Extended Abstract
6th PLATE 2025 Conference
Aalborg, Denmark, 2-4 July 2025

AI-Powered Consumer Electronics Repair towards a Digital Circular Economy

Nazlı Terzioğlu[a]
a) School of Design, Royal College of Art, London, UK

Keywords: Repair; AI-Powered Repair; Circular economy; Consumer electronics; EEE

Introduction

Electronic waste is a growing global challenge, with projections indicating a significant increase from 58 million metric tons in 2021 to an alarming 112 million metric tons by 2050 (Forti et al., 2020; Parajuly et al., 2019). This surge underscores the urgent need for circular solutions in managing the lifecycle of electronic products. Furthermore, the current economic and marketing dynamics often make replacement seem more appealing than repair (Sonego et al., 2022; Terzioğlu et al., 2015; VandenBerge et al., 2023). Addressing this challenge requires understanding the multifaceted barriers users face, which the Repair Motivation and Barriers Model categorizes into technical, emotional, and value-related aspects of repair (Terzioğlu, 2021). This research aims to tackle these barriers by introducing an Artificial Intelligence (AI)-powered tool called AI-Fixer that provides step-by-step repair instructions, building user confidence, and enabling self-repair practices.

Within the field of Circular Economy, researchers are increasingly investigating the role of emerging digital technologies in enabling circular practices (Bressanelli et al., 2018; Sherpa & Sinha, 2021). Among these, AI holds significant promise offering capabilities such as diagnostics, predictive maintenance, and real-time repair support.

This study explores the feasibility of AI-Fixer in assisting users with repairing consumer electronics. It specifically investigates whether AI can assist and empower users to repair devices.

Methods

This research employed a co-design workshops and interviews to evaluate the feasibility of AI-Fixer. Nine participants were recruited, including five non-experts with no prior repair experience and four experts from different fields such as product design, AI, and electronics repair were involved (Table 1). Sixteen workshops were conducted: eight on repairing the Fairphone 5 screen and eight on repairing the FairBuds XL battery. These tasks were selected based on criteria such as required time to complete the repair, task complexity, and relevance to AI-guided support. During the workshops, participants interacted with AI-Fixer to complete the repair tasks (Figure 1). The tool provided step-by-step guidance via a chatbot interface. Participants were asked to fill out a worksheet to provide feedback based on their experience. Workshops for the Fairphone 5 screen replacement lasted approximately 20 to 40 minutes, while workshops for the FairBuds XL battery replacement took around 10 to 20 minutes. After each workshop, semi-structured interviews were conducted to gain deeper insights into participants' repair experiences. These interviews focused on their interaction with the tool, the repair process, and the overall outcome.

The data collected were analyzed to identify patterns and themes related to the tool's usability and effectiveness. Comparisons between expert and non-expert users highlighted differences in expectations and satisfaction. Key aspects included user confidence, and the perceived usefulness of AI-Fixer's features, such as instructions and interactivity.

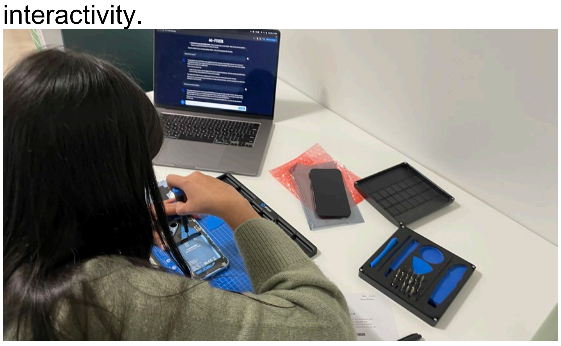

Figure 1. Participants interacted with AI-Fixer to complete the repair tasks.

Results

Co-design workshops and interviews provided valuable insights into the strengths and weaknesses of AI-Fixer, revealing differences in how expert and non-expert users interacted with the tool (Table 2).
Non-expert users found AI-Fixer to be a helpful entry point for repairing electronics. The tool's step-by-step guidance reduced the intimidation often associated with repairs and fostered confidence. For instance, Participant 1, described feeling empowered after completing a headphone repair, which motivated them to tackle a more complex phone repair.

However, non-expert users also encountered challenges. Reading the instructions and composing replies was sometimes tiring and complex, which led to confusion and disengagement. They requested multimodal support, including images and voice instructions as purely textual guidance was insufficient for tasks requiring precise identification of components, such as the cable connector or screws. Features like progress indicators (e.g., "Step 1 of 10") were suggested in the co-design process and the tool was updated based on these kinds of requests to help users better navigate the repair process.

Participants (P)		Workshop with Fairphone 5	Workshop with Fairbuds XL
P1	Non-expert	✓	✓
P2	Non-expert	✓	✓
P3	Non-expert	✓	✓
P4	Expert on AI	✓	✓
P5	Expert Product Designer	✓	x
P6	Non-expert	✓	✓
P7	Non-expert	✓	✓
P8	Expert on Repair	✓	✓
P9	Expert on Repair	x	✓

Table 1. Co-Design Workshops participants included five non-experts and four experts.

Aspect	Strengths	Weaknesses
Empowering Users	-Provides step-by-step instructions for non-expert users. -Builds confidence by allowing users to proceed at their own pace.	-Instructions can be tiring to read or complex. -More detailed instructions needed.
Accessible Guidance	-Real-time, interactive chatbot support reduces intimidation compared to repair manuals. -Enables clarification during steps, minimizing confusion.	-Repetitive and non-adaptive responses fail to address user-specific queries, frustrating users.
Enhancing Repairability	-Data collected identifies the challenges that users face during repair to improve repairability.	-Repair instructions require manual creation, making scalability challenging.
Visual Aids	-Multimodal guidance can enhance user understanding (potential to include images, diagrams, and videos).	-Currently lacks sufficient visuals, making tasks like identifying connectors or screws difficult.
User Trust	-Potential to build trust by delivering reliable guidance.	-Users may hesitate to rely on AI for complex tasks.
Compatibility Challenges	-Framework is flexible and adaptable to various repair tasks.	-Wide range of consumer electronics with varying repair requirements complicates achieving broad compatibility.
Environmental Impact	-Promotes sustainable practices by encouraging repair over replacement.	-Training and operating resource-intensive AI models increase energy consumption and carbon emissions.

Table 2. The strengths and weaknesses of AI-Fixer based on the co-design workshop and interview results are summarised.

Experts viewed AI-Fixer as a supplementary tool but were more critical of its usability. They valued concise, to-the-point instructions and found the lack of brevity in responses frustrating. Participant 4, an AI expert, highlighted the need for visualizations, while Participant 5 suggested integrating color-coded components to the design, such as screws, to simplify identification.

Another common critique was the tool's inability to adapt responses dynamically. Experts found repetitive answers unhelpful and emphasized the importance of context-sensitive interactivity. Despite these limitations, experts acknowledged AI-Fixer's potential to support non-experts when they get stuck during the repair process. They also valued the potential of this tool to provide data insights for improving product design. AI-Fixer's ability to collect repair data offers significant potential for improving product design. By identifying what goes right and what goes wrong while the users are fixing these products, the tool can guide designers and manufacturers in improving the repairability of products.

Acknowledgments

This project was supported by a grant from the Ecological Citizens Network+, an EPSRC funded Network, EP/W020610/1. I would like to thank Dr Ravi Sikhwal for his contributions. I would also like to thank Fairphone for their support and contributions. I would also like to acknowledge the valuable discussions I have had within the Ecological Citizens Network including Dr Rob Phillips, Jude Pullen, and Emily Boxall.

References

Bressanelli, G., Adrodegari, F., Perona, M., & Saccani, N. (2018). Exploring how usage-focused business models enable circular economy through digital technologies. Sustainability, 10(3), 639. https://doi.org/10.3390/su10030639

Forti, V., Baldé, C. P., Kuehr, R., & Bel, G. (2020). The global e-waste monitor 2020. Quantities, flows, and the circular economy potential, 1-119. ISBN 9789280891140

Parajuly, K., Kuehr, R., Awasthi, A. K., Fitzpatrick, C., Lepawsky, J., Smith, E., Widmer, R., & Zeng, X. (2019). Future e-waste scenarios. https://wedocs.unep.org/bitstream/handle/20.500.11822/30809/FutEWSc.pdf?sequence=1&isAllowed=y

Sherpa, Y., & Sinha, D. (2021). Digital solutions for a circular electronics value chain: A thought paper for International E-Waste Day 2021. International Telecommunication Union (ITU), WEEE Forum, GSMA, & Sofies Group. https://weee-forum.org/wp-content/uploads/2021/10/Thought-Paper-2021.pdf

Sonego, M., Echeveste, M.E.S., & Debarba, H. G. (2022). Repair of electronic products: Consumer practices and institutional initiatives. Sustainable Production and Consumption, 30, 556-565. https://doi.org/10.1016/j.spc.2021.12.031

Terzioğlu, N., Brass, C., & Lockton, D. (2015). Understanding user motivations and drawbacks related to product repair. Sustainable Innovation 2015, 9-10. https://www.researchgate.net/profile/Nazli-Terzioglu/publication/294256488_Understanding_User_Motivations_and_Drawbacks_Related_to_Product_Repair/links/56bf27cb08aee5caccf4b556/Understanding-User-Motivations-and-Drawbacks-Related-to-Product-Repair.pdf

Terzioğlu, N. (2021). Repair motivation and barriers model: Investigating user perspectives related to product repair towards a circular economy. Journal of Cleaner Production, 289, 125644. https://doi.org/10.1016/j.jclepro.2020.125644

Vanden Berge, R., Magnier, L., & Mugge, R. (2023). Until death do us part? In-depth insights into Dutch consumers' considerations about product lifetimes and lifetime extension. Journal of Industrial Ecology, 27, 908-922. https://doi.org/10.1111/jiec.13372