Towards a right to repair for the Internet of Things

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Towards a right to repair for the Internet of Things: A review of legal and policy aspects

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ABSTRACT

The way in which consumers engage with, utilise, or discard the technologies in their lives is constantly being reassessed and changed. This paper questions what role the emergent "right to repair" could play in resolving issues posed by the increasing ubiquity of the Internet of Things (IoT). The right gives consumers the ability and freedom to fix their devices, or to fair access to appropriate services that can carry out repair on their behalf. In this paper, firstly we establish the problem space surrounding consumer IoT – i.e., devices that are interconnected via the internet, enabling them to send and receive data. We reflect on hardware, software, and data components that pose legal and policy challenges for data protection, security, and sustainability. Through a literature review we then reflect on the current socio-legal developments that support or oppose changes in the consumer IoT market in regards to repair. We then highlight gaps in the existing literature that should inform future research trajectories in this area. This includes exploring disparities between environmental and consumer autonomy approaches, assessing consistency in regulatory developments, and market prioritisation. Finally, the paper concludes with a series of key insights and recommendations from our analysis including: recognition of the growing e-Waste problem and the inequalities it exacerbates and perpetuates; the need for identification and argumentation for different formulations of "repair" and how these may impact the implementation of a right going forward; the need for identification of the reasoning behind disparities in governmental approaches to the right to repair; and the need to practically translate better IoT design practices into reality.

1. Introduction

In this paper, we consider the socio-technical issues posed by consumer Internet of Things (IoT) devices, examine the role of emerging right-to-repair laws and propose recommendations for how to proceed to realise the right to repair for IoT. For many technologies, IoT integration and compatibility has become a mainstay, with many consumer devices now being internet enabled, allowing them to send and receive data. This includes devices like smart speakers, watches, or fridges. However, common practices in IoT system design are of concern, such as the planned obsolescence of hardware. This practice is unsustainable from an environmental perspective due to the volume of physical electronic waste (e-Waste) it generates and from a consumer rights perspective where IoT devices are only supported for a specific period not explicitly agreed to. In response, there has been a growing call for greater repairability of IoT technology alongside wider calls to move towards more circular economies and sustainable relationships with technologies.

The "right to repair" aims to give citizens and repair communities greater leverage and standing to fix broken products and to redress the impacts of design choices of manufacturers such as planned obsolescence. However, IoT devices have not been a central focus of such regulations to date. IoT systems pose unique challenges for repair as they implicate hardware, software, and data jointly in a complex ecosystem of actors such as users, designers, manufacturers, and retailers. This means that products can continue to be altered, serviced or restricted past the point of sale by manufacturers. The relationship between manufacturer and consumer is more intricate and ongoing than conventional products. Thus, understanding how to realise the right to repair for IoT in practice is a complex research challenge. In this paper, we will provide an overview of the legal and policy developments shaping the conversation around the right to repair and its implementation. We will illuminate some of the key motivations and questions underpinning the right and map out the priorities that our future work will build upon to further realise the right in the United Kingdom.

The modern proliferation of consumer IoT products has ushered in an

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era of unprecedented connectivity and convenience, embedding smart technologies into everyday devices ranging from refrigerators to thermostats. However, this surge in interconnectedness has brought forth a host of challenges, fuelling the momentum of the "right to repair" movement. One significant issue is planned obsolescence, a practice where manufacturers intentionally design products with a limited lifespan, making repairs difficult or impossible. This is particularly pertinent in the realm of IoT, where rapid technological advancements can render devices obsolete in a short span. As a result, consumers find themselves trapped in a cycle of constant upgrades, contributing to electronic waste and environmental concerns.

IoT products present intricate challenges related to repair, encompassing hardware, software, and data concerns. On the hardware front, manufacturers often employ proprietary designs, making it difficult for consumers or third-party repair services to access and replace faulty components. This lack of modularity not only obstructs repairs but also contributes to a throwaway culture, where entire devices are discarded due to a single malfunctioning part. Furthermore, intricate integration of hardware with software poses a dual challenge. Many IoT devices have embedded software tightly intertwined with the hardware, hindering independent repair efforts. Without access to source codes and diagnostic tools, users are left at the mercy of manufacturers, impacting their ability to fix or upgrade devices.

Software-related issues also extend to update restrictions imposed by manufacturers. Limited support for software updates can render devices obsolete, forcing consumers to purchase new models rather than maintaining and repairing their existing ones. Additionally, the vast amounts of personal data processed by IoT devices raise concerns about data security during repairs. The interconnected nature of these devices means that mishandling during repairs could compromise sensitive information. This intertwining of hardware, software, and data issues in IoT products collectively jeopardizes consumer rights. The right to repair is challenged as manufacturers retain tight control over repair processes, limiting consumer autonomy. This lack of access impedes not only the practicality of repairs but also hinders the ability to make informed decisions about the longevity, security, and functionality of the IoT products consumers purchase, ultimately impacting their rights to privacy, choice, and sustainability.

Cybersecurity emerges as another critical facet of the IoT landscape, intertwining with the right to repair movement. With devices collecting and transmitting vast amounts of personal data, the security of these interconnected systems becomes paramount. However, manufacturers often restrict access to the inner workings of their products, hindering independent repair efforts and leaving consumers vulnerable to potential security breaches when support ceases. The right to repair is intricately linked to the need for transparency and accountability in addressing cybersecurity threats, as empowering users to fix and update their devices can enhance the overall resilience of the IoT ecosystem.

Update cycles and maintenance pose additional challenges, further underlining the importance of the right to repair. IoT devices often rely on regular software updates to patch vulnerabilities and introduce new features. However, manufacturers frequently design products with limited update support, pushing consumers towards purchasing new models. The right to repair seeks to break this cycle by advocating for access to necessary tools, documentation, and software to enable users or third-party repair professionals to extend the lifespan of devices through updates and maintenance.

In essence, the right to repair movement is a response to the evolving landscape of consumer IoT products, addressing the interconnected issues of planned obsolescence, cybersecurity, update cycles, and maintenance. By advocating for the ability to repair and maintain one's devices, the movement seeks to empower consumers, reduce electronic waste, and foster a more sustainable and secure IoT ecosystem. As technology continues to advance, the right to repair becomes not just a consumer preference but a crucial element in ensuring the responsible and ethical evolution of the IoT industry.

The structure of the paper is as follows: first, an explanation of the literature review conducted is given in Section 2. This outlines the methodology utilised for the review, including an explanation of its limitations, focus and preliminary assumptions. Following this, Section 3 provides an overview of the current state of affairs around the 'right to repair' and its implementation. This overview is not a comprehensive doctrinal legal analysis, but instead aims to provide a broad picture of the different concepts and methodologies that are at play in the research, implementation, or intentions around the right to repair within the law and policy domain. In Section 3.1, an overview of the problem space around repair and IoT is provided, focusing on challenging design practices, such as planned obsolescence, and issues arising in respect of data, privacy, and cybersecurity. Following this, in Section 3.2, an overview of the international legal and policy developments supporting or opposing the right to repair is outlined. Next, Section 3.3 will discuss the findings of the literature review, identifying the key areas of discussion for the right to repair, reflecting on their significance for design practices and future study. This literature review provides a clear roadmap of domains deemed critical to development or implementation of the right to repair, including gaps for further research in Section 3.4. Finally, Section 4 pulls together key insights from Section 3 and makes a series of recommendations of ways to realise the right to repair for IoT. This includes the urgency created by the worsening e-Waste problem globally, and the often accompanied social, class and geopolitical inconsistencies of this. By identifying the disparities in governmental responses and reasoning towards the right to repair, the aim is to create a clearer path forward in the policy direction.

2. Methodology

A literature and policy review was conducted to identify three things: the current legal and policy developments around the right to repair, dominant themes and considerations that arise in academic discussions around repair and IoT, and identifying gaps or areas of discussion that warrant further research and focus going forward. The goal of this review was to create a broad perspective overview of the current situation around IoT products in the consumer space, the legal frameworks developing around these, and the social movements that have driven these pushes. The preliminary assumption of this review is that the current policy trajectory globally is in favour of a right to repair, and that this is overall a positive and desirable shift. The desired end-goal is to understand the various policy drivers and barriers towards implementing of the right to repair equitably within the UK, thus we look internationally to learn lessons from other jurisdictions and reflect on emerging law and policy changes in the UK, particularly influences from the EU.

The review was conducted on a grounded theory basis,[1] attempting simply to identify and collect relevant information to inform a hypothesis on which to base future work. Sources were collected through two primary database searches: firstly, Lexis Nexis, which was targeting more legal and policy specific literature components; and secondly, Google Scholar, which was to identify a broader range of non-legal literature that would inform the earlier sources. This is where the bulk of engineering or scientific, as well as references towards mainstream media was sourced. All official texts were sourced from their respective government or intergovernmental agency websites, such as UK Gov or the EU Commission. A table has been provided which details the primary search terms, by subject area, used during the literature review.

[1] B. Glaser and A.L Strauss, 2017. *Discovery of grounded theory: Strategies for qualitative research.* Routledge

Primary search terms of the literature review:

Legal & policy	Sustainability	Design & repair	News media
Intellectual property in repair	e-Waste and repair	Prolonging product lifespans	Consumer repair
Repairing patented designs	Sustainable design	Sustainable methods of repair	The right to repair
Patents and spare parts	Cybersecurity and lifecycle of devices	Designing for repair	Modular consumer products
Industrial designs, disclosure	Updates and sustainability	Interoperability of products	Opposition to repair
Consumer disclosures	Product lifespans	Modular design and sustainability	Repair legislation
The right to repair	Circular design	Planned obsolescence	Legal responses to repair
Ecodesign	Economics of repair	Data security	Community repair
Product safety and security		Consumer privacy	Repair cafes
Liability for repair		What is "repair"?	Repair protests
Circular economy			AllAAll

In terms of mainstream press and grey literature sources, a timeframe was set from 2015 to the date of writing – unless referring to a historical event that inspired later shifts – so as to only engage with recent grassroot movements, specific updates, and policy that could be directly seen as interlinked. For academic sources, there was a slightly greater flexibility in terms of timeframe depending on what the sources were utilised for. Legal and policy resources were almost always kept to the same timeframe, except where the major development steps (which have either inspired or driven social movements) were earlier. In respect of non-legal sources, such as more ethics or sociological focused work, a greater timeframe was permitted, with some sources reaching the 1950s. This is because these were relevant to a longer period of social shifts and economic factors, as opposed to specific markers of government action or refusals.

The sources used were to illustrate a broad-spectrum from regulatory reality to the wider social movements around repair. The three levels of sources used were:

(1) **Primary doctrinal sources**: this included legislation, case law and regulatory documents, as well as their accompanying explanatory or policy notes. These provide the map of the current regulatory landscape around repairability alongside emerging policy trends.
(2) **Academic secondary sources**: this was particularly from legal, ethical, and socio-legal studies areas. These provide evidence of the current arguments, trends and sources which inform those sources in (1) and help to illuminate the dominant themes or considerations in repairability discussions.
(3) **Grey literature and press**: this included mainstream news articles and output from social advocacy groups and NGOs such as RepairEU or iFixIT that helped highlight the current social movements surrounding repair. These movements are often, although not always, pushing for a more "idealized" or prospective future position than the current doctrinal realities.

Sources were found firstly through their respective repositories or publication bases. For example, government legislation was sourced from each respective government's own publication websites, and advocacy groups from their own websites. Secondary sources were identified through Google search and Google Scholar primarily, and then using SCOPUS and WebofScience to identify specific journals or collections that focused on repair, sustainability, and equitable technology.

The sources used within this literature review are not globally comprehensive. This paper sits within a wider UK-centric research project, and thus the UK was centred as the principal focus. From here, two major Western markets, the EU and USA, were used for comparison as they are either the dominant economic association (in the case of the EU) or the country in which much of these social advocacy movements occur (in the case of the US). Due to disparities in legal systems and comparative legal application, the more "application" focused a source (i.e., legal documentation) the more it was restricted to the UK and EU. The less application focused, such as ethical argumentation, the less rigidity on location was applied. Beyond the EU and USA, policy was mostly only considered relevant if from an appropriately comparable Westminster system, such as Canada, Australia, and New Zealand.

3. The repair problem space

The right to repair has been discussed for decades in various contexts.[2] Its history mainly relates to automobiles,[3] with major US legal decisions shaping its development from the 1950s to 1970s.[4] The first published government reference to "a right to repair" by the US government was in 2001, again in the context of automobiles.[5] It has since arisen in nearly every consumer context, for example smartphones through Apple's public opposition to repair,[6] or their overly complex repair kits when seeking to comply with regulation. This section focuses on repairability issues in IoT technologies and recent developments in the right to repair space within the last five years. There have been rapid changes in this timeframe, in part driven by grassroots movements against manufacturers like John Deere[7] and major regulatory changes from the European Union (EU).

First, a discussion of the kind of problems that arise in respect of IoT repairability will be given. An almost endless array of problems could be considered in this section, however this paper will focus on a core selection: planned obsolescence, data handling and privacy, cybersecurity, and sustainability. The reason for this selection is that it covers a spectrum of an IoT products characteristics and lifecycle, and aligns with both common concerns expressed within the literature and some of the most popular concerns addressed within the mainstream media. While there are certainly other issues relating to IoT, particularly when discussing repairability, these ones provide a comprehensive overview of the kinds of issues that are affecting consumers and have relatable, real-world examples to pull from. This section will be populated by the

[2] The dominant domain of repairability discussions throughout the 20th Century was automotive repair. The repairability of early automobiles was at the crux of the economic battle between Ford and General Motors in the 1920s. Henry Ford wrote on his philosophy at this time, see: Henry Ford, "My life and work" (Fairfield Iowa, 1st World Library, 2005), p.81

[3] "Unfair Competition – Reconditioning Used Goods – Permissible Limits of Resale of Patented or Trademarked Articles" (1939) Washington University Law Review, 24:2

[4] A landmark case in this area was *Aro Manufacturing Co. v. Convertible Top Replacement Co.*, 365 U.S. 336 (1961) which contributed to the development of the Magnuson-Moss Warranty Act 1975.

[5] Motor Vehicles Right to Repair Act S.2617 (2001) (this Act failed to be enacted)

[6] *Apple Inc vs Huseby, HR*-2020-1142-A, (sak nr. 19-141420SIV-HRET); interestingly, Apple was an early proponent of modular and easy to repair computers, despite their current reputation for being one of its most ardent opponents. See: Michael Kan, "Apple Co-Founder Steve Wozniak Publicly Backs Right to Repair", (2021, PCMag), <https://uk.pcmag.com/computers-electronics/134387/apple-co-founder-steve-wozniak-publicly-backs-right-to-repair>

[7] Koebler, J. and M. Gault (2021). John Deere Promised Farmers It Would Make Tractors Easy to Repair. It Lied. Vice.

findings of the literature review; what are the issues that arise within these areas, and how are these problems expressed, cautioned or argued for in a variety of contexts. The goal is to create a roadmap of the different ways in which IoT and repair may interlink, and how this may influence future design considerations taken to address these concerns. This will also inform later work which through ethnographic and empirical research will attempt to identify disparities between the focus of the literature and policy developments and "ground level" concerns that arise for consumers or repair advocates.

3.1. Problems that arise from the regulation, design & repairability of IoT technologies

The "Internet of Things" (IoT)[8] is the latest term for a class of technologies that has been emerging since the early 1990′s, so called Ubiquitous Computing. Weiser's original vision of Ubicomp was one of embedded computer systems that ambiently sense and collect data, where they become domesticated into everyday life to the point they are deemed 'invisible in use'.[9] In practice, Ubicomp has manifested in different ways,[10] with the current IoT being one example.[11] Consumer IoT involves networked, physical computing devices that use data from users and the environment around them to provide services like home security with smart locks on doors, entertainment with conversational agents in smart speakers, or well-being with wearable fitness trackers.[12] In this section will briefly outline some of the most prominent regulatory problems discussed in relation to repairability of IoT.[13]

Planned obsolescence is the deliberate design of technologies to become redundant. This can be managed through hardware redundancy, where parts are designed to fail sooner than their lifespan allows, or software redundancy, where security mechanisms or updates impair functionality or permitted use beyond certain times. Motivations vary but can include perceived fashionability or a desire to produce more sellable product, or to encourage a business model where consumers continually seek upgrades.[14] Planned obsolescence can also be coupled with design features that impair repair entirely or increase its difficulty, or when manufacturers deny access to necessary parts. Examples include Apple's "tamper-resistant" pentalobe screws[15] and IBM being sued by the Department of Justice for anti-competitive behaviour by restricting access to repairs while holding a near-monopoly.[16]

It should be noted however, that while much of the mainstream conversation around planned obsolescence and repairability focuses on big names like Apple, this is not indicative of the wider consumer market. A significant number of companies pioneering innovative solutions are often small to medium-sized enterprises (SMEs). These entities play a crucial role in pushing the boundaries of IoT technology. However, many find themselves grappling with the challenges of incorporating sustainable and secure design practices. Unlike their larger counterparts, SMEs may lack the resources, both in terms of finances and expertise, to invest in robust cybersecurity measures and eco-friendly product development. The demanding nature of the IoT industry, characterized by rapid advancements and evolving standards, places considerable strain on these companies to balance competitive innovation with security and sustainability.[17]

The economic models prevalent in the IoT space further exacerbate the struggles of smaller enterprises in prioritizing security. Traditional economic structures often favor rapid product development and time-to-market, placing immense pressure on companies to deliver cutting-edge solutions quickly.[18] In this competitive environment, the flexibility necessary for innovative firms to prioritize security measures is often compromised. Resource constraints, coupled with the prevailing emphasis on speed and cost-effectiveness, create a challenging scenario where security considerations may take a backseat to meet immediate market demands.[19]

Moreover, the lack of standardized security protocols and sustainable design guidelines for IoT products adds complexity to the situation. While larger corporations may have the capacity to navigate and contribute to the establishment of industry standards, many SMEs find themselves caught in a cycle of reactive responses to security issues, rather than proactively integrating robust measures into their products. This scenario not only poses risks to consumers but also hinders the long-term viability of IoT technologies by potentially eroding public trust in their security and sustainability.

As devices become more interconnected, managing their data, hardware, and software becomes complex. Problems include maintaining a device's operating system or functionality after the company responsible fails or moves on and does not maintain updates (sometimes called software obsolescence). Many devices are also "goods as services," where continued association with the manufacturer is required. An example is BMW's new car model where heated seats are an additional monthly cost.[20] This not only limits consumer choice and functionality but also keeps them beholden to an economic relationship with a manufacturer they may not wish to maintain. An overarching problem is that IoT functionality is increasingly the default for consumer products. When the market force consumers into purchasing interconnected devices designed to support a specific manufacturer or product, this can create frustrations and exacerbate equitability issues.

There are wider implications for the lack of repairability in IoT devices. The lifespan of devices is important when examining environmental consequences. E-Waste has been increasing dramatically, seeing increases of 3–5 % per year and nearly three times faster than conventional municipal solid waste.[21] This has a devastating effect on the environment and is a principal argument for the right to repair by consumer groups advocating for greater repurposing to mitigate waste. This waste and the economic costs of repair also contribute to societal

[8] Ashton, K., 2009. That 'internet of things' thing. *RFID journal, 22*(7), pp.97-114.; Holler, J., Tsiatsis, V., Mulligan, C., Karnouskos, S., Avesand, S. and Boyle, D., 2014. *Internet of things*. Academic Press.

[9] M Weiser (1991) Computer for 21st Century. *Scientific American.*

[10] Dourish and Bell (2014) Divining A Digital Future: Mess and Mythology in Ubiquitous Computing.

[11] Urquhart, L. (2020), *White Noise from the White Goods* in Edwards, Schafer and Harbinja *Future Law* EUP.

[12] See Atabey, Schafer and Urquhart (2023) *How do You Solve A Problem Like Alexa?* JusLetter IT. https://www.research.ed.ac.uk/en/publications/how-do-you-solve-a-problem-like-alexa

[13] For more work from an Australian Context see Manwaring, K. et al (2022) What Does a Right to Repair Tell Us About Our Relationship With Technology? *47(3) Alternative Law Journal 179*

[14] Jeremy Bulow, "An Economic Theory of Planned Obsolescence," (1986) The Quarterly Journal of Economics, 101:4, at 5-8

[15] Chris Foresman, "Apple "screwing" new iPhones out of simple DIY repair" (January 20, 2011, Ars Technica), <https://arstechnica.com/gadgets/2011/01/apple-screwing-new-iphones-out-of-simple-diy-repair/>

[16] David N. Edelstein, "IBM Consent Decree" (January 25, 1956) New York: United States District Court

[17] Maria A. Quintas, Ana I. Martinez-Senra and Antonio Sartel, "The Role of SMEs' Green Business Models in the Transition to a Low-Carbon Economy: Differences in Their Design and Degree of Adoption Stemming from Business Size" (2019) Sustainability 10(6)

[18] Elizabeth Loucks, et al. "Engaging small- and medium-sized businesses in sustainability" (2010) Sustainability, Management, Accounting and Policy Journal, Vol.1:2, at 5-6

[19] Thaddeus McEwen, "An Examination of the Barriers that Impact the Implementation of Environmental Sustainability Practices in Small Businesses" (2013) Journal of Business & Entrepreneurship, Vol.25:1, at 120; 125-127

[20] Peter Valdes-Dapena, "Why BMW is offering heated seats on a monthly subscription" (July 14, 2022) <https://edition.cnn.com/2022/07/14/business/bmw-subscription/index.html>

[21] Pontsho Ledwaba and Ndabenhle Sosibo, "Cathode Ray Tube Recycling in South Africa" (2017) Recycling 2(1)

inequalities across local and international geographies. The distribution of waste globally and shipping to economically poorer countries leads to disproportionate impact on different global communities.[22] And economic accessibility of repair leads to societal stratification of technology by economic class, further entrenching pre-existing inequalities in access, opportunity, and development.[23]

The regulatory landscape for promoting repairability and sustainability in products encounters notable challenges, primarily stemming from the need to strike a delicate balance between consumer rights and the protection of intellectual property and industrial rights. The proprietary nature of both hardware and software in many IoT devices makes it inherently challenging to devise regulations that empower consumers to repair their products while respecting the intricate intellectual property frameworks established by manufacturers. Regulators face the complex task of fostering a repair-friendly environment without undermining the legitimate rights of companies to safeguard their innovations.

Another hurdle arises from the rapid pace of technological evolution in the IoT sector. Crafting relevant regulations becomes a perpetual challenge as technology advances at an unprecedented rate. Regulations that may be apt today risk obsolescence tomorrow, necessitating a dynamic framework that can adapt to the swiftly changing landscape of IoT technology. Striking this balance between forward-looking regulation and accommodating the constant evolution of devices poses a considerable regulatory challenge.

Communicating regulatory changes effectively to developers and companies adds another layer of difficulty. The intricacies of evolving legal frameworks must be conveyed in a manner that allows for smooth implementation without imposing undue burdens on innovators. The challenge lies not only in formulating regulations but also in ensuring that they are comprehensible and practical for the entities responsible for IoT product development. Clear communication is crucial to encourage compliance and foster a collaborative approach between regulators and industry players, thereby facilitating the integration of repair-friendly practices without stifling technological progress.

These are a select few examples of what different groups attempting to enact or advocate for the right to repair focus on. With these in mind, the next section will detail some of the developments in the legal and policy domain around the right to repair.

3.2. *Developments in the legal & policy domain – attempts to enable or prevent change*

Numerous jurisdictions have begun implementing policies that facilitate a future right to repair. This policy direction has largely been guided by environmental motivations, with many markets now transitioning towards a "circular economy" – a sustainable, repairable and reduced waste-based economy.[24] This section will outline the major legal and policy frameworks implemented (or initiated) at time of writing, to promote sustainable, equitable design and repair. In opposition to this, some examples of resistance (namely by manufacturers) will be provided.

3.2.1. *Sustainability and circularity*

The largest market thus far engaging in changes in this area is the EU, which in 2015 initiated a five-year plan to promote a circular economy. This is an ongoing development, and is a component of the wider EU 2050 Climate Neutrality Project (CNP). The purpose of these regulations is to:

> "…target how products are designed, promote circular economy processes, encourage sustainable consumption, and aim to ensure that waste is prevented […]."[25]

In March 2023, the European Commission announced a proposal promoting the repair of goods, amending earlier regulations for consumer repair access.[26] This is essentially a right to repair in all but name. Working within the CNP, this serves the EU's comprehensive goal of environmental sustainability. Some parts of this plan include:

- Eco-innovation support for manufacturers trying to transition their design and production processes to greener methods;
- New guidelines for green public procurement, and sustainable design measures in buildings and products; and
- The introduction of an eco-label to provide consumers with greater information about products environmental impacts.[27]

As part of the CNP, this plan works alongside developments in chemical, industrial and textile regulation, as well as carbon emission and import regulations. These components form the European Green Deal, the EU's action plan to develop a "climate neutral continent".[28]

The UK has implemented similar regulatory measures, including the *Ecodesign for Energy-Related Products and Energy Information Regulations* (2021).[29] Like the EU, these regulations aim to promote a green economy built on longer product lifespans, lessened e-waste and more sustainable design.[30] These focus mostly on household appliances such as refrigerators,[31] washing machines,[32] and dishwashers.[33] Currently, there is a recognition that these rules are too narrowly framed; the UK law has already come under substantial criticism for its exclusion of smartphones and computers.[34] With the Green Alliance arguing that it

[22] John Vidal, "Toxic E-waste Dumped in Poor Nations says the United Nations," (December 16, 2013) <https://ourworld.unu.edu/en/toxic-e-waste-dumped-in-poor-nations-says-united-nations>

[23] Wim Naude and Paula Nagler, "Is Technological Innovation Making Society More Unequal?" (December 21, 2016) <https://unu.edu/publications/articles/is-technological-innovation-making-society-more-unequal.html>

[24] European Parliament News, "Circular economy: definition, importance and benefits," (Updated: February 22, 2023), <https://www.europarl.europa.eu/news/en/headlines/economy/20151201STO05603/circular-economy-definition-importance-and-benefits>

[25] European Commission of the Environment, "Circular Economy Action Plan" <https://environment.ec.europa.eu/strategy/circular-economy-action-plan_en>

[26] Proposal for a DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCILon common rules promoting the repair of goods and amending Regulation (EU) 2017/2394, Directives (EU) 2019/771 and (EU) 2020/1828

[27] A comprehensive overview of this 2050 goal can be found in the "A Clean Planet for all - A European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy" (November 28, 2018) (Document 52018DC0773).

[28] "A European Green Deal: Striving for the first climate neutral continent" <https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en>

[29] This is an update to the earlier Eco-design for Energy-Related Product Regulations (2010).

[30] Much of the planning of these regulations occurred alongside and during BREXIT, and as a result could be said to originate from the same thinking. This perhaps accounts for some of the parallels in attention between the early EU and UK regulations. Similarly, the need for UK based manufacturers to abide by EU market regulations to remain competitive in a market which they are no longer integrated may be a guiding force, commonly known as the "Brussels effect."

[31] Chapter 5

[32] Chapter 4

[33] Chapter 3

[34] Ben Lovejoy "British right to repair law comes into force today, but excludes smartphones and computers" (1 July 2021) <https://9to5mac.com/2021/07/01/british-right-to-repair-law/>

could not even be considered a right to repair law at all, given its narrow and ineffectual framing of applicable products.[35]

Within the EU, Member States have begun to implement their own extensions of regulations. A notable example is France, who in 2020 mandated the inclusion of the "L'indice de réparabilité" ("index of repairability") on specific consumer products.[36] The list of these products is continuously expanding with decrees,[37] and requires that manufacturers provide information on: a products projected lifespan, access to repair components, access to manuals and repair directions, and its waste or recyclability.[38] France's approach appears rooted in a consumer-centric approach to sustainability, as opposed to the EU's environmental-regulation focus. It is believed this index will influence consumer preference towards more sustainable products.[39] In doing so, creating a market-manipulative force from the ground-up as opposed to the EU's top-down applied regulations. It should be noted, while this is the intention, there is conflicting evidence as to whether this is the outcome that occurs.[40] Circular economy and sustainability action plans play a pivotal role in mitigating the environmental impact of planned obsolescence and short lifecycles in IoT devices. By emphasizing the principles of reuse, repair, and recycling, these plans encourage (and often oblige) manufacturers to design products with longevity in mind. Implementing circular economy practices can break the cycle of premature device replacement, reducing electronic waste and promoting sustainable consumption patterns. While there may be a lack of economic incentive to develop products that last longer normally; by obligating specific base metrics, this incentive can be shifted to encourage both compliance and long-term development ideals.

Many of these developments can be said to support the physical lifespan or maintenance of devices, but thus far do little to support the digital or data components over time. However, they show a willingness to progress in this area as the broader regulations expand.

3.2.2. *Cybersecurity & data protection*

Cybersecurity and data protection are important components of IoT and repair futures. Data protection laws, particularly the EU General Data Protection Regulation (GDPR), govern how IoT devices interact with personal data. There are fundamental requirements like lawful basis for processing data, obligations to minimize data collected, implementing data protection by design and default, or demonstrating compliance. Data subject rights provide citizens with rights of access, erasure, or portability of their data, valuable when devices break and cannot be repaired. This is important when considering a right to repair as a mechanism for equitable use and access but also has importance to discussions of repair and customization over network-connected devices, which are often health-related.[41] A right to repair may help facilitate availability of previous software iterations, customizable privacy settings, and jailbreaking or sideloading of applications.[42] How data, security, and networking are regulated will be integral to ensuring equitable IoT functions effectively and fairly in a repairable world. Examples of developments include the EU's forthcoming Cyber Resilience Act[43] specifying design requirements for market access and the UK's Product Security and Telecommunications Infrastructure Bill 2022 (PSTI) concerned with product and infrastructure security and security by design.[44]

In the realm of cybersecurity, establishing robust standards is essential to curb data misuse in IoT devices. By mandating stringent security protocols, regulators can mitigate the risks associated with interconnected systems. This not only safeguards user data but also enhances the overall trust in IoT technologies. Simultaneously, incorporating maintenance requirements into these standards ensures that devices receive timely updates and security patches, reducing vulnerabilities and prolonging their effective lifespan. The synergy of cybersecurity standards and maintenance mandates fosters a more secure and enduring IoT ecosystem.

Good data protection is crucial for enabling repairability and extending the lifespan of IoT products. In the interconnected world of IoT, devices often collect and process sensitive user data. Robust data protection measures, including encryption and secure storage, ensure that user information is safeguarded during repair processes. This not only protects user privacy but also mitigates the risk of data breaches that could occur during repair activities. Additionally, when IoT products are designed with strong data protection mechanisms, it becomes easier to implement software updates and maintenance without compromising user information. Manufacturers and third-party repair professionals can confidently perform necessary updates, enhancing the overall security and functionality of the device over time. This promotes a culture of continuous improvement and extends the lifespan of IoT products by allowing them to adapt to evolving technological and security requirements. In essence, good data protection practices create a foundation for secure and sustainable repair processes, fostering a longer and more reliable lifespan for IoT devices.

These developments are influenced by a variety of different market and regulatory standards, depending on the market. Notably, the ETSI (European Telecommunications Standards Institute) standards, such as 303 645 were pivotal for IoT security, intersecting with theUK's

[35] Green Alliance, "The UK's New "right to repair" is not a right to repair" (6 July 2021) <https://greenallianceblog.org.uk/2021/07/06/the-uks-new-right-to-repair-is-not-a-right-to-repair/>

[36] LOI no 2020-105 (2020) du 10 février 2020 relative à la lutte contre le gaspillage et à l'économie circulaire (1). Journal Offciel de la République Française 0035 du 11/02/2020, Journal Offciel de la République Française 0035 du 11/02/2020 Texte 1 sur 65.

[37] Decrees in this context are akin to executive orders or ministerial orders; they have force of law, and are permitted for through the introduction of the dominant legislation or the office of the Minister responsible.

[38] One example, is the decree that expanded the index to include information about the quantity and uses of recycled material: Ministère de la Transition, É. (2021). Décret n° 2021-254 du 9 mars 2021 relatif à l'obligation d'acquisition par la commande publique de biens issus du réemploi ou de la réutilisation ou intégrant des matières recyclées, Journal Offciel de la République Française 10 mars 2021, Texte 4 sur 172.

[39] La Indice de réparabilité: "L'objectif de l'indice" (accessed October 2022) at <https://www.ecologie.gouv.fr/indice-reparabilite>

[40] For some different perspectives on this, see: C.Tanner and W.S. Kast, "Promoting sustainable consumption: determinants of green purchases by Swiss consumers", (2003), Psychology and Marketing, 20:10 pp. 883-902; C. Lucarelli, C. Mazzoli, and S. Severini, "Applying the theory of planned behavior to examine pro-environmental behavior: the moderating effect of COVID-19 beliefs",(2020) Sustainability, 12:2 pp. 1-17

[41] One such example is the recent movement in the USA where feminist and women's action groups have begun to recommend the deletion of menstrual tracking applications, due to changes in abortion access and legality, since the successful challenge to *Roe v Wade* in 2021. See Flora Garamvolgyi's article "Why US Women are deleting their period tracking apps" (January 28, 2022) <https://www.theguardian.com/world/2022/jun/28/why-us-woman-are-deleting-their-period-tracking-apps>

[42] To "jailbreak" means to modify/remove restrictions imposed by the manufacturer on a device, such as to allow the installation of unauthorized software on a smartphone. To "sideload" means to install software obtained from a third party source that is not the authorized provider (this is essentially the secondary action associated with jailbreaking).

[43] Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND THE COUNCIL on horizontal cybersecurity requirements for products with digital elements and amending Regulation (EU) 2019/2020. 2022/0272 (COD)

[44] Product Security and Telecommunications Infrastructure Bill (Sessions 2021-22, 2022-23); the continued parallels between the UK & EU market regulation is something to keep an eye on in the coming years, as Brexit's continued effects are felt.

regulatory initiatives too,[45] as lack of security patching and updates could be one route to redundancy for IoT systems. The main standards relevant are the CEN—CENELEC[46] and ESTI standards[47] on standardization, and industry applicability. Both of these standards originate from the EU, but are critical for infrastructure integration within the UK, USA and other markets.

3.2.3. Intellectual property

Parallel to these regulatory movements, scholars have argued for legal interpretations that promote flexibility, particularly within intellectual property (IP). It is reasonable to suggest the dominant viewpoint is in favour of a right to repair, with much of the literature presenting ways to circumvent, adapt, or modify laws to accommodate it. Support for an "IP-consistent" right has arisen within several jurisdictions. For example, it has been argued that American federal IP law is already consistent with the right in some contexts, and that the Library of Congresses power to exempt certain classes of technologies may be utilised.[48] Others have argued that different ideological backings for IP support a right to repair, such as utilitarianism or fair dealing.[49] Commonly, the DMCA or TPM's are discussed as mechanisms of enforcing copyright restrictions, and their circumvention has become a common discussion point.[50] DMCA is the Digital Millennium Copyright Act 1998, a piece of legislation in the USA that gives IP holders a mechanism to take down material which conflicts with their IP rights. TPM's, or Technological Protection Measures, are methods by which to restrict access to IP-controlled content. These can be encryption and authentication tools, passwords, product registration keys, paywalls and subscriptions. Competition law is often discussed, in parallel with IP, for a repair-consistent transition.[51] Warranties, TPM's, licensing and generic products have all become common argumentative battlegrounds in the growing literature movements around the right to repair.

Within the USA,[52] sustainable "green development" legislation has been proposed or initiated in over 25 states.[53] Much of this is broader than consumer products, and is largely focused on agricultural and industrial manufacturing so far, likely in response to situations like the John Deere farmer protests in 2017[54] although some have gone so far as to include an explicit right to repair. John Deere refused to allow farmers to repair their tractors when they experienced both hardware and software failures (new generation tractors often involve self-driving components and weather sensors). In some instances, repair of tractors would cost farmers upwards of $50,000. This resulted in jailbreaking of tractors, and agricultural sector boycotts of John Deere. Much of the USA's discussion around repairability has centred on the circumvention of TPMs and the use of the DMCA, and IP.[55]

The largest state which has passed consumer legislation is New York, with the Digital Fair Repair Act (formerly Bill S.B S4104A) being signed into law on December 28th, 2022. This Act includes a right to repair for many digital and electronic devices, including mobile phones, laptops and televisions.[56] Federally, President Biden in February 2022 ordered an executive inquiry into repair and consumer sustainability, protection and autonomy. The Federal Trade Commission (FTC) released its report, *Nixing the Fix,*[57] in August 2022, supporting the introduction of a consumer right to repair, and a reduction in manufacturer obfuscation of repair processes.[58] Thus far, this report has not resulted in any notable executive orders or legislative movement.

Opposition to the right to repair has come in two forms: firstly, lobbied or promoted opposition to right to repair movements; and secondly, legal challenges to individuals or groups engaging in commercial repair. The former has seen considerably greater effect within the USA, where many of the bills mentioned were "killed off" during committee stages.[59] It can be difficult to verify manufacturer involvement, largely due to the opaque nature of commercial influence, but the John Deere situation and Silicon Valley's public resistance[60] shows a clear opposition to the concept. Notable legal challenges include Apple,[61] Nokia,[62] and a collective of watch manufacturers.[63] These have been based around a purist application of IP law; an individual engages in repair practices of a patented technology, and the manufacturer seeks to enforce their patent exclusivity. These cases resulted in the court finding in favour of their exclusive control of the IP. In the past, these attempts to enforce strict interpretations of IP law have also led to conflicts in other areas, such as academic freedom.[64] Through more protective legal jurisprudence, manufacturers maintain greater entrenchment of their exclusive control over repair. There may be different motivations for these decisions. Manufacturers may be attempting to maintain control

[45] Department of Science, Innovation and Technology Guidance ", The UK Product Security and Telecommunications Infrastructure (Product Security) regime" (2023) accessed at <https://www.gov.uk/government/publications/the-uk-product-security-and-telecommunications-infrastructure-product-security-regime>

[46] Comité Européen de Normalisation Électrotechnique (English: European Committee for Electrotechnical Standardization). These standards are given force in the EU by Regulation 1025/2012

[47] European Telecommunications Standards Institute

[48] Dudding, K. (2021). "HOW FEDERAL COPYRIGHT LAW SUPPORTS THOSE ADVOCATING FOR THE RIGHT TO REPAIR." Drake Journal of Agricultural Law 26(1).

[49] Grinvald, L. C. and O. Tur-Sinai (2019). "Intellectual Property Law and the Right to Repair." Fordham Law Review 88: 63-127; Pihlajarinne, at 10; Hernandez, R. J., et al. (2020). "Empowering sustainable consumption by giving back to consumers the 'right to repair'." Sustainability (Switzerland) 12(3)

[50] Rosborough, A. D. (2020). "Unscrewing the Future: The Right to Repair and the Circumvention of Software TPMs in the EU." Journal of Intellectual Property, Information Technology and Electronic Commerce Law 26; Montello, S. K. (2020). "The Right to Repair and the Corporate Stranglehold over the Consumer: Profits over People." Tulane Journal of Technology & Intellectual Property 22: 165-185.

[51] Imarhiagbe, M. (2022). "The Right to Repair in EU Competition Law." Nordic Journal of European Law 1: 166-173; Rosborough, A. D. (2020).

[52] It should be noted, much of the grassroots movements in this area have originated within the United States, and many historical developments such as automobile repair were facilitated here first. However, more recent developments within the United States have been comparably scarce compared to the EU and UK.

[53] Gault, M. (2021). Half the Country Is Now Considering Right to Repair Laws. Vice.

[54] Koebler, J. and M. Gault, fn 7.

[55] In 2023, Colorado became the first state to provide an explicit right to repair to farmers. See the Consumer Right To Repair Agricultural Equipment 2023 (HB23-1011).

[56] At [10]-[25]

[57] Federal Trade, C. (2021). Nixing the Fix: An FTC Report to Congress on Repair Restrictions. Federal Trade Commission.

[58] At [36]-[45]

[59] A notable example of this was California, where SB 983 failed despite widespread consumer support. Claburn, T. (2022). California Right-to-Repair bill quietly killed in committee. The Register.

[60] Apple has been seen to lead coalition movements to defeat repair bills in California on a number of occasions, one such example is detailed here: Jason Koebler, "Tim Cook to Investors: People Bought Fewer New iPhones Because They Repaired Their Old Ones" (January 02, 2019) Vice.

[61] Originally the owner Henrik Huseby was found to not be in breach of Apple's intellectual property, but ultimately Apple succeeded on appeal in the Supreme Court of Norway in 2020. See, *Apple Inc vs Huseby,* HR-2020-1142-A, (sak nr. 19-141420SIV-HRET)

[62] *Technoservice Limited v. Nokia Corporation*, ICC Case No. 23513/FS

[63] Case T-712/14 *Confédération européenne des associations d'horlogers-réparateurs (CEAHR) v Commission* EU:T:2017:748

[64] A notable example is Edward W. Felton, who along with his research group, sued the Recording Industry Association of America (RIAA) after they attempted to prevent their publication of a paper on cracking SDMI watermarks. See, *Edward W. Felten Et Al. vs Recording Industry, Et al.* (2001) 01 CV 2669

for purely economic reasons (to sell more products, such as the cited example of Tim Cook's statement to investors) or for proprietary reasons (to protect their trade secrets from public scrutiny). So far, no legal challenge has arisen to advocacy-led repair movements, such as repair cafés.

3.3. The right to repair in context: insights from the literature review

We will now outline key themes or considerations arising from the literature review. These help highlight the priorities within this area, as well as specific changes to policy, design and regulation that may be suggested. Finally, an overview of considerations less common or absent from the dominant literature is provided. This is done to elucidate future research trajectories and areas of focus.

3.3.1. What is meant by "repair"?

A foundational theme that arises in the literature is what "repair" means. The literature appears to suggest four formulations, as a sort of continuum.

First, the normative position, is repair as mending; something is broken, and an individual has the right to return it to a workable form.[65] Following this is repair as "customization". A consumer should have the ability to actively modify and alter a product to fit their specific needs.[66] Customization discussions arise both in respect of physical aspects of products and also regarding data privacy, security and software variation.[67] Next, there is repair as "re-purposing" – taking a product that is no longer suited for its original use, and modifying it to function in a new context.[68] An example may be where an older model of iPhone, such as an iPhone 6, is repurposed to act as a remote garage sensor by utilising the inbuilt camera and processor. This form of repair comes most into question when discussing IoT devices strict controls over backdoor access, sideloading, or jailbreaking.[69] Finally, perhaps the most remote form of repair is "repair as tinkering" – the right for people to experiment and innovate with their owned devices.[70] Championed by Hatta, this does provide a distant horizon for which to target policy directives, especially around consumer autonomy and freedoms. This more speculative dapproach envisions an intended future to be designed (i.e. one where the social inequalities caused by repair access are greatly mitigated) and the prospective research is carried out in a way to bring about this goal.

3.3.2. Environmental consumers

The literature engages thoroughly with how best to develop, design and maintain technologies in an increasingly waste-conscious world. Methodologies here are broadly divided into two approaches: first, the development of sustainable design methods, materials and practices (the practical side)[71]; and secondly, the development of policy, regulatory mechanisms and enforcement to oversee it (the legal side).[72] *Repair Work Ethnographies* is a collection of essays on different models of repair, community engagement and the relationship between consumer and product. This work includes a number of different viewpoints on what role repair plays in one's environment, such as in regards to peoples living arrangements,[73] where it is argued that tenancy communities are strengthened by engaging in communal repair practices and mitigating their collective waste.[74] The conclusion of such work is not always an explicit right to repair, but almost invariably arrives at the conclusion that products that can be prolonged past their normal lifespan are more sustainable; a society that can mend and repurpose generates less waste, and the waste generated is also more recyclable and green.[75] Eckersall and Grehan, and Delaney et al. argue that by enabling consumers to repair their products, their autonomy and market influence is desirably championed. By empowering consumers, their market force arises and empowers their desire for sustainability.[76] As said, evidence in this area is contradictory.

Montello argues that consumer autonomy is the goal in itself, arguing that individual freedoms in respect of ones consuming habits relates to broader questions of property ownership, privacy, financial and corporate independence.[77] Lande argues that consumer choice is "the ultimate goal of antitrust law"[78] and that developments in this area should be made with a consumer choice model in mind that enables maximum autonomy within the marketplace. This is an area of research for marketing and economics going forward, to try and provide a clearer picture of exactly how this supposed force does or does not actualize.

3.3.3. Balancing benefits & burdens

An implied sentiment common within the literature is that through recognising the burdens and consequences of repairability "not everyone wins". Betterment for consumers may be economically burdensome for manufacturers, and healthy market competition may have negative environmental consequences and so on. It might be fair to suggest that sustainable design policy comes with an implicit awareness that the way the technology sphere interacts with the market warrants changes; perpetual growth and innovation is undesirable. This touches on questions of the "triple" or "fourth" bottom line developments.[79] These are economic models which include metrics beyond the conventional "bottom line" (money made) measure of success. Triple bottom line is sometimes phrased as the 3 P's: people, planet and profit, whereas

[65] This is essentially the starting position of all advocacy groups, such as Repair EU. See their explanation of "What we want" at < https://repair.eu/what-we-want/>

[66] Tamò-Larrieux, A., et al. (2021). The Right to Customization. Privacy Technologies and Policy: 9th Annual Privacy Forum, APF 2021. Oslo, Norway, June 17-18, 2021. Proceedings. N. Gruschka, L. Filipe Coetho Antunes, K. Rannenberg and P. Drogkaris, Springer: 3-22.

[67] Tamò-Larrieux, A., et al. at [3.1]-[3.5]

[68] Lepawsky, J. A., Erin; Davis, John-Michael; Kahhat, Ramzy (2017). "Best of two worlds? Towards ethical electronics repair, reuse, repurposing and recycling." Geoforum 81: 87-99.

[69] Apple does not support jailbreaking as a function, see their detailed support release available here < https://support.apple.com/en-us/HT201954>. However, Apple has not specifically tested the legality of jailbreaking in a court setting, but has utilised it as a means to deny warranties.

[70] Hatta, M. (2020). "The Right to Repair, the Right to Tinker, and the Right to Innovate." Annals of Business Administrative Science 19(4): 143-157.

[71] Delaney, E. L., Wei; Zhu, Zicheng; Xu, Yuchun; Dai, Jian S. (2022). "The investigation of environmental sustainability within product design: a critical review." Design Science 8(e15).

[72] Malinauskaite, J. B. E., Faith (2021). "Planned Obsolescence in a Holistic Legal Sphere and the Circular Economy." Oxford Journal of Legal Studies 41(3): 719-749.

[73] Alain Bovet and Ignaz Strebel, "Job Done: What Repair does to Caretakers, Tenants and Their Flats," (in *Repair Work Ethnographies: Revisiting Breakdown, Relocating Materiality,* (Pan MacMillan, 2019)), at p.89

[74] At p.95

[75] Eckersall, P. and H. Grehan (2021). "Necessity or Choice: Demanding the right to repair." Performance Research 26: 1-4.; it should be noted, that in examples like *Repair Work Ethnographies*, often repair is discussed irrespective of its legality and instead as a matter of practical reality.

[76] Eckersall, P. and H. Grehan (2021), fn 36.; Hernandez, R. J., et al. (2020). "Empowering sustainable consumption by giving back to consumers the 'right to repair'." Sustainability (Switzerland) 12(3).

[77] See Montello, S. K. (2020). "The Right to Repair and the Corporate Stranglehold over the Consumer: Profits over People." Tulane Review.

[78] Robert H. Lande, "Consumer Choice as the Ultimate Goal of Antitrust" (2009) University of Pittsburgh Law Review, 62:3, p.503-525

[79] Hal Taback, Ram Ramanan, "Environmental Ethics and Sustainability: A Casebook for Environmental Professionals" (2013) CRC Press

the fourth line is a broader sense of an ethical purpose. This is different, but closely related, to another contemporary economic theory, degrowth, which instead argues for the scaling back of economic markets, as opposed to circularity.[80]

Caution or opposition to the right to repair are comparatively rare. It is reasonable to suggest that public favour is in support of the right,[81] and thus the literature only reflects briefly on the counter-arguments. There are generally three arguments: the impact on innovation, the economic burden, and the impact on healthy competition.[82] All three are often discussed as a continuum; because of one, the others arise. Some argue that by forcing manufacturers to create products with extended lifespans it reduces their incentive to continually develop new, better, faster products.[83] Accordingly, they are economically worse off (due to fewer new products coming to market) and under significant financial burdens to adjust their development, manufacturing and distribution processes to meet standards.[84] And finally, by creating more repairable – often conflated with "simple" – products, they are more susceptible to third-party generic competition. This is exacerbated by mitigating their exclusivity over repair, further extenuating the economic cost of transition.[85]

3.3.4. Liability

Some literature has already considered the potential issue of liability in respect of repairability. It has been suggested that by changing the expectations of manufacturers around repairability, and permitting third-party repairs, this complicates product liability and safety considerations.[86] This has arisen in respect of both physical safety as well as cybersecurity standards owed by the manufacturer.[87] The validity of this concern however is unclear pending more legal challenges or legislative clarity. The distribution of responsibility is less commonly discussed than the importance of the movement, but is no doubt an important component of mitigating manufacturer resistance to change in this area.

With these themes in mind, the literature appears to imply a dominant background question to the possibility of a right to repair: how to best balance the perceived needs and goals of sustainable development (or repairability generally) between the desires and needs of the community, and the desires and ambitions of, or burdens imposed on manufacturers? Depending on the stance taken, this question could have a wide variety of answers, mechanisms and formulations. One thing common within the literature that is important for making steps towards an approach is identifying a clear end-goal; what is the "right to repair" that is desired, and what does it look like? In identifying this, clarity can be obtained over where concessions should lie, or whose interests should be prioritized.

3.4. Themes of further discussion

This final section will outline themes which do not commonly appear in the literature; these may be either briefly touched on but not the focus, or apparent gaps in the literature. These serve to illustrate where future research is warranted, and areas where potential issues may arise.

An oddity within the literature is the disparity between the EU and USA approach, rationale and implementation of repair questions. The EU appears to favour broad-spectrum changes for environmental reasons, with the primary focus being on economies' role and impact; a top-down implementation. The USA appears to favour individual rights and consumer autonomy, by enabling people to take ownership of their products in opposition to economic powers; a bottom-up approach. It is important to ask two questions: firstly, why does this disparity exist?[88] And secondly, which conceptualisation of the issue should other markets, such as the UK, pursue?

The disparity between the EU and USA approaches underscores the varied perspectives on repair, with the EU emphasizing broad-spectrum changes for environmental reasons and the USA prioritizing individual rights and consumer autonomy. This dichotomy prompts questions about why such differences exist and which conceptualization should guide other markets like the UK, especially post-Brexit. This has direct implications for IoT devices, as regulations can significantly impact their design, repair processes, and overall lifecycle, and their place within a global market can be difficult to appropriately balance amongst this landscape.

A question arises how to best balance the different regulatory developments and shifts in a systemically consistent way. For example, in the automotive industry there are a number of different areas of development which may conflict with one another, although they all seemingly intend to support progress. Changes to automotive design for repairability, sustainability, emissions standards, and safety are all valid and desirable developments, but may not all be compatible with one another in each instance. Establishing, or at least arguing in favour of, a specific arrangement of priorities would be invaluable going forward. How these priorities are determined, or by whom, will depend on an established normative position being established and argued for in advance.

A related consideration is how to prioritise the implementation of the right to repair in different sectors, technologies or spaces. Within the EU framework, as well as in France, the legislators have implemented clearly articulated roadmaps. How the decisions to prioritise certain technologies over others, or areas of technology, and whether there are alternative methods which can be applied in other markets like the UK, is an important strategic question for implementation. Some considerations that may be relied upon to make such determinations are: the ease of implementation within a particular market, the complexity of the technologies in question, the degree of public education or skills necessary to engage with the changes, the comparative economic burden of manufacturers and their economic role, their comparative environmental impact, and the impact on day-to-day citizen's lives.

From these practical considerations, stem a number of questions

[80] Demaria, F. S., François; Sekulova, Filka; Martinez-Alier, Joan (2013). "What is degrowth? From activist slogan to social movement." Environmental Values 22: 191-215; Degrowth has seen significant popularity in recent years, in part due to the success of Kohei Saito's book *Capital in the Anthropocene* (Shueisha, 2020).

[81] Avery Wendell and Mark White, "The Public Supports A Right to Repair" (2019) <https://www.dataforprogress.org/blog/2019/5/29/right-to-repair-laws-are-popular>

[82] Jalan, A. (2021). 6 Arguments Against the Right to Repair that Make Sense. MakeUseOf.

[83] For a discussion of this argument, see Galasso, A. L., Hong (2022). "When does product liability risk chill innovation? Evidence from medical implants." American Economic Journal of Economy Policy 14(2): 366-401.

[84] McCann, Duncan. (2019) Demanding a 'Right to Repair'. NewEconomics. https://neweconomics.org/2019/01/demanding-a-right-to-repair; The Security Innovation Center, an Apple-backed research centre, opposed the New York Right to Repair Bill on these grounds, see Bergen, Mark (2021) Microsoft and Apple Wage War on Gadget Right-to-Repair Laws. Bloomberg. <https://www.bloomberg.com/news/articles/2021-05-20/microsoft-and-apple-wage-war-on-gadget-right-to-repair-laws?leadSource=uverify%20wall>

[85] An extension debate around these positions occurred during the Royal Academy of Engineering and UKRI Interdisciplinary Centre for Circular Metals roundtable on Right to Repair (2021). Notes on this are available at BigRepairProject, here < https://www.bigrepairproject.org.uk/blog/right-to-repair-roundtable>

[86] A notable discussion of how to approach this is given in, Maitre-Ekern, E. (2020). "Re-thinking producer responsibility for a sustainable circular economy from extended producer responsibility to pre-market producer responsibility." Journal of Cleaner Production 286

[87] Hernandez, R. J., et al. (2020).

[88] There may be some readily apparent conclusions that can be drawn culturally, but identifying specific motivators for big picture federal decisions is still worthwhile for comparative reasons.

around the community and day-to-day functionality of the right to repair. Some angles of inquiry may be: what role does the right play in community repair development e.g. repair cafes? What new structures need to be in place in terms of access, education or information for its effective use? These structures are also critical to the upscaling and provision of repairs associated service industry; the upskilling and implementation of this system needs to be carefully considered in advance to ensure efficacy. As IoT devices become increasingly integral to daily life, these considerations are paramount. The impact on communal structures, employment, equity, and the upskilling necessary for repair-associated service industries directly correlates with the evolving landscape of IoT technologies. Will some citizens be adversely affected in terms of employment, equity, or availability? And accordingly, will some be prioritised, and gain advantages or privileges unavailable to others?[89] Often the impact on communal structures, social gatherings and upskilling are discussed,[90] but rarely the specific outputs or detriments that may arise. How best to formulate a "repair society" is a complex matter and it is unlikely that any society is adequately prepared to optimally utilise a right to repair currently. Crafting a "repair society" that optimally utilizes the right to repair for IoT devices necessitates careful navigation of these intricate challenges, ensuring a balance between technological progress, consumer empowerment, and environmental sustainability.

4. Discussion

In Section 4, we will summarise the key insights from Section 3, and reflect on the implications that arose from these and make recommendations for future research. This section illustrates the major complexities and questions that arise around the repair of IoT devices.

4.1. Waste & sustainability

e-Waste is increasing globally and will continue to do so unless sustainable design and waste management practices are employed. Management of this problem requires a broad holistic approach to market sustainability, due to the complex array of different actors involved within the consumer market. Repair will play an important role in the wider initiatives towards sustainable design, use and circularity. By extending the lifespan of devices, the volume of e-Waste generated can be reduced, and this can help facilitate the meeting of circular economy or net zero goals in different markets if appropriately implemented.

Waste generated has not only environmental consequences but also geopolitical and social consequences too which need to be considered and redressed. Inequalities around waste distribution, management capabilities and economics, as well as in different stages of the design and manufacturing process, mean that poorer countries may be disproportionately harmed by larger markets transitions towards circularity. Proper recognition of this dynamic needs to occur, and thorough research into how plans like the Climate Neutrality Project may impact this is important. While the EU's goal of a net zero continent is of course desirable, doing so at the cost of smaller markets is not. These inequalities contribute to not only economic harms but also reinforce colonial and historical methods of oppression on the Global South[91] that need to be addressed to ensure the benefits of sustainability are equitable and effective.

We recommend that further research is undertaken into managing the specific challenges of e-Waste from IoT to help mitigate its continual growth. For example, the rapid proliferation of data processing and storage leads to significant e-Waste, largely from the redundancy of storage methods. How these devices are recycled, or maintained in the future will be critical to mitigating e-Waste, particularly as Big Data and interconnectivity only continue to grow.[92] Similarly, how countries engage with rare earth metals (procurement, mining and recycling) has significant environmental effects that are often disproportionately to the detriment of the Global South. Further engagement with how these metals are acquired, utilised, recycled and disposed of will have a significant role to play in developing more equitable and sustainable supply chains going forward. We also recommend that future research into how waste and recyclable material is distributed within target markets (i.e. within the EU for the CNP, or within the UK for Ecodesign regulation) is undertaken. This will identify whether the "net zero" goals of a continent are actually sustainable, or whether the emissions are simply being redistributed onto other markets.

4.2. The nature & formulation of repair

There is a spectrum of formulations for "repair" and going forward it is important to identify what the goals of repair are, and which formulations are most effectual in bringing this about. While much of the regulatory changes thus far have focused on a normative "mending" conception of repair, planning for speculative and desired futures is important to ensure that continued transitions are managed effectually. In determining which formulation of repair should be argued for within the UK, identifying and prioritising the different motivations behind repair is important; consumer choice and autonomy, environmental sustainability, market competition etc.

The right to repair is oft-discussed as a blanket object, a broad wall, which must be advanced readily in all contexts. While conceptually it is a desirable, this approach tends to ignore both the practicalities of doing so and the role of other forms of development. While this may appear pre-emptive, it is important to investigate these considerations in parallel to the more doctrinal aspects of the right to repair. In doing so, smoother implementation is possible wherein certain citizens or advocacy groups are not "caught out" when attempting to engage with the right to repair. Simply put, it is unlikely any codified right to repair will be a carte blanche green-light to repair however one wishes, and ensuring that the finer details are both clarified and communicated effectively will help ensure nobody runs afoul to legal, ethical or economic consequences later.

The right is instead likely to be fragmented, partial ways, dictated by the practicalities of different skillsets, access to support and economic realities. Upskilling, community integration and facilitating access to the right will be critical to maximize its effectiveness in practice. It is recommended that research is done into community responses to different repair availabilities going forward. How the community wishes to engage with or more effectively engages with repair will be important

[89] While this is stated in regards to localized phenomenon, there is of course a global aspect to this question to. How goods and services, especially those that rapidly change, contributed to colonial and third world exploitation needs to be carefully considered to ensure equitable treatment.

[90] This is a dominant theme of *Repair Work Ethnographies*, particularly Tim Dant's "Inside the Bicycle: Repair Knowledge for All"

[91] Dipali Mathur, 2022, *Available to be poisoned*. Lexington Books, at 10-25; Robert D. Bullard, "Confronting Environmental Racism in the Twenty-First Century" (2002) Nicosia Vol. 4:1; Joshua O. Reno and Britt Halvorson, 2021 *Waste and Whiteness*. Routledge.

[92] Burkhard Schafer, "D-waste: Data disposal as challenge for waste management in the Internet of Things" (2014) International Review of Information Ethics 22:101-107

to identify to ensure the benefits are actualised.[93]

4.3. Government policy

There is a disparity within the motivations and approaches taken by different governments that is readily apparent. The EU and USA have disparate approaches to the question of repair already, and the gulf between is likely to be exacerbated going forward based on current trajectories. The EU's approach to repair has also developed faster in recent years, with more substantive changes being implemented, which will only compound their evidentiary returns and enable further divergence in approach. Identifying the motivations behind these approaches, and how to apply lessons from each will be important to tailor the trajectory of the developing repair scene within the UK.

This disparity will also contribute further to the already mentioned establishing of priorities by illustrating the motivations behind each approach. In doing so, a clearer picture can be ascertained as to how best to manage the concurrent priorities of governments – such as environmental sustainability, consumer autonomy, and manufacturer competition.

4.3.1. Environmental policy

Current formulations of repair and sustainability regulation have been criticised for their narrow scope and framing already. There is change already underway in this area but research into how to better prioritise implementation going forward is important. Additionally, the effectiveness or impact of new regulatory changes in this area should be investigated. For example, the new consumer repair regulations introduced in March 2023 expands the ambit of EU law to include mobile phones and wider data storage devices. How this may or may not fulfil some of the current criticisms around these policies, and what the next steps may be, warrants investigation. There are a number of competing interests and factors at play – the skillsets necessary and upskilling required, consumer desires and understanding of repair, the relative environmental impacts of each technology – which complicate decisions on what to include in eco-design laws going forward. Identifying issues discussed in [4.1] and [4.2] will help to direct this policy going forward.

4.3.2. Technical policy

Data protection rules can help guide practices of manufacturers and provide rights to data subjects that can be important during times of repair. Ensuring that appropriate mechanisms are in place to protect consumers, but also allow them to appropriately engage with their own data rights and privacy is crucial. There are questions around the viability of some repair desires (particularly in respect of the use of out-of-date software or customizable data privacy) that need to be investigated.

Cybersecurity legislation is already seeking to address some industry practices which could lead to redundancy of devices (i.e. lack of software updates) and ensure that security is considered during the design and maintenance processes from the outset. How these regulations develop will be important to understand how developers will practically implement these requirements and impacts this could have on wider routes to redundancy. The effectiveness of such regulation is also something which should be considered. There has already been some analysis of the economic cost of compliance under the GDPR with the cost associated with risking violation.[94] Ensuring that measures introduced are effective and not simply a "cost of business" is critical to managing the continued technological shift in these areas.

4.3.3. Economics & market impact

It is recommended that further research is needed to clarify the desired outcomes of repair. This will be important for developing future policy that impacts the economic realities of manufacturers and consumers. For example, there remain unanswered questions around how repair impacts manufacturers – impacting innovation, economic benefits, and competition – and greater research into this area will be important going forward. The EU is providing a number of case studies in the next few years which may provide insight in this area, such as the requiring of USB-C on smartphones and changing rules around warranties.

Liability around repair and repair outcomes is a factor which appears to lead to conservative or cautious approaches from manufacturers. There is a need to understand how to establish consistent priorities (for policy makers) within this space, and to identify the different legal triggers which may impact repair going forward. Certainty (or at least greater clarity) in outcomes is an important component of market health, and further research into how liability may be impacted by repair access and availability will likely play an important role in manufacturer comfort.

4.4. The role of consumers

There is currently contradictory evidence as to whether some of the policy intentions at play in repair and sustainability actually manifest into practice. For example, France's index of repairability is intended to empower a consumer market force that favours sustainable, green consumer products. It is still unclear as to whether this actually occurs, and to what degree consumers influence sustainable design practices. Although in the coming years, as the index is expanded to more products, there may be greater evidence available on which to judge its effectiveness. Deloitte has found that consumers adopt more sustainable lifestyles as a response to inflation and economic pressures,[95] whereas White et al has shown that despite consumer assertions they prefer green products, less than 30 % actually do buy the sustainable option.[96]

In the coming years, there will be more opportunities to research consumer market influence in this area. The French index is being continually expanded and applied to more consumer products, and there are more manufacturers developing repairable or modular products which may influence consumer choices. Greater research into the role of consumers in driving repairability or sustainability will be important for justifying and empowering policy trajectories.

4.5. Repair & manufacturer control

Manufacturers have increased control of consumers and their devices through the "goods as services" approach to products. This limits consumer choice and control over their device and continued relationship with a manufacturer. The available methods of repair offered by a manufacturer may also be unviable for some consumers, due to consumer limitations geographically, economically, or accessibility wise. As such, social stratification may be further entrenched and continue to

[93] Some work in this area has been undertaken by the University of Lancaster, see: Matthew Pilling et al., "Preparing to Repair: Using Co-Design and Speculative Design Methods to Explore the Future of IoT Right-to-Repair with Citizens and Communities" (2022) in Cumulus Detroit 2022: Design for Adaptation. Cumulus.

[94] Annika Selzer, Daniel Woods and Rainer Böhme, "Practitioners' Corner • An Economic Analysis of Appropriateness under Article 32 GDPR" (2021) European Data Protection Law Review Vol.7:3

[95] Deloitte UK, How consumers are embracing sustainability. 2022. Available at: <https://www2.deloitte.com/uk/en/pages/consumer-business/articles/sustainable-consumer.html<

[96] Katherine White, David J. Hardisty and Rishard Habib, "The Elusive Green Consumer", (2019) Harvard Business Review.

exacerbate existing inequalities within society.

There is a need to understand and address the different motivations behind design decisions such as planned obsolescence or shifting practices such as denying access to repair or repair services. Developing policy, or community advocacy, around repair will be empowered by better understanding and accommodating (where reasonable) these motivations.

Opposition to the right to repair has largely come from sustained litigation by major conglomerates, and through lobbying pressure on the regulatory process. Repair policy may be impaired by strict legal interpretations of the law (particularly IP) going forward, and policy going forward should be made with this in mind. Greater attention to the motivations and reasoning behind certain legal protections, such as IP, will help illuminate different solutions going forward. Whether there are substantive changes made to IP protections, or repair is implemented in methods considered consistent with the existing law, will depend on how policy makers prioritise the interests of manufacturers and consumers.

4.6. IoT design

IoT devices have increasingly become the norm. As more consumer products come bundled with interconnectivity and software components, it is important to recognise the inequalities and difficulties that arise from this change. The ability for consumers to opt out of this connectedness, and more importantly maintain control and awareness of their data, rights and privacy, becomes increasingly difficult. This can contribute to social stratification, in a way not dissimilar to the inequalities that arise from distribution of e-waste and sustainability.

We recommend two approaches: firstly, supporting consumers to understand their rights and capabilities in regards to repair and their data by building consumer understanding of their devices and their options will enable them to better engage with the policy developments that occur, and also to improve confidence in their ownership and relationship with their devices. Secondly, we recommend the development of means to translate user and community repair needs around repair into design practices to be implemented by manufacturers. Co-creating recommendations for changes through repair cafes or other community engagement approaches, which can be implemented will help facilitate manufacturer uptake of repairable design, but also helps illustrate the possibilities that can be targeted by policy and advocacy groups. Similar work in this area has been recommended by Ausloos and Veale, where they argued for the analysis of data subject rights as a methodology to understand how consumer information is being utilised.[97] The wealth of data that can be obtained in these areas, by partnering with consumer repair spaces or those engaging in data protection, utilisation and management, can serve to enhance future research in these areas.

5. Conclusion

IoT devices present unique complications for consumers, policy-makers, and manufacturers. Their combination of software, hardware and data components means that they interact with a wide variety of legal and technical challenges for their repair, maintenance, and sustainable development. This paper has explored the socio-technical problem posed by consumer IoT devices and the role of emerging right-to-repair laws in their integration and management. The paper has highlighted concerns over planned obsolescence, which is unsustainable from both an environmental perspective and a consumer rights perspective. The “right to repair" aims to address this issue and others, and give citizens and repair communities greater leverage and standing to fix broken products.

Realising the right to repair for IoT is a complex research challenge that requires a comprehensive view of the interests and parties involved in this area. This paper has provided an overview of the legal and policy developments shaping the conversation around the right to repair IoT devices and its implementation, as well as the key challenges for the right going forward. The findings of this paper highlight the importance of recognising the worsening e-Waste problem globally, identifying disparities in governmental response and reasoning towards the right to repair, and addressing the current evidentiary gap between regulatory intention and actual outcomes. It is our hope that this paper will contribute to a better understanding of the right to repair and its implementation and provide a roadmap for future research in this area.

Declaration of competing interest

There is no conflict of interest to declare for this work.

Data availability

No data was used for the research described in the article.

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[97] Jef Ausloos and Michael Veale, “Researching with Data Rights” (2020) Technology and Regulation, Vol. 2020