Considerations for the design of a UK Repairability Index

BIG REPAIR PROJECT

24th October 2022

UCL

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Aims of this report;

- **Contextualise the need for a UK repairability assessment framework (UK Repairability Index) as part of the UK's 'Right To Repair' Regulations.**
- **Provide an overview and analysis of existing repairability assessment frameworks (i.e. design, scope, methods) adopted by other economic regions and summarise key considerations for the development of a UK Repairability Index.**
- **Gather stakeholder feedback to develop a general approach for the development of a repairability assessment framework for electrical and electronic equipment (EEE) for the UK.**

This report was compiled by the UCL Plastic Waste Innovation Hub as part of the UCL Big Repair Project, a UKRI Interdisciplinary Centre for Circular Metals initiative. If you or your organisation would like more information, or to take part in further activities supporting the development of a UK Repairability Index, please contact;

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1. Introduction

The amount of waste electrical and electronics equipment (WEEE) is rising globally. The UK generates the second most WEEE waste per capita in the world (Forti et al., 2020). Most of the products contributing to WEEE waste are not manufactured in the UK and so the embodied CO_2 emissions, along with other environmental impacts fall into Scope 3 emissions. Reducing WEEE waste mountain and our scope 3 emissions is important to meet the UK's statutory commitments to achieving net zero (UK Parliament, 2020).

A recent roundtable with industry, third sector organisations and academics hosted by the Royal Academy of Engineering recognised that the causes of the problem are complex (UCL Plastic Waste Innovation Hub, 2021). The roundtable highlighted a number of factors: (1) high demand for electronics and appliances; (2) a cultural norm where 'newness' has high social capital; (3) designed obsolescence of electronic products resulting in short product lives; (4) high wage costs of repair engineers making many products cheaper to replace than to repair.

As Figure 1 illustrates not all routes to circularity of products are equal. Recycling an electrical appliance requires it to be collected, disassembled, all the constituent materials separated and remanufactured and made into a new product. Each step costs energy and produces CO_2 emissions as well as other sources of pollution. Repair of the same product has a simpler journey, see Figure 1, often not leaving the home. This reduces energy consumption, emissions, and other negative environmental impacts. Thus repair and reuse is almost always the most environmentally friendly option. The exception to this rule is when the new product is vastly most efficient in its operational use of energy and other resources (Bovea et al., 2020). Repair and reuse provides other benefits to society, it is inherently local, and so helps in 'levelling up' providing skilled jobs in all regions of the UK (Green Alliance, 2021). Repair and reuse also allows access to lower cost products for those with reduced budgets (LOTI, 2022). A successful UK repair economy could also make supply chains more resilient to global material import/export and manufacturing and supply shocks (as illustrated by those experienced during the Covid 19 pandemic) (Right To Repair, 2020). This is particularly relevant to products that rely on strategic elements (HM Government, 2022) for their operation, these materials have periodically undergone disruption due to political and economic factors and are likely to continue to do so in the future.

One measure that has been introduced in the UK and other countries to reduce WEEE waste and reduce CO_2 emissions is Right to Repair legislation (Wikipedia, 2021; HM Government, 2021; UK Parliament, 2021). This law increases the responsibilities of appliance manufacturers to provide spare parts and technical repair information. A few countries have implemented (or a planning to implement) a mandatory 'repairability index' which gives customers information at the point of sale about the ease and cost of repair (France Repairability Index, 2020; La Moncloa, 2021; European Commission, 2020). A repairability index is intended to act in a similar way to energy efficiency ratings, providing information to help citizens make more informed purchasing decisions, and to provide a level playing field to drive manufacturer design and innovation towards more repairable and longer lasting products (Dangal et al., 2022).

The UK does not currently have a repairability index as part of its Right to Repair law but it was one of the agreed outcomes of the Royal Academy of Engineering roundtable that such a measure would have support across the sector (UCL Plastic Waste Innovation Hub, 2021). A citizen science study called the Big Repair Project shows evidence that UK citizens are largely in favour of implementing a UK repair assessment framework (UCL Plastic Waste Innovation Hub, 2022). The aim of this report is to review repairability assessment frameworks that have been proposed and implemented in other regions and to consider what a UK repairability index should cover.

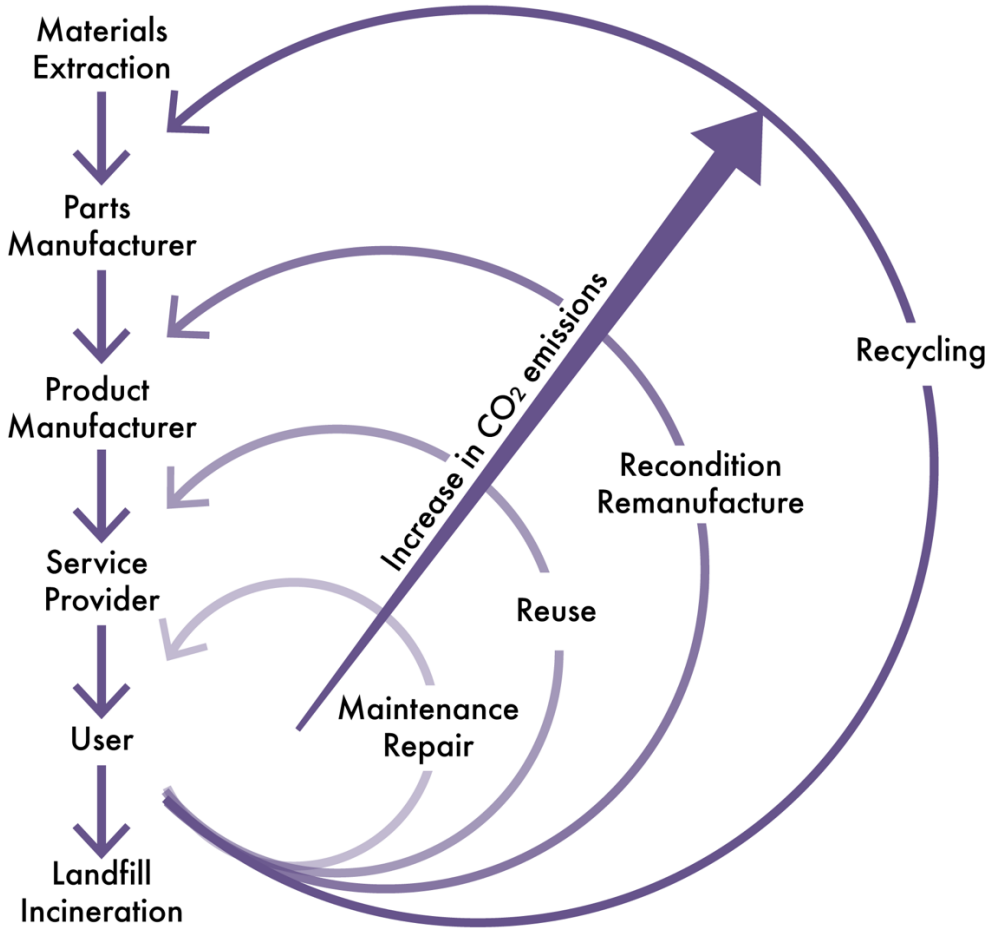

Figure 1. Adapted from *Bundgaard. A, Ecodesign for a Circular Economy: Regulating and Designing Electrical and Electronic Equipment and Ellen Macarthur Foundation.*

2. Repairability Assessment Frameworks

UK 'Right to Repair' regulations came into force in July 2021 as part of the Ecodesign for Energy-Related Products and Energy Information Regulations 2021 (UK Parliament, 2021). These regulations aim to increase consumer product lifespans by up to ten years by giving

professional repairers access to spare parts and technical information from July 2021 (manufacturers have a grace period of up to 2 years to make parts available).

The UK's 'Right to Repair' regulations do not cover the full range of electrical and electronic equipment (EEE) goods contributing to WEEE waste. It only covers dishwashers, washing machines, washer-dryers, refrigeration appliances as well as televisions and electronics displays. They also do not include a requirement to publish information about the repairability of products based on an agreed repairability assessment framework.

Over the last few years several countries and organisations have developed tools and standards for evaluating and communicating the repairability of EEE products, see Figure 2. Prevalent tools and standards (latest iterations) for assessing repairability of EEE include:

- France Repairability Index (2020) (Indice de Réparabilité, 2021)
- EN 45554 (European Standards, 2020)
- iFixit Repairability Scorecard (2019) (IFIXIT, 2019)
- The Repair Scoring System (RSS) JRC (2019) (Sanfelix et al., 2019)
- Ease of Disassembly Method (eDim) KU Leuven / JRC (2018) (Vanegas et al., 2018)
- Assessment Matrix for ease Of Repair (AsMeR) KU Leuven / BeNeLux (2018) (Bracquené et al., 2018)
- Austrian Durability Label (ONR 192 102:2014) (Beuth Publishing, 2014)

Under development;

- Spain Repairability Index (La Moncloa, 2021)
- EU Repair Score (European Commission, 2019)

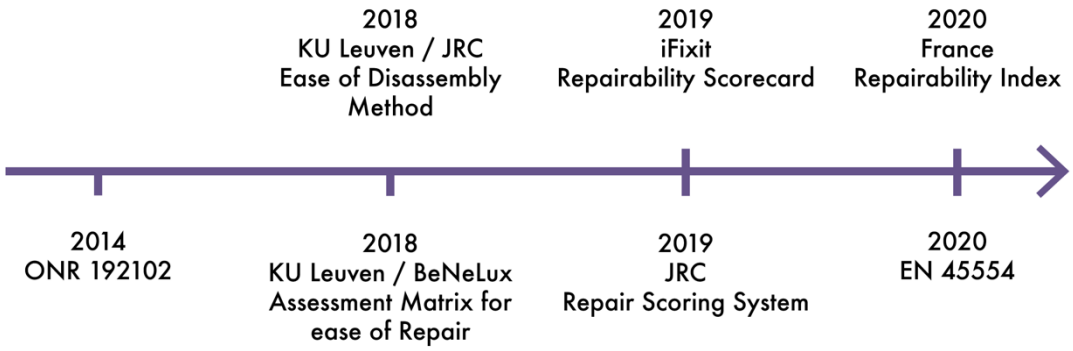

Figure 2. Timeline of repair assessment framework (latest iterations) development.

Additionally, there are several other relevant reports and studies described in the literature;

- ADEME report on 'International benchmark of the repair sector' (ADEME, 2018)
- ADEME 'Preparatory study for the introduction of a durability index' (ADEME, 2021)
- WRAP study 'The effectiveness of providing pre-purchase factual information in encouraging more environmentally sustainable product purchase decisions (WRAP, 2019)
- European Commission 'Study on socio-economic impact of increased repairability' (European Commission, 2016)
- European Commission 'Behavioural study on consumers' engagement in the circular economy' (European Commission, 2018)
- Groupe SEB 'Product 10Y Repairable' label (Groupe SEB, 2012)

Several studies have been carried out using different methods to assess the scope and evaluation methods of these frameworks, with recommended developments needed to improve their performance (Bracquene et al., 2019; Bracquene et al., 2021; Dangal et al., 2022; European Commission, 2019). Additionally, several organisations, charities and community interest groups have critiqued these frameworks (HOP, 2022; Right To Repair, 2021; BEUC, 2022). An overview of these frameworks and a summary of their analysis is discussed in section 2.3.

2.1. Measures of Success

The measures of success of implementing a UK repairability assessment framework need to be identified and agreed with all stakeholders at an early stage. They should be measurable and quantitative over a relevant period of time. Direct measures might be a follows:

- Easy to understand, accurate and popular with citizens (measured through surveys),
- Easy and low cost to implement for manufacturers (measured through surveys),
- Ensures safety of technology users and homes (measured via Office for National Statistics).

Indirect measures of success could be:

- Reduction of WEEE per capita in the UK,
- Reduction in scope 3 emissions due to EEE products,
- Increase in high skilled repair technician jobs and GDP associated with the repair economy in the UK,
- Increased access to affordable tech in the UK for the vulnerable and socially deprived.

2.2 Effectiveness of repair assessment frameworks

Figure 3 illustrates the flow of information used in a repairability framework used to create a repairability index for a particular product. An important issue is whether a repairability index creates results that are accurate, minimise bias, and within a marketplace, lead to

changes in the buying behaviour and product design that achieve the objectives, as detailed in the section 2.1. A summary of the published evidence on the role of and effectiveness of repair assessment frameworks highlights the following common characteristics:

- Objective and providing a complete assessment of the repairability of products (Franceschini et al., 2010; Dangal et al., 2022; European Commission, 2019).
- Reflecting the science-based literature on design aspects related to repairability, promoting the repairability of products (Dangal et al., 2022).
- Co-designed and responsive to the varying needs of all stakeholders of a repair economy, including professional repairers and self-repairers (European Commission, 2019).
- Offer a balance between detailed and objective assessment methods and user feasibility constraints such as cost and time to carry out the assessment (Dangal et al., 2022; European Commission, 2019).

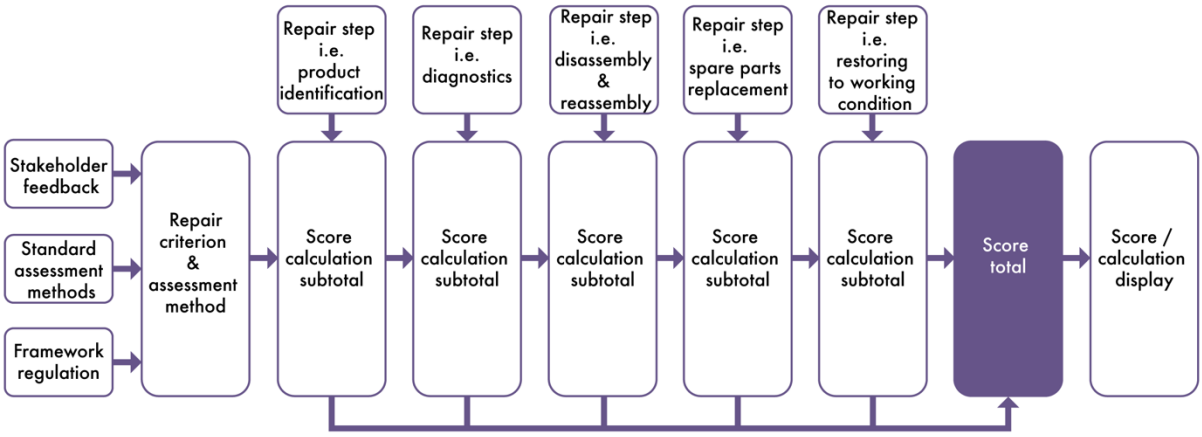

Figure 3. Illustration of repair assessment framework design. Adapted from Repairability Assessment Methodology (Bracquené et al. 2018) and French Repair Index (Indice de Réparabilité, 2021).

2.3 Review of existing repairability frameworks

Existing repairability frameworks have been reviewed and analysed by a number of authors (*Bracquene et al., 2019; Bracquene et al., 2021; Dangal et al., 2022; European Commission, 2019; HOP, 2022)*. Here we summarise key findings and systematically compare the French Repairability Index (2020), the European Standard for repairability (EN 45554), iFixit Repairability Scorecard (2019), JRC Repair Scoring System (2019), KU Leuven / BeNeLux Assessment Matrix for ease of Repair (2018), KU Leuven / JRC ease of Disassembly Metric (2016), and ONR 192102 (2014). In each case we comment on (1) the basis of the design of the index – who designed it and their evidence base; (2) the scope the index – which types

of products it covers; (3) the repairability framework method; (4) recommendations for further development by reviewers. Table 1 shows a summary of this analysis.

It is notable that most repairability indices are co-designed by a consortium representing all the stakeholders in the system, such as engineering organisations, manufacturers, repairers, and citizen groups. In most cases the scope is limited to a few types of EEE products. The exceptions are the European standard for repairability (EN 45554) and the KU Leuven / BeNeLux Assessment Matrix for ease of Repair (2018) which are aimed at all EEE products. The framework methods vary considerably in their complexity varying from a set of three general criteria such as 'Repairability, Reusability, Upgradability' to more complex frameworks such as the iFixit Repairability Scorecard which has eight criteria. The iFixit framework is the only one aimed solely at self-repairers, while all the others are aimed at both professional repairers and self-repairers. Table 1 also identifies defects in these frameworks such as the lack of objectivity in the health and safety criterion, ease of reassembly, parts interchangeability, and ease of fault diagnosis.

Table 1. Table adapted and expanded from Dangal et al., 2022.

Assessment Framework (date implemented)	**Design Based on**	**Scope**	**Method**	**Recommendations for further development**
France Repairability Index (2020) Reference: Indice de Réparabilité, 2021	• Literature research on product repairability. • Co-designed by professional organisations, manufacturers, distributors, repairers, NGOs, start-ups, and experts.	• Products; -Porthole washing machines -TVs -laptops -smartphones -lawnmowers • Additional products added (November 2022); -Top washing machines -dishwashers -vacuum cleaners -high pressure cleaners	• Based on five criteria; -Ease of disassembly -Repair documentation -Availability of spare parts -Price of spare parts -Product specific aspects • Reference Standards; - EN 45554 General methods for the assessment of the ability to repair, reuse and upgrade energy-related products - AFNOR NF EN 13306 X 60-319 • Aimed at professional repairers and self-repairers • Self-assessed by manufacturer, regulated by French Market Authorities (MSA)	• Missing criteria (Dangal et al., 2022); -Reassembly -Fastener visibility -Modularity -Diagnosis -Health and safety risk (design) -Standard parts and interface -Updateability / Adaptability -Design Simplicity / Complexity -Handling -Interchangeability -Material selection / Robustness -Redundancy • Recommendations for improvement (HOP, 2022); -Stricter application of repair index display -Greater discrimination and sensitivity needed between product applications -Greater consumer and marketer education about the index needed

				-Greater transparency of score calculation through public database -Submission of repair index score and calculation should be mandatory -Greater regulation of scores and calculation -Current scoring system is too generous, weighting review needed in particular related to disassembly and availability and price of spare parts -More ambitious sub criteria needed such as serialisation and spare parts pairing
EN 45554 (2020) Reference: European Standards, 2020	• Literature research on product repairability • Co-designed by professional organizations, manufacturers, distributors, repairers, NGOs, and experts.	All EEE	• The general method of assessment for repair, reuse, and upgrade. Provides a generic set of tools and is not tailored to specific products. • Aimed at professional repairers and self-repairers	• Missing criteria (Dangal et al., 2022); -Modularity -Health and safety risk (design) -Design simplicity / Complexity -Handling -Interchangeability -Material selection / Robustness -Redundancy
iFixit Repairability Scorecard (2019) Reference: IFIXIT, 2019	• Literature research on product repairability • Co-designed by iFixit experts, and sustainability (SMART) consortium.	Mobile phones	• Eight criteria aimed at assessing ease of self-repair. • Aimed at self-repairers. • Self-assessed, not regulated?	• Missing criteria (Dangal et al., 2022); -Reassembly -Fastener removability and Reusability -Modularity -Diagnosis -Health and safety risk (design) -Standard parts and interface -Updateability / Adaptability -Design simplicity / Complexity -Handling -Interchangeability -Material selection / Robustness -Redundancy • (Bracquene et al., 2019). Most criteria in the scorecard evaluate the repair

				process rather than overall repairability and are subjectively rated, so difficult to compare. More objective metrics needed.
JRC Repair Scoring System (2019) Reference: Sanfelix et al., 2019	• Literature research following preliminary EN45554 and AsMer2018 • Co-design by industry, trade associations, repairers, academic. • Case studies	VCs, Laptops, TVs, Mobile phones, Washing machines, Dishwashers	• Three criteria; -Repairability -Reusability -Upgradability • Aimed at professional repairers	• Missing criteria (Dangal et al., 2022); -Fastener visibility -Modularity -Health and safety risk (design) -Design simplicity / Complexity -Handling -Interchangeability -Material selection / Robustness -Redundancy • Missing criteria (Bracquene et al., 2021); -priority parts replacement or upgrade -ease of disassembly expressed using eDim metric -maintenance and repair service offered during product use. • Potential to simplify assessment method to focus on a more limited number of criteria.
KU Leuven / BeNeLux Assessment Matrix for ease of Repair (2018) Reference: Bracquené et al., 2018	• Literature research on product repairability • Case studies	All EEE	• Based on five main repair steps; -Product identification -Failure diagnostic -Disassembly and reassembly -Spare part replacement -Restoring to working condition • Three criteria; -information provision -product design -service • Uses eDim	· Missing criteria (Dangal et al., 2022); -Fastener removability and Reusability -Fastener visibility -Health and safety risk (design) -Updateability / Adaptability -Design simplicity / Complexity -Handling -Interchangeability -Material selection / Robustness -Redundancy

			• Aimed at professional repairers and self-repairers	• Missing criteria (Bracquene et al., 2021); -priority parts replacement or upgrade -ease of disassembly expressed using eDim metric -maintenance and repair service offered during product use. • Potential to simplify assessment method to focus on a more limited number of criteria.
KU Leuven / JRC ease of Disassembly Metric (2016) Reference: Vanegas et al., 2018			• Uses Maynard operation sequence technique (MOST) to calculate disassembly time	• Missing criteria (Bracquene et al., 2021); -although useful to evaluate the disassembly effort of product repair, use of this method alone is limited.
ONR 192102 (2014) Reference: Beuth Publishing, 2014	• Co-designed by repairers and the Federal Ministry of Land, Forestry, Environment, and Water	Brown goods and white goods	• Assessment of durability and repairability • Three criteria; -product design -information provision -services • Aimed at professional repairers	• Missing criteria (Dangal et al., 2022); -Reassembly -Fastener visibility -Health and safety risk (design) -Handling -Interchangeability -Material selection / Robustness -Redundancy • Missing criteria (Bracquene et al., 2019); -include more guidance for the interpretation and scoring of each criterion -in order to be applicable to small household appliances (i.e. vacuum cleaners) the existing critieria need revision

3. Discussion

There is an opportunity to design a UK repairability framework building on the analysis of other repairability frameworks, as summarised in Table 1. We list a number of discussion points below that are important to resolve through the co-design process that would be the next step.

Product scope

- Should the product scope cover all EEE products sold in the UK? If not, what is the criteria for including or omitting some products? If reducing WEEE waste and embodied CO_2 emissions are the primary goals, should the criteria for inclusion be based on this data?
- Should the repair evaluation method be tailored to specific product categories and weighted according to relative importance of each criteria?

Parts pricing and availability

- Should the price of spare parts assessment be based on the most expensive part, or on an average of the parts that are most often replaced?
- How should part pairing and serialisation be addressed?
- Should the focus of evaluation be limited to priority parts as most common product failures can be traced to specific parts?

Information availability

- How should we evaluate the quality of repair information since it is important to understand what information is most critical to promote repair (Dangal et al., 2022)?

Reassembly

- Time for reassembly is sometimes higher than for disassembly, therefore should ease of reassembly be a separate criterion whenever eDim is not used (Dangal et al., 2022)?

Diagnosis

- Diagnosis of failure is the first major hurdle of any repair. Many products contain error codes but these are often hard to navigate, especially if the documentation is no longer available. Should assessment of accurate failure diagnosis be an expanded criterion?

Health and safety risk

- Repair safety is a major barrier to increasing product repair from policy and manufacturing perspectives. Safety concerns include the safety of the person carrying out the repair, the safety of using the product after repair, and safety related to product damage that might occur during or after the repair (Dangal et al., 2022). Aspects of safety during repair are addressed by several assessment frameworks (EN 45554, RSS, ONR 192102, iFixit) but product safety after a repair is not addressed (Dangal et al., 2022). Additionally, most repair actions are safe to perform and others could be made safe through relatively minor design changes

(Ingemarsdotter et al., 2021). Should these be included in a UK Repairability framework?

- Currently product safety data collection methods are methodologically diverse and highly fragmented (Radovnikovic, 2020; Dangal et al., 2022). Product safety data collection improvements and further analysis of safety issues caused by products after repair would help the development of objective health and safety criterion as part of a repair assessment framework and would provide useful feedback for designers to design products for safe repair. Should these issues be included in the UK Repairability framework?

Product lifespan

- Knowing the designed operation lifetime for the product might help citizens when considering whether to replace a product or repair it. Products that fail before their designed life would automatically be considered for repair. This already happens in mobile phones and laptops where software support has well published limits e.g. 3-5 years. Should the estimated lifetime be included in the UK Repairability framework in the form of a durability index?

Data and calculation transparency

- Should the eDim database be expanded and used?
- Make access to the detailed calculation grid mandatory (not just the summary)?
- Create an open access database gathering all scores and calculations for greater transparency?

Score calculation

- Weighting of repairability criteria makes a big difference to the overall score. It is important to validate the scoring with real world data. Should we have a system to monitor how user experience of successful repair correlates with repairability index? (Dangal et al., 2022).

Regulation and compliance

- How do we balance the ease and cost of testing methods versus objectivity and completeness of testing programme (Dangal et al., 2022)?
- Who pays for monitoring the accuracy of self-declared scoring by manufacturers?

4. Next Steps

If you or your organisation would like further information, or to take part in further initiatives to support the development of a UK Repairability Index, please contact;

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