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The hibernating mobile phone: Dead storage as a barrier to efficient electronic waste recovery

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ABSTRACT

Hibernation, the dead storage period when a mobile phone is still retained by the user at its end-of-life, is both a common and a significant barrier to the effective flow of time-sensitive stock value within a circular economic model. In this paper we present the findings of a survey of 181 mobile phone owners, aged between 18–25 years old, living and studying in the UK, which explored mobile phone ownership, reasons for hibernation, and replacement motives. This paper also outlines and implements a novel mechanism for quantifying the mean hibernation period based on the survey findings. The results show that only 33.70% of previously owned mobile phones were returned back into the system. The average duration of ownership of mobile phones kept and still in hibernation was 4 years 11 months, with average use and hibernation durations of 1 year 11 months, and 3 years respectively; on average, mobile phones that are kept by the user are hibernated for longer than they are ever actually used as primary devices. The results also indicate that mobile phone replacement is driven primarily by physical (technological, functional and absolute) obsolescence, with economic obsolescence, partly in response to the notion of being 'due an upgrade', also featuring significantly. We also identify in this paper the concept of a secondary phone, a recently replaced phone that holds a different function for the user than their primary phone but is still valued and intentionally retained by the user, and which, we conclude, should be accounted for in any reverse logistics strategy.

1. Introduction

Given the global prevalence of supply and demand, and linear economic models (built upon the ideas of neoclassical economics and its theories of consumption), the goal of continuous growth is predicated upon intensive energy and material use in both the production and consumption phase (Mont and Bleischwitz, 2007). However, in order for these linear economic models to work it must also be assumed that there is an unlimited supply of natural resources and that the planet has a limitless capacity to assimilate the waste created by these processes (Cooper, 1999; Stahel, 1998), an assumption that is clearly flawed. At present, the European Union consumes approximately 25–30% of all metals globally produced, but is only responsible itself for 3% of production (Department for Environment Food and Rural Affairs, 2012), resulting in an increasing dependency on the import of raw materials. Although it has been apparent for some time that such a linear economy is unsustainable, both in terms of long-term maintainability and sustainable development, it has become problematic to decouple resource throughput and move to more circular economic models, as it would slow down economic growth, and this would undermine 'growth is good' policies (Stahel, 2010).

An alternative to the current linear economic model is the concept of a circular economic model (Hawken et al., 1999; Stahel and Reday, 1976/1981; McDonough and Braungart, 2002), incorporating biologically inspired production models and closed-loop, cradle-to-cradle, industrial cycles (McDonough and Braungart, 2002). The circular economy provides an opportunity to mitigate (but not eliminate) the negative ecological, social, and economic consequences generated by the increased turnover of consumer electronics (Zhang et al., 2012) by not only ensuring that the lifetime of products is increased (where appropriate) (Cooper, 2010; Stahel, 2010), but also by ensuring that end-of-life products (and the precious materials that they contain) are returned back into the loop and are not land filled, incinerated or lost (Darby and Obara, 2005).

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Turning attention towards mobile phones, there are clear issues surrounding the disposal of these small electrical products at their end-of-life. Polák and Drápalová (2012), for example, have shown that a very small percentage, between 3 and 6%, of old mobile phones in the Czech Republic are ever actually returned for recovery or recycling. Similar low values have also been reported in Germany (Buchert et al., 2015) and from elsewhere around the world (Tanskanen, 2013; Chancerel and Rotter, 2009). Compounding this issue, mobile phones are material rich, often containing more than 40 different elements (UNEP, 2009; OECD, 2010), many of which are classified as having a high risk of supply disruption (British Geological Survey, 2012). Although the relative weight of each mobile phone's metal content is low, for example copper, gold, palladium, and silver only make up 13.2% of a mobile phones total weight (Yu et al., 2010), mobile phones represent a significant material resource. For example, although mobile phones are composed of only 0.04% gold by weight (an average gold content of 44 mg), this concentration of gold is approximately 200 times greater than the concentration found in a South African gold mine (Takahashi et al., 2009). Therefore, the issue of dead storage is problematic if these hibernating devices are not returned back into a circular loop: the resources they contain leak out of the system and are essentially lost. This results in increased production and the associated impacts as well as harvesting of a finite supply of raw materials, which is unsustainable when trying to meet the modern world's insatiable demand.

Although official figures are not known, the Green Alliance (2015) claims that in UK homes, there were between 28 and 125 million mobile phones in hibernation; even the conservative end of this estimate represents a significant resource. As such, hibernated mobile phones represent a significant barrier to the effective recovery of electronic waste within a circular economic model. In this paper, as part of the Closed Loop Emotionally Valuable E-waste Recovery project [CLEVER], we report on findings of a study that explored mobile phone ownership, reasons for hibernation, and replacement motives (mobile phone obsolescence) amongst 18–25 year old university students living within the UK.

2. Hibernation

To be clear, the definition of 'hibernation' we use here is that as defined by the work of Murakami et al. (2010); where the 'possession span' is the combination of the 'duration of use' (during which the consumer is using the goods) and 'dead storage period' (when the goods are no longer in use). It is the dead storage period which we define as hibernation here. Others in the literature discuss hibernation in similar terms such as 'household storage' (when phones have been taken out of service) (Jang and Mincheol, 2010); 'stockpiling' (the storage of any e-waste product at home or at off-site facilities before end-of-life management) (ICF International, 2011; Wagner, 2009); or 'permanent hoarding' (Used Electrical and Electronic Equipment [UEEE] in the home but no longer used) (Haig et al., 2011). We avoid using the term stockpiling to prevent confusion with the retaining of stock within the system by manufacturers for reprocessing or remanufacture; here, hibernation refers to the mobile phone and suggests a latent value that although steadily reducing, could be 'reawakened' and recaptured.

For a circular economic model to function effectively, the loss of resources and value within the loop must be reduced. It stands to reason that any leakage, including hibernation, will have manifold effects, as not only are the precious resources lost for reinvestment as remanufactured components or reused products, but also the shortfall in material will necessitate a rebalance with virgin stock. Further compounding the environmental impact of rebalancing with new products or components, it has been shown that the majority of emissions are from manufacture, depending on the system boundary, as opposed to the products' use over lifetime (Green Alliance, 2015; Suckling and Lee, 2015). In the context of these circular economic models, the primary concern is not with the movement of product from manufacturer to user to disposal, but with a systemic approach of maintaining high quality *stocks* through appropriate *flows*. The mobile phones and the components and materials within them represent the stock. This stock of mobile phones provides the service of communication. By maintaining this stock for the appropriate amount of time, the service of communication can be provided with least impact. The flows of materials necessary to achieve this must be carefully controlled to minimise the inputs from the natural world, and maintain them within the circular economy.

As proposed in the development of a mobile phone product-service system (PSS) by authors Lee et al. (2015) and Wilson et al. (2015), mobile phones are considered the stock, the flow of which is managed around the system based upon unit/component *value*; value here being contingent upon environmental, economic, and technological indicators. Social values are not considered in this treatment, these must also be considered before something can be considered truly sustainable (Lee et al., 2015). As shown in Fig. 1, the value of stock can inform and direct channel flows, by, for example, directing used mobiles phones for (in order of most to least sustainable) reuse or remanufacture; or at a component level, towards stockpiling (reusing the components for mobile phone remanufacture) or reprocessing.

Once products and their internal components (e.g. circuit board, battery, etc.) become obsolete (likely through a combination of physical and psychological obsolescence types, as defined in Table 1 below) they no longer hold sufficient economic value for reinvestment towards reprocessing, recycling or export (Geyer and Blass, 2010; Lee et al., 2015; OECD, 2010). For example, phones operating with antiquated or discontinued software systems with no possibility of upgrade have very limited economic resale value for reuse in the original geographical location (Green Alliance, 2015) (but may still hold functional value in regions where a lower specification is the norm). Furthermore, the shelf-life of physical components are also limited, with the functional value of a CPU dropping as newer and more capable versions (increased clock speeds, number of cores, &c.) become the norm and more cost effective as a result (Lee et al., 2015). Therefore, the stock and flow of electronic goods, mobile phones in particular, is predicated upon finite lifespans for given geographical locations (Murakami et al., 2010).

In addition to the eight identified categories of obsolescence, is the concept of 'planned obsolescence', a term that has existed since 1932 (Chapman, 2005), but has been a practiced corporate strategy since the economic model of supply and demand embraced mass production and market. It is perhaps unsurprising that certain producers of goods have manipulated obsolescence as a way of increasing consumption as a means of maximising profit (Packard, 1960). A classic early example of planned obsolescence was enforced by the Phoebus cartel, a consortium of manufacturers in the early part of the last century, that fixed higher prices and restricted the life expectancy of light bulbs produced by cartel members (Aladeojebi, 2013; Reich, 1992). Even Apple's flagship mobile phone, the iPhone 6s Plus, only has an assumed use phase of three years according to their environmental report (Apple, 2015). Although previously mobile phones purchased under contract were subject to obsolescence due to incompatibility issues when changing service provider, the ability to 'unlock' the handset has enabled users to switch providers and keep their phones, or conversely, has allowed the same handset to be used by multiple users with different service providers. However, manufacturers