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Existing barriers to consumer repair of small household appliances from a product design approach: A scoping review

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Abstract: Small Household Appliances (SHA) and their associated electric and electronic waste are a major concern for the EU, which is tackling this problem with an emphasis in repair as a key strategy to prolong product lifetime. The field of product design plays a fundamental role in the configuration of products to enable their future repair. Therefore, this study explores the main barriers that consumers face when trying to repair their household appliances through a literature scoping review focused on small household appliances, from the product design and the repair ecosystem aspects. This study proposes a novel classification at product system level and product-service system level barriers. The first level relates to the physical product and its repairability, while the second relates to the entire system surrounding the product and the repair experience. According to the literature, most relevant repair barriers from the product system level were 'Understanding of product operation' (specially 'Product complexity'), 'Product accessibility' (specially 'Difficult disassembly and reassembly'), 'Impossibility to repair', 'Obsolescence' and 'Safety concerns'. From the product-service system level, the most relevant were 'Economic factors', 'Consumer factors' (specially 'Lack of time'), 'Access to information' and 'Lack of support by OEM'. The discussion section points out that some of these barriers may be downplayed by shifting the mindset of the SHA industry, currently focused on cost reduction, towards quality and repairability. Finally, least mentioned barriers in the literature are worth of attention and shouldn't be forgotten, as they point to possible research gaps.

Introduction

A regulatory framework is being developed to enable sustainable consumption and product design in Europe, with programs such as the new Circular Economy Action Plan, and regulations like the EU 2024/1799 'Right to Repair' Directive, the EU 2024/825 empowering consumers Directive and the EU 2024/1781 Ecodesign for Sustainable Products Regulation (ESPR)). Among other aspects, these regulations are promoting product repair.

Repair as a research topic has received more attention in recent years because it can promote sustainability and as a key principle of the Circular Economy, as it enables longer product lifetimes (Bakker et al., 2014; Jaeger-Erben et al., 2021). However, consumers tend to discard products before their technical end-of-life is reached, meaning repairable products aren't necessarily repaired (Sonego et al., 2022). Repair has been explored under the lenses of economic feasibility, consumer attitude and socioeconomic aspects, policy, product design and environmental benefits (Purkiss et al., 2024; Von Gries & Bringezu, 2022). In this regard, SHA are reported to be less repaired than other types of products (Korsunova et al., 2023; Pérez-Belis et al., 2017) and consumers are less likely to learn skills related to their repair (Lundberg et al., 2024). For that SHA is therefore the main focus of this work.

Product design has been recognised as an important factor influencing consumers' repair behaviour (van den Berge et al., 2023). Although other studies have analysed repair barriers from a product design perspective, this study proposes an original classification that brings together all typologies and ranks them in order of relevance in the scientific literature. The proposed classification of barriers of this study makes a differentiation between 'Product system barriers' and 'Product-service system barriers', based on the Multilevel Design Model (Joore & Brezet, 2015). The former are related to the physical product, its characteristics and design features, while the latter is related to the whole system surrounding the product and the

repair experience: repair businesses, product manufacturers, consumer and economic factors. This can support other researchers to identify research gaps.

Method

Systematic search

A literature review was performed in the Web of Science and Scopus databases, as well as in the Design Research Society (DRS) digital library and the 5th PLATE 2023 proceedings.

In the Scopus and WoS iterative searches using keywords “product design”, “repair”, “consumer”, “user”, “barrier”, “appliances”, “EEE”, “household”, “small”, “vacuum cleaner”, “behaviour”, “self repair” and “repair cafe” in title, abstracts, topic and other search fields, narrowing it down to a time interval between 2016 and 2024. Wildcards and special characters were used to improve search results. The main focus was on articles from the engineering or environmental sciences fields. From the DRS library and the PLATE 2023 conference, just the search terms “product design” and “repair” were used. Articles found in these two sources were screened based on title.

For the second round, *171* articles had been obtained after discarding duplicates. These were screened based on abstracts. This article focuses on repair of SHA, so articles related to mending or furniture were not selected. At first, *60* articles were approved, and *30* more after discussion between all authors. Finally, these *90* studies were screened by reading the text to assess their relevance. ***26*** papers were selected.

Study identification and data extraction

Identified barriers were clustered and coded given their thematic similarities, from Product System barriers and from Product-Service System barriers. Barriers were listed in two tables along with the number of sources in which they are mentioned. Some barriers were also grouped in common categories. For those, the quantity refers to the aggregated number of mentions of the barriers contained in them.

Analysis and findings

A list of found barriers can be seen in Tables 1 and 2. A more extensive table can be found in the Supplementary Materials[1] showing the analysed articles and the mentioned barriers.

Both tables show barriers, in white and green colors. White barriers are grouped under a parent barrier or category, in green. Quantity refers to the number of articles mentioning each barrier. For the category barriers, this quantity is the aggregation of the subordinate barriers.

Found barriers apply to SHA, however, some of them also apply to bigger appliances like fridges, washing machines, etc; as the sources weren’t always focusing only on SHA.

Product system barriers

Consumers can be motivated or discouraged to repair given certain product characteristics, mostly decided at the design stage. These barriers are listed in Table 1.

Product System barriers	Qty.
Understanding of product operation	**17**
- Product Complexity	12
- Difficult diagnosis	8
- Technical knowledge needed	2
- Visibility of components	2
Product accessibility	**14**
- Difficult disassembly and reassembly	11
- Irreversible repair process	4
- Component accessibility	2
Impossibility to repair	**13**
- Product can't be opened	6
- Product can't be repaired (generic)	5

[1] https://docs.google.com/spreadsheets/d/1TVAu4BrMciWwWfAReuN7F36HjZbyphQHNdQlW235hYo/edit?usp=sharing, (accessed April, 2025)

- Integral products	5
- Product designed to be discarded	4
- Digital locks	1
Obsolescence	**12**
- Perceived Obsolescence	7
- Technological Obsolescence	6
- Obsolescence (generic)	3
- Physical Obsolescence	3
Tools required	**12**
- Tools required (generic)	7
- Non-commercial tools required	5
- Special tools required	4
Safety concerns	**10**
Perceived quality of the product	**9**
Type of fasteners	**7**
- Use of permanent fasteners	7
- Use of adhesives	7
- Fragile components and fasteners	3

Table 1: Repair related product system barriers found in the literature and number of mentions.

Understanding of product operation

Understanding the product is critical to a successful repair. 'Product complexity' is a major barrier. Consumers would repair simple products but are reluctant to repair electrical appliances (Korsunova et al., 2023). This barrier is also linked to 'Difficult diagnosis', as simple products are easier to diagnose (Hjorth Nielsen et al., 2023). SHA have fewer parts and are usually limited to a single function, making them easier to understand. Fault diagnosis is important because understanding the product failure could motivate consumers to repair (van den Berge et al., 2023). Moreover, 'Technical knowledge needed' to operate certain tools or to understand the product, and 'Visibility of components' are important in assessing product failures and their repairability (Hjorth Nielsen et al., 2023). Component visibility also affects the ability to disassemble the product or to access critical components (Flipsen et al., 2016).

Product accessibility

Accessible products are easier to repair (Blanco-Espeleta et al., 2024). Repair operations are complicated by 'Difficult disassembly and reassembly (Pozo Arcos et al., 2021). An 'Irreversible repair process' reduces consumer confidence and may discourage them from repairing (Bracquené et al., 2021). Bad 'Component accessibility' refers to tightly packed components, which are typically found in SHA due to the limited space available. Other cases are disorganised product architectures, hidden fasteners or long disassembly sequences to access a single component. (Boix Rodríguez & Favi, 2022; Bracquené et al., 2021).

Impossibility to repair

Some articles mention product repair difficulties related to its design, that's the 'Product can't be repaired (generic)' barrier (Laitala et al., 2021). More specific cases are when products 'Can't be opened', given consumer's tools or skills (Pozo Arcos et al., 2021; Rudolf et al., 2022). 'Integral products', where the product has complex, integrated electronics or encapsulated or confined components (Bracquené et al., 2021; Pozo Arcos et al., 2020) which impede component interchangeability and fault diagnosis. Moreover, products 'Designed to be discarded' (Sonego et al., 2022; van den Berge et al., 2023), which is essentially the main reason behind most barriers, as the focus of SHA design is on cost reduction rather than repairability. In contrast, larger appliances are designed to be repairable by technical support because users expect them to be repaired rather than replaced. Finally, there's the use of 'Digital locks', software, encryption, licenses, supported by legal mechanisms, to impede independent repair (Roskladka et al., 2023).

Obsolescence

Mentions of obsolescence without further details are coded as the 'Obsolescence (generic)' barrier (Hertzum, 2024). Cooper (2004) divides obsolescence into: "absolute obsolescence" and "relative obsolescence", which includes "technological", "economic" and "psychological obsolescence". In this article,

obsolescence barriers have been subdivided in three: 'Physical obsolescence', when the product fails for physical damage or is worn out (Russell et al., 2023), 'Technological obsolescence', when the product software is too demanding for its hardware, new products in the market have superior functions and old products can't be updated (Amend et al., 2022; Roskladka et al., 2023), and 'Perceived obsolescence': psychological and social factors making consumers perceive a product as outdated, not trendy or just too old (Amend et al., 2022; Jensen et al., 2021). SHA are more prone to psychological obsolescence as users don't form strong attachments.

Safety concerns

When consumers are faced with the decision to repair, previous experience is positive (Sandez et al., 2023). However, skills and knowledge about repair are declining and consumers see it as a dangerous activity, even more if products are electric or electronic (Lefebvre et al., 2018), making SHA specially affected by this barrier. Other design aspects can make repair hazardous, such as sharp edges (van den Berge et al., 2023).

Perceived quality of the product

This barrier is different from 'Perceived obsolescence' because a newly purchased product can break, and consumers decide not to repair because they see it as cheap, low quality and not worth repairing, rather than because it is obsolete. Usually, price is seen as a factor of quality (Laitala et al., 2021). SHA have more affordable prices and are thus considered easier to replace than to repair, in terms of time and cost (Sonego et al., 2022). Even repair services can advise consumers of this practice (Lefebvre et al., 2018). Material quality can also decrease consumers' intention to repair when time passes (Jensen et al., 2021).

Tools required

Repair gets more complicated when there are 'Special tools required', like soldering equipment or digital multimeters (Hjorth Nielsen et al., 2023). 'Non-commercial tools required' refers to the use of tools such as screwdrivers with special shapes that are uncommon in the average household. (Flipsen et al., 2016). Sometimes this is done to prevent self-repair for safety reasons.

Type of fasteners

Fasteners are recognised as a key aspect of repairability, being usually an indicator in different repairability assessment methods, such as EN 4554 and RSS (Dangal et al., 2022). The 'Use of permanent fasteners' such as welding make it difficult to disassemble the product (Boix Rodríguez & Favi, 2023; Roskladka et al., 2023). 'Use of adhesives', while being a type of permanent fastener, has been considered an independent barrier given its recurrency in the literature and its relevance. Adhesives are very difficult to remove, requiring great effort and special tools like heat guns (Dangal et al., 2022; Flipsen et al., 2016). They're usually used when the product is small and there's limited room for other fasteners. Finally, 'Fragile components and fasteners' are used (Roskladka et al., 2023). For example, some SHA enclosures tend to use fragile snap-fits to avoid screws for aesthetic reasons.

Product-service system barriers

A variety of stakeholders and factors outside of the physical product generate a repair ecosystem. Barriers outside the 'Product System' level form a 'Product-Service System' level, and are listed in Table 2.

Product-Service System barriers	Qty.
Economic factors	**17**
- Price of repair VS price of a new product	8
- Price of repair service	7
- Product is out of warranty	5
- Economic factors (generic)	4
- Price of spare parts	4
Consumer factors	**17**
- Lack of time	13
- Lack of ability	10
- Having a physical space to repair	1
Access to information	**15**
- Access to information (generic)	13

- Lack of relevant repair information in the manuals	3
- Not knowing where to take the product to repair	2
- Lack of publicly available repair information	1
Lack of support by Original Equipment Manufacturers (OEM)	**12**
- Access to spare parts by the product user	5
- Lack of repair alternatives (generic)	5
- Access to spare parts (generic)	4
- Lack of independent repair services	3
- Access to spare parts by independent services	2
- Poor customer service	1
Mistrust	**9**
- Mistrust in repair services	6
- Mistrust in repair quality	6
Legal barriers	**3**

Table 2: Repair related product-service system barriers found in the literature and number of mentions.

Economic factors

Economic factors are especially relevant. Some specific barriers found are 'Price of spare parts', 'Price of repair service' (Lundberg et al., 2024) or not repairing because the 'Product is out of warranty' (Russell et al., 2023), while some articles discuss the "price of repair" but don't elaborate, that's the 'Economic factors (generic)' barrier (Hertzum, 2024). However, the most common decision consumers face when considering repair is 'Price of repair VS price of a new product' (Sandez et al., 2023). Around 20% of the original product price is a common limit (Rudolf et al., 2022). In the market for SHA, this barrier is exacerbated as these product's prices tend to be very adjusted, and there are less "premium products" which are seen as worth repairing. Results from Pérez-Belis et al. (2017) indicate consumers aren't willing to pay more than 20€ for electric kettles.

Consumer factors

'Lack of time' refers to the capacity of consumers to invest their own time repairing by themselves, gathering information or living without their product while it is being repaired. (Huang et al., 2016). Secondly, 'Lack of ability' is when consumers don't have the skills for repairing themselves (Lundberg et al., 2024). When common SHA are cheaply replaced, users aren't incentivised to waste their time and effort on repairs. Finally, 'Having a physical space to repair' barrier is only mentioned once (Flipsen et al., 2016).

Access to information

The associated inconvenience with repair starts with the consumer collecting information about the product and how to repair it, where to take it, and other aspects (Blanco-Espeleta et al., 2024). User manuals are relevant to install a product, use it for the first time or carry out maintenance operations, but it's uncommon to have useful repair information in them OEMs argue this is due to security issues, but common, safe and simple repairs could be explained in manuals (Pozo Arcos et al., 2023). Consumers also face 'Not knowing where to take the product to repair' (Sonego et al., 2022) and 'Lack of publicly available repair information' about a specific product in public sources like OEMs' web page or internet forums (Russell et al., 2023).

Lack of support by OEM

Involvement of OEM is crucial for repair. 'Access to spare parts', be it in a generic way, for the product user or for independent repair services is a recurrent barrier directly related to the willingness of the OEM to provide these (Blanco-Espeleta et al., 2024; Terzioğlu, 2021). 'Lack of independent repair services' limits consumers' repair capacity and is influenced by OEMs when they take legal action against third party repairers or limit the number of authorised repairers (Roskladka et al., 2023). 'Lack of repair services (generic)' doesn't specify what kind of services (Laitala et al., 2021) . Finally, consumers find repair inconvenient when OEMs provide 'Poor customer service' (Lefebvre et al., 2018).

Mistrust

There are two types of mistrust. 'Mistrust in repair service', dealing with the relationship between repair businesses and consumers, who often point at a lack of transparency, (Sonego et al., 2022). 'Mistrust in repair quality' is when consumers don't trust the services to do a good job (Fachbach et al., 2022) or the product to keep working in good condition after a repair (Roskladka et al., 2023). Closely related to the economic factors, consumers won't waste money on a repair that may fail when they can just buy a new product at a lower price.

Legal barriers

There are different legal mechanisms which aren't necessarily made with the intention of difficulting repair operations, but can limit independent service and consumers capacities. Legal instruments like intellectual property, contracts, unauthorizing independent repair businesses, consumer laws, tax laws, and chemical laws (Russell et al., 2023; Sonego et al., 2022).

Discussion and conclusion

A scoping review of 26 articles has been made, giving out 56 barriers related to repair of small household appliances. Barriers were identified in the literature and clustered according to their thematic similarities. The interdependencies between barriers sometimes made clustering challenging because barriers were difficult to separate.

From the product system level, the most relevant barriers were 'Understanding of product operation' (specially 'Product complexity'), 'Product accessibility' (specially 'Difficult disassembly and reassembly'), 'Impossibility to repair', 'Obsolescence' and 'Safety concerns'. From the product-service system level, the most relevant were 'Economic factors', 'Consumer factors' (specially 'Lack of time'), 'Access to information' and 'Lack of support by OEM'.

Having analysed the various barriers, it's clear that several of them stem from a product design culture focused on reducing production costs, where repairability is not considered. This trend, present in many industries, is exacerbated in the SHA market where products are seen as 'workhorses' and expected to be low cost and easily replaceable. This shift in focus would mean the end of the 'impossibility to repair' barriers.

Designers could elevate the SHA product category, making it more influential and meaningful in the creation of the user's identity, which in turn would increase the consumer's attachment to products and therefore their willingness to repair them. Obsolescence in its various forms would reduce its prominence in SHA products. Moreover, moving design towards repairability can open up new ways of approaching the consumer's relationship with products. This means getting the user more involved in the care and maintenance of the product and becoming more aware of waste.

Although some OEMs resist repair movements in order to maintain a model based on the sale of new products, increased consumer involvement and support for repair could lead to greater consumer satisfaction and brand loyalty. Greater OEM repair support and increasing access to product information can reduce understanding of product operation and product accessibility related barriers.

Adopting these measures would mean reducing the large number of poor quality products on the market and increasing consumer interest in product repair, with the associated waste reduction and environmental benefits. The redesign of products for repairability wouldn't be constrained by extremely tight cost margins, as consumers would be willing to pay more for higher quality and more durable products.

This study can serve as a design checklist for future SHA redesigns to remove some of the barriers to the repairability of this type of product.

Future research could find policy and product design solutions in the literature and point out relationships with the barriers found in this article. Further research could validate the effectiveness of design solutions to overcome different repair barriers through prototyping, user testing and workshops.

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