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Perceived Capabilities and Barriers for Do-It-Yourself Repair

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Abstract: Understanding the extent of common users' capabilities to repair products themselves, and the barriers during the repair could help legislators and manufacturers improve the design of products. This paper investigates users' capacity for using various common repair tools, their experience in repairing different household appliances, and the degree to which greater repair experience enables them to overcome related barriers to repair. Data was collected through questionnaires by 276 participants. Most respondents said they were able to use basic mechanical tools, but less than half stated proficiency in using soldering irons or multi-meters for repair. This indicates that more users may be able to perform diagnosis and repair of mechanical problems than electrical problems. However, 74% have repaired an electronic household appliance at least once in their lifetime (even if the repairs were mechanical). This suggests that repair could be a widespread activity. Users with no repair experience listed significantly more design-related barriers to repair than users with repair experience. These design-related barriers mostly concerned diagnosis and disassembly. Thus, designing products with features facilitating ease of diagnosis and disassembly with basic tools could remove some of the major barriers towards repair, and stimulate more users to repair their products.

Introduction

Consumer goods are nowadays less durable and repairable than in the past. Their average product lifetimes have been decreasing over the years (Bakker et al., 2014). This contributes towards an increase in Waste Electronic and Electrical Equipment (WEEE), which has been growing at the rate of 2-5% per year (Baldé et al., 2017). Extending products' lifetimes could contribute towards solving this issue (OECD,2015). As a response, The Circular economy action plan, adopted by the European Commission, sets out to keep value in products as high as possible throughout its lifetime by developing product-specific requirements for durability and reparability (European commission, 2020). Moreover, an increase in users' repair activities could contribute to longer product lifespans (Cooper, 2005; Raihanian Mashhadi, 2016).

Current studies on barriers towards repairs distinguish between two types of repair actors, namely professionals (Deloitte, 2016; Sabbaghi et al., 2017; Stamminger et al., 2018; Tecchio et al., 2019) and common users (Bovea & Pérez-Belis, 2018; Coppens et al., 2018; Jaeger-Erben et al., 2021; Laitala et al., 2021; Rogers et al., 2021; Victoria et al., 2017). however, research investigating the distinction in barriers between users with little or no repair experience (i.e., users who have never or once self-repaired a product of a specific category) and users with experience in repair (i.e., users who have self-repaired a product of a specific category 2 or more times) seems to be lacking.

Understanding whether there is a significant difference between barriers for self-repair between users with little or no repair experience and users with experience in repair, and what the difference is, may open an opportunity for future studies to make a distinction based on what type of users the study would like to focus on. This difference in barriers could provide an indication of the design-related aspect of a product that may need to be improved to promote users with little or no experience to dive into self-repairing the products. Therefore, the foremost contribution of this paper is to shed light into the difference in design-related barriers for self-repair in users with almost no repair experience against more experienced users.

In addition, this paper also provides insights into users' capacity for repairing products based on their ability to use basic tools and their previous experience.

These insights could guide designers, product manufacturers, and legislators to guide the design of the products in such a way that it promotes product repair activities. This may in turn increase the overall repair rate of household appliances.

Literature

Factors influencing repair

Flipsen et al., (2017) establish that the main influential factors during self-repair are: repair manual, tools, and spare parts availability, ease of access to components (incl. not excessive adhesives), effort to repair, cost to repair, risk of injury, ease of identification of the problem, no damage to other components and time to repair a component. Similarly, Ackermann et al., (2018) indicate that users' ability, motivation, and triggers are influential for repair; For factors during self-repair, the following ability related factors are found to be relevant: users perceived knowledge and skill for repair, time and effort, lack of tools, and general reparability of products. Additionally, Victoria et al., (2017) indicate that a major barrier towards repair repairs being too expensive relative to buying a new product. The same survey indicates the following barriers to self-repair: "no time or too complicated", "repair impossible without breaking it" and "diagnosing it too expensive". Furthermore, Jaeger-Erben et al., (2021) present that low competence and high perceived costs of repair (time, energy, and money) could be the main indications for low repair rates.

Overall, the studied literature indicates that the following factors are influential for self-repair:

- High effort
- Expensive spare parts
- Spare parts unavailability
- Not enough time for repair
- Not knowing what is wrong
- Not knowing how to take the product apart
- Not having the right tools
- Chance of further damaging the product
- Chance of injury

Repair tools

According to the standard on general methods for the assessment of the ability to repair, reuse and upgrade energy-related products (CEN/CLC, 2020), we distinguish between basic tools (screw drives, Alen keys, wrench, pliers) and advanced tools (soldering iron and multi-meter). This list of tools served as the basis of the survey in determining the ability for users to use common tools for repair

Method

A questionnaire was sent to a user panel who lived within a radius of 30 km from TU Delft. This panel includes over 1000 volunteers (53% male and 47% female) aged 21-70, with different professional backgrounds. 47% of the panelists have Bachelor's or higher education level. We received 276 responses, with a median age of 57, 46% of the respondents being female and 54% male.

The participants were asked about: (a) their experience using standard tools for repair (with a picture): a plier, a screwdriver, a wrench, an Allen key, a soldering iron, and a multi-meter; and (b) previous experience repairing different durable goods: small and large household appliances, and electronic products. The participants specified how often they had repaired the appliances themselves from 5 options: never, once, a few times (2-5 times), several times (more than 5 times), or "at a professional level".

Additionally, participants were asked to indicate their level of agreement or disagreement via a 5 point Likert scale (1 = strongly disagree, 2= somewhat disagree, 3= neither agree or disagree, 4= somewhat agree and 5 = strongly agree) on statements related to barriers towards self-repair 'I don't know what is wrong with the product', 'I don't know how to take it apart properly', 'I could damage the product even more', 'I don't have the necessary tools', 'it requires too much effort', 'Spare parts were too expensive', 'Spare parts were unavailable', 'I could injure myself', 'I don't have enough time', 'I don't see any barriers'. For visual representation, the percentage of respondents in agreement with the barriers was calculated by the sum of the respondents indicating either "somewhat agree" or "strongly agree".

The statistical significance in the difference between perceived barriers for self-repair between users with little or no repair experience

and users with experience was calculated using Mann Whitney U test (based on the points associated with the Likert scale) as the data is ordinal with independent samples (Field, 2005). Furthermore, pairwise comparison of barriers was conducted using related-samples Friedman's two-way analysis of variance by ranks.

Additionally, a random sample of 12 participants who have repaired more than once was interviewed and asked the types of activities they considered as repair activities.

Results and discussion.

Barriers to self-repair

The statistical analysis (Table 1) showed that users who have never repaired a household appliance rated the following barriers significantly higher than users who have repaired a household appliance before; "I could damage product even more", "I don't have necessary tools", "I could injure myself", "I don't know how to take apart properly", and "I don't know what is wrong with the product". Interestingly, these barriers are all affected by how products are designed (Figure 1). Predictably, experienced repairers listed "I don't see any barriers" much more than inexperienced repairers. They also more frequently listed "spare parts were too expensive" and "spare parts were unavailable". This large variation in barriers for self-repair between users with repair experience and users with no repair experienced may indicate that users with little or no repair experience are more affected by their perception of design-related barriers than users with repair experience.

In addition, the barriers, "I don't know what is wrong with the product", "I don't know how to take apart properly", and "I could damage product even more" are significantly higher than other barriers for users with little or no repair experience. These barriers closely relate to the processes of fault diagnosis and product disassembly. Hence, facilitating the design of the product for disassembly and diagnosis could potentially lower this barrier.

The barrier from "not having the necessary tools" could be lowered by designing products that require only basic tools to diagnose and repair. However, it also could be that part of these users do not have tools because they do not intend to repair products. Additional research is needed to investigate how to incentivize such users.

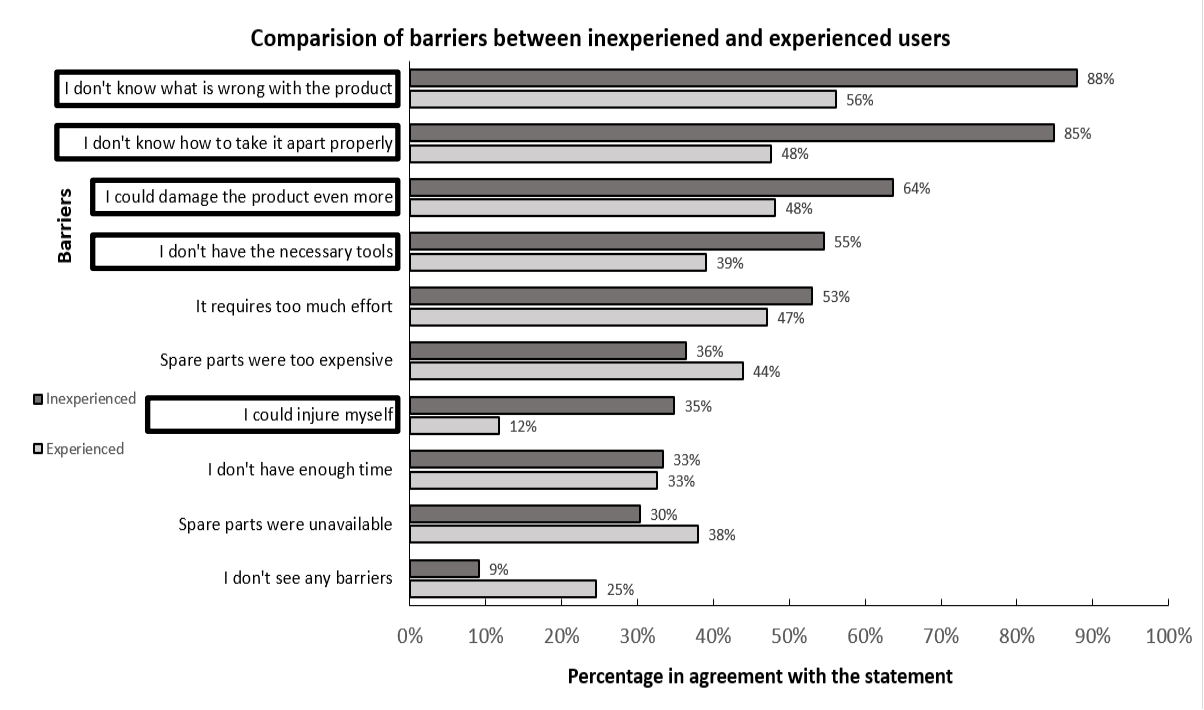

Figure 1: Percentage of respondents listing barriers to repair, in order of agreement. Barriers listed significantly more often by inexperienced users are outlined in boxes.

Mann whitney U test	I don't know what is wrong with the product	I don't know how to take it apart properly	I could damage the product even more	I don't have the necessary tools	I could injure myself	I don't see any barriers	I don't have enough time	Spare parts were unavailable	Spare parts were too expensive	It requires too much effort
Z Score	-4.77	-5.892	-2.654	-3.205	-4.989	2.987	0.218	1.578	0.552	-0.871
P value	<0.001	<0.001	0.008	0.001	<0.001	0.003	0.826	0.114	0.582	0.384
Significance	Significant	Significant	Signifcant	Significant	Significant	Significant	Not Significant	Not Significant	Not Significant	Not Significant

Table 1: Mann Whitney U test indicating significance of differences in barriers between inexperienced users and experienced users.

In addition, the barrier related to safety "I could injure myself" seemed to be significantly higher for users with little or no experience than users with experience in repair. This might be attributed to users' increased confidence in safety as their experience with repair increases.

Tool Proficiency

Figure 2 indicates that the majority of respondents were able to use basic tools for repair (screwdriver, Allen-key, Wrench, Plier). However, only 43% stated to have proficiency using a soldering iron and 33% knew how to use a multi-meter. This indicates that more users are likely to be able to perform mechanical repair related activities than electrical.

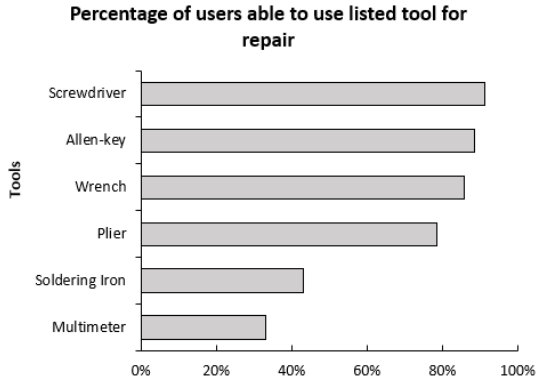

Figure 2: Percentage of users able to use listed tool for repair

Repair Experience

Figure 3 indicates that 74% of the users have repaired their household appliance more than once. A small sample of users (n=12) was further interviewed on what activities were carried out during repair. Two out of twelve (16.7%) users indicated that they performed a maintenance activity such as changing the vacuum cleaner filter but called it a repair activity. Adjusting for this discrepancy, the result still indicates that majority of users have repaired their own household appliance more than once. The reported past repair experience seems to be much higher compared to other studies (Jaeger-Erben et al., 2021; Rogers et al., 2021; Victoria et al., 2017), where less than 10% would attempt repair. There may be some selection bias as people interested in repair may be more likely to participate in the survey and also the panel itself is on average relatively high-educated. However, recent literature by Laitala et al. (2021) also found a relatively high percentage of users (31.6%) attempting repair on household appliances, out of which 24% attempted to repair household appliance themselves in past two years. This result may therefore indicate that users may be more experienced to repair their household products than previously thought.

Limitations and Further research

Whilst this research mostly focused on design- and product-related factors influencing self-repair, other factors, e.g., related to motivation, and triggers also play a large role in the repair rate of product. This research could be expanded to compare the effect of other factors influencing repair between users with little to no repair experience against users with repair experience.

Additionally, a wider study sample that is more representative for all users could unveil bias that may be attached to this study.

Conclusion

Overall, this research shows a large variation in the perception of design-related barriers for self-repair between users with repair

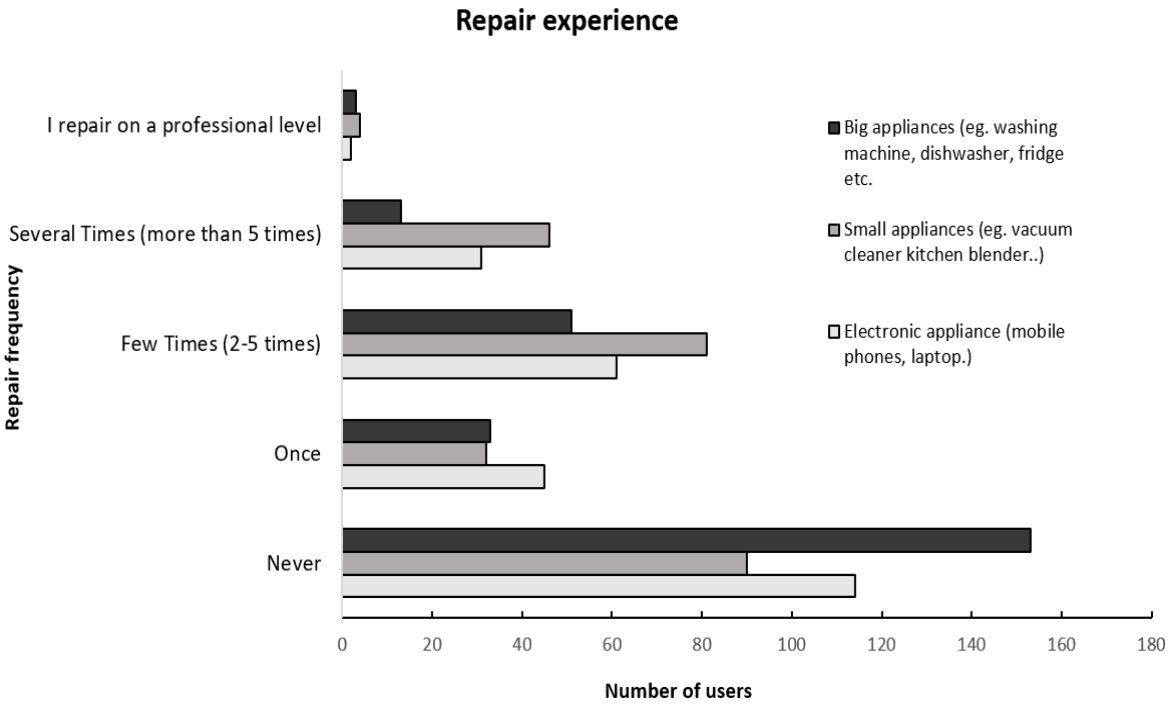

Figure 3: Repair frequency from number of users who have reported to self-repaired the listed category of appliances in the past.

experience and users with limited or no repair experience. It indicates that Inexperienced users are more affected by design-related barriers than users with repair experience. This perception of barriers seems to be related to the ease of diagnosis and disassembly. Additionally, the majority of the users are able to use basic mechanical repair tools, but are not proficient in using electrical repair tools such as a soldering iron or multimeter. Thus, electric or electronic faults will be more difficult to diagnose and repair; product design strategies should consider how to lower these barriers. Finally, this study indicates that users may be more experienced to repair their household products than some other studies indicate. Therefore, designing products with features facilitating repair could stimulate users to repair their products.

These insights can guide designers, product manufacturers, and legislators to promote repairability in product design. This could, in turn, increase product lifetimes and reduce waste, especially waste electrical and electronic equipment.

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