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## Towards a circular economy: exploring routes to reuse for discarded electrical and electronic equipment.

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### Abstract

Waste reduction should be an integral strategy for meeting European Union commitments on the circular economy. The reuse of household goods, thereby increasing their life-spans, is thus not only part of the waste reduction agenda but necessary for progression towards a circular economy. Reuse does take place through many different routes and involves many actors. This complexity makes monitoring and increasing reuse particularly challenging. Previous research has concentrated on reuse through local government collections and there has been with limited enquiry into other routes. This paper characterises and analyses operations of two UK organisations that facilitate the resale of used electrical and electronic equipment in order to establish how levels of reuse may be increased. It discusses findings from semi-structured interviews with senior representatives from the organisations and makes recommendations for reuse networks that could manage waste streams more effectively. The paper illustrates how different business approaches can make a significant contribution to tackling waste and implementing the circular economy.

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### 1. Introduction

Advances in technology and the ever-increasing demand for electrical and electronic equipment (EEE) have led to an exponential growth in waste electrical and electronic equipment (WEEE). In Europe, the total quantity of WEEE generated in 2014 was 11.6 Mt, with 1.5 Mt originating in the United Kingdom (UK) [1]. Waste reduction has been portrayed as a key element in UK and European Union (EU) government strategies [2, 3], which have developed significantly to address detrimental impacts of waste on the environment and human health. Electrical and electronic products frequently contain carbon intensive materials [4, 5] which, in addition to implications for climate change, resource use and energy consumption [6, 7], lead to air, water and land pollution from waste treatment and disposal. The environmental benefits of

reuse include waste reduction and increased product longevity [8], such that products reach their optimal lifespan and carbon emissions during their life cycle are minimised [9].

This paper outlines the operations of two UK organisations that facilitate the sale of EEE for reuse. By comparing different approaches, products and market for second-hand items, the research seeks to establish variables that could increase current levels of reuse.

The EU Waste Framework Directive (75/442/EC) introduced the waste hierarchy, setting out a preferred order for waste disposal and treatment methods according to their impact on the environment. In the hierarchy, waste reduction and reuse are preferred to recycling, energy recovery (i.e. incineration) and disposal (i.e. landfill). Reuse is a generic term covering operations where end-of-life products are put back into service, essentially in the same form, with or without repair or

remediation [10]. EU legislation further develops the reuse concept through the recast WEEE Directive (2012/19/EC) including “preparation for reuse” guidelines for WEEE, its components and consumables. These refer to recovery operations such as checking, cleaning or repairing products (or components) that enables them to be reused, without further processing, when they would otherwise have become waste.

Strategies such as increasing durability, engendering emotional attachment and improving care and maintenance regimes are crucial for longer product lifetimes [11]. Significantly, product life extension is prominent in the EU Circular Economy Package [12]. However, previous research has highlighted the difficulties involved in large scale reuse, notably with regard to electrical items [5, 13]. For example, many detrimental environmental and health impacts associated with WEEE arise from its improper collection and treatment [1], and these must be addressed in order to increase reuse levels in a multi-faceted approach to implementing a circular economy.

## 2. Routes to reuse

Reuse takes place through formal routes, such as the businesses and charity shops examined in this paper, and informal routes that include giving items to friends or relatives, and selling via car boot sales and online platforms such as eBay and Freecycle [14, 15]. Charities play a role in furthering reuse, with donated goods accounting for 79% of the income generated by charity shops in the UK in 2014 [16].

Due to the high cost of waste disposal, retailers have sought to develop sustainable solutions for items returned under warranty and through “take-back” schemes [17]. Through partnership agreements, many products previously destined for waste treatment are now diverted to reuse [18].

Reverse logistics involves the movement of a discarded product from a final place of use in order to recapture value or ensure proper disposal [19] and is a form of corporate social responsibility [20] with the potential to increase levels of reuse [21]. However, this requires an input flow of suitable used products and a collection and transportation system that ensures goods are handled carefully [22]. The likelihood of products being recovered for reuse increases where retailers view reverse logistics as a potential source of items suitable for resale [23]. Many challenges to increasing reverse logistics are recognised [20], such as its relationship with the market for new goods and the acquisition of suitable items [24, 25]. However, there are potential benefits for consumers and manufacturers in the provision of convenient return routes [26], which include higher levels of consumer satisfaction and customer retention [22, 20]. Solutions to promote the uptake of products obtained through reverse logistics include incentivising consumers to return products [21], using deposit schemes to provide consumers with motivation to ensure items are returned [27], and using finance from producer responsibility regulations to facilitate a reverse supply chain [26].

## 3. Methodology

A desk-based review of relevant literature was undertaken to further knowledge on current practices, challenges and implications for end-of-life EEE, including academic papers, industry and NGO reports, and EU and UK legislation. In addition, the websites of the two organisations studied in this paper were examined, together with associated reports and other publications.

This paper draws upon findings from a large research study which involved a series of semi-structured, face-to-face interviews. Interviewees were selected using a purposive sampling method [28] to ensure they possessed relevant levels of knowledge and experience in order to provide meaningful insights.

For the present purpose, interviewees from two organisations were selected using strategic sampling, based on their ability to address the research problem [29], to reveal how reuse of electrical and electronic items is facilitated in the UK and consider how current levels could be increased.

The interviews were undertaken with a senior representative of each organisation and each lasted approximately an hour. This offered insight into operational strategies, motivations and principal challenges from different perspectives. Whilst a formal set of questions was initially used, open-ended questions provided the flexibility to expose insights that had not been anticipated [30]. This approach allowed the interviewees to shape and lead discussion and to focus on topics that were central to their role in product reuse.

The interviews were audio-recorded and transcribed. Analysis of the transcripts was undertaken utilising Yin’s [31] general analytical framework to identify priority areas for investigation in three stages:

- Examination of individual interviews
- Identification of common themes
- Exploration of themes to establish complementary and contradictory areas.

Both organisations facilitated a site visit and tour of facilities. This provided an overview of the organisation and gave the researcher the opportunity to make observations which enabled company-specific questioning to take place as part of the semi-structured interviews.

This paper reports on the findings from the data collection and analysis, outlines commonalities and differences in the way that the organisations perform reuse, identifies challenges and successes, and reveals some factors which may weaken or strengthen their performance.

## 4. Organisational comparison

This section introduces the organisations. Each organisation’s context is outlined, detailing how it facilitates reuse. The paper explores the respective approaches in order to ascertain if there are opportunities to increase reuse.

#### 4.1. Organisation one: medical research charity

The first organisation is a national charity raising funds for medical research (Table 1). It relies on good quality donations which it sells at “reasonable” prices to private individuals through a network of 750 shops; this makes it a recognisable presence across the UK. Shops are staffed by a network of volunteers, alongside a smaller workforce of paid employees. The organisation has little control over stock input, mostly relying on donations received in an ad-hoc fashion either in store or collected from donors’ homes or business premises.

A small proportion of items are received from retailers operating take-back schemes who have recognised the reuse potential and social benefits of supporting the charity’s work. The organisation operates its own fleet of vehicles for the collection and delivery of goods and for managing stock movements between premises.

On receipt, all items are safety tested and cleaned before going on sale. No repair work is carried out other than superficial work (e.g. cleaning to remove marks, replacing broken handles). Goods not in a saleable condition are disposed of through a waste collection service.

Table 1- Comparison of the two organisations.

Type of organisation	Charity	Private company
Source of goods	Donations, which causes irregular stock input. Some contracts with local authorities for recovery of WEEE. Retailer take-back schemes.	Retailers with high levels of customer satisfaction. Quality brands of white goods and TVs received in reliable, good condition. Local authorities via compliance schemes. Goods are mostly in poor condition and are recycled rather than reused.
Work undertaken	No repairs. Minimal cleaning.	Electrical safety testing. Repairs by qualified engineers. High level of cleaning on all items.
Warranty / guarantee	No warranty – sold as seen.	Guarantee all goods for 6 months.
Who they sell to	Sell to individuals through 750 High Street shops.	Sell in bulk to businesses. Around 40% of sales exported to mainland Europe.
Online presence	Limited online selling through a central point (using eBay).	Online selling to individuals through secondary company (minor part of business).
Challenges	Charity accrues costs for waste disposal.	Online search engines favour larger electrical retailers, despite them not selling second hand goods.
Motives	Provide an income to support charitable work. Social impact.	Profitability. Provide a service that enables businesses to comply with legislation.

#### 4.2. Organisation two: private company

The second organisation, based on three sites in the UK, is a private company undertaking recycling and reuse of EEE. It concentrates on the market for reuse of white goods, television sets and laptops (Table 1). The company receives a steady input of high quality, branded, reusable electrical (and other) goods, mostly from retailer take-back schemes, and electrical and electronic items from local authorities obtained through national compliance schemes.

On receipt, items are examined to assess their condition and, if broken, whether they are repairable. Any that do not pass the screening test are treated on-site purely for material recovery through a two stage process. Firstly usable components are recovered through disassembly, these are then used to facilitate repairs to other machines. And secondly, recyclable materials are recovered through a series of large-scale shredding technologies.

Items suitable for reuse are examined by an engineer, tested to ascertain if they are safe (and working), and thoroughly cleaned. Any minor defects are repaired. Following a grading process, they are priced for resale.

Around 30% of items received are suitable for resale, the majority coming from retailer take-back schemes. Reuse of items received from local authorities is negligible. All useable items are sold in bulk to other businesses, with around 40% of sales going to mainland Europe.

The company sees the reuse part of its operation as the most important. This was said to be on ethical grounds, although it also acknowledged that it made more money from reusing washing machines than recycling them.

### 5. Interview findings

An overview of findings from the interviews are presented and discussed below. The responses were grouped into key topics and evaluated through close reading of the transcripts in the context of showcasing the reuse of EEE within the two organisations.

Whilst reuse has an established place in the waste hierarchy, both organisations indicated that goods recovered from the waste stream frequently have little, or no, reuse value. Both commented on the loss of reuse potential once items enter the waste stream.

“We don't really want an electrical item going into a waste collection facility before it comes to us” (Charity).

“When we collect goods from local government-run waste collection establishments, the reuse potential is negligible” (Private company).

The charity has a collection strategy in which all donors are offered an efficient removal service at no cost. When items have no resale value, the charity frequently incurs additional costs for waste disposal; this gives it a “disincentive to handle items that might not sell”. However, they see this service as providing long term benefits to the charity despite the short term costs.

Being dependent on receiving donated goods to sell, the charity also recovers a limited number of items from the local government waste stream, even though aware that they will quite often have little value or be damaged, which causes further problems.

“[L]ow value reduces the chance of reuse, particularly with items that attract high repair costs” (Charity).

The private company, which has contracts to handle waste items from local authorities through national compliance schemes for WEEE, referred to the limited likelihood that these items are in a reusable condition due to the way they are handled, stored and transported; it almost exclusively assigns them to recycling.

Local government collection methods for unwanted EEE were discussed and it became apparent that both interviewees felt that current collection systems do not take any account of the reuse potential of items.

“Collecting goods in waste collection vehicles makes things difficult to sell. Items get damaged through being handled badly. We [charities] can collect and deliver items using small vehicles and the same teams for delivery and collection. We handle recovered items with the same care that we handle new items” (Charity).

“[The] local government system is set up to handle waste. When our customers deliver new items, they collect old unwanted items for us to process. Old goods are handled as carefully as new ones. This does not happen with waste collection” (Private company).

The recovery of reusable items from households was regarded by both interviewees to be a barrier to reuse that needs to be addressed. Both saw it as an area that should not be the responsibility of local government. The charity said that items should be intercepted before they become waste because “the logistics loop is the most important part of reuse” (Charity).

The charity also felt that, whilst local government should not be involved in the logistics of reuse, it had a role to play in communicating and in signposting the public to different reuse routes. It suggested that this activity could be funded by improving producer responsibility and retailer participation:

“If there were clear signposts to reuse from local authorities, possibly some general communications campaigns around donating still usable items in a way that enables them to remain usable, it would offer more opportunities for that item to reach a second owner. This should be financed by producers, not from council taxes” (Charity).

The private company mentioned a reluctance amongst manufacturers of some electrical goods to encourage reuse, while noting that, by contrast, second-hand cars are sold alongside new models. He likened this to his company’s sale of branded used white goods for reuse. He also suggested that

supplying top brands to customers with limited means could develop an entry-level brand loyalty. Rather than regarding this as losing trade to the reuse market, these companies could create brand loyalty in customers at a stage in their lives when they could not afford new items:

“Mercedes do not resist the sale of a used car to a new young driver just because it’s not new. They think that the driver may, later in their life, afford to buy a new car and will prefer their cars because they are familiar. This develops loyalty to the brand” (Private company).

Consumer attitudes towards reuse and their common preference for new items was discussed. The private company said that there is a demand for high quality, branded items when sold with the assurance of a guarantee or warranty. He felt that reuse in the UK is sometimes associated with “certain” demographic groups and that there are opportunities to expand reuse in other groups. However, he also argued that there is a preference amongst British consumers for new goods that contrasts with other EU countries. His company exports a large number of items for reuse to the Netherlands and Spain where, he suggested, reuse is far more widely accepted:

“[the] British need educating about reuse. Here, reuse is seen as something poor people do. There is potential to market good quality second-hand items that are easily repaired and don’t often break to students and new families” (Private company).

The interviewee also felt that consumer preference for reuse varies between products. His company concentrates on white goods, televisions and laptops because such items retain residual value beyond the first user. The interviewee explained that it is economically worthwhile to repair and issue warranties on these goods, whereas this is not the case for lower cost items such as kettles and irons because the cost of any repair and testing work would make them as expensive as new goods.

## 6. Conclusions

Each organisation appeared to carry out successful reuse operations and face similar challenges. The environmental benefits of reuse were recognised by both organisations, although considered secondary to their main purpose, raising money for a medical charity (organisation one) and operating a profitable business (organisation two). They each pointed out the social benefits of their operations, supplying cheap items to people unable to afford to purchase new items and providing employment or training and skills development opportunities for volunteers.

Reuse is above recycling in the waste hierarchy and the variables that lead to reuse may be very different from those in the case of recycling [32]. Reuse appears to be a practice that is mostly situational; few people appear to connect reuse to environmental values [14]. The interviewees confirmed that reuse works best for relatively expensive or infrequently used products that retain value beyond their first use and can be

transported without damage. While recycling was undertaken largely by environmentally-conscious individuals until the late 1990s [33], it is now normative behaviour and carried out by the majority of people [34]. Reuse could likewise become more common if it was made easier to donate reusable items and items were more likely to reach subsequent owners in a usable condition.

In order to increase the reuse of EEE, a better understanding of reuse organisations is essential. This paper has outlined two different approaches to meeting this objective. The two organisations studied in this paper each operate economically efficient recovery of items suitable for reuse and facilitate the process of goods reaching new owners in a reusable condition, thereby extending a product's lifetime. There are many similar examples of small-scale reuse which could operate on a larger scale if a network was developed specifically for managing reusable waste items and recovering them in a way that meant they did not become damaged, therefore retained their reuse potential.

It is recommended, therefore, that the key issues of logistics, process operation, quality and consumer acceptance are tackled. The interviews demonstrated that moving reusable items outside the waste stream, possibly even outside the responsibility of local government, should be explored as a way of ensuring re-useable items retain their reuse potential. The possibility of amending current producer responsibility frameworks should be further explored in order to provide an incentive to enhance reuse alongside recycling, and to perhaps provide funding to encourage this.

Reuse represents an important activity that needs to be encouraged in a multi-faceted approach to developing a circular economy. Addressing obstacles discussed by the two organisations, such as reverse logistics, would increase the chances of goods remaining suitable for reuse and therefore increase supply. The interviews further established not only are there the complex issues of reverse logistics to tackle, which go beyond merely transporting goods and include processing requirements such as testing, repairing, cleaning and refurbishment; these address questions of aesthetic appearance, functional condition and safety before items can be resold. Additionally, developing a generic standard, or quality label for reused items that provides better and reliable information about functionality and lifespan could assist in addressing issues of public confidence in purchasing second hand items.

Political and economic factors as well as consumer attitudes and behaviour also influence the attractiveness of reuse and the extent to which it can grow in the UK. Addressing them nationally and at EU level offers the possibility of reducing the significant detrimental impacts on the environment of end-of-life electrical and electronic equipment.

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