumer and/or culture. Google Scholar also yielded consultant and government reports pertaining to the keywords and 'right to repair'. Abstracts/summaries were then read to determine the relevance to the scope of this study and the final literature reviewed. As mentioned, consumer electronics were the main examples in the literature and we scoped out other product categories unless relevant to a certain issue for electronics. See Appendix A for a literature review protocol. Once the key barriers were determined, a subsequent search also targeted news reports on the latest developments in the legal repair issues, specific case laws, and policy documents. The solutions in Section 3 were found in existing policy proposals, academic and grey literature, or derived from the characteristics of the barriers.

This review is structured as follows: Section 2 provides a review of legal and market mechanisms impeding 'stakeholder participation', i.e., barriers to stakeholder interest and ability to participate in the repair market (conducting the transaction and performing the actual repair), focusing on impediments to ability. In Section 3, we review policy approaches that may serve to mitigate identified barriers, and thereby enable and promote increased stakeholder participation, in addition to voluntary market solutions as possible complements, or alternatives, to policy measures. In Section 4, we bring together the findings from Sections 2 (barriers) and 3 (current and proposed solutions) in comparing the U.S. and the EU contexts. The ability of stakeholders to participate in the repair market and the governance of repair is also discussed. The current state of repair from a systems-perspective is discussed with the introduction of a Repair Society Framework. Lastly, in section 5 we summarize our findings and suggest key areas for further research.

2. Barriers

This section explores the legal and market mechanisms that may limit stakeholder participation in various ways, i.e., preventing anyone from being able and willing to participate in repair activities. The barriers are presented according to the legal or market area they pertain to, e.g. Intellectual Property (e.g. patents, copyrights, design, and trademarks), Contract (e.g. end-user licence agreements (EULAs)¹ and sales contracts), Consumer Law (warranties and guarantees), Tax and Chemical Law. Other barriers addressed included consumer perceptions, design barriers, and market barriers. The difference between the EU and the U.S. are clearly indicated throughout the sections and the absence of such indication implies that the situation is deemed to be the same. For a summary of barriers to repair and which stakeholders they hinder, see Appendix B, Table 1 (columns 1 and 2).

2.1. Barriers in IP law

Intellectual Property Rights (IPRs) can limit repair opportunities. The doctrine of exhaustion and other exceptions and limitations to IPRs restrict the right holders' ability to enforce their rights after an

authorized sale has taken place (i.e. once the IP right holder has consented to have the product enter the market). Hence, these limitations to the IPRs generally allow for repair activities. However, some types of repair are hindered as IP laws prevent, or are meant to preventively hinder, reconstruction of protected work. E.g., in the case of patent, the repair cannot constitute a substantial alteration² - if so, it might constitute an infringing reconstruction.³ The IPRs thereby lead to wasteful behaviours as the protection deters extensive repairs. Overall, the narrow interpretations of exceptions and limitations are a consequence of IPRs being considered of greater importance as a property right, and therefore IPR holders' interests easily override interests related to CE (Pihlajarinne, 2020).

2.1.1. Patent

U.S. utility patents or simply 'patents' in the EU are issued for novel technical innovations. Many kinds of functions can be patentable. For instance, patents relating to cell phones can range from patents concerning cellular network technology to patents on "slide to unlock" systems.

Under **Patent law**, repair activities deemed 'reconstruction' or 'modification' are considered to directly infringe patents in the **U.S.** (**United States Code, 1952**; **U.S. Federal Circuit Court, 1997**; **U.S. Supreme Court, 1961**) and the **EU**^{4,5} alike. A patented product can only be legally repaired within its 'normal lifespan' - which is currently very narrowly defined (Pihlajarinne, 2020).

Unlike the sale of a product, genuine licencing ('licence') might not invoke the exhaustion doctrine, since ownership is not transferred. A licence can be viewed as a contract (see Section 2.2) or as an IPR permission of use. Hence, the IPR holder can stipulate stricter end-user terms via End-User Licence Agreement (EULA) and conditioned sales contracts.⁶ Stipulations in EULAs and contracts can forbid some types of repair, disassembly, and use of non-OEM parts. Prior to 2017, breaches to such end-user restrictions in a conditioned sales contract could be enforced as patent infringement in the **U.S.** (Mallinckrodt, 1992) but not anymore (**U.S. Supreme Court, 2017**). Instead, they are enforced under contract law and possibly copyright law (Gomulkiewicz, 2018). In the **EU**, the lack of harmonisation of national patents makes this an issue for national law.⁷ In both jurisdictions, a DIY repair cannot constitute patent infringement.⁸

The manufacture, sale, and import of spare parts can also directly infringe patents in the **U.S.** (**United States Code, 1952**) and

² Kohler (1900) p. 452-456.

³ E.g., the German Supreme Court has outlined the following test: initially assessed is whether the replacement of the components is to be expected during the functioning of the device. If so, it is considered a repair, unless the replaced components reflect the technical effect of the invention. In that case, the modification is considered reconstruction, rather than repair, and constitutes a patent infringement.

⁴ Since Patent law in the EU is not extensively harmonized, any mention of EU Law regarding patent refers to a rough overview of the member countries' such laws.

⁵ See for instance (German Supreme Court, 2012), (German Supreme Court, 2017).

⁶ The primary difference between the two approaches is that end-user restrictions enforced under IP law could allow the IPR holder to pursue the repairer for infringement. On the contrary, enforcement under contract law does not offer such a possibility, since only contractual parties are bound. However, a repairer could potentially run the risk of being sued for tortious interference, at least in the US. See (Gomulkiewicz, 2018); (McSherry, Walsh).

⁷ Patent law is not fully harmonized in Europe. At the EU-level, there is however, a directive on the legal protection of Biotechnological Inventions. Patentability requirements have been substantially harmonized by the European Patent Convention. Adoption of the system of Unitary Patents will enable obtaining a patent in 26 EU Member States by a single application.

⁸ For instance, see (European Parliament, 2013) article 27.

¹ EULA is a legal contract between a software developer/vendor and the user of that software.

the EU⁹ if these are unauthorized replications of a patented spare part. Supply of non-patented spares used to repair an article protected by a combination patent might be indirectly infringing in both **the U.S.** (United States Code, 1952) (U.S. Supreme Court, 1961) and **EU** (Holder and Schmidt, 2006). This constrains the aftermarket by forcing manufacturers of spares to keep track of what their spares will be used for. Unauthorized replication and distribution of patented tools, such as a specialized screwdriver, also constitute infringement.

Design patents (U.S.) or **design rights** (EU) are issued for unique visual qualities. Design patents on spare parts (e.g., a particular wave shape or corner of a device) makes replication illegal. If the spare is not available, this constitutes a barrier to repair if the use of non-identical parts would transfigure the appearance of the device, such as when a design patented side view mirror of a car has to be replaced with a generic one. In **the U.S.**, 'must-match' parts are protected, making unauthorized replication unlawful (United States Code, 1952), (Derclaye et al., 2009). In **the EU**, some spares are protected, while others are exempted from design protection (see Section 3.1.4 below about the 'repair clause').

2.1.2. Copyright

Under **Copyright law**, terms in EULAs, usually accompanying the purchase of a software-enabled product, regulate permissible use of the software. Sometimes clauses forbid unauthorized repair, disassembly, and/or use of non-OEM parts, see e.g., (Sony Global, 2020; Microsoft, 1375). In **the U.S.**, despite the 2017 verdict in *Impression Products v. Lexmark* that seemingly ended the use of copyright law to enforce end-user restrictions, arguments are still presented in favour of continued enforceability of user restrictions under copyright law (Gomulkiewicz, 2018). In **the EU**, case law indicates that the exhaustion doctrine regarding repair cannot be limited by contract¹⁰ (see 3.3.1).

Unauthorized spreading of copyrighted repair information (i.e., manuals, guides, and schematics) constitutes infringement without exemptions in the **U.S.** (United States Code, 1947a), (Wiens, 2012) and **EU**¹¹ alike. In addition, **the EU** Digital Single Market Directive requires online platforms featuring user-generated content to ensure that publications with copyright have been authorized¹² (Doctorow, 2019). This could pose a risk to some platforms providing user-generated repair manuals and guides when considering their dissemination.

In **the U.S.**, repair activities, such as copying of the software and/or programming codes, can be considered copyright infringement, but the majority are permitted. (United States Copyright Office, 2016). **The EU** employs an exception allowing lawful users to correct errors,¹³ but this can be partially or completely revoked by contract.

Since 2018, unauthorized circumvention of digital locks¹⁴ on copyrighted software is now permissible in **the U.S.** (see Section 3.1.2). However, in **the EU**, the protection of digital locks in relation to copyright restrictions and limitations is unclear (Sganga and

Scalzini, 2017). The use of *self-made* tools for circumventing digital locks recently became legal in **the U.S.** (see Section 3.1.2); however, the 'trafficking' (sale) of circumvention tools is still illegal (The US Copyright Office and Library of Congress, 2018) (Wiens, 2018). Further, unauthorized replication and distribution of software tools, e.g., restoration disks necessary for restoring the functionality of the device, are prohibited (U.S. 11th Federal Circuit Court, 2018; United States Code, 1947b; United States Code, 1970). In **the EU**, it is not permissible to use one's own tool for circumvention or sell a circumvention tool.¹⁵

2.1.3. Trademark

Selling or importing **trademarked** refurbished spare parts is prohibited. **The U.S.** Customs and Border Protection Agency seizes refurbished aftermarket parts as 'counterfeit' (Koebler, 2018) on the grounds that a trademark can cause confusion if it lacks disclaimer or if the condition of the spare parts have changed (United States Code, 1946; U.S. Supreme Court, 1947; U.S. Federal 5th Circuit Court, 1998; CJEU, 2011; CJEU, 1999). Similarly, in **the EU**, a trademark holder might be capable of preventing further commercialization of the product (CJEU, 2011), (CJEU, 2009b), (CJEU, 1997).¹⁶

In a high profile **EU** court case, a Norwegian independent repairer was charged with having imported allegedly refurbished screens bearing the Apple logo. While the first court sided with the repairer (Oslo District Court, 2018) (see Section 3.1.4), the Court of Appeals and the Supreme Court alike found the spares to be counterfeit (Norwegian Høgsterett, 2020), (Norwegian Borgarting Lagmannsrett, 2019) although it is common for refurbished spares to consist of a mix of original and non-original components. Independent repairers are now likely to be increasingly cautious about using refurbished parts (Värjö and Öhman, 2019), (van der Velden, 2020).

2.2. Barriers in contract law

Many terms in EULAs and conditioned sales contracts forbidding unauthorized repair or modification can be enforceable under contract law - de facto circumventing the exhaustion doctrine. EULAs are common for software-enabled devices, while conditional sales contracts are generally used for e.g., machinery and vehicles.

In **the U.S.**, violation of such terms constitutes a breach of contract. The utilization of contract terms to restrict repair has arguably been 'normalized' by the Supreme Court (Gomulkiewicz, 2018), (U.S. Supreme Court, 2017) and is upheld by a decade of court rulings predominantly backing EULAs, in spite of substantial repudiation of their enforceability (Gomulkiewicz, 2018), (Perzanowski and Schultz, 2016). Similarly, the United States Copyright Office (USCO) identified no barriers to the enforcement of contractual terms under state law, 'regardless of the resolution of those copyright issues'.¹⁷ In the case of an independent repairer performing a repair, any contractual claim must be directed to the customer who employed the independent repairer, as the independent repairer is not in contractual privity with the seller of the product. However, sellers are notably reluctant to engage the consumer, and may instead levy tortious interference claims against independent repairers (Gomulkiewicz, 2018), (McSherry and Walsh, 2017). On the contrary, in **the EU**, the exhaustion doctrine can presumably not be overridden by contract¹⁸ (see Section 3.3.1). Regarding potential implications for an independent

⁹ see e.g. (CJEU, 1988) para. 8.

¹⁰ see (CJEU, 2012a) on distribution rights.

¹¹ A threshold for originality is usually considered as relatively low when literary works are concerned. For instance, in (CJEU, 2009a) the CJEU concluded that a reproduction of an extract of a work comprising 11 words can be a copyright infringement if the elements thus reproduced are the expression of the intellectual creation.

¹² Article 17, EU Copyright Directive (European Parliament, 2019).

¹³ Article 5.1, EU Directive on legal protection of computer programs (European Parliament, 2009).

¹⁴ Commonly referred to as Digital rights management (DRM) tools or technological protection measures (TPM).

¹⁵ Article 6.2.2, The InfoSoc Directive (European Parliament, 2001).

¹⁶ Article 15.2, The EU Trade Mark Directive (European Parliament, 2015).

¹⁷ USCO (United States Copyright Office, 2016) p. 63.

¹⁸ see (CJEU, 2012a) on distribution rights.

repairer, the possibility to pursue a non-party of a contract varies greatly depending on the legislation of the EU Member State (Norrgård, 2006).

2.3. Barriers in consumer law

OEMs often deny consumers the right to demand repair as a remedy, instead leveraging warranty and guarantee conditions, i.e. the consumer may be given a new replacement product even if they would accept or prefer to have their product repaired (Consumer Law Ready, 2018). Furthermore, the lack of clarification of warranty rights and guarantees for consumers is often exacerbated through stickers on devices and language in warranty documents; Consumers can be deceived by OEMs' suggestions that a legal/implied warranty will be automatically voided by unauthorized repair or disassembly of the device. The U.S. Federal Trade Commission (FTC) noted several examples and issued warnings to those companies (Federal Trade Commission, 2018) as such information is in violation of the Magnusson-Moss Warranty Act. However, these warnings were not effective: a U.S. survey conducted shortly after showed that 90% of manufacturers surveyed continued to inform, or imply, that the warranty would be void if the consumer employed an independent repairer or conducted a DIY ('third party repairer') (U.S. PIRG, 2018). To the authors' awareness, no EU authority or organization has reacted to this warranty language in a similar manner, though the EU Consumer Sales and Guarantees Directive guarantees the consumer against existing faults, and there is no mention that repair or consumer intervention can violate this guarantee unless it caused the fault. This is a potential barrier for all consumer electronics under warranty.

2.4. Barriers in consumer knowledge and perceptions

In addition to confusion about consumer rights under warranty (discussed above in Section 2.3), access to repair can effectively be blocked due to consumers' inadequate knowledge of their rights (Directorate General Communication, 2011). Terms in the commercial guarantee (from manufacturer) can be confused with the legal guarantee (from consumer law), and vice versa.¹⁹

Consumers may lack knowledge about their legal rights regarding repair (i.e. if they void warranties through DIY repair) and how products work (Hernandez et al., 2020), which in turn may inhibit their capacity to judge a product's reparability or future opportunities to access repair when purchasing (Scott and Weaver, 2015). In addition to *actual* premature and planned obsolescence, discussed below in section 2.5, consumers live in the context of the current throwaway culture, which is fuelled by *perceived* obsolescence (Dewberry et al., 2016; Rivera and Lallmahomed, 2016). On an individual level, consumers have different perceptions, motivations, levels of affinity, triggers and other motivating factors related to self-identity, which can positively or negatively influence their decisions for repair (Ackermann et al., 2018). Fast product cycles, technological obsolescence, and peer effects also influence decisions to repair (Diddi and Yan, 2019); and repair can be made less attractive due to the perception of the current product as being obsolete (Wieser and Tröger, 2018). Appearances can matter and there is pressure to be "up to date", hence the drive to replace can be significant and disfavor repair (Department for Environment, Food and Rural Affairs, 2011). Further, a lack of emotional and economic attachment to devices (Colebatch, 2014) can prompt consumers to discard and replace items frequently and is reinforced by short product lifetimes (Cooper, 2005), (Rivera and

Lallmahomed, 2016). While the discarding of items can be anxiety-laden (Gregson et al., 2009), it does not mean that the owner is willing to repair (Jaeger-Erben et al., 2020). There is evidence that consumers do not give equal value to refurbished and repaired items as they do to new, even if quality and lifetime are equal (Atasu et al., 2008), (Debo et al., 2006). This can also constitute a barrier for OEMs when providing repair as a remedy under warranty law (i.e. consumers may insist on a new product to replace a defective product - see (Rechtbank Amsterdam, 2016).

2.5. Design barriers

Product design can often play a role in preventing repair either as a business strategy or as an incidental consequence. Examples of this include intentionally shortening lifetime in design (planned obsolescence), designing product using low-quality material that results in a short functional lifetime as a result of low product durability (premature obsolescence), developing software designed only for newer product models, and/or lacking compatibility/modularity with existing models (functional obsolescence) (Rivera and Lallmahomed, 2016). Design strategies can also consist in 'software doping', which can impede the operability of the device with third-party spares and equipment (e.g. printers ink cartridges; or electronics battery chargers) (Barthe et al., 2016). Many repair challenges result from decisions at the design phase, including increasing use of customized parts, glue and fasteners, and the related increasing inventory of parts and proprietary tools that must be on-hand to enable repair (Deloitte, 2016).

2.6. Barriers in tax law

Taxes on refurbished spare parts can make the latter less cost-competitive to new spares manufactured on low labour costs and low tax countries. In addition, some jurisdictions have additional taxes that can affect repair activities (Mont et al., 2017), (Montalvo et al., 2016). For example, in the EU, Sweden has introduced a chemical tax on flame-retardants in electronics, with the intent of promoting substitution for hazardous materials. The tax also targets refurbished electronic remanufacturers, who have no opportunity for substitution and must incorporate the tax into the prices for their products (Kristoffersson, 2019).

2.7. Barriers in chemical substances laws

Rules related to chemicals in products can restrict the re-use and remanufacturing of spares. For instance, when there are rules related to chemicals in products, older products, components or spare parts, they may be banned from being re-introduced on a market as they will not comply with rules on chemicals (Technopolis Group et al., 2016), (Dalhammar et al., 2020). Therefore, substance-based laws place burden and risk on actors in the supply chain of both new and reused spares (Deloitte, 2016). In the EU, the REACH Directive (European Parliament, 2006) regulates several chemicals in products, e.g., coatings, paints, solvents, and even those used during manufacturing to ensure consumer safety and protect the environment. To comply with REACH, manufacturers and importers of refurbished spares are obligated to collect and register information on the chemical substances in the product. The use of restricted substances in refurbished spare parts can put limitations on sales, and lead to inventory tracking and management challenges over time to comply with the requirements - putting administrative burdens on secondary market actors. Further, the RoHS Directive (European Parliament, 2011), restricts specifically listed substances present in electrical and electronic equipment (EEE), e.g., wiring, circuit boards, and displays, requiring

¹⁹ Only legal warranties give remedy for pre-existing defects; see (ECC-Net, 2015).

both certificates and markings. However, unlike REACH, this directive contains an exception for most spares (see Section 3.7).

2.8. Market barriers

2.8.1. Repair limitations in supply

Repair limit replacement refers to 'common practice' employed by OEMs when choosing between a repair or replacement; OEM's decision process regarding the fate of malfunctioning products under warranty often includes complex algorithms that account for the conditions related to the age of the product, and the number of times it has previously been overhauled or repaired, the availability (or inconvenience of 'unavailability') of alternate options, and the expected costs, including labour (Hastings, 1969). All of these factors are ultimately grounded in the expected costs associated with repairing or replacing, incorporate both direct and overhead costs, and involve a commonly understood repair limit or threshold. For example, a rule-of-thumb commonly used in the appliance industry is that if the total cost of repair (including parts, labour, expected value-retention) exceeds 50% of the value of the project, then replacement is preferred; OEMs will utilize similar thresholds internally to guide warranty support decisions for repair (Perkins, 2003).

The complexity of repair and level of expertise required from the repair technician differ from repair to repair, and this creates challenges related to skilled labour, training, and other necessities (McCollough, 2010a; Pérez-Belis et al., 2017; Raihanian Mashhadi et al., 2016; Sabbaghi et al., 2017). Staffing all OEM repair facilities with staff capable of conducting non-routine repair would lead to increased labour and operating costs (Wuerthele and Owen, 2018).

Short innovation cycles and diversity of brands and models require wide technical skills and continuous training, which is costly. It also requires access, or storage, of a wide range of customized tools and spares, along with schematics and guides (McCollough, 2010b). Without the latter, the repair can be very time-consuming, or even impossible. OEMs are not obligated to provide passwords to DIY consumers or independent repairers to open digital locks (Wiens, 2015), nor are they obligated to provide necessities or maintenance training (Deloitte, 2016). Further, repair and diagnostic tools might not even exist for some products. In addition, the requirement to maintain a large inventory or production capacity for spares for product models with long service lives can be very costly for OEMs, particularly when this capacity could be used to produce new models (Sahyouni et al., 2010).

OEMs are not incentivised to enable and engage in repair activities in the current market and policy context. In some cases, market forces even incentivise OEMs to prevent repair activities. Especially in sectors that produce devices for the consumer marketplace, the OEM business model is driven by the volume of product sales, which leads to a strategic emphasis on replacement; repair is typically seen as being in direct competition with this objective. For example, Apple's recent communication to shareholders referenced the slowing demand for new products as well as the increased use of iPhone battery replacements as a reason for lower than anticipated revenue (Cooker, 2019). There is also little incentive to perform repairs when the profits from selling new replacements are more attractive, an issue tied to planned obsolescence rather than design for longevity or repair (Maitre-Ekern and Dalhammar, 2016). In situations where information asymmetry exists, i.e. the OEM performing the repair service has greater knowledge of the parts used, the work done, and the actual value of those activities than the customer receiving the repair service, there is the risk, or the perceived risk, that customers may be overcharged for the repair service (Kerschbamer and Sutter, 2017). Exploiting this expertise and asymmetrical information advantage,

OEMs have been accused of systematically inflating repair prices (Wuerthele and Owen, 2018) and preventing unauthorized repair through the means outlined above in this section (Deloitte, 2016), (Nolan, 2019), (Miller, 2017).

Overall, the repair sector has been found to be declining around the world for several decades due to the influx and availability of lower-cost replacement options (McCollough, 2009).

2.8.2. Repair limitations in demand

As presented in section 2.4, consumer attitudes towards repair, and their willingness to engage in repair, may differ depending on the type of device, and the value it represents to consumers. This has implications for the demand of repair services. Devices that are linked to conspicuous consumption are more likely to be replaced, even when repair makes financial sense (McCollough, 2020). For devices that are perceived to be easily replaceable, with low relative replacement cost (e.g. small appliances and electronics), repair may be less attractive to consumers. EU and U.S. surveys show that repair of electronics is often not conducted due to a consumer perception of it being economically disadvantageous (Pérez-Belis et al., 2017), (Sabbaghi et al., 2016), (Directorate General Communication, 2013). In contrast, for other devices, such as vacuum cleaners, the repair vs. replace decision is more complex and involves the relationship between the perceived degree of brokenness of the device (e.g., if high degree of brokenness, replacement may be preferred), combined with the perceived level of effort required to repair it (e.g., if high level of effort required to repair, replacement may be preferred) (Salvia et al., 2015).

Across most product types, the most significant concern to a consumer when faced with the choice between repair or replacement, is the *price* of the replacement (McCollough, 2009). Generally, the willingness to pay for repairs of small electronics has been estimated to be 20% of the replacement cost (McCollough, 2007). This evaluation of relative worth (i.e., 20% of the replacement cost) is similar to repair limit replacement models that are used by many OEMs to support decision-making regarding the provision of warranty services. For consumers, such repair decision guidelines are also typically influenced by perceptions about the brand of the product and anticipated quality of the repair service (Camacho-Otero et al., 2017). Driven by rising labour costs in local markets and the skilled, labour-intensive nature of repair services, the price of repair has increased; in contrast, the price of replacement products has fallen significantly due to improved manufacturing technology, cheap overseas labour, and the failure to account for the production externalities of new manufacturing (e.g., resource consumption and environmental pollution) in the price of a new device (McCollough, 2009). Consumers have also become accustomed to cheaper and shorter-life products and less accustomed to conducting servicing and repair required to maintain and retain them (Cooper et al., 2013).

Consumer *perceptions and expectations* about repair service convenience (e.g. ease of decision, access, benefit) and repair service quality (e.g. tangible service, reliability, responsiveness) influence their intention to have maintenance and repair activities performed (Chang et al., 2013). Depending on the complexity of the repair, *time* becomes a compounding issue: the increased time required to complete a repair drives up embedded labour costs and the total cost of repair for both consumers and repairers; it also increases the period during which the consumer must find an alternative, or get by without, which likely present an issue in the case of ICT devices breaking down (Wieser and Tröger, 2018), (Sabbaghi et al., 2016), (Sabbaghi and Behdad, 2018). The more time constraint a consumer is under, the less likely the person is to choose repair over replacement (McCollough, 2020). The cost of repair, which includes perceived inconvenience, the value received,

and the cost of a substitute option (McCollough, 2012), has been identified as the primary reasons why consumers decide to replace a failed product, rather than repair it (Sabbaghi et al., 2016), (King et al., 2006).

On a broader level, a dominant 'throwaway society' culture can cause replacement to be seen as more desirable than repair, regardless of repair cost and other barriers (Wieser and Tröger, 2018), (McCollough, 2010a), (Cooper et al., 2013).

3. Policy solutions and proposals for increased stakeholder participation

In this section, we review various policy solutions and proposals, some of which are already adopted in some countries or regions that have the potential to address several barriers outlined above. Any differences between the EU and the U.S. are clearly indicated. Without such an indication, the situation is deemed to be similar in both jurisdictions.

3.1. Repair under IP laws

As many of the barriers to repair originate in IP law, amendments and different interpretations of such laws represent possible solutions. This section provides an overview of possible amendments, re-assessment, and re-interpretations of IP law.

3.1.1. Assessment of infringements compatible with CE

The current exhaustion doctrine could be modified in various ways to ensure that CE goals are considered (see e.g. (Pihlajarinne, 2020), (Liu, 2014)). Further, the IPRs themselves could be formulated so that they would not prohibit acts whose genuine purpose is to maximize the lifespan of a product or material. Hence, sustainable lifespan would directly define the scope of exclusive rights, which would mitigate the structural bias that repair activities are dependent on IPR exceptions and limitations. To accomplish this, adoption of more detailed, product-category specific guidelines for sustainable lifespan is needed (Pihlajarinne, 2020). However, to date this policy solution has not been implemented.

3.1.2. Repair exemption for circumventing digital locks and tools

A U.S. general repair exemption for home appliances, smartphones, home systems, and motorized land vehicles was introduced in 2018. Circumventions required for repairs are thereby permissible, a right that is transferable to a third-party repairer performing the circumvention on behalf of the product owner. The exemption also includes making one's own circumvention tools for the breaking of digital locks, allowing third-parties to make and use their own tools to perform a circumvention on behalf of the product owner, however, such tools cannot be sold (The US Copyright Office and Library of Congress, 2018), (Wiens, 2018). A proposal for legalizing a market for such tools, and to provide further clarity for tool developers has been proposed in the U.S., but is not yet implemented (Lofgren, 2015).

3.1.3. Access to copyrighted repair manuals

Under the Clean Air Act of 1990, the U.S. Congress issued a 'wholesale exception' on copyright protection of maintenance and repair information regarding motor vehicles. For electronics, such an extensive exception may not be necessary; to balance the interests of maintaining copyright protection and facilitating repairs, some suggest that the copyright could be upheld until the next product model is introduced, alternatively until the device's end-of-life (Raymond, 2014), (United States Code, 1990). However, if there is no access to copyrighted repair manuals at the time that the device fails (e.g. shortly after the device model is made available),

then there will be no opportunity to repair the new device. Furthermore, this measure fails to provide equal opportunities to independent repairers by restricting the time they have to assimilate the new product information and train their staff. A clear exception similar to motor vehicles may therefore be more appropriate and effective for electronics and appliances.

3.1.4. Repair despite design and trademarks

The EU limits the *design* protection on complex products, including the parts of such products, to cases where the part is visible throughout normal use of the product.²⁰ Disagreements regarding if spare parts ought to be excluded from design rights has led to a hybrid system (Hartwig, 2016). An EU repair clause,²¹ exempts spares provided that they are used in repair or restoration of the product's original condition, hence enabling repair. However, the majority of member states have not introduced this repair clause, making the exemption largely ineffective in practice. In the U.S., the proposed 'Promoting Automotive Repair, Trade, and Sales (PARTS) Act', suggests either to exempt parts used in repair or decrease the time of the protection of such parts, from the current approximately 15 years–30 months (Darrell, 2017).

Regarding *trademarks*, the Court of First Instance in the Norwegian trademark infringement case with refurbished Apples spares (see Section 2.1.3) relied on EU and national jurisprudence (Norwegian Supreme Court, 2018; CJEU, 2010; CJEU, 2002; CJEU, 1978), when assessing the risk of damage to the function of the Apple trademark (i.e. to guarantee of origin and quality). In the initial ruling, the independent repairer was freed of charges and the court seemingly sought to enable increased competition on the spares market. While the subsequent appeals court did not take into account the potential role of the trademark on spare parts and repair, critics have argued that this should be part of the interpretation (Reimers and Opsvik, 2018). This would more clearly limit trademarks as a barrier and protect repair activities as exceptions.

3.2. Competition & antitrust laws preventing repair monopolies

Competition and Antitrust Laws²² can potentially address barriers related to OEMs limiting consumer access to repair services and the availability of necessities for non-authorized repairers. These laws have the potential to curb OEM market dominance.

Firstly, claims of *abuse of dominant position* may offer a response to the effective monopolization and barring of competitive, independent repairers on the markets. In the absence of requirements on OEMs to make repair necessities available outside of their authorized network, this antitrust claim could offer a solution. However, to be considered 'market dominance' in the EU, the market shares must be 50% or more (CJEU, 1991; CJEU, 2007; CJEU, 2012b), in which case dominance is not presupposed, but such claims may be substantiated.²³ Dominance must be proven in both primary and secondary markets (Kodak principles).²⁴ With the exception of cars, the EU has shown little interest in opening up

²⁰ Article 3(3) of the EU Design Directive (European Parliament, 1998); Article 4(2) The Community Design Regulation (The Council of the European Union, 2002). 'Normal use' is defined as the 'use by the end user, excluding maintenance, servicing or repair work', see Article 3(4) The EU Design Directive (European Parliament, 1998) and Article 4(3) The Community Design Regulation (The Council of the European Union, 2002).

²¹ Article 14, The EU Design Directive (European Parliament, 1998).

²² see Article 102 (TFEU, 2012).

²³ Article 3(1) EU Regulation on Article 101(3) of Treaty on the Functioning of the European Union (European Commission, 2010).

²⁴ EU embraced the conclusions from US Supreme Court judgment (U.S. Supreme Court, 1992).

aftermarkets for competition (EU Regulation and Commission Regulation (EU), 2010). The General Court of the EU recently ruled that market dominant Swiss watch manufacturers' withholding of spare parts from independent repairers did not constitute abusive conduct (CJEU, 2017) owing to the fact that competition still remained amongst the authorized repairers, and additional repairers could join the network (CJEU, 2018).

In **the U.S.**, market dominance (United States Code, 1890) requires market share beyond 50% (The US Department of Justice, 2015). Recently, General Electric (GE) restriction of third-party servicing of their anaesthesia machines, foremost by obligating independent repairers to acquire spares at inflated prices from a specific supplier and limiting opportunities for training, was considered anti-competitive conduct. Despite GE's attempt to justify their conduct as consumer safety measures, the jury discerned intent to obtain monopolistic power (Texas Eastern District Court, 2017), (Krochtengel, 2017). Regarding damages, some of the claims from the plaintiffs were later denied and others granted and the case was finally closed in 2019 at the joint request of the parties (Texas Eastern District Court, 2019). U.S. repair advocates deem the ruling a symbolic success against OEMs' anticompetitive repair programs, but note the verdict's limitations (Paben, 2018). Healthcare providers have filed another class-action lawsuit against GE over claims of anticompetitive conduct forcing them to pay inflated maintenance and service prices (Massachusetts District Court, 2019) that ended in a settlement (Massachusetts District Court, 2020).

Secondly, when OEMs effectively force consumers to purchase aftermarket products (e.g. spares) and services from them or a designated supplier, via contract, technical means, or high switching costs, it can constitute unlawful 'lock-in' or 'tying'.²⁵ When OEMs withhold necessities from independent repairers, the de facto outcome is that the consumer is 'locked in' to the OEM-provided aftermarket services, a practice also referred to as exploitation. In **the EU**, the probability of a conviction of an OEM for 'lock-in or tying',²⁶ is low, and the regulatory conditions in **the U.S.** are very similar (United States Code, 1890). The reason for the lack of enforcement is due to the lengthy and costly litigation process (i.e. OEMs are seldomly brought to court, leaving consumers 'tied up') (Gordon-Byrne, 2018).

If enforced properly, antitrust laws hold great potential for eliminating important barriers on the consumer electronics repair market.

3.3. Limiting repair restrictive contractual clauses

Contractual clauses in EULAs can deter both consumers and independent repairers. Limiting the use of such clauses can remove this barrier. In essence, this entails a clarification of the boundary and balance between IP rights and repair rights (i.e. exceptions to IP rights and recognition of other rights to be balanced with these) and the protection of consumer rights against sellers or license-holders with superior bargaining power.

3.3.1. Restricting contract law

The main issue with EULAs is due to the contractual enforcement of conditions against consumers, and terms that conflict with public interests and policies, e.g., sustainability goals (Heath, 2014). A central question is whether a private agreement, such as a EULA, can revoke a repair right granted by law (i.e. Copyright and Patent

law) (Gordon-Byrne, 2016). The existence of exceptions to IPRs in proprietary laws that permit repair should make it unlawful to employ digital locks and EULAs to remove this exception (i.e., right granted) (Derclaye et al., 2009). Enforcing these exceptions could address digital locks and EULAs as a barrier.

In **the U.S.**, contract law is a state matter. Given the principle of pre-emption prohibiting states from going against federal laws, such as IP laws, any contractual terms restricting repair should therefore be inconsequential (Derclaye et al., 2009).

The Electronic Frontier Foundation, which aims to defend civil liberties in the digital world, have argued that manufacturers' ability to force customers to waive their property rights should be limited, in accordance with several such already existing limitations to the waiving of rights, e.g., the Copyright Act prevent authors from contractually surrendering some of their copyright ownership to their work (McSherry, Walsh). United States Copyright Office has proposed that alterations to state law principles could barr overly restrictive conditions, particularly the enforceability of EULAs with regard to both contract formation requirements and unconscionability²⁷ (United States Copyright Office, 2016), but with a decade of court ruling backing EULAs (Gomulkiewicz, 2018), (Perzanowski and Schultz, 2016), changing interpretations to favour repair exemptions could prove difficult.

Regarding EULAs in **the EU** copyright context, it is likely that the exhaustion doctrine regarding repair cannot be overridden by a contract, because the prevention of repairs cannot be justified as safeguarding the 'specific subject matter of copyright'.²⁸ Due to limited case law where contractual imbalances were corrected using rules on good faith and fairness (see e.g. (Sganga and Scalzini, 2017)), rules regarding unfair contractual terms have been sparingly applied, so as yet, this has not been an effective solution to restrictive clauses on repair. Assessment of breach of contract is also governed by national contract and IP laws.

3.3.2. Patent and copyright misuse

Misuse relates to concerns about IPR holders overreaching their right for anticompetitive purposes. As such, misuse can be viewed as a mix between IP and antitrust laws (Lim, 2014). A misuse defence could prevent the use of overly restrictive end-user contractual clauses, such as in EULAs, as well as the use of copyright, such as digital locks, to create a monopoly. Copyright misuse is not yet codified into law, but doing so would potentially deter IPR holders from preventing repair.

According to USCO, **the U.S.** case law on copyright misuse: '... pave a path for a misuse defence to prevent anti-competitive behaviour regarding copyright in embedded software'. Although, to include a clause on misuse defence in the Copyright Act was deemed 'premature'. USCO is awaiting more case law.²⁹

In **the EU**, copyright misuse has also been brought up in relation to the application and legal protection of digital locks on embedded software, and EULAs. The inclusion of a general copyright misuse clause in EU copyright has been proposed as a potential means of solving these issues, and other similar ones,³⁰ and is viewed as promising due to the current fragmented nature of copyright in the

²⁷ Contractual terms that are so immensely unjust, or overwhelmingly one-sided in favour of the party with superior bargaining power, that they are against good conscience.

²⁸ see (CJEU, 2012a) on distribution rights.

²⁹ USCO (United States Copyright Office, 2016) p. 60.

³⁰ Sganga & Scalzini state that it is problematic that Article 6 of the Infosoc directive not only leaves the relationship between TPMs and copyright exceptions and limitations unclear but, additionally, it fails in taking into account, for instance, when considering EULAs, potential differences in the parties' bargaining power (Sganga and Scalzini, 2017). See also (Raymond, 2014).

²⁵ Note that the conditions for 'lock-in' vs. 'tying' practices differ slightly. The description in this section constitutes a summary.

²⁶ Article 101(1) (TFEU, 2012); (EU Commission, 2009) p. 7.

EU (Sganga and Scalzini, 2017).

3.4. Design measures

Many barriers to repair relate to the design of products (e.g. quality, lifetime, reparability, spare parts) and putting more explicit requirements on design, spare part availability and information are possible solutions to these barriers.

3.4.1. Design and information requirements

In the EU, the establishment of requirements for minimum lifetime and disclosure about product's durability and feasibility of repair may offer legal mechanisms to combat planned obsolescence (Brönneke, 2017). The importance of product design in improving products' durability, reparability, upgradeability or remanufacture is acknowledged in the 2015 EU Circular Economy Action Plan and in the Ecodesign Working Plan 2016–2019. Design for durability includes design for reuse and design for repair, but these are two different design strategies and trade-offs between the two should be carefully examined to optimally promote extended product lifetimes (Shahbazi, 2019). The Ecodesign regulations are updated on a product group basis; thus, requirements added to one product group can indicate upcoming trends in requirements for other product groups.

New EU ecodesign requirements, adopted in October 2019 for TVs, refrigerators, dishwashers, washing machines, and servers, have requirements related to reparability. These include: 1) firmware updates and data deletion tools available for eight years after a server's production; 2) design for easier dismantling (i.e. with common tools) for repair, recycling, material recovery and depollution procedures, 3) declaration on spare parts availability, requiring availability (for 7 years for refrigerators, 10 years for dishwashers and washing machines) and delivery within 15 working days; and 4) access to information relevant to repair and maintenance for professional independent repairers (European Commission, 2019). A new Ecodesign Action Plan will be adopted in 2021. The background documents indicate (Viegand Maagøe A/S, Oeko-Institut e.V., and Van Holsteijn en Kemna BV, 2020) that measures related to product durability and reparability will become more prominent in the working plan.

Consumer organizations find it especially important that spare parts are reasonably priced and that software updates for connected appliances are made easily available (ANECBEUC, 2017). In its formulation of Ecodesign requirements and Energy Labelling measures, the EU Commission continues to develop provisions to improve durability and accessibility of information and spare parts. The EU is considering introducing a displayable repair score to indicate the reparability of products in an understandable way for consumers (Joint Research Centre, 2018). There has also been discussion on appropriate communication of product lifetime and durability information, as there are several different dimensions that are not easily measured or communicated (Dalhammar and Richter, 2017), so this policy could be less effective in practice.

Since 2014, the French Consumer code has gone beyond the EU Ecodesign regulations and obligated French sellers to state to the consumers the time frame in which spare parts for repair will be provided by the manufacturer or importer. During this time frame, manufacturers or importers are required to provide such spares, no later than 2 months after the request from any repairer (including unauthorized independent repairers) and seller.³¹ To strengthen the law, consumer organizations also want to see requirements on informing consumers about the unavailability of the parts (Mader

et al., 2014). On 30 January 2020, an anti-waste and circular economy law was introduced in France (French Parliament, 2020), establishing a number of measures about consumer information, such as the development of a durability and a reparability index (resp. by 2024 and 2021), and the introduction of mandatory information about spare parts availability (from 2021).³²

Some U.S. states have introduced product requirements, including minimum lifetimes for specific products (e.g. for LED products in California) (California Energy Commission, 2016). Proposed design criteria can also be seen in Washington's Fair Repair-bill, which includes the banning of design measures that impede '... reasonable diagnostic or repair functions by an independent repair provider.' In the definition of such an action, the bill explicitly includes 'permanently affixing a battery in a manner that makes it difficult or impossible to remove.'³³

3.4.2. Fair Repair Bills

Fair Repair-bills, or Right to Repair Acts, have been proposed in 18 U.S. states during 2019 (U.S. PIRG, 2019).³⁴ The majority of these state bills require OEMs to offer independent repairers and product owners access to necessities, on fair and reasonable terms, that the OEM is already providing to their authorized network,³⁵ with several of the bills explicitly stating that there is no obligation for OEMs to provide spares if the spare is no longer available to them.³⁶ However, four of the bills go beyond these requirements. The Virginia bill bans OEMs from deactivating or altering embedded software in response to the product owner's use of a third-party repairer.³⁷ The California bill requires access to spares and information for at least three years after the date a product model or type was manufactured (Eggman, 2019a). The Vermont bill requires access for repair professionals (but does not mention product owners) to repair information and spares for seven years after the good was manufactured (Pearson, 2019). The two Washington bills (Senate and House of Representatives) propose mandatory provisions specifically addressing reparability in design (see Section 3.4.1).

None of the Fair Repair-bills have yet been passed. The strategy behind these state-level bills is to mimic the success of the Massachusetts Right to Repair-bill for automobiles. The passing in 2012 in one state convinced automobile OEMs to apply the terms in all U.S. states (Auto Alliance Global Automakers, 2014), (Gordon-Byrne, 2018), (Jensen, 2017).

Fair Repair-bills have been criticized for having too wide scope (i.e. on multiple product categories) though this varies, e.g., the New York bill has a narrow scope only for mobile devices and computers (Boyle, 2019) and the California bill does not ask for access to diagnostics (Eggman, 2019a). Criticisms also relate to claims of state law preemption (i.e. that the issues pertain to the federal legislative mandate and are therefore outside of the legislative mandate of individual U.S. states). However, the existence of the 2012 Massachusetts' Right to Repair-bill for automobiles proves that this is not a legitimate concern. Further, these bills are also criticized for their vagueness, especially regarding the exact meaning of the provision of repair necessities at 'fair and

³² See Title II of the French law (French Parliament, 2020).

³³ Section 3(6), Washington State Senate Fair Repair Bill (Hasegawa); Section 3(6), Washington State House Fair Repair Bill (Hudgins).

³⁴ Although 20 states considered introducing bills, Nevada did not draft a bill for 2019 and Montana never introduced their bill draft.

³⁵ E.g. repair information and tools already in circulation for use by the OEM technicians and subcontractors, see (Gordon-Byrne, 2018).

³⁶ See e.g., Section 2(1) & 4, Massachusetts Fair Repair bill (Brady, 2019); Section 2(A), State of New York Fair Repair Bill (Boyle).

³⁷ § 59.1–572, Virginia Fair Repair Bill (Carter, 2019).

³¹ Article L 111-3 (French Parliament, 2015).

reasonable terms' (MacAneney, 2018).³⁸

In 2019, a U.S. national right-to-repair law for agriculture equipment was endorsed (Warren, 2020), presumably prompting the Federal Trade Commission to hold a workshop in 2019 to better understand how OEMs limit third-party repairs and the impact on markets and consumers (U.S. Federal Trade Commission, 2019). In response to the COVID-19 pandemic and the repair issues with essential medical equipment, such as ventilators, a 'Fair Repair'-bill has been introduced in the U.S. Congress. The bill proposes that the repair market for these devices is opened up for the duration of the pandemic (Wyden, 2020).

3.5. Consumer law and protection

The lack of, or misleading, information available to consumers was identified as a barrier, as well as planned obsolescence practices. Protecting consumers from planned obsolescence practices and extending consumer rights can help address product faults impeding reparability.

3.5.1. Warranties promoting repairs

Since the majority of the issues with warranties is due to insufficient information, misinformation and inadequate enforcement about consumers' current rights under warranties, EU has considered measures to improve information and enforcement on warranties and guarantees. It has further been suggested that the current 2 years-long liability period (i.e. when repair is accessible to the consumer as a remedy for product malfunction) is prolonged. Certain eco-labels and some EU member states have already integrated this requirement; In Sweden, this period extends to 3 years, and Finland employs mandatory guarantee periods for the duration of the expected lifetime of products (ECC-Net, 2015). In the French Consumer law from 2020, legal guarantees are prolonged when a product has been repaired (French Parliament, 2020).

Another approach has been to extend the period after which the burden of proof for the fault falls to the consumer; usually six months after purchase. During this period, the product is typically assumed to be faulty due to a pre-existing manufacturer error. However, once this time period has ended, the default is instead presumed to have been caused by some kind of mishandling on the part of the consumer. It is then up to the consumer to prove any pre-existing defect, a task that often requires expert consultation (UK Parliament, 2015). In Portugal and France, the manufacturer carries the burden of proof for 2 years; and in Finland, this responsibility lasts for the duration of the expected product lifetime (Brönneke, 2017), (Maitre-Ekern and Dalhammar, 2019; Watson et al., 2017; European Union, 2020).

3.5.2. Consumer information and protection laws

In the EU, France (EU) recently criminalized manufacturer conduct leading to planned obsolescence.³⁹ However, it requires proof that it was the manufacturer's intention to 'reduce the lifespan of a product to increase the substitution rate'.⁴⁰ A complaint against Epson for misleading information for its print cartridges (communicating them to consumers as empty when they could have between 20 and 40% ink remaining) was made in 2017 and is still under investigation. In 2018, a complaint in France against

Apple accused the company of having deliberately slowed older iPhone models as part of a global strategy to increase the sale of new products (Le Figaro, 2018). After an investigation, the Directorate General for Competition, Consumption and the Suppression of Fraud (DGCCRF) fined Apple €25 million (Direction générale de la).

In 2018, Apple and Samsung were fined €10 million and €5 million, respectively in Italy for violating the Consumer Code that transposed the provisions of the EU's Unfair Commercial Practices Directive (European Parliament, 2005). It was found that the release of firmware updates caused malfunctioning and reduced functionality of phones, and 'in this way speeding up their replacement with more recent products.' The authority found that the companies induced consumers 'without adequately informing them, nor providing them an effective way to recover the full functionality of their devices.' (Italian Autorita Garante della Concorrenza e del Mercato AGCM, 2018).

In the U.S., similar suits have also been brought against Apple in no less than four U.S. states. The main complaint in the cases in New York (New York Eastern District Court, 2018) and California (California Central District Court, 2018) were that Apple did not inform its customers about any decrease in the performance of their devices. Two California class action complaints argued that Apple violated the Computer Fraud and Abuse Act because customers were not informed about the effects of the iOS updates and Apple in fact concealed information from consumers, which is also argued to violate CA unfair competition law (California Northern District Court, 2019; California Northern District Court, 2018; United States Code, 1986; California Business & Professions Code, 1992).

3.6. Tax law reducing repair price

Tax exemptions for repair services could help address the cost barrier of repair. Several EU member states have value-added tax (VAT) exemptions for minor repairs, though currently most of these do not apply to electronics (RREuse, 2017). However, in Sweden, the repair of larger household appliances and some electronics, such as computers, speakers, and smartphones, are eligible for a tax reduction on 50% of the labour costs for professional repairs that take place in the owner's home (up to a maximum of roughly €2500/year or €5000 if owner is over the age of 65) (Skatteverket, n/d), (Skatteverket, n/d). Also in Sweden, some repairs, including bikes and shoes, have reduced VAT (Skatteverket, 2018). The effects of these tax measures are uncertain. A recent report indicates that they have had a very limited impact on the willingness to repair, and that the price of the product is more decisive than the price of undertaking repair when consumers make decisions (Almén et al., 2020).

3.7. The 'repair as produced-principle' in Chemical Laws

Chemical laws were identified as a barrier to selling repaired products as well as harvesting and reusing spare parts. In the EU, the general principle in product legislation of 'repair as produced' implies that all spare parts of a product are excluded from any requirement introduced after the date the product entered the EU market, given that the device was in compliance with the legal requirement at the time of entrance (European Commission, 2016). In accordance with this principle, RoHS Directive was amended explicitly to support the creation of a CE market and avoid unnecessary administrative burden on secondary market operators (European Parliament, 2011). It now allows for the conditional use of spares that do not conform to the Directive (European Parliament, 2017). In the latest introduction of new substance

³⁸ However, this language is in Article 6 of the passed Massachusetts Automobile Repair Bill (Commonwealth of Massachusetts and Bill 4362, 2012).

³⁹ Up to two years in prison and a fine of €300,000, which can be increased by up to 5% of the average annual revenue calculated on the basis of the three previous known annual turnovers, see Article L. 213-4-1 (French Parliament, 2015).

⁴⁰ Translation of Article L. 213-4-1 French Consumer Code, FR490, from (Maitre-Ekern and Dalhammar, 2016).

limitations to the Directive, spare parts used for repair are exempt for products that entered the market prior to July 22, 2019, with even more generous exemption for specific high-cost product categories (Commission Delegated, 2015).

3.8. Potential market solutions

Many barriers identified, such as provision of repair necessities, could also be addressed through voluntary market measures instead of government policies. Here we describe examples of such measures found in the review.

3.8.1. OEMs' internal repair initiatives

In response to the push for more repair opportunities, OEMs are beginning to modify their relationship with repair, to varying degrees. Some organizations, including Lenovo and its subsidiary, Motorola, have fully embraced repair as an opportunity. In addition to designing mobile/smartphones to be modular and accessible, Motorola and Lenovo supply a wide range of product manuals and guides, warranty information, DIY instructions, and multiple repair service options and solutions directly from their corporate websites (Motorola, 2020). Supporting both independent repairers and DIY, Motorola has officially partnered with well-known repair organizations (iFixit (iFixit, 2020) and Cell Phone Repair (CPR) (Cell Phone Repair, 2020)) to distribute DIY information and tools, and to connect users with a national network of independent repairers to enable walk-in repair options (Kumparak, 2018), (Allen, 2019).

Other organizations use an incremental approach to test how these new models for repair will affect their business interests. E.g. Apple's 'Independent Repair Provider Program' will provide independent repairers that are not part of the Apple Authorized Service Provider network with parts, tools, and training limited to certain approved repairs (Apple, 2020a).

As part of their 'Repair Terms and Conditions', Apple presents a 'Do-it-yourself (DIY) Parts Service', with conditions where Apple has incorporated changes into their warranty policy to account for third-party repairs and/or non-conforming parts. Provided that customers disclose unauthorized modifications, repairs, or replacements, Apple may still consider providing the requested repair service and, if provided, may charge the associated repair costs to the customer regardless of warranty or 'Apple Care Program' coverage.⁴¹

3.8.2. Voluntary agreements

Voluntary agreements - called a 'Memorandum of Understanding' (MOU)- have been reached in the U.S. in the automobile (Auto AllianceGlobal Automakers, 2014) and farm equipment (California) sectors. These cover OEM obligations to enable repair activities outside of their authorized networks. Following the later MOU agreement, authorized agricultural dealers are now empowered to use/provide manuals, guides, training, and diagnostic services and/or interfaces to support agricultural customers (California Farm Bureau, 2018). It is important to note that these agreements were implemented in response to the legislation being implemented on one state (i.e. Massachusetts) or in response to the threat of legislation. However, these types of industry agreements tend to be heavily restricted, unproportionally reflect OEM interests, and offer limited repair options to independent repairers and DIYs. E.g., the California MOU was heavily criticized for explicitly excluding software modifications that can affect equipment operations and controls. Similarly, the U.S. MOU for the

automotive sector has been criticized for limiting access to diagnostics,⁴² as did the original Fair Repair bill passed in Massachusetts.⁴³ Nevertheless, these MOUs present incremental industry-level advancement.

3.8.3. Voluntary design measures

Though design requirements are being enacted in the EU and proposed in certain U.S. states, the majority of the current U.S. design initiatives are on a voluntary basis, e.g., the Electronic Product Environmental Assessment Tool (EPEAT) eco-label design guideline, containing some criteria on reparability (Green Electronics Council, 2020). Such criteria is also part of the voluntary EU Ecolabel, as well as regional/national initiatives, e.g., the Nordic Swan label and German Blue Angel. Further, EU Green Public Procurement (GPP) contains criteria favoring certain repairable products, e.g., disassembly requiring only simple tools and the time frame for when spares are available is specified (Alhola et al., 2017). These voluntary standards are relatively new, with the sole exception of early modularity requirements for computers, and are still open to wide interpretation of reparability (Schaffer, 2017).

In regards to the U.S. EPEAT standards, it took 'prolonged and contentious negotiations, [before] members were able to include some repair/reuse related criteria in the UL 110 standard for cell phones' ((Schaffer, 2017) p. 26). These criteria relate to design that allows for disassembly for the purpose of repair, with standard or non-proprietary tools, and the provision of information on e.g., tools, manuals, and repair services.⁴⁴ Despite the fact that design permitting disassembly and battery removal without the use of tools would facilitate replacement and repair, the standard does not require that battery access, removal or replacement be possible without the use of any tools.⁴⁵ Instead, design in which battery access and removal are possible using either standard tools, non-proprietary tools, or without the use of any tools, are all permitted. In other words, the extent to which mobile phones are designed for easy disassembly, under the standard, remains the option of the OEM. Furthermore, with the way the current criteria on reparability and upgradeability are formulated and applied, the majority of OEMs' practices are approved of.⁴⁶ Clear and meaningful standards, reflecting best practice in terms of reparability, are needed.

4. The current repair landscape

This section discusses the current state of the repair landscape, first comparing the U.S. and EU. Then, we examine how barriers impede different actors and the implications on the repair market governance. Lastly, the types of barriers and solutions reviewed in parts 2 and 3 are considered in terms of what is necessary to up-scale repair activities.

4.1. Comparative assessment

This paper's comparative approach has revealed several

⁴² Section 2 (2)(d)-(e) 'immobilizer and telematics', Memorandum of Understanding (Auto AllianceGlobal Automakers, 2014).

⁴³ §2 Massachusetts Automobile Right to Repair Bill (Commonwealth of Massachusetts and Bill 4362, 2012).

⁴⁴ Standard 110, Sec. 11.4, UL Standard for Sustainability for Mobile Phones (Standards Comm 2000 and ", 2017).

⁴⁵ Standard 110, Sec. 11.3.1, UL Standard for Sustainability for Mobile Phones (Standards Comm 2000 and ", 2017).

⁴⁶ For example, Samsung's Galaxy S8 - a phone heavily glued - meets the requirements as a gold-level device according to the EPEAT registry, see (Schaffer, 2017).

⁴¹ see §1.11.6 'Disclosure of Unauthorized Modifications' in Apple's Repair Terms and Conditions (Apple, 2020b).

intriguing insights. Notably, it exposes that, although actions towards upscaling repair activities are happening both in the U.S. and EU, these efforts are propelled by rather different framing. In the U.S., the consumers' right to repair has constituted a powerful driver to liberalize the aftermarket, and the U.S. Federal Trade Commission is actively exploring the issue. Only one of the U.S. Fair Repair-bills mention reduction of premature disposal, but framed it as a means 'to create lower cost entry points for consumers to own advanced electronics'.⁴⁷ Furthermore, one bill was first introduced as targeting e-waste but was later revised to focus on consumer protection (Eggman, 2019a).⁴⁸ Nevertheless, the U.S. Fair Repair movement is using environmental reasoning to support their positioning (Proctor, 2018), (The Repair Association, n/d). In the EU, waste prevention constitutes the main framing of the issue, and repair was elevated on the political agenda with the emergence of CE. As mentioned, repair presents an opportunity to decrease environmental impacts by slowing product loops (International Resource Panel, 2018), and thus, the motivation for upscaling repair activities in the EU; the empowerment of consumers to engage in repair is a recent, although pivotal, strategy. These differences in views explain why the U.S. debate largely revolves around the 'right to repair', while in the EU, the focus is on product design using design requirements and consumer law.

Another interesting insight is that neither jurisdiction has embraced a regulatory approach to repair that is harmonized and holistic. Even though certain regulation is taking place at the federal/European level, the majority of the legal experimentation is happening at the state/national level; Fair Repair bills, varying slightly in their content,⁴⁹ are multiplying across the U.S. states, and some EU Member States have implemented national legislation to prevent planned obsolescence. However, important discrepancies persist in both jurisdictions. While certain U.S. and EU states are leading the charge in the development of innovative ways to up-scale repair activities, other states remain inactive on the issue. The creation of repair laws that are uniform, aligned, and appropriately scoped (e.g., the nature and extent of the obligations for OEMs to supply necessities outside of their authorized network) would reduce uncertainties and strengthen market predictability, benefiting everyone.

Barriers present in the EU and the US markets respectively, seem to present similar obstacles to upscaling repair in slightly different forms. The U.S. is in the forefront when it comes to tackling IP law barriers, such as digital locks. However, U.S. case law so far supports that consumers can be made to relinquish ownership rights through contract (despite being awarded such rights under the exhaustion doctrine in IP law). This is in contrast to EU law, which seemingly does not support such waiving of ownership rights in favour of IPRs. This diminishing of ownership is in contrast with the U.S. framing of repair as an ownership rights issue.

Comparing the solutions and proposals in the EU and U.S., there are also differences. The majority of the proposed U.S. Fair Repair bills are, in essence, requiring OEMs to extend access to necessities, which they are already providing to their authorized networks, to independent repairers and DIYs as well. Similarly, the EU Ecodesign Directive is obligating OEMs to sell necessities to independent repairers, but unlike the Fair Repair bills, no consideration is taken to what necessities are currently available to the OEM. Instead, OEMs who wish to sell their product on the EU market can be obligated to start making and providing new necessities. In addition,

compliance with the Ecodesign Directive can require OEMs to adapt the design of their devices (to meet the criteria for disassembly) and also to restructure their service part supply chains (to comply with the amount of years during which spares must be available and the speed in which they are to be delivered to independent repairers). Similar introduction of obligations for OEMs to actually improve the reparability of their products are found only in three (Vermont, California and Washington) of the 18 U.S. Fair Repair bills. Hence, while the focus of the bills is seemingly to bring about open competition, the EU Ecodesign Directive is decreasing barriers for independent professional repairers while *also* facilitating repairs in general through repairable design measures.

The EU is taking a slow, but sure, route to upscale with the introduction of ecodesign requirements on repair, one product group at a time. Further, the many member state solutions, such as the criminalization of planned obsolescence in France and the tax relief initiative from Sweden, fortify an EU lead. The advantage with the EU approach is that the ecodesign requirements will be enforced in all member states alike. Further, in numbers, the EU presents the most solutions. The U.S., on the other hand, holds the potential for the most dramatic upscale of repair through the Fair Repair-bills applying to wider product categories. However, these bills might never be approved. Further, there is always the risk that, like repair of motor vehicles, the nation-wide voluntary agreements following the passing of a state bill are less ambitious.

4.2. Repair market governance

The barriers and solutions reviewed can also be understood by examining the stakeholders who are impeded (a more detailed analysis attributed stakeholder with barriers is found in Appendix B, columns 3 and 5). Which stakeholders that are impeded gives an indication about the governance of the repair market. In practice, governance tends to be a negotiation with and between stakeholders. Different legal, policy, and market mechanisms can be used to steer action (Colebatch, 2014), and enable or hinder the participation of different repair stakeholder groups. We consider the repair market governance as a spectrum between two governance structure extremes. In a *distributive repair market governance*, independent repairers, consumers (as DIY) and OEMs alike are all free to supply repair activities and consumers have the choice of who to purchase the repair service from. At the other end of the spectrum, in a *centralized repair market governance*, OEMs control the transaction and actual repair (see Fig. 2 below).⁵⁰

In a centralized governance, nearly all repairs would be performed by the OEMs and/or their authorized repair service network, making the OEM the main decision-maker regarding what is repairable, how and where repair is offered, and at what price. At the other end of the spectrum, independent repairers argue that a distributive governance would level the playing field for local and social enterprises in offering repair services.

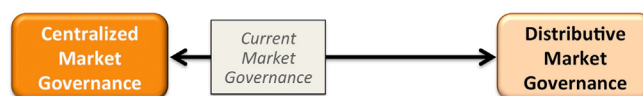


Fig. 2. The current repair market governance.

⁴⁷ Section 1, Washington State Senate Fair Repair bill (Hasegawa).

⁴⁸ See changes to bill text (Eggman, 2019b).

⁴⁹ See e.g., Section 59.1-572, Virginia bill which bans OEMs from deactivating or altering software in response to third-party repairs (Carter, 2019).

⁵⁰ The concept of distributive and centralized CE markets is derived from: slide 10 (Webster, 2019).

Consumers/product owners would also be empowered to control product repair decisions and activities. An example of such a repair market governance can be seen for automobiles, where car owners can have their car serviced and repaired at the facility of their choice.⁵¹ These two governance structures create vastly different repair market conditions.

The review revealed that, overall, the most heavily impeded stakeholders are independent repairers and DIYs, while OEMs constitute the least hindered stakeholders in the current system (see Appendix B Table 1's Column 3 for this analysis). Consumer choice regarding who should repair their product is limited. These attributes are characteristic of a mostly centralized governance structure (see Fig. 2).

It should be noted that even in centralized governance, OEMs encounter barriers; these are primarily market barriers, and largely a consequence of their business model structure, as shown in Section 2.

Recalling the two jurisdictions' different initial framing of the need to increase repair activities, with the EU looking to create a CE and the U.S. safeguarding consumer ownership rights, it is interesting to find that their current governance structures differ slightly. While the Ecodesign Directive regulations ensure repair professionals access to spare parts, the Fair Repair-bills also seek to grant DIYs such access, with the exception of one state bill.⁵² The U.S. approach with the Fair Repair-bills is thereby notably a push for a more distributive governance, with ownership in the forefront, compared to the EU, where the approach to upscale is still within a more centralized structure, due to the exclusion of DIYs. The decision to exclude DIYs from the EU Ecodesign requirements was made despite stakeholder consultations throughout the legislative process and may be regarded as the result of a compromise, with OEMs arguing issues with risk and liability against including DIYs (Harrabin, 2019). The two jurisdictions are currently under a similar, mostly centralized governance.

Overall, it is uncertain whether the EU and U.S. policymakers have fully considered the implications of the chosen governance structure, which are still largely under-explored, clearly indicating a need for future research.

4.3. A systems perspective on the current state of repair and upscaling

To truly realize the potential of a CE, repair must become valued in mainstream culture by consumers, and by society at large - a Repair Society. To achieve such a society, this review indicates a path forward. The main barriers and solutions, summarized in Appendix B Table 1 in column 2 and 4, indicate that three pillars are necessary: *Infrastructure and Systems* support the upscale of repair by ensuring access and opportunity (i.e. consumers are able to obtain the service, and suppliers are able to conduct and offer it); *Business and Industry* accounts for the economic rationale (i.e. repair is priced to be viable and preferable for both consumer and supplier); and finally, the *Culture and Market* must be such that supply- and demand choices favors repair (i.e., adequate knowledge of repair options, as well as attitudes, norms, and behaviours in favour of general prolonging of the lives of devices).

A Repair Society constitutes the end-goal of a transformation, where an optimized level of repairs is taking place (i.e., where all repairs that are desirable from an economic and environmental

perspective are conducted). The realization of such a society will require a dramatic upscale of repair, captured in the Repair Society Framework (Fig. 3) on the vertical axis as: low (i.e., repair is possible); mid (i.e., repair is preferable) and high (i.e., repair is normalized). The Framework provides a systematic approach to informing the transition to such a society. Each individual pillar entails different conditions for low, vs. mid vs. high scales of repair. A successful ascent first necessitates overcoming the conditions for low scales of repair, and so on. This implies that each of the three pillars pertaining to the same level should preferably be addressed before moving to the next level (e.g., improvements to culture and the business case, without also improving infrastructure and systems, is likely to fail). Moreover, the three pillars at each level are interconnected (e.g., a culture of repair presumably has a positive impact on the willingness to pay for repair services). This gradual approach is illustrated in Fig. 3 by the coiling arrow, sweeping from pillar to pillar in an ascending movement through the levels.

In both the EU and the U.S. the scale of repair activities is still low, with repair hindered by barriers pertaining to all the three pillars. Repair activities, including access to necessities, are often a legal offence or an impossibility (*Infrastructure & Systems*). The profitability of repair is limited, e.g., low product replacement cost, lack of design for reparability (increasing labour time and need for specialized tools), and risks due to legal obligations and uncertainties (*Business & Industry*). Lastly, unfavourable consumer preferences and misinformation/lack of information are perpetuated (*Culture & Markets*).

Some barriers clearly pertain to only one pillar of the Repair Society Framework, such as the permissibility of a third-party repair (*Infrastructure & Systems*), while other barriers notably cut across pillars; an *Infrastructure & Systems* barrier 'spilling over' into a *Business & Industry* barrier can be observed in the following example. To ensure consumer safety, refurbished spare parts might have to comply with the same legal standards as new products, and thus become subject to EU chemical restrictions and chemical taxes. These requirements increase cost and risk, and ultimately decrease the profitability of providing refurbished spare parts into the market. As such, these legal standards effectively become a market barrier to reuse of spares as original spares are either more expensive, or not even accessible for unauthorized independent repairers, and ultimately, consumers bear the cost.

Attempts to pinpoint the most significant barriers depend upon the stakeholder perspective and the associated systems-impact. Currently, repair markets in the EU and the U.S. have barriers to

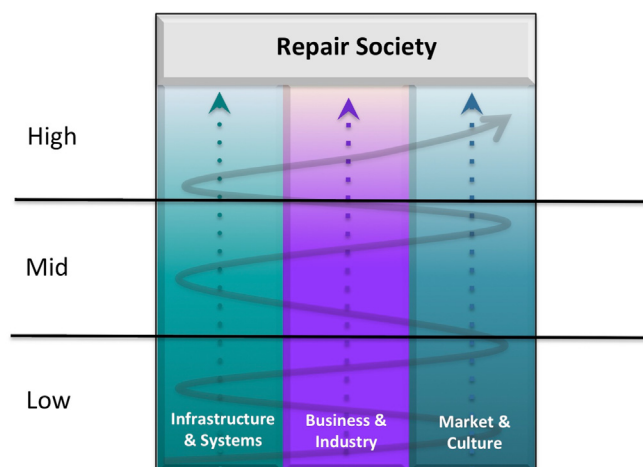


Fig. 3. The repair society framework.

⁵¹ For an outline of the U.S. condition for the automobile aftermarket, see (Moore, 2018).

⁵² The Vermont bill makes no mention of device owners, only professional repairers, see section 1 (Pearson).

both repair demand and supply. It has been argued that electronics are increasingly treated as consumables (Sabbaghi et al., 2017), and the review found consumers are deterred from repair due to high repair prices and lack of access to repair infrastructure, and perceived obsolescence. At the same time, the growth of the repair industry is held back by many of the technical, operational, legal and economic obstacles. The general lack of awareness of repair is supposedly an important underlying cause behind many of the barriers discussed above, in addition to legislators being suspicious or ignorant of the content of legislative proposals for facilitating repair. Also, the control of repair and lobbying of policymakers by OEMs implies reduced repair opportunities (Rossmann, 2020).

The partially implemented or proposed policy solutions show how barriers can be mitigated both within, but also across different, legal disciplines. For instance, design barriers can be mitigated through consumer law measures, while contract law barriers could (in theory) be overcome by the use of Antitrust Laws or even copyright misuse. Further, several market barriers that lack direct solutions can be addressed indirectly through legal obligations. For example, OEM requirements on spare part availability for a specified number of years, as introduced in the EU Ecodesign Directive and proposed in some Fair Repair bills, obligates OEMs to find cost-effective ways to keep stock of spare parts for older models. Similarly, extended warranties will incentivise OEMs to improve durability (i.e. reduce or even eliminate planned and premature obsolescence) and perhaps even reparability in design. Furthermore, the EU Ecodesign requirements on mandatory supply of some tools require OEMs to deal with the barrier of not having access to such tools (i.e. when products are designed for manufacturing and not repair). In addition, the design requirements on the use of 'common' tools for disassembly disincentivizes OEMs from creating the need for specialized tools, thereby reducing the number of different tools independent repairers and DIYs will need access to (i.e. profitability barrier in 'Business & Industry').

Fair Repair-bills proposed in the U.S. would eliminate several barriers related to *Infrastructure & Systems* and may influence *Business & Industry* barriers, such as enabling 'reasonable' price for necessities. Although, to be successful they presumably require clarifications of OEM obligations and limitations in scope, at least to begin with. Once necessities are accessible, design-related initiatives are important to ensure reparability. Although some progress has been made through voluntary measures, such as MOUs and design standards, it is important to keep in mind that the majority of these initiatives exist as a response to proposed mandatory obligations.

Although the majority of the solutions and proposals reviewed are targeting barriers keeping repair scales low (Fig. 3), we can also see some examples of higher level interventions of *Infrastructure & Systems* (e.g., prolonged warranty in the event of a repair in France) and *Business & Industry* (e.g., tax reductions on repair services in Sweden). Regarding *Culture & Markets*, in this paper delimited to a focus on consumer knowledge and information, there remain questions about whether the conditions in the other two pillars are sufficient to begin influencing *Culture & Market* barriers, i.e., perceived obsolescence and individual consumer preferences.

5. Summary & future outlook

This review aimed to develop a knowledge and understanding of the role of policy in both creating and addressing barriers and opportunities for repair activities in moving to a more sustainable CE. The core contribution of this review consists in providing a unique systems-level overview of the current state of repair in terms of the barriers and currently implemented and proposed

legal and market solutions. To this end, this paper introduced the concept of a Repair Society Framework as a potential tool for analysing systematic market transformation towards a Repair Society where repair is normalized. This Framework, however, needs to be further developed and tested. Topics for further research include exploring and outlining the characteristics and conditions of both the end-state (i.e. a Repair Society) as well as the three pillars, at all three levels. Further, the barriers can be said to be upheld by a multitude of (seemingly) opposing interests, such as innovation (IP Law), consumer safety and OEM profitability. These interests must be reviewed for their legitimacy and trade-offs further explored. While we reviewed many policy solutions, research could evaluate policy solutions more comprehensively.

The transition to a CE and to more sustainable production and consumption, within the planetary boundaries, requires the upscaling of repair activities. However, it must be noted that the development of a Repair Society is not limited to creating new business models or enabling consumers, but also contributing towards a sustainable economy. For this purpose, the Repair Society Framework should also be examined in the context of other CE models, such as the Sharing Economy, product service systems, and in relation to recycling strategies and policies.

This paper has also shown how the barriers and policies address stakeholders differently and influence the current governance structure of repair. A remaining question is to what extent the different market governance structures affect the speed and effectiveness of the upscale of repair activities (i.e., a realization of a Repair Society), illustrated in the Repair Society Governance Matrix in Fig. 4.

The choice of governance structure has implications on the realization of a Repair Society and the way the different governance structure pathways would impact stakeholders within a CE needs to be better understood. For governments to make a strategic, and successful, decision regarding what policies to adopt with the purpose of bringing about an upscale of repairs, an understanding of the implications, challenges and opportunities with each repair governance structure constitute a necessity. Without a clear understanding of the impacts, there is a risk that the choice of governance structure in realizing a Repair Society is simply the result of a strong stakeholder influence, lacking holistic considerations. Key topics for further research include exploring the relevant stakeholder interests and the role of governments in each structure (Fig. 1) in navigating these interests in order to ensure a

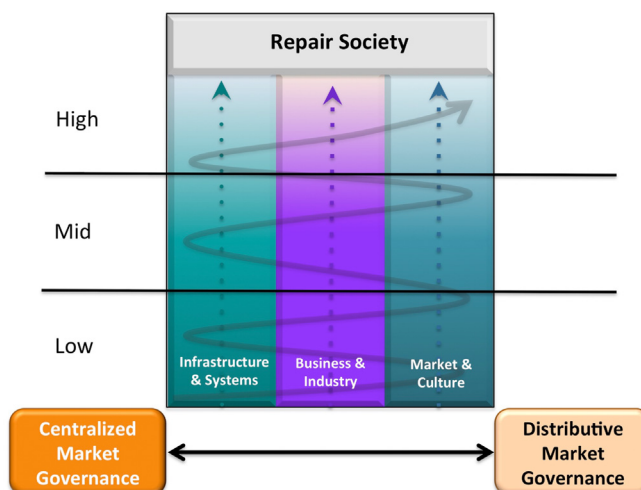


Fig. 4. The repair society governance matrix.

successful upscale of repair. The trade-offs in each structure need to be better understood, and how they can be managed in relation to overall policy goals.

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CRediT authorship contribution statement

Sahra Svensson-Hoglund: Conceptualization, Data curation, Formal analysis, Writing - original draft, Supervision, Writing - review & editing. **Jessika Luth Richter:** Conceptualization, Data curation, Formal analysis, Writing - original draft, Supervision, Writing - review & editing. **Eléonore Maitre-Ekern:** Data curation, Formal analysis, Writing - original draft. **Jennifer D. Russell:** Data curation, Formal analysis, Writing - original draft, Writing - review & editing. **Taina Pihlajarinne:** Data curation, Formal analysis, Writing - original draft. **Carl Dalhammar:** Conceptualization, Data curation, Formal analysis, Writing - original draft.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

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