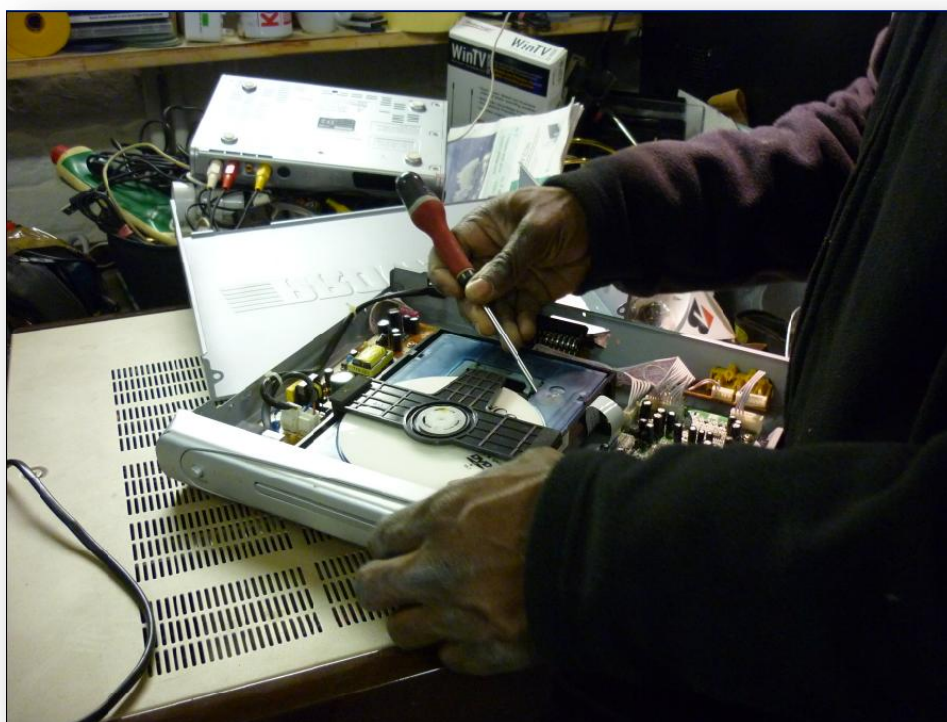


MAKING MORE DURABLE AND REPARABLE PRODUCTS

Building a rating system to inform consumers and trigger business innovation



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1. INTRODUCTION

The pace of consumption in our society which involves buying products, throwing them away and purchasing new ones endanger the carrying capacity of the planet. Humans are not only generating more waste but also accelerating the depletion of natural resources. Today our global consumption is already exceeding the earth's carrying capacity by around 50% and with a business-as-usual scenario in 2030 we will need equivalent of two earths to support us (UNEA, 2014). The Organization for Economic Cooperation and Development (OECD) estimates that the amount of materials extracted, harvested and consumed worldwide doubled since 1980: reaching 72 billion tones (Gt) per year in 2010 and is projected to reach 100 Gt by 2030 (OECD, n.a.). In a world where demand and competition for resources will continue to increase (in Europe, elements such as cobalt, rare earth minerals or platinum are currently 100% imported) and pressure on resources is causing serious environmental and social problems, Europe can benefit economically and environmentally from making better use of natural resources (EC, 2014b).

In its 2014 Communication "Towards a circular economy: a zero waste programme for Europe" ([COM\(2014\)398](#)) the European Commission sets a plan to keep the added value in products for as long as possible and to design out waste. It is estimated that resource efficiency improvements all along the value chains could reduce material inputs by 17%-24% in 2030. In addition, better use of resources would bring economic benefits that boost EU GDP by up to 3.9% (Macarthur, 2012). Therefore, moving towards a circular economy paying more attention to resource conservation would lead to resources savings and the creation of new economic opportunities for Europe.

This report at hand will focus on defining some durability and reparability criteria to make products last longer. Documents and reports already exist. For example, the Book "Products that last" published by TU Delft, contains innovative examples of reducing materials in products and orienting business models (Bakker, 2014). The Austrian Standards for assessing the reparability of white and brown goods (Austrian Standards, 2014) and the criteria used by IFIXIT are examples of inspiring directions (IFIXIT, 2015). The European Consumer Organization (BEUC) has launched a new campaign for durable goods, more sustainable and better consumer's rights ([BEUC campaign](#)). Suitable policy instruments already exist at EU level that could address durability and reparability of products such as the Ecodesign Directive (2005/32/EC), the European Ecolabel Regulation (EC 66/2010) the Energy labelling (2010/30/EU) or the Green Public Procurement (GPP). However, there has been so far no systematic consolidation and nothing like a simple list of criteria that have been developed and applied consistently in terms of reparability and durability of products at European level. It is time to consider durability and reparability with a more systematic approach by establishing a proper rating system. This report intends to act as a first step in that direction.

There is a need to create alternatives to the usual consumption model of buying, possessing and disposing things by exploring other business models like leasing, sharing, exchanging or collective purchasing. Making relevant information available aims at allowing consumers to purchase more sustainable products, that last longer, can be easily repaired and upgraded and whose parts and materials can be reused. Getting a clear rating system for assessing and informing on durability and reparability of products is crucial to make sure we can inform end users on the products they use, and enable a proper comparison between products. This also aims at creating robust baseline for orienting business innovation and differentiation strategy among manufacturers.

Criteria for more durable and repair friendly products can be elaborated for specific product groups or applying more horizontally across different product categories: e.g. the availability and standard format for repair manuals could be applied to a broad range of different products categories (transversal level). In contrary, some criteria would only fit for specific products, such as the ability to upgrade chipset/processing unit in ICT products. In addition, criteria can also be classified depending on the feasibility of development: is the information for documenting the criteria easy to obtain in short-term or not, is it immediately accessible to an average consumer or not?

OBJECTIVES

The objectives of this report are:

- To define criteria on durability and reparability of products which can lead to a more comprehensive rating system for products in the future.
- To define criteria on durability and reparability of 2 specific products: tablets and wardrobes.

SCOPE

The products groups in which this report refers to are: electrical and electronic equipment, furniture and textiles. Electrical and electronic products are first candidates for extended repair and longevity as one of the fastest growing sector and containing critical materials whose supply shortage could be more of an issue, but this could also apply to other products, such as textiles and furniture. Consumable products such as food or detergents are not targeted in this report.

STRUCTURE OF THE REPORT

This report consists of 7 main chapters:

Chapter 1 provides introductory information to the reparability and durability of products.

Chapter 2 highlights different aspects that have to be considered before developing the criteria needed for a rating system: durability and reparability definitions and consumer attitudes.

Chapter 3 presents a list of criteria for rating the durability and reparability of products differentiating if criteria could or not be applied horizontally. Furthermore, an evaluation and comparison of some of the existing standards that work with reparability and durability of products (Austrian Standards, Blue Angle and IFIXIT scorecard) is undertaken. Finally, criteria are also classified depending on the feasibility of development.

Chapter 4 contains criteria which go beyond durability and reparability of products. Those criteria are related to the sustainable resource use of a product.

Chapter 5 defines criteria based on reparability and durability of two specific products: tablets and wardrobes.

Chapter 6 summarizes the main conclusions of the report and Chapter 7 proposes further research to carry out.

2. BASIC FRAMEWORK FOR A RATING SYSTEM

In this chapter the concepts of durability and reparability of products are defined and consumer's attitudes regarding durability and reparability of products are described.

2.1 Durability of products

Extending the lifetime of a product would generate benefits such as: less resource extraction, less energy embedded (the direct and indirect energy required to produce goods plus the energy needed to source and process raw materials contained therein) and less waste generated. Maintaining the first life use of a product as long as possible is the best approach to reduce the use of resources. Nevertheless, some products are becoming obsolete rapidly, as the technology of the product group is evolving, and consumers prefer to replace a product before the end of its functional lifetime ("fashion" or technological obsolescence). This may be the case with, for example, mobile phones and televisions (Ricardo-AEA, 2014).

Technical planned obsolescence also plays a role in the durability of products. This is the case when the technical lifetime of the products is becoming shorter and forces the consumer to replace the product earlier than desired. Even though there is no proof that technical planned obsolescence is an overall business strategy, there is considerable anecdotal evidence that it occurs (Ricardo-AEA, 2014). Therefore, there are two main factors that determine the lifetime of products: the decisions made at the point of design by manufacturers, and the decisions made by consumers responding to those made in the design phase, whether to repair a product, or whether to replace it (Ricardo-AEA, 2014).

The other main issue with regards durability is to identify the right balance in terms of environmental and social costs between continuing to use a product or replacing it by a more performing product. If the existing product consumes more resources during its life time than a new one, it may be worth to change it, providing the environmental and social costs to manufacture a new product do not offset the expected benefits linked to changing product. This is particularly the case for the energy and water consuming products. However, in view of the achieved gains in energy and water efficiency over the last years, and the increased burden to extract natural resources in the future due to their depletion, we can without major risk predict that going for more durable and repairable goods is justified today and in the close future. The specific situation of Europe, importing most of its natural resources enhances further the potential benefits of conserving resources rather than replacing products.

DURABILITY DEFINITION

A common definition of durability is not established yet.

The [Ecodesign Directive](#) (Directive 2009/125/EC) draws attention to the lifetime of the product as well as the following parameters: maintenance, minimum guarantee lifetime, minimum time for spare parts, modularity, upgradability and reparability.

The European Commission (EC, 2004) defines durability as: "the ability of a product to maintain its functions over the time and the degree to which it is repairable before it becomes obsolete".

The study of Ricardo-AEA (Ricardo-AEA, 2014) defines durability as: “durability is the ability of a product to perform its function at the anticipated performance level over a given period (number of cycles – uses- hours in use), under the expected conditions of use and under foreseeable actions”... “Performing recommended regular servicing, maintenance, and replacement activities as specified by the manufacturers will help to ensure that a product achieves its intended lifetime”. In this definition, the concept of reparability is not included since it is considered unpredictable.

For the purpose of this work to define and further develop a rating system and given the close interdependence between durability and reparability issues, a more comprehensive definition is proposed:

“Durability is defined by the maximum potential lifetime of a product before it becomes obsolete for further usage because it cannot maintain its main functions any longer, it is no longer economically viable to be repaired or to exchange wear out parts, and/ or it lacks necessary possibilities for tuning, personalizing or upgrading.”

2.2 Reparability of products

The reparability of products also extends their lifespan slowing down waste generation, reducing the use of materials, energy consumption and the environmental impact associated. Nowadays, reparability offers new economic and awareness opportunities for services providers. For instance, repair cafes have been founded to reduce the amount of waste generated but also to motivate the consumer to repair their own products increasing their awareness on resource consumption at the same time.

Repair is a response to a failure of a product. Ability to repair is not always taken into account when designing a product. The level of repair can vary within the same product; however there seems to be some predictability about the components which might require repair (Ricardo-AEA, 2014). If predictable, reparability might be part of durability and understood as possible maintenance as for cars. Reparability could start where predictive maintenance stops.

REPARABILITY DEFINITION

Reparability is defined by the ability and ease of a product to be repaired during its life cycle (Eco3e, 2015).

2.3 Consumer attitude

In a recent Eurobarometer (EC, 2013) about attitudes of Europeans towards building the single market for green products, 77% of the respondents stated that are willing to pay more for environmentally-friendly products if they are confident that the products are truly environmental-friendly. In addition, 81% of the respondents would like to find the environmental information about a product on its label. Moreover, 59% of the respondents think that current product labels do not provide enough information and 48% that the label is not clear.

In the same study was found that 92% of the respondents agreed that the lifespan of products available on the market should be indicated. Currently, the products guarantee in Europe is 2 years but 66% of respondents would be willing to pay more for a product with a guarantee of 5 years.

Finally, repair costs are still high considering that nearly half (47%) of EU citizens have decided not to repair a faulty product because repair costs were too high.

In the Eurobarometer 2014 (EC, 2014a) about attitudes of Europeans towards waste management and resource efficiency, consumers were asked about durability of products. Eight potential options were given to consumers being allowed to name three of them. One of the questions was the following: which of the following aspects do you consider most important when buying a durable product, like a washing machine or a fridge?

The results were:

- 39% prefer low running costs due to greater efficiency
- 39% prefer the seller taking back the old product when supplying a new one
- 39% prefer being able to use the product for a long time
- 35% prefer that producers provide a longer guarantee for the product
- 32% are in favour that the product is environmental friendly
- 25% prefer that product can be recyclable after using it
- 17% think that it is important that the product is made by recycled materials
- 9% feel it is important to sell the product once it is no longer used

Finally, reparability was also addressed in this Eurobarometer. There was a list of eight possible actions taken to reduce the amount of waste generated and respondents were allowed to give multiple answers. The most relevant result was that 77% of the respondents made an effort to get broken appliances repaired before buying new ones.

3. HORIZONTAL CRITERIA FOR MORE DURABLE AND REPAIR FRIENDLY PRODUCTS

In this chapter existing standards on durability and reparability of products are introduced. Furthermore, a list of durability and reparability criteria (for electrical and electronic appliances, furniture and textiles) and a basic ranking system for electrical and electronic equipment is provided. Finally, the feasibility to obtain the mentioned criteria is also presented.

3.1 Description of existing standards

THE BLUE ANGEL STANDARD

The Blue Angel certification for products and services was created in 1978 in Germany and since then it has been a voluntary instrument for environmental policy. Blue Angel provides environmental information of the product to consumers to make an environmental friendly purchasing choice. It considers durable products and easy to repair as a requirement ([Blue Angel standard](#)).

THE AUSTRIAN STANDARD

The Austrian Standard Organization was created in 2008. The Austrian Standard Organization publishes ÖNORM Standards which are European Standards. The Austrian Standard Organization also offers quick available normative documents (ONR) which bridge the gap between ÖNORMs (based on broad consensus) and those specifications developed by few companies or institutions ([Austrian Standard](#)).

A durability mark (ONR 192102) for electrical and electronic appliances designed for easy repair (white and brown goods) was published in 2006. This standard was reviewed in 2014: “Label of excellence for durable, repair-friendly designed electrical and electronic appliances”.

THE IFIXIT SCORECARD STANDARD

IFIXIT was started at 2003 in United States. IFIXIT provides free repair manuals in internet for mainly electronic products (but also other categories such as furniture) with the contribution of people experiences. IFIXIT also provide tools for repair and spare parts which can be ordered in a web shop ([IFIXIT](#)).

3.2 Durability and reparability of products

This sub-chapter introduces criteria for durability and criteria for reparability. However, in many cases the criteria are very linked, since the improvement of reparability issues leads to an extended lifespan of the product.

3.2.1 Criteria for durability

1. Average lifespan

Expected product lifespan: *Is the average lifetime of the product (expected for normal use in normal conditions) communicated?*

A system to rate durability should include a criteria about whether or not consumers receive adequate information on the average lifetime of the product (for instance the technical lifetime of the product under normalised conditions).

The Austrian standard demands that the average lifetime for white goods must be at least 10 years and 5 years for brown goods. This information will be provided in a label which will be available to consumers.

Lifespan of key components: *Is the average lifetime of the most common wearing components of the product (expected for normal use) communicated?*

In some cases the lifespan of some components is lower than the overall lifespan of the product. In this case, it is crucial to maximise the lifespan of the components so that it corresponds with the expected lifespan for the overall product. In the study of Ricardo-AEA (Ricardo-AEA, 2014) two products groups (domestic refrigerators, freezers and ovens) were selected to study their durability. The main components that are reported to be wearing more often are identified so that they can be considered for durability testing. On this basis, minimum durability requirements for products components should be proposed.

The Blue Angel standard established a minimum product lifespan for specific components of vacuum cleaners.

2. Product guarantee

Longer guarantees: *Does the manufacturer provide free longer guarantees than the legally required warranty of two years?*

The legally established warranty period for products in the European Union is 2 years. Consumer should be able to check before purchasing a product if the manufacturer provides an additional guarantee free of charge.

The Austrian standard establishes a guarantee of 5 years for brown goods and 10 years for white goods. It also considers the guarantee to reflect both the product's life span and the time for which spare parts should be available.

Burden of proof: *Does the manufacturer provide free longer burden of proof than the legally required warranty of 6 months?*

The actual burden of proof is currently of 6 months after purchase. It means that if faulty or wear goods are returned within 6 months of purchase, the consumer has the benefit of a presumption that the goods were faulty when delivered. However, after six months the retailer is allowed to ask the consumer to prove that the item was faulty when it was bought. Portugal extended the burden of proof to two years (Rreuse, n.a.).

3. Instructions for maintenance

Maintenance instructions: *Are there maintenance instructions of the product available?*

Consumer information and instructions for users about how to carry-out the maintenance of a product and good practices would lengthen the lifespan of the product. The inclusion of a default detection device which warns the end user about the need of maintenance practices could for example prevent early failure of the device due to poor maintenance.

Maintenance instructions could also refer to more technical operations that need to be performed by a technician or at least identified as requiring more competences than we can expect from a normal end user.

4. Product experiences from other users

Product experiences: *Is there any report on early failure or other concerns on the internet forums?*

Before buying a product, the consumer has the option to use internet sources to see if there is any report on early failure or other concerns about the product that he/she is considering to buy. It might be possible to find information on the common causes of failure (e.g. overloading a fridge can cause an earlier failure), products to repair most easily, the best performing products (also in terms of longevity) or products that commonly fail.

Topten is a consumer oriented online tool, which presents in a form of ranking the best products within different categories and best products per country (Topten, 2015). However, so far most of those rankings do not consider yet how durable the product is. The criteria are based on energy efficiency, impact on the environment, health and quality.

5. Product upgradability

Product upgradability: *Is there a possibility to upgrade the product?*

Design for upgradability encompass the possibility to change a product without changing it all completely (Bakker, 2014). It is important to ensure that worn-out parts can be easily exchanged or upgraded with more powerful, up to date or fashion features.

Modular products design can be easily modified or upgraded as the product is made up of different sub-systems (modules). A modular product design would facilitate reuse, refurbishment and remanufacturing without discarding all materials. There should be accessories available to personalise the appliance which can be exchanged if this is what consumers demand for.

6. Compatibility

Models and brands compatibility: *Are the components of a product compatible with other products?*

There is a need to standardise product components to make reparability easier and to upgrade the product. For instance, the chargers of mobile appliances should be standardized to prevent the buying of a new one with each new mobile appliance.

Version compatibility: *Is it possible to upgrade your software or to keep the old hardware and provide updates for it for a minimum period?*

Rapid changes in product design and components are hampering repair efforts. As an example, new software should be able to be used with hardware placed on the market few years ago, as new hardware should be compatible with software placed on the market.

3.2.2 Criteria for reparability

Product reparability is addressed by all aforementioned standards.

1. Repair manuals

Availability of repair manuals: *Is a repair manual associated to the product publicly available?*

The Blue Angel Personal Computer standard and the Austrian Standard require the open availability of a repair manual. Repairing manuals have to be available and should be delivered to:

- The end consumer for repair purposes which do not require too technical repairs.
- Accredited centres for more technical repairs or when there is a risk that the user can be harmed or damages the product.

Repair manuals should be easily accessible, readable, understandable (self-explanatory), free of charge and as simple as possible. It could be provided through a Quick Response (QR) code, which links to information provided on the internet but also in a printed version which will be attached to the product. Repair manual should contain the following information:

- Manufacturer's service centers (after sales services): address, phone and business hours should be provided to the consumer directly by the manufacturers or through retailers. This service should offer:
 - o A substitute for the original product during the repair time
 - o The possibility to get repair swiftly
 - o An answer any kind of question regarding the product performance such as maintenance or reparation of the product
- Product maintenance instructions
- Instructions for disassemble a product:
 - o Kind of repair tools needed and their availability (affordable price)
 - o Information about type and number of screws
 - o Description of actions that must be carried out to repair the product (basic fault diagnostic advice and troubleshooting tree)
- Index for spare parts: includes information on where to get spare parts and cost

2. Product disassembly

Non-destructive opening of the device: *Is it easy to open the device without damaging it?*

This criterion addresses the complexity in opening the device.

Non-destructive disassembly and reassembly of products: *Can the product be disassembled (no use of glue or welding to assemble parts), and are fixing features conventional (not with specific shape patterns that make them difficult to handle without specialized tools?)*

This criteria addresses the ease of disassemble a product. Products designers decide how accessible components are when dismantling their products (Bakker, 2014). Design for disassemble includes practices to optimize the way how a product will be treated at end of life, and to optimize the separation of components and materials for their reparation (Eco3e, 2015).

Products should be designed to be assembled but also easy to disassemble and re-assemble: if a product is designed in a way that it is easy to repair (for instance by using screws instead of glue) it is much more likely that this product has a second life, by being brought to the repair shop instead of being directly thrown away. However, reparation is sometimes difficult due to the complexity of products (Eco3e, 2015). As an example, by using standard fasteners and reducing their number would improve product reparability (Austrian Standards, 2014). A modular product design facilitates the disassembly of products without having to discard all materials contained. A good example of modular product design are the phone blocks (Phoneblocks, 2015).

IFIXIT has provided a reparability rate of smartphone and tablets ([Tablet Reparability](#) and [Smartphone Reparability](#))

Removability and replacement of components: *Is it easy to remove and replace components of the product?*

There is a need to facilitate access to parts which might be replaced during the life of the product. Batteries should be replaceable and not glued or soldered as is the case with some smartphones.

The Blue Angel Personal Computer standard, the Austrian white goods standard and IFIXIT standard require the easy removal of the battery and other consumables by the end user.

3. Repair Tools

Define type and number of tools required to repair: *Is the information about type and number of tools required for repairing a product given?*

Access to repair tools: *Are the required tools to repair public available?*

Products should be easy to be dismantled into its key components as well as to be tested and repaired with common tools (Remmen, n.a.) which should be affordable and public available (not just available to the after sales service providers of the manufacturers).

4. Spare parts

Availability of spare parts: *Can you find evidences on the web or related documentation that spare parts are sold? If yes, for how long will they be made or kept available?*

One of the common obstacles to repair a product is the availability of spare parts which should be able for purchase on an individual basis. Spare parts are those parts which, typically may wear or break down within the scope of the ordinary use of a product (Blue Angel, 2015). One of the reasons that spare parts are often unavailable is rapid design changes. Different cases have been reported for domestic fridges and ovens (Rreuse, n.a.). Spare parts should be available at least during the normalized lifespan of the product and consumers should be informed about where to find or order them.

Mobile phones are often reported to fail due to the low battery performance and in many cases those are discarded without considering the replacement of one component leading to a loss of materials including precious metals (Ricardo-AEA, 2014).

One alternative to make spare parts available after the production has ceased is to use 3D printers. This option would cut costs compared to the need of stocking all kinds of spare parts which are only needed in small quantities. The prerequisite for that would be that the original manufacturer provides a license allowing the production of spare parts for free after the product's production ceases.

The Austrian standard establishes that spare part should be available during a period of 10 years for white goods and 5 years for brown goods after ceasing their production. The Blue Angel standard points to different periods when spare parts should be available depending on the product: for instance: 10 years for refrigerators, freezers and washing machines. 5 years for households microwaves, televisions and computers. 8 years for vacuum cleaners (Blue Angel, 2015).

A new law ([Décret n° 2014-1482](#)) in France will oblige retailers to inform consumers about the availability of spare parts for products. The manufacturers will have to deliver the parts needed to repair within two months. This information will be given to consumer in a "visible manner" before purchasing a product.

The Rreuse organization also states that spare parts for washing machines, dishwashers and fridges must be guaranteed for a period of 10 years following the last component batch (Rreuse, n.a.).

Spare parts cost: *Does the manufacturer provide spare parts at a competitive price?*

The manufacturer has to provide spare parts at a competitive price (e.g. always cheaper than 25% of the product's overall cost), which foster reparability.

5. Hazardous substances

Hazardous substances location: *Is it easy to identify the location of all hazardous components that must be handled safely and or contained/isolated when extracted for repair of the product (e.g. batteries, printed circuit boards)?*

In order to tackle the problem of hazardous substances contained in products the EU proposed the Directive on Restrictions of Hazardous Substances (RoHS) which came into force on 2006. Some of the benefits of the implementation of the RoHS directive is the reduction of the toxic effect: Cadmium, Lead and Mercury have been reduced by 63%, 20% and 56% respectively (ChemSec, 2014). But since some hazardous substances are not yet banned in products, there is a need to mark the parts which contain hazardous substances and that should be handled with care for repair or discard. The reduction in the number/weight of hazardous components would make the disassembly and reparation of products safer and most cost effective.

3.2.3 Summary of durable and repairable criteria

Table 2 summarizes the above mentioned durability and reparability criteria. The following criteria can be applied to different product groups: FU: Criteria which can be applied for furniture, EEE: Electrical and Electronic Equipment and T: textiles.

Some of the criteria are mandatory (M) and the other criteria should be scored between 0 and 4. The higher the score the better awarded the product will be. The overall result is rated as good, very good and excellent. Table 1 corresponds to the quality grading for electrical and electronic equipment.

Table 1. Grading system for electrical and electronic equipment

Points rewarded	Quality Level
1-10	Good
11-18	Very good
19-24	Excellent

Table 2. Durability and reparability criteria and ranking for EEE (EEE: electrical and Electronic Equipment, T: Textiles, FU: Furniture)

DURABILITY CRITERIA		MAXIMUM POINTS	POINTS AWARDED
1	Average lifetime		
	Expected product lifespan (EEE, FU,T)	M	
	Lifespan of key components (EEE, FU)	4	
2	Product guarantee		
	Longer guarantees (EEE, FU)	2	
	Burden of proof (EEE)	2	
3	Instructions for Maintenance		
	Maintenance instructions (EEE, FU,T)	M	
4	Product experiences from other users		
	Product experiences (EEE, FU,T)	1	
5	Product upgradability		
	Product upgradability (EEE, FU)	4	
6	Compatibility		
	Models and brands compatibility (EEE, FU)	2	
	Version compatibility (EEE, FU)	2	
REPARABILITY CRITERIA			
1	Repair manuals		
	Availability of repair manuals (EEE, FU,T)	M	
2	Product disassembly		
	Non-destructive opening of the device(EEE)	M	
	Non-destructive disassembly and reassembly of products (EEE, FU)	4	
	Removability and replacement of components (EEE)	M	
3	Repair tools		
	Define type and number of tools required to repair (EEE, FU)	M	
	Access to repair tools (EEE, FU)	M	
4	Spare parts		
	Availability of spare parts (EEE, FU)	M	
	Spare parts cost (EEE, FU)	3	
5	Hazardous substances		
	Hazardous substances location (EEE)	M	

3.2.4 Feasibility to obtain the criteria

Criteria are classified depending on the feasibility to obtain them (Table 3).

- Easy to obtain (E): accessible by the end user today;
- Feasible (F): we have the information/possibilities today, but they are not necessarily made available, compiled or implemented, but could be through requirements or manufacturer declaration;
- Need further documentation (D): it is necessary to elaborate a normalized way of documenting the criteria.

Table 3. Feasibility to obtain criteria for durability and reparability of products (E: Easy to obtain; F: Feasible to obtain; D: Need further documentation)

DURABILITY CRITERIA		FEASIBILITY TO OBTAIN THE CRITERIA
1 Average lifetime		
	Expected product lifespan	D - Need for elaboration of normalized lifetime tests
	Lifespan of key components	F or D - As some lifetime requirements exists for certain components (e.g. determine the lifetime of components failing most often in refrigerators (Ricardo-AEA, 2014))
2 Product guarantee		
	Longer guarantees	F - Not done yet as no incentives, but could be done (e.g. for cars the longer guarantee period came as a completion pattern)
	Burden of proof	F - In France the burden of proof has been extended up to two years. It would be possible but the legislation needs to change
3 Instructions for Maintenance		
	Maintenance instructions	E - Information about product maintenance already exist in internet forums. However, manufacturers should provide this information
4 Product experiences from other users		
	Product experiences	E - Internet forums can provide essential information about the product to purchase
5 Product upgradability		
	Product upgradability	F - Depends on the manufacturer
6 Compatibility		
	Models and brands compatibility	D - Need to set the standardized interfaces
	Version compatibility	F or D - As software could be required to be compatible with hardware placed on the market within ten years before
REPARABILITY CRITERIA		
1 Repair manuals		
	Availability of repair manuals	F - Repair manuals are not systematically provided. Manufacturers are not interested in sharing information
2 Product disassembly		
	Non-destructive opening of the device	F - The possibilities are there but it depends on the willingness of the manufacturer
	Non-destructive disassembly and reassembly of products	F - The possibilities are there but it depends on the willingness of the manufacturer
	Removability and replacement of components	F - The possibilities are there but it depends on the willingness of the manufacturer
3 Repair tools		
	Define type and number of tools required to repair	F - The possibilities are there but it depends on the willingness of the manufacturer
	Access to repair tools	F - The possibilities are there but it depends on the willingness of the manufacturer
4 Spare parts		
	Availability of spare parts	F - The possibilities are there but it depends on the willingness of the manufacturer
	Spare parts cost	F - The possibilities are there but it depends on the willingness of the manufacturer
5 Hazardous substances		
	Hazardous substances location	F - It is a matter of product information to be disclosed (e.g. product passport which contains information about the properties of the product)

4. CRITERIA BEYOND DURABILITY AND REPARABILITY

If a rating system is intended to go beyond the criteria on durability and reparability of products described above, it should make reference to the broader issues related to the sustainable resource use of a product. This chapter presents a brief description of different criteria which could be used to evaluate their sustainability performance but it is not meant to perform a full cycle analysis in order to assess the overall environmental footprint of a product. It focuses on practical approaches to improve resource use related aspects of products.

1. **Use of secondary raw materials (plastics/wood but not metals):** *What is the percentage of secondary raw material used in the product?*

The use of secondary raw materials during the manufacturing of products would reduce the need for extraction of virgin material and would promote the secondary market for raw materials. Giving economic incentives such as the taxation of raw materials use would favor the secondary raw material use.

This criterion could be declared according to a scale 0 to 5%, from 5% to 10%, from 10% to 20% and more than 20%.

The quantification of secondary metals contained in a product is not always possible since smelters make use of primary and secondary metals. That is the reason why metals are not included in this criterion.

2. **Prioritizing materials:** *How much critical raw materials are contained in the product? Where are they located in the product?*

Certain materials are particularly critical in terms of security supply as well as their environmental and social impacts in the production stage. Thereby, highest priority should be given to products and components that contain high amounts and/or high concentrations of critical metals what require separate treatment for recycling.

It is important to provide information about the quantities and the location of raw materials found in the product. Ensure adequate marking and separation of components containing a high content of those defined materials. Therefore, it will be possible to extract them and to create a market for secondary raw materials.

3. **Greenhouse Gas (GHG) emissions:** *What are the GHG emissions embedded to manufacture the product?*

There is a need to standardize the methodology to calculate GHG emissions embedded to manufacture a product. The total emissions of the Fair Phone though it's LCA are the equivalent of 16.40 kg CO₂. The emissions embedded in the production phase represents 33% of the total emissions (Fair Phone, 2015).

4. **Material recyclability:** *How recyclable is the product and the components contained in the product?*

The design of products determines the potential recyclability of the resources they contain (Van Schaik, 2012). To improve functionality, product design increasingly mixes a large variety of different materials within products (UNEP, 2013). Products are becoming increasingly complex mixing metals and materials and recycling products have become more challenging. Through environmental software the calculation of recycling rates become feasible (e.g. recyclability of LCD) (UNEP, 2013).

A Bill of Materials (BOM) consisting on a data about the composition of products would facilitate the calculation of resource efficiency data which will turn into recyclability index (UNEP, 2013).

5. Sustainable resource extraction: *How sustainable is the raw materials extraction?*

The unsustainable extraction of raw materials generates serious environmental, social and health problems: from pollution and extremely dangerous working conditions to child labor (Fair Phone, 2015). *Solutions for Hope* is a platform that supports companies, civil society organizations, and governments working together to responsible source minerals from regions with opaque supply chains (Solutions for hope, 2015).

The European Commission proposed to “*stop profits from the trade of minerals fueling conflicts around the globe*” focusing on four elements tantalum, tin, tungsten and gold (EC, 2014b). The EU proposal focuses on self-certification of direct importers and smelters. It pretends to cover more aspects than categorizing minerals as conflict-free (OECD, 2013) and it has a worldwide focus.

Raw materials importers should justify whether or not the mining place where the natural resource is extracted should comply with these criteria. These criteria include different aspects for instance: to be an accredited place where there is no abuse associated with the extraction, transport or trade of minerals, there is no direct or indirect support to non-state armed groups or environmental impacts.

5. CRITERIA FOR SPECIFIC PRODUCTS

5.1 Durability and reparability criteria for tablets

A Tablet is a Notebook Computer with a reversible touch-sensitive screen and a non-detachable physical keyboard (Ecolabelling, 2013). Conceptualized in the middle of the 20 century, tablet devices become popular and widespread in recent years. The reparability of tablets in many cases is almost impossible due to its complex design: components of the product are impossible to disassemble (glued) or there is a high chance to cracking the glass during disassembly (IFIXIT, 2014b).

In order to evaluate the durability and reparability of tablets, new specific criteria will be added to the general criteria mentioned in Chapter 3.2 with special focus on disassembly. In order to develop a list of criteria for tablets the following sources have been taken into consideration: Epeat (EPEAT, 2015), TCO Development (TCO Development, 2015), the EU Eco-label (EC, 2009) the Nordic Ecolabel (Ecolabelling, 2013) and IFIXIT (IFIXIT, 2014b).

5.1.1 Criteria for durability

1. Product components

Minimisation/avoidance of the use of problematic components: *Is it possible to find problematic components in the device (ribbon cables minimized or self-destructive fasteners for instance)?*

The minimisation of ribbon cables (which tend to tear easily) and destructive fasteners would guarantee longer life of the product (IFIXIT, 2014b).

2. Product upgradability

Updating software: *Is there information available on updating software?*

Updating hardware: *Is it possible to update the hardware? Does the tablet have ports for an external monitor and for an external keyboard and mouse?*

Exchangeable and upgradable memory and graphic cards: *Are exchangeable and upgradable memory and graphic cards available? Can the working memory be expanded (Ecolabelling, 2013)?*

5.1.2 Criteria for reparability

1. Product disassembly

Non-destructive opening of the device: *Is there a chance of cracking the glass during disassembly?*

Screws use: *Are the number and types of screws provided? Are screws identifiable (for instance colour-coded)? Are proprietary screws used?*

IFIXIT defines a maximum number of 3 types of screws and a total number of 30 screws.

Accessibility of components: *Are all major repairable/replaceable components (such as cameras, Printed Circuit Boards (PCB)...) accessible to repair?*

Removability of components: *Is it easy to remove and replace major components of the product?*

Sometimes components in the product are fused making the disassembly of the product difficult. Batteries sometimes are difficult to replace since are soldered in place or contain strong adhesives. Other examples are the Liquid Crystal Display (LCD) fused to the display glass or to the front panel and rare case is also sometimes problematic to remove and replace.

Connectors: *Are connections easy to locate and access and easily separable with generally available tools? Are connections standardised?*

2. Spare parts for tablets

Availability of spare parts: *Can you find evidences on the web or related documentation that spare parts are sold? If yes, for how long will they be made or kept available?*

Spare parts should be available for at least 3 years from the time that production ceases (TCO Development, 2015).

3. Repair Tools

Tools availability: *Are the common tools to repair available?*

No need of specific tools: *Can the user replace the components without the use of specific tools (Ecolabelling, 2013)?*

5.2 Criteria for a wardrobes

In order to evaluate the durability and reparability of wardrobes, new criteria will be added to the general criteria for furniture presented in Table 2. The main documents which have been consulted to develop the specific criteria on durability and reparability for wardrobes are: the EU Ecolabel proposal for Furniture (EC, 2008), the Blue Angel for “low-emission furniture and slatted frames made of wood and wood-based Materials” (Blue Angel, 2013) and the Nordic Ecolabelling of furniture and fitments (Ecolabelling, 2011).

5.2.1 Criteria for durability

Furniture has relatively long lifespan compared with electronics. Therefore, it needs to be replaced less often, uses fewer raw materials and generates less impact. However, in some cases furniture wears out quickly or becomes out of fashion so consumers prefer to replace it in advance.

1. Expected product lifespan: *Is the average lifetime of the product (expected for normal use in normal conditions) communicated?*

In Belgium the life span must be at least 5 years (EC, 2008). Free longer guarantees should be promoted.

2. Type of material: *Is the wardrobe material durable?*

The type of material will determine the durability of a wardrobe. The focus will be on wood since it is one of the most commonly materials used in wardrobes, rather than comprehensively addressing all possible materials types. Wood can be classified as:

- Medium Density Fiberboard (MDF): it is used in products by breaking down hardwood or softwood residuals into wood fibers combined with a synthetic resin or other suitable bonding system and bonded together under heat pressure. The wood fibers usually come from pines, which grow fast but it can also come from any wood waste in its manufacture including paper.
- Solid wood: the wood is the same in the entire product (one piece) and it is very resilient and durable. The price of a solid wood wardrobe is considerably higher than a MDF wardrobe.

3. Maintenance instructions: *Are there maintenance instructions of the product available?*

The maintenance of the product will depend on the materials of the product. Maintenance must be possible without products containing organic solvents (EC, 2008). In addition, it is important to give to consumers the care instructions which contain information about the correct use (e.g. the recommended weight that product can hold).

5.2.2 Criteria for reparability

- 1. Easy to assemble and disassemble:** *Can the product be disassembled (no use of glue or welding to assemble parts), and are fixing features conventional (not with specific shape patterns that make them difficult to handle without specialized tools?)*

One important element with respect reparability is how the parts or materials are connected or assembled (e.g. the type of glue, the use of screws or welding) (EC, 2008). The connections among different product parts (e.g. the doors or the shelves with the frame) must be easy to assemble and disassemble during the lifetime of the wardrobe.

- 2. Availability of spare parts:** *Can you find evidences on the web or related documentation that spare parts are sold? If yes, for how long will they be made or kept available?*

The availability of functionally compatible spare parts shall be guaranteed for a period of at least 5 years after production (Blue Angel, 2013).

5.2.3 Additional criteria beyond durability and reparability

Additional criteria beyond durability and reparability of products are considered for a wardrobe rating system.

- 1. Towards sustainable sourcing:** *How sustainable is the sourcing of the materials contained in the wardrobe?*

According to the Nordic Ecolabelling, 70% by weight of all purchased pine, spruce, birch and tropical timber must derive from certified forest operations (it applies to solid wood, laminated wood and veneer). For other types of wood this requirement is 50% by weight (Ecolabelling, 2011).

It is important to define robust sustainability criteria for commodities like wood which need to be verified by third party certification systems such as the Forest Stewardship Council (FSC). This international nonprofit organization was established in 1993 to promote environmentally appropriate, socially beneficial and economically viable management of the world's forest. Its main tools for achieving this are by establishing standard setting and labeling of forest products.

2. VOCs emissions

The emission of Volatile Organic Compound (VOC) is regulated by the EU VOC Solvents Emissions directive in order to limit VOCs emissions due to the use of organic solvents in certain activities and installations. This directive has been amended by the EU Paints directive (2004/42/EC). This covers a wide range of solvent using activities such as coating of wooden surface and other coatings such as textiles, metal wood and plastic. Coating systems are usually used for the protection (e.g. wood preservation, anti-corrosion, heat resistance) and the designs of the surfaces of products (EC, 2008).

VOCs emissions by coating: *Does the surface treatment of the wardrobe contain volatile organic compound (VOC)? If yes, specify the chemical name and quantity in % by weight.*

The Nordic Ecolabelling of furniture and fitments establishes thresholds for the use of organic solvents applied in the product. In addition, it gives grants if the total quantity of VOC in the applied product is less than 5% by weight (Ecolabelling, 2011).

Adhesives containing VOCs: *Is the product an adhesive containing volatile organic compounds (VOC)? If yes, specify the chemical name and quantity in % by weight.*

The Nordic Ecolabelling requires that the content of VOCs in glue must not exceed 3% by weight. In Belgium the restriction is lower and adhesives cannot contain more than 10% of VOCs (EC, 2008).

6. CONCLUSIONS

Consumer must have the right to have access to relevant product information. Making product information available aims at allowing consumers to purchase more sustainable products, which last longer and can be easily repaired and upgraded.

The report lists different criteria for durability and reparability of products with a specific focus on electrical and electronic equipment, furniture and textiles and proposes a very basic rating system. Both can be used as background information to develop a more generic and elaborated rating system which is crucial to inform the end users on how durable and repairable the products are, and enable a proper comparison between products. At the same time, this rating system in products will trigger business innovation to move towards more sustainable product design and will enhance to close the materials cycles.

This report highlights the feasibility to obtain these criteria, differentiating if the information presented in the criteria is accessible by the end user today, if the possibilities of obtaining this information are in place but not available, or if the criteria needs further documentation. Many of the criteria have the possibility to be documented but information is not made available nowadays, being the case of product disassembly, repair manuals or repair tools. On the other hand, the product lifespan criterion requires further documentation such as the elaboration of normalized lifetime tests.

Finally, the description of specific criteria for more durable and repair friendly products for tablets and wardrobes was presented. In the case of tablets, more emphasis has been given in criteria for disassembly since it is an important factor which hampers their reparability. In contrast, for wardrobes, the durability depends very much on the material and the easy assembly and disassembly of the components and additional criteria beyond durability and reparability such as sustainable sourcing have been considered important to be included.

7. FURTHER RESEARCH

This work is only able to deliver an initial screening on the subject which needs further research to be conducted as a follow up. Further research is needed on:

- Develop harmonized methodologies to measure the criteria proposed in this report
- Investigate test standards and calculation methodologies to define and validate the estimated life time for specific product groups
- Identify key components of products which wear out more often than others and define minimum requirements to avoid early failures or to facilitate easy replacement
- Develop further specific criteria for different product groups
- Integrate further criteria beyond reparability and durability of products (for instance, to ensure better recyclability of priority materials contained)

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