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# "What do I do with my old mobile phones? I just put them in a drawer": Attitudes and perspectives towards the disposal of mobile phones in Liverpool, UK

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The rapid rise in the use of mobile (cell) phones, combined with their shortening lifespan, due to a high replacement frequency, are posing disposal management challenges at a time when mobile phones are the fastest growing component of Waste Electrical and Electronic Equipment (WEEE). In this study, 250 people in Liverpool, UK, were surveyed using mixed methods quantitative and qualitative approach to investigate their attitudes and perspectives towards their use and disposal of mobile phones. Most people change their phones every one to two years. However, despite asserting that mobile phones should be recycled, repaired or reused, and demonstrating awareness of the hazards and toxicity of mobile phones, 86% of people store their 'retired' phones, with almost half, having three to four phones stockpiled. The small size and light weight of mobile phones make stockpiling an easy option and create obstacles for 'take-back' and other more formal ways of reuse or recycling.

**Key Words***: mobile (cell) phones, disposal, electronic waste, stockpiling, attitudes and perspectives, Liverpool, UK.*

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## Introduction

Advancements in technology have led to the continuous replacement of old electronic products with newer, cheaper and more advanced electronic gadgets. According to Gurung *et al.*, (2013) technological advancement has not only increased the consumption rate of electronic products but also shortened the life

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cycle and life span of electronic products due to individuals' changing lifestyles and aspirations. Among electronic products, the use of mobile phones has increased rapidly.

Their disposal presents significant challenges due to their high replacement frequency, and they have become the fastest growing component of waste electrical and electronic equipment (WEEE) (Robinson, 2009). In terms of material composition, such as plastic, glass and ceramics and metals, mobile phones are similar to other electronic products (Nnorom & Osibanjo, 2008). They are also a significant source of precious and rare metals such as platinum, gold and antimony (Hägeluken, 2007). Therefore from a resource perspective, mobile phones are an extremely valuable product, and it is important that issues relating to their reuse and recycling are explored, including the development of understanding about how and why people treat their 'retired' phones in the ways they do.

The main contribution of this study is the exploration of individuals' attitudes and perspectives towards the disposal of mobile phones, and the consequent implications for the betterment of the sustainable management of the disposal of mobile phones in the context of waste electrical and electronic equipment.

## Background

### *Mobile phones and electronic waste*

Mobile phones are becoming one of the most ubiquitous electronic products in the world. In the past decade, there has been an enormous growth in mobile phones. Huisman *et al.* (2007) suggested that the most frequently sold appliances into households are mobile phones. Statistica (2015) reported that the number of cellular mobile phones rose globally from 4.12 billion in 2012 to 4.4 billion in 2013, with similar figures being suggested by The International Telecommunications Union (ITU, 2013). In the UK, in which this study is situated, Ofcom (2015) estimated that in 2013 there were 83.1 million mobile phone subscriptions, within a total population of 64.1 million (Office for National Statistics, 2013).

Although markets for mobile phones are nearing saturation in most developed countries, the rapid introduction of new and improved technology into mobile phones, coupled with increasing their functionality, implies that mobile phones have relatively short life cycles and are frequently considered to be obsolete within a little over a year, even though they are still in excellent working conditions (Ongondo & Williams, 2011; Ongondo *et al.,* 2011). In fact, most consumers upgrade their phone in less than three years (Geyer & Blass, 2010; Paiano *et al.*, 2013). AEA (2010) reported that in 2006, 27% of European mobile phone users changed phones every year, and 60% had done so in two years. Ongondo *et al.* (2011) reported that mobile phones consumers in high-income countries replace their mobile sets at intervals of 12 and 18 months. However, Ethical Consumer (2015) reported that in the UK approximately 70 million unused phones are stored (i.e. stockpiled) and that only 25% of retired mobile phones are recovered. Li *et al.* (2012) also remarked that most mobile phones are not properly disposed of (reused/recycled) but stockpiled at their end of life.

In many respects, the observation about the apparent pervasiveness of hoarding and stockpiling raises critical concerns with respect to the resource recycling perspective and the safe disposal of hazardous materials found in mobile phones. From a sustainability point of view, the material composition of mobile phones makes them a high-value product (Ongondo *et al.,* 2011) and a very rich source of secondary raw materials. They also described end-of-life (EoL) mobile phones as being of high value (review and recovery), high volume (quantity), low cost (residual monetary value), and transient (with a short life cycle). Wright *et al*. (1998) and Bains *et al.* (2006), among others, have argued that if waste electrical and electronic waste is not recycled, then raw materials including metals (e.g. platinum and gold) will need to be processed to make new products, resulting in a significant loss of resources. Thus in terms of energy, the take-back and recycling of mobile phones are essential to the environment, in general, for example, Umicore, in 2015, estimates that one tonne of old phones (weighed without their batteries) yields about 300g of gold (BBC News, 2014).

However, in addition to the benefits of the potential for high-value material recovery of valuable metals, mobile phones also release harmful substances if they are not disposed of properly. Deloitte-UK (2012) confirmed that heavy metals such as mercury, lead, cadmium, and brominated flame retardants are used in mobile phone parts like the liquid crystal display (LCD), the printed circuit board (PCB), the plastic casing and the battery.

Mobile phones which end up in landfill sites or dumped illegally, emit toxic substances which infiltrate into the soil and groundwater and make the disposal of mobile phone a global environmental problem (Deloitte-UK, 2012). For example, it has been reported that cadmium from one mobile phone battery is enough to pollute 600,000 litres of water (Lean, 2004).

End-of-life mobile phones can be collected and processed in order to ensure resource recycling and reduce environmental degradation. Khetriwal *et al.,* (2009) gave two reasons why mobile phone waste should be managed separately from household waste; first, they constitute harmful substances which can infiltrate landfills into water and soil, hence contaminating the environment; second, refurbishing and recycling programmes can divert these wastes away from the environment while recovering raw materials that have high value. As an illustration, AEA (2010) reported that the recovery of gold from mobile phone circuit phones in disposal might offset over 85% of environmental impacts from the raw material acquisition phase.

*Legislation on electronic waste*

There is no direct or specific legislation relating to the handling, treatment or management of end-of-life mobile phones in specific in the UK and European Union (EU) in general, but since mobile phones form part of the electronic waste, this is the context in which it is handled. In the EU, WEEE Directives are geared towards sustainable resource and waste management practice and more responsible behaviour by producers and consumers (Ylä-Mella *et al*. 2015). This reflects the UK's current efforts to improve on household recycling rates and WEEE is no exception (Kissling *et al*. 2013). According to Nnorom *et al*., (2009), in the last 20 years, there has been an increase in the number of environmental

policies and legislation focusing on the product development process with a view to reducing the environmental impacts resulting from the products throughout their entire lifecycle from product design, manufacture, through to consumption and eventual end-of-life management. These policies and legislations are almost all based on the principles of extended producer responsibility (EPR). EPR is a method of integrating sustainable development principles into international trade based on an international environmental law principle known as the 'Polluter Pays Principle' (Kibert, 2004) and has become an established part of environmental policy in many countries.

By the late 1990s, the increase in WEEE had become a concern for European Commission (Queiruga *et al.,* 2012) so in April 1998, the first proposal for European Directive on WEEE was published, followed by a five additional drafts, the most recent in 2000, before the Directive went into effect in February 2003 (European Parliament & Council, 2003). The EU legislation prohibiting the use of hazardous materials in electrical and electronic equipment, and enhancing the collection and recycling of such equipment has been enforced since 2003 (European Commission RoHS Directive, 2003 and European Commission (2013). In 2007, 40% collection rate was achieved for larger equipment and 25% collection rate for medium-sized equipment. With few exceptions, the collection rate for small appliances (e.g. mobile phones) was close to zero percent. The present fixed collection target of 4kg per person per year does not reflect the amount of WEEE arising from individual EU member states and is not ambitious enough for increasing collection of small WEEE (Polák & Drápálova, 2012).

The implementation of the EU WEEE Directive in the UK was delayed for several years and finally became operational on the 1st January 2007 (Turner & Callaghan, 2007). In the UK, the WEEE regulations transpose the majority of the provisions of the WEEE Directives into law. However, take-back and recycling of WEEE became fully operational on 1st June 2007 (Watson & Crowhurst, 2007) and the UK government published a non-statutory guidance note to support and help clarify the UK WEEE regulations.

This document gives an outline of products covered by the regulations and roles and responsibilities of different stakeholders. The European Directive on WEEE covers the prevention; reuse, recycling and another form of recovery of WEEE in an effort reduce the need for its disposal. It gives member states the freedom to determine the exact structure of their national take-back systems, in whatever way; it mandates that producers must take-back devices from collection points (Queiruga *et al.,* 2012). This implies producers will be responsible for the collection, treatment, evaluation, and if applicable elimination of waste related to their products. According to Ongondo *et al.,* (2011) producers are required by law to take part in a Producer Compliance Scheme (PCS) approved by the Environment Agency, of which their duties will include financing the treatment, recovery, recycling, and environmental sound disposal of WEEE.

*Management options for retired mobile phones*

Any successful waste strategy must be inclusive and integrated with economic and social practices, and incorporate all sectors of society (Purcell & Magette, 2010). This means therefore that a wide range of social groups and actors must be

actively involved in successful waste management planning (Coakley & Cunningham, 2004). According to Geyer & Blass (2010) mobile phones tend not to be disposed of properly (reused/recycled) at their end-of-life but are instead stockpiled. Estimates in the UK reveal that there are more than 90 million unused mobile phones in households with only a quarter of retired phones returned to take-back schemes, leaving about 11 million phones each year unused or in landfills (Bains *et al.*, 2006).

Despite the relatively small percentage (4%) of mobile phones thrown into the general waste, in terms of mass and volume they still present one of the most valuable electronic products currently found in large numbers in waste streams (Bains et al., 2006). Geyer & Blass (2010) concluded that this value stems from their reusability as well as their material composition. The main reason for promoting the environmentally sound treatment of mobile phone waste is their very high content of both hazardous and valuable substances (Polák & Drápálova, 2012). Hugh & Berry (2007) proposed an optimization model for the planning of end-of-life mobile phones in developing countries, by developing a generic manufacturing plan for mobile phones, and taking into account their potential environmental impacts. Nnorom et al. (2009) carried out research into the economics of mobile phone reuse and recycling and concluded that reuse offers a larger monetary profit margin compared to recycling, which is in effect a by-product of reuse. Taking into account the increasing quantity of electronic waste, studies have been focusing on e-waste disposal including mobile phones (Wang et al., 2011).

The principle of Extended Producer Responsibility (EPR) suggested by Lindhqvist in 2000, states that producers should extend their responsibility to the whole life cycle of their product, not only production and sale but also in reclaiming and disposal of the end of life product (Lindhqvist, 2000). Nnorom (2009) argued that there should not only be a focus on extended producer responsibility but also that the performance of government and people's attitudes towards the use and disposal of electronic equipment should be considered. Ongondo et al. (2011) assessed and evaluated mobile phone take-back services in the UK and recommended future actions to improve the management of end-of-life mobile phones and other accessories.

These issues placed emphasis on the importance of retrieving unwanted mobile phones from consumers for reuse or recycling, in order to avoid adverse environmental impacts and also to retrieve imported resources embedded in the phones. Most (2003) in his report identified four vital factors for the success of mobile phone take-back schemes: 1. Collection method used by the scheme, 2.Convenience for potential phone donors, 3. People's awareness of the service as a result of promotion and advertisement, 4. Customer incentives to encourage the return of phones.

However, the main driving force for product take-back services for high volume, transient devices such as mobile handsets is the shortage of key metals (Ongondo *et al.*, 2011). However, Schluep *et al.* (2009) argued that if WEEE is not recycled, raw materials will need to be processed in order to manufacture new products that will, therefore, result in a significant loss of resources and environmental degradation. They illustrated that the recycling of 1kg of aluminium could save 8kg of bauxite, 4kg of chemical products and 14 kilowatts of electricity. Ongondo *et al.* (2011) among others maintain that the challenge is not

only to improve on the reuse, recycling and collection of retired mobile phones and divert them from landfills but also to recover the handsets and contribute to the conservation of natural resources.

*Attitudes and perspectives*

The term 'attitude' is derived from the Latin word '*aptus*', which means 'fit and ready for action' (Oxford Dictionary, 2013). Recently, however, researchers view attitude as a construct that, although not directly observable, precedes behaviour and guides our choices and decisions for action (Hogg *et al.,* 2008). According to Fabrigar (2004), attitude is a negative or positive feeling towards a specific object; it exerts an influence on behaviour, and consciously or not behavioural decisions are usually based on attitudes. Most of the attitudes that people have, are the product of direct experience with attitude objects, and there are several explanations for its effect: more exposure, operant conditioning, classical conditioning, social learning theory and self-perception theory (Hogg *et al.,* 2008). Attitudes are an integral part of the socialization process and are developed through direct experiences or through various interactions with others (Mainieri *et al*., 1997).

Attitude affects an individual's behaviour by filtering information and shaping the individual's perception of the world (Fazio, 1986). Strength in the attitude amplifies or cancels the effect of attitude on behaviour (Krosnick & Petty, 1995; Petty & Fabrigar, 2004; Petty & Krosnick, 2014). For example, a user who strongly holds a favourable attitude towards using a certain technology may adopt and continue to use the technology: but a user who weakly holds a favourable attitude towards using the technology may be easily persuaded to change that attitude if others point out faults in the technology, and they stop the adoption (Kim *et al.,* 2009). Human characteristics also influence waste management behaviour (Purcell & Magette, 2010). However, attitudes, skills, knowledge and aspiration determine an individual's behaviour and also the ability to change behaviour (Barr & Gilg, 2006). In Ireland, Morrissey & Phillips (2007) recognized that waste management problems could continue to increase unless a greater understanding of the people and issues is achieved.

The published literature provides some insights into the use and disposal of mobile phones for example; the frequency with which people replace their mobile phones (Most, 2003); age and sex differences with respect to the use of mobile phones among students in the USA (Selian, 2004); the short life cycle of mobile phones (Bains *et al,* 2006); the importance of incentives and take-back services to influence the return of mobile handsets (Ongondo *et al,* 2011); the quantities of mobile phones stockpiled (Geyer & Blass, 2009; Darby & Obara (2005) analyzed household behaviour and attitudes with respect to disposal of small WEEE (including mobile phones) in the UK, and argued that a one-size-fits-all approach is not appropriate for recycling WEEE.

Nnorom *et al.* (2009) evaluated consumer behaviour towards waste mobile phones, discussed their willingness to participate in waste mobile phone recycling and to pay for a more environmentally friendly mobile phone (Li *et al.,* 2012). People's behaviour and willingness to e-waste recycling brings some uncertainties (Ravi *et a*l., 2005): the diversity of consumers' recycling habit directly affects the time and place of e-waste recycling; the willingness of people to afford the e-waste

recycling fee could also affect the quantity of reclaimed e-waste (Wang *et al.,* 2011). However, even where recycling infrastructures are available, an understanding of people's willingness to participate in e-waste recycling programmes is still significant (Saphores *et al.,* 2006; Saphores *et al.*, 2009; Saphores *et al.,* 2012)), a process which is starting to be explored (e.g. see Ylä-Mella *et al.*, 2015).

This research project makes a contribution to reducing this knowledge gap and the findings reported in this article about consumers' attitudes and perspectives towards retired mobile phones provide information that can contribute to informing the sound and sustainable management of retired mobile phones. Also, indirectly, during the survey, public awareness of the dangers of poor management of retired mobile phones is also raised, for as Ongondo *et al.,* (2011) have asserted, the challenge is not to improve collection, reuse, and recycling of retired mobile phones and divert them from landfills, but also to recover these mobile phones and contribute to the conservation of natural resources.

## Methodology

A social survey questionnaire, using a mix of open-ended and closed questions was used to investigate people's attitudes and perspectives towards the use and disposal of mobile phones in Liverpool city centre, in order to inform and enhance the sustainable management of mobile phones. The questionnaire contained 21 questions comprising both open ended and closed (multiple choice) style questions that would enable subsequent data analysis using a combination of quantitative and qualitative techniques in a mixed methods approach (Creswell & Plano, 201; Creswell, 2013). This informed choice was made to ensure a study of breadth i.e. to identify at wider overall numerical and statistical patterns (see e.g. Gillham, 2000; Kumar, 2011) and also to explore the qualitative dimensions of people's narrated comments and feelings about their disposal of mobile phones. The use of qualitative techniques was considered to be essential in order to gain deeper insight into why people behave as they do with their end-of-life mobile phones.

Along with questions to determine the socio-demographics of participants (i.e. particularly, gender, age and main occupation), the survey used included questions arranged in the following order to find out:

- Participants' socio-demographic characteristics particularly age, gender and main occupation (closed questions).
- People's frequency of replacing mobile phones (multiple choice), and the underlying reasons for those actions (multiple choice questions)
- The number of extra mobile phones kept by people (multiple choice) and their reasons for keeping them (multiple choice questions)
- People's willingness to recycle end of life mobile phones (Likert scale)
- Awareness of harmful materials in retired mobile phones (multiple choice questions)
- Awareness of precious materials in retired mobile phones (multiple choice questions)
- Proposal of management systems (open ended questions)
- People's awareness and experience with mobile phone take-back services (multiple choice questions).

Before full administration of the survey took place, the questionnaire was pre-tested (piloted) and some minor adjustments were made to the wording of questions, to increase clarity for the participants.
A simple systematic sampling technique was used to make sure that each respondent had an equal chance of being selected (e.g. Denscombe, 2010). This was achieved by administering the face-to-face questionnaire to every fifth person who walked past the interviewer on Church Street in the commercial core of central Liverpool, during data collection periods in February and March 2013. It provided a sample size of 250 participants that was appropriate within the limited time constraints inherent in the project programme, to provide an indicative snapshot of people's attitudes towards and perspectives on, the disposal of mobile phones.
Prior to the research being conducted, ethical approval for the project was granted by Liverpool Hope University according to its usual practice and procedures.

## Data analysis

Given the mixed methods nature of the data collection used in the survey, the tools used in data analysis reflected this and included quantitative and qualitative techniques. First, for the statistical analysis, data from the completed questionnaires were converted into numbers in order to produce a codebook. This coding was done by marking each question with selected identification numbers. Thereafter, the coded data were entered into Microsoft Excel 2010 and percentages of the responses were calculated for each question.

Because a simple random probability sampling technique was adopted during the survey process, the Statistical Package for the Social Sciences (SPSS version 12) was used for Pearson chi-square testing to determine the levels of significant association between responses to the questions and the chosen variables (age, gender and occupation). Second, the qualitative information i.e. the participants' narratives in response to open-ended questions were analyzed using categorization by keywords (Strauss & Corbin, 1998) and thematic analysis (Braun & Clarke, 2006) and reported as thematic commentary. The results presented in the next section, therefore, include both outputs of the quantitative and qualitative data collected in order to narrate the attitudes and perspectives of the mobile phone users surveyed

## Results and discussion

*Participants' characteristics*

The following section reports on the main findings of the research including: Socio-demographic parameters of the 250 participants; relationships between age, gender and occupation and frequency of replacing mobile phones; opinions on the recycling of mobile phones; willingness to participate in waste mobile phone recycling and willingness to pay for more environmentally friendly mobile phones; willingness to participate in waste mobile phone recycling; and willingness to pay for a more environmentally friendly mobile phone; perspectives on the effect of

mobile phones on people and the environment; and awareness of mobile phone take-back services.

The rationale behind the choice of these variables for contingency testing was their direct relevance to addressing the specific research aims, although they are clearly not exclusive or exhaustive. Furthermore, age, gender and occupation were chosen as base parameters for testing for contingency because they serve as the main distinguishing socio-demographic attributes of the participants and have been used in cognate work (e.g. Nnorom *et al*., 2009 and Dwivedy & Mittal (2013). In all, there was a broad gender balance with 133 (53%) of the participants were male, 117 (47%) female. In terms of age parameters, 150 (60%) were between 25 and 39 years of age, 49 (19.6%) were between 40 and 59, 43 between 18 and 24 and 8 (3.2%) over 60 years old. By main occupation, 100 (40%) identified themselves as skilled workers, 80 (32%) as students, 40 (16%) as unskilled workers, 21 (8.4%) as unemployed and 9 (3.6%) as retired.

*Frequency of replacing mobile phones, retention of retired phones and reasons for keeping them*

Table 1 shows the descriptive frequencies of mobile phone use and other measures relevant to it. The other measures include how long participants have used mobile phones, the main reason for changing their last mobile phone and their opinions on the best management of mobile phone disposal.

All participants of this study made use of mobile phones, and 96% said that they had active mobile phones. The vast majority had used mobile phones for over 5 years, for instance, 104 (41.6%) participants had used mobile phones for 6-11years, 93 (37.2%) for 12-17 years and 48 (19.3%) for 18-23 years. Furthermore, 129 (51.6%) participants had used 3-4 phones in the past 5 years, followed by 55 (22%) who had used 1-2 phones. A total of 15 participants claimed to have used between 7-12 mobile phones in the past 5 years while, at the other end of the scale, 10 participants claimed not to have changed their mobile phone during this time. Inquiry into reasons for changing mobile phones showed that upgrade and change of model were the main reasons with 112 (44.8%) and 79 (31.6%) participants respectively. At the time of the survey, 104 (41.6%) participants were on contract with their mobile phones. In addition, 45 (18%) had paid between £100-199 for their mobile phones and 36 (14.4%) £0-99 and 26 (10.4%) participants said that they had paid £400 or more for their mobile phones.

Most participants changed their phone after 1 to 2 years, and enquiry into the main reason for this showed that it was primarily due to technological advancement (upgrade and change of model). This pursuit of advanced technology accounted for a total of 76.4% of total participants' motive for changing their mobile phones. Of this, 44.8% of participants changed their phones because they needed to upgrade and 31.6% did so to change model. When asked to specify *why* they replaced their mobile phones, the participants provided an array of reasons for example:

"Whenever it breaks" *(P34) [i.e. Participant (P) number 34]*

"Whenever I feel like" *(P165)*

"It depends on new models" *(P188)*

"When needed" *(P213)*

"If my mobile phone is ok, I can't replace it" *(P117)*

**Table 1.** Frequency of mobile phone use and other measures

| Parameters and Measures | Frequency | Percentage (%) |
|---|---|---|
| For how long (period) have you been using mobile phones? | | |
| 0-5 years | 2 | 0.8 |
| 6-11 years | 104 | 41.6 |
| 12-17 years | 93 | 37.2 |
| 18-23 years | 48 | 19.3 |
| 24-29 years | 1 | 0.4 |
| Don't remember | 2 | 0.8 |
| How many mobile sets have you changed in the past 5 years? | | |
| None | 10 | 4.0 |
| 1-2 | 55 | 22.0 |
| 3-4 | 129 | 51.6 |
| 5-6 | 40 | 16.0 |
| 7-8 | 9 | 3.6 |
| 9-10 | 5 | 2.0 |
| 11-12 | 1 | 0.4 |
| Don't Remember | 1 | 0.4 |
| What was your main reason for changing your last mobile phone? | | |
| Lost | 16 | 6.4 |
| Damaged | 37 | 14.8 |
| Change of model | 79 | 31.6 |
| Upgraded | 112 | 44.8 |
| Other | 6 | 2.4 |
| What was the price for the replaced mobile set? | | |
| Free (on contract) | 104 | 41.6 |
| £ 0-99 | 36 | 14.4 |
| £100-199 | 45 | 18.0 |
| £200-299 | 33 | 13.2 |
| £300-399 | 6 | 2.4 |
| £400 and above | 26 | 10.4 |
| How many phones do you have stock-piled in your house? | | |
| None | 36 | 14.4 |
| 1-2 | 63 | 25.2 |
| 3-4 | 100 | 40.0 |
| 5-6 | 39 | 15.6 |
| 7-8 | 9 | 3.6 |
| 9 and above | 3 | 1.2 |
| What did you do with your last mobile phone? | | |
| Recycled | 17 | 6.8 |
| Stored | 102 | 40.8 |
| Thrown in the bin | 39 | 15.6 |
| Taken back to company for replacement | 12 | 4.8 |
| Pass it on to someone else | 55 | 22.0 |
| Sold to mobile phone take-back services | 12 | 4.8 |
| Other | 13 | 5.2 |
| What do you think is the best management for waste mobile phones? [responses themed by researcher post survey] | | |
| Recycle, repair and reuse | 169 | 67.6 |
| Dump in the bin | 37 | 14.8 |
| Burn (Incinerate) | 25 | 10.0 |
| No idea | 19 | 7.6 |

*n*=250

**Table 2.** Socio-demographic parameters and frequency of replacing mobile phones, (how often do you replace your mobile phone?)

| Demographic Parameters | | Six months | Yearly | Every two years | Every three years | Other | Total |
|---|---|---|---|---|---|---|---|
| *Age* | | | | | | | |
| | 18-24 | 3 | 21 | 14 | 4 | 1 | 43 |
| | 25-39 | 9 | 74 | 49 | 8 | 10 | 150 |
| | 40-59 | 0 | 24 | 13 | 2 | 10 | 49 |
| | 60 and above | 0 | 3 | 2 | 2 | 1 | 8 |
| *Gender* | | | | | | | |
| | Male | 7 | 59 | 45 | 9 | 13 | 133 |
| | Female | 5 | 63 | 33 | 7 | 9 | 117 |
| *Occupation* | | | | | | | |
| | Student | 5 | 42 | 27 | 5 | 1 | 80 |
| | Skilled | 3 | 48 | 33 | 6 | 10 | 170 |
| | Unskilled | 3 | 16 | 13 | 2 | 6 | 40 |
| | Retired | 0 | 3 | 2 | 2 | 2 | 9 |
| | Unemployed | 1 | 13 | 3 | 1 | 3 | 21 |

*n*=250

Furthermore, an inquiry into how the number of mobile phones participants have changed in the past 5 years (Table 2) revealed that more than half of total participants (51.6%) had changed about 3-4 phones, a value was anticipated having observed that majority of people change their phones in 1-2 years of acquisition.

The results of Pearson chi-square contingency testing between frequency of change of mobile phones and age $\chi^{2+}(3) = 20.419$, $p>0.05$, gender $\chi^{2+}(1) = 2.273$, $p>0.05$ and occupation $\chi^{2+}(4) = 19.980$, $p>0.05$ (see Table 2) showed that these three baseline measures did not significantly influence participants' frequency of changing mobile phones (i.e. the null hypothesis – that there is no relationship between frequency of replacement of mobile phone and age, gender and occupation is retained) and that this will be likely to happen too in the wider population.

The over-riding response to the question, 'what did you do with your last mobile phone?' was that participants stored them. In all, 102 (42%) stated that they stored (stock-piled) their last mobile phone. Participants were asked to provide in an open-ended question the main reason why they stored their last retired phone. The responses were then themed by the researcher into the following categories, no reason (24%), back-up/spare (18%), obsolete (17%), keep it because it is precious and expensive/valuable (16%), collect as a souvenir (14%) and do not know how and where to recycle it (11%).

*Willingness to recycle mobile phones*

Beyond the predominant response to the question, 'what did you do with your last mobile phone?" by the participants that they had 'stored it', 17 (6.8%) said that they had recycled it, with a further 55 (22%) indicating that they had passed it on to someone else, 12 (4.8%) stating that they had taken it back to the company they had got it from, for replacement, and 12 (4.8%) sold their phone to a take-back service. A further 39 (15.6%) had thrown them 'in the bin'. Of the 17 who responded that

**Table 3.** Socio-demographic parameters and willingness to participate in waste mobile phone recycling, (are you willing to participate in waste mobile phone recycling?)

| Socio-demographic Parameters | Yes | No | Total |
|---|---|---|---|
| *Age* | | | |
| 18-24 | 29 | 14 | 43 |
| 25-39 | 112 | 38 | 150 |
| 40-59 | 32 | 17 | 49 |
| 60 and above | 2 | 6 | 8 |
| *Gender* | | | |
| Male | 74 | 59 | 133 |
| Female | 101 | 16 | 117 |
| *Occupation* | | | |
| Student | 56 | 24 | 80 |
| Skilled | 78 | 22 | 170 |
| Unskilled | 25 | 15 | 40 |
| Retired | 3 | 6 | 9 |
| Unemployed | 13 | 8 | 21 |

*n*=250

they recycled, the three key themes to emerge were that 10 (58.8%) had given their old phone to an eco-team for recycling, 6 (35.3%) had donated to charity (the other kept it to use as an alarm clock). The 211 participants who had responded 'yes' to the question 'do you think mobile phones should be recycled at their end-of-life?' were then asked to state the main reason why, and these were then analysed thematically by the researcher. The key thematic categories identified were material reuse and recovery (42.6% of participants), protecting the environment (41%), economic reasons (13.3%) and did not know why (2.4%).

Among the responses from the 39 participants who did not think that mobile phones should be recycled, the main themes identified were that it was, a waste of time (46.2% of participants), a waste of money (17.9%), a waste of resources (23.1%) and that they did not know why (12.82%).

The fact that 86% of participants had stock-piled their old phones is particularly interesting behaviour in the light of their opinions on recycling mobile phones i.e. that 84% thought that mobile phones should be recycled and were able to give reasons why (see Table 3), and that 70% indicated their willingness to participate in mobile phone recycling.

This willingness was tested for contingency with participants' age $\chi^{2+}(3) = 9.918$, $p<0.05$, gender $\chi^{2+}(1) = 27.909$, $p<0.05$ and occupation $\chi^{2+}(4) = 10.536$, $p<0.05$. All of the three baseline measures show a significant relationship with participants' willingness to recycle mobile phones. For age, the results revealed that the age group 25-29 years were more willing to participate in mobile phone recycling than any other. With respect to gender, more females than males were willing to participate in mobile phone recycling than males i.e. 101 of the 117 female participants (86.3%) in comparison to 74 of the 133 males (55.6%). In terms of occupation, the group reporting the highest number and percentage stating willingness to participate in waste mobile phone recycling was skilled workers (78%) followed closely by students (70%). These results provide insight into people's perspectives about the recycling of end-of-life mobile phones. The also accord with findings in studies which have investigated recycling in a wider context and have also found significant positive relationships between e-waste (including

**Table 4.** Socio-demographic parameters and perspectives on the effect of mobile phones on humans and the environment, (do you think mobile phones are harmful to humans and the environment?)

| Socio-demographic Parameters | | Yes | No | Total |
|---|---|---|---|---|
| *Age* | | | | |
| | 18-24 | 26 | 17 | 43 |
| | 25-39 | 95 | 55 | 150 |
| | 40-59 | 29 | 20 | 49 |
| | 60 and above | 5 | 3 | 8 |
| *Gender* | | | | |
| | Male | 80 | 53 | 133 |
| | Female | 75 | 42 | 117 |
| *Occupation* | | | | |
| | Student | 49 | 31 | 80 |
| | Skilled | 59 | 41 | 100 |
| | Unskilled | 25 | 15 | 40 |
| | Retired | 5 | 4 | 9 |
| | Unemployed | 17 | 4 | 21 |

*n*=250

mobile phones) recycling and age, gender and occupation (see Nnorom *et al.* 2009; Dwivedy & Mittal, 2013).

*Perspectives on recycling and the hazards of mobile phones*

Given that most people were willing to recycle their retired mobile phones, even though many did not, it was useful to explore what people thought were the reasons for doing so in terms of their perspectives on mobile phones as hazardous (e.g. the presence of harmful materials) to humans and the environment.

A total of 155 (62% of all participants) considered that mobile phones are harmful to humans and the environment. Their concerns were categorized by the researcher into three broad themes i.e. environmental reasons (reported by 33.3%), health reasons (58.1%), social reasons 97.7%). The remainder was not so sure why mobile phones are harmful.

Contingency analysis showed that there was no relationship between participants' perspectives on mobile phones as hazards to humans and the environment and their age $\chi^{2+}(3) = 0.322$, $p>.05$, gender $\chi^{2+}(1) = 0.413$, $p>.05$ and occupation $\chi^{2+}(4) = 3.766$, $p>.05$.

First, environmental concerns were revealed in responses such as:

"They contain materials that are difficult to degrade" *(P1)*

"It [the phone] has a potential to be harmful. The battery, for example, could be toxic especially if unused for a while and abandoned" *(P119)*

"They contain toxic materials which could be harmful to the environment if not properly disposed of" *(P212)*

Second, health concerns tended to be expressed in the following ways:

"Radiations [*sic*] can damage the brain in a long term" *(P10)*

"Because of the radiation that emanates from them which is highly detrimental to humans if not handled properly" *(P55)*

"People might have accidents through using phones when walking through the street" *(P101)*

"Some components consist of harmful chemicals which may be harmful to human health" *(P218)*

Third, social concerns were narrated in observations such as, mobile phones:

"Damage relationships" *(P 110)*

"Break relationships" *(P190)*

"[Bring] many negative impacts to humans such as bad relationships and making people sleepless" *(P77)*

From these comments, it is clear that the respondents who thought that mobile phones are harmful to humans and the environment were generally well aware of the main issues. Among the 95 participants who did not think they were harmful, the reasons tended to be more nebulous and tenuous, although they could be categorized into four main themes, communication reasons (52.2% of participants), that they are 'part of life' (27.4%), that there is not enough data [to prove that mobile phones are harmful] (10.5%) and not sure (9.5%).

All 250 participants were asked the question 'did you know that mobile phones contain toxic materials and radiation that can be harmful during use and disposal'. The results were, 'yes' by 121 (48.4%) and 'no' by 129 (51.6%). This almost equal division was also evident in the response to the question 'did you know that mobile phones contain scarce and precious metals such as mercury, gold, silver, lead etc.' In this case the responses were 'yes' by 121 (48.4%) and 'no' by 129 (51.6%).
Together, the data presented in this section suggest that there is evidentially need to increase knowledge and awareness about the environmental, health and social impacts of mobile phones and how to mitigate and reduce the negative effects of their use and subsequent disposal.

*Proposal of management systems*

When asked what do you think is the best management for waste mobile phones? The majority of the participants (67.6%) suggested recycling, repair and reuse. Next, were those who thought it should be dumped in the bin with 37 (14.8%), followed by 25 (10%) who suggested burning, and 19 (7.6%) who said that they had no idea. However, in terms of how waste mobile phones were actually managed by individuals, it was apparent that in reality most people kept and stored their old mobile phones at home i.e. 3 (1.2%) of the participants had 9 or more stock-piled, 39 (15.6 %) had 5 or 6 stock-piled, 100 (40%) of the participants had 3 or 4 mobile phones stored (stock-piled) in their homes, and 63 (25.2%) had 1 or 2. Only 36 participants had not kept any. Thus overall, 206 (86%) of the participants stored (stock-piled) old phones at home. No participant suggested that the problem of the proliferation of mobile phones and associated waste disposal challenges could be addressed by manufacturing sturdier, more environmentally friendly phones. However, when asked if they would be willing to pay more for one, 68.4% said yes.

Testing for contingency showed that neither age ($\chi^{2+}$ *(3)* = 0.196 $p>0.05$) nor occupation ($\chi^{2+}$ *(4)* = 1.730, $p>0.05$) influenced participants' willingness to pay, but gender *did* ($\chi^{2+}$ *(1)* = 39.224, $p<0.05$) – with a higher percentage of all females (88%) than all males (51%) being prepared to pay. This may also be reflective of a greater environmental consciousness in females than males as also suggested by the indicators that females were also more willing to engage in mobile phone recycling than males.

**Table 5.** Socio-demographic parameters and willingness to pay for a more environmentally friendly mobile phone, (are you willing to pay for a more environmentally friendly mobile phone?)

| Socio-demographic Parameters | | Yes | No | Total |
|---|---|---|---|---|
| *Age* | | | | |
| | 18-24 | 30 | 13 | 43 |
| | 25-39 | 103 | 47 | 150 |
| | 40-59 | 33 | 16 | 49 |
| | 60 and above | 5 | 3 | 8 |
| *Gender* | | | | |
| | Male | 68 | 65 | 133 |
| | Female | 103 | 42 | 117 |
| *Occupation* | | | | |
| | Student | 51 | 29 | 80 |
| | Skilled | 71 | 29 | 100 |
| | Unskilled | 27 | 13 | 40 |
| | Retired | 6 | 3 | 9 |
| | Unemployed | 16 | 5 | 21 |

*n*=250

**Table 6.** Socio-demographic parameters and awareness of mobile phone take-back services, (are you aware of mobile phone take-back services?)

| Socio-demographic Parameters | | Yes | No | Total |
|---|---|---|---|---|
| *Age* | | | | |
| | 18-24 | 14 | 29 | 43 |
| | 25-39 | 58 | 92 | 150 |
| | 40-59 | 20 | 29 | 49 |
| | 60 and above | 5 | 29 | 8 |
| *Gender* | | | | |
| | Male | 56 | 77 | 133 |
| | Female | 41 | 76 | 117 |
| *Occupation* | | | | |
| | Student | 30 | 50 | 80 |
| | Skilled | 40 | 60 | 100 |
| | Unskilled | 17 | 23 | 40 |
| | Retired | 5 | 4 | 9 |
| | Unemployed | 5 | 16 | 21 |

*n*=250

*Awareness and experience with mobile phone take-back services*

Strikingly, the results showed that most participants (61.2%) were unaware of mobile phone take-back services despite the observed high frequency of changing their mobile phones. The application of Pearson chi-square to test for contingency between age $\chi^{2+}(3) = 2.683$, $p>0.05$, gender $\chi^{2+}(1) = 1.307$, $p>0.05$ and occupation $\chi^{2+}(4) = 1.132$, $p>0.05$ showed that none of these significantly influenced participants' awareness of mobile phone take-back services (Table 6).

Of the 97 (38.8%) who were aware and who gave details about how they knew about take-back services, 42 had seen it on a television advert, 26 on the internet, 15 had heard about it from a friend and 10 had read it in newspapers. Overall, just 12 (4.8%) of all participants stated that they had sold their last old mobile phone to a take-back service.

When the 17 participants who had responded that they had used a take-back service were asked about what their reward for doing so had been, 8 (47%) said 'cash', 3 indicated that they had received a replacement, and the remainder did not give specific detail.

In summary, the key findings of this results and analysis section are as follows. All the participants in this study had mobile phones, but not all had active mobile phones. The majority of the participants had used mobile phones for over 5 years. Most of them had used 3 or 4 mobile phones in the past 5 years with only 10 participants claiming not to have changed their mobile phones in the past 5 years. A total of 15 participants claimed to have used between 7 and 12 mobile phones in the past 5 years. Inquiry into the reasons for changing mobile phones revealed that upgrade and change of model were the main reasons. Also, most had mobile phones on contract. Notably, 86% of participants had mobile phones stock-piled with 45% having 3 or 4 mobile phones stockpiled in their homes.

Various parameters and measures have been tested for a contingency with age, gender and occupation. Age, gender and occupation each had no significant relationship with the frequency of replacing mobile phones, awareness of mobile phone take-back services, opinions on the recycling of mobile phones, and perspectives on the effect of mobile phones on humans and the environment. However, there were significant relationships between age, gender, occupation and willingness to participate in waste mobile phone recycling (the age group 25-29 years, females and skilled workers were more willing) but only gender had a significant relationship with willingness to pay for more environmentally friendly mobile phone (i.e. females were more willing to pay than males).

These results demonstrate that while there is substantial awareness of the impacts of retired mobile phones and a general willingness to recycle, it is by no means universal. There are sizeable gaps to be filled in terms of awareness raising and reducing/removing barriers to people actually operationalizing their inherent willingness to do so. This is particularly evident in the case of the very limited use of waste mobile phone take-back services.

## Conclusion

The use of mobile phones is now commonplace, and it is logical to expect a further increase in the number of mobile phones users in the foreseeable future. The frequency of change of mobile phones is rapid and requires some serious attention in view of their impacts on people and the environment during use and disposal. The main reason for changing phones indicated by participants in the study that it was primarily due to technological advancement (upgrade and change of model). Remaining fashionable and a desire to have a mobile set with longer battery life, were cited as other reasons for the rapid replacement and concurred with findings in studies by Ongondo *et al.* (2011) and Ylä-Mella *et al.* (2015) and run counter to calls for manufacturers to produce sturdier, longer lasting phones.

This study presents a variety of responses to, and perspectives, of hazards of mobile phones, use on people and the environment, which suggest that there is some degree of awareness in the minds of people about the harm of mobile phones, yet they seem unwilling to recycle, reuse or have them repaired. Despite attempts

to increase their use, mobile phone take-back services are relatively uncommon in the UK and most other countries. Mobile phone take-back service providers need to look into popularizing the service they offer to engage more people in mobile phone recycling. AEA (2010) noted that one of the aims of the Integrated Product Policy (IPP) study carried out in 2005/6, was to research and develop incentives and actions that contribute to increased retired phone take-back and that the way forward is to foster better consumer awareness and behaviour. Importantly, a decade after the IPP study and some of the first investigations into mobile phone take-back (e.g. Tanskanen and Butler, 2007), the data presented in this paper demonstrate there are still substantial problems, and its authors assert that these require considerable and concerted action. However, one of the key positive outcomes of the research is to show that people are willing to engage with issues to do with retired mobile phones, particularly first, their inherent willingness to participate in mobile phone recycling and second, to pay more for environmentally friendly phones, even if they do not actually do so.

Based on the results of this research, several observations applicable to the management of retired mobile phones can be made. Retired mobile phones are small in size and light in weight, which makes stock-piling possible and sets particular obstacles for take-back schemes that are less apparent for more bulky electronic goods. It is logical to encourage mobile phone owners to participate in take-back schemes, but the relative underuse of such initiatives suggests that there is still much to be done. Monetary incentives as realization processes for the residual value of retired phones can motivate the owner to participate in take-back services (Li *et al.*, 2012; Ylä-Mella *et al.*, 2015) but in the study reported here, there is little evidence of its effectiveness in raising participation. Other ways forward may include the development of a more efficient formal take-back service network in which targeted publicity can be used to promote the awareness of mobile phone owners (Li *et al.*, 2012) and third party take-back enterprises might emerge as the core approach. The development of free of charge mobile phone collection systems that have collection points conveniently located in high traffic areas such as schools, shopping malls and libraries for users could go some way to maximizing the return of retired mobile phones. There is room for more active engagement in take-back services by mobile phone manufacturers to attempt to remove some of the obstacles and barriers to user take-back and to promote better waste management.

Last, it is evident that there is much scope for further informing the public on the dangers of poor disposal of mobile phones and boosting knowledge in order to move towards providing more effective solutions to the burgeoning environmental problems relating to electronic waste disposal.

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