An Investigation of the Implications and Effectiveness of Producer Responsibility for the Disposal of WEEE.

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EngD Portfolio – full reference list

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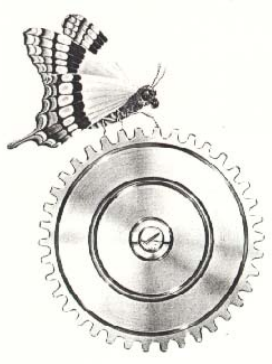

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Chapter 3, Vol. 1

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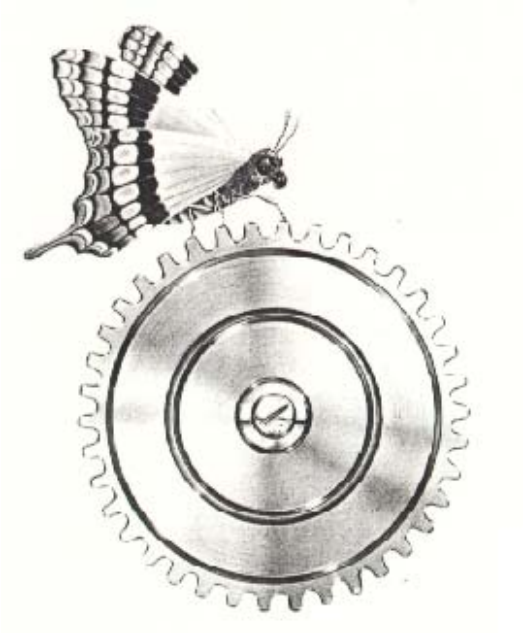

Prospects for Household Appliances

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PROSPECTS FOR HOUSEHOLD APPLIANCES

E-SCOPE

Electronics Industry – Social Considerations of Product End-of life survey

TECHNICAL REPORT

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Abstract

This report presents findings of the most comprehensive investigation into the patterns of use and disposal of household appliances undertaken in the UK. The investigation was conducted using a statistically representative sample of 802 households from 188 locations across the UK, and using 5 focus groups. Research findings reveal:

- *How householders purchase, use and disposal of household appliances.*
- *Quantitative information on product ownership, lifetime, use, and disposal representative of the UK as a whole.*
- *The likely effectiveness of different approaches to addressing the need to reduce WEEE.*

The implications of findings are discussed in the context of product life extension, the development of product resale, recycling and disposal services, and the development of future government policy in these areas. Potentially useful areas of future research are also outlined.

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The City and County of Cardiff
Urban Mines Limited

Foreword

This report presents a study investigating patterns of the use and disposal of household appliances in the UK, forming the third chapter of the first volume of the Research Engineer's project Portfolio (Chapter 3, Vol. 1). The research has been completed as part of the Engineering Doctorate programme in Environmental Technology at Brunel and Surrey Universities. The previous volume in this thesis (Chapter 2, Vol. 1) presented the findings of a similar study investigating the patterns of use and disposal of office equipment by companies in the UK. In next and final chapter (Chapter. 4, Vol. 1), papers written to date as part of the research are presented, including a summary paper on the research presented in this chapter.

The report has been authored jointly with Tim Cooper at the University of Sheffiled, and peer reviewed as part of his Ph.D thesis. A statement of contributions can be found in Section 1.3. An overall summary of the portfolio, including reader's guidelines, is presented in Chapter 1, Vol. 1.

Contents

1. Introduction

The effect that profligate consumerism is having on the state of the global environment is a major contemporary concern. For example, current levels of energy consumption have led to a build up of carbon dioxide within the Earth's atmosphere, which is likely to result in serious climate change through the greenhouse effect. Increased economic output has generally resulted in a growth in waste production (Williams, 1998). Current patterns of economic development cannot be sustained indefinitely without threatening the interests of future generations (inter-generational equity) and impoverished people, particularly those in less industrialised countries (intra-generational equity) (UNDP, 1998).

Inter- and intra-generational equity was a major topic at the 1992 United Nations Conference on Environment and Development (the Rio 'Earth Summit'), one of the largest international conferences ever held, attended by governments from 178 nations (Grub *et al*, 1993). The conference resulted in a series of principles relating to sustainable development (the 'Rio Declaration'), a programme for achieving sustainable development known as Agenda 21 and other agreements such as the Framework Convention on Climate Change. While many of the objectives and agreements made at Rio have not been met, the occasion signified a global recognition of the importance of the environment and development challenge.

At the heart of the environmental dilemma is the perceived sovereignty of the affluent consumer. Although an individual may benefit as additional products are consumed, society as a whole suffers as the quality of the environment diminishes through the cumulative impact of increased consumption. This arises from a failure of the free market to ensure that common resources are used for the benefit of all, the 'tragedy of the commons' described by Hardin (1968). It can also be seen to result from the 'externality effect', through which the side effects of market activity are passed onto society as a whole rather than being borne by the parties responsible (Pigou, 1920).

Regulatory approaches to the environment have, to a limited extent, reduced the growth of pollution and waste. However, they have not influenced the key drivers of environmental impact, the overall quantity of goods produced and consumed. Governments throughout the world are increasingly turning to economic-based policy instruments and consumer information and education in attempting to address problems of market failure.

As the prevention of unnecessary waste has become an important goal of public policy at EU and national government levels, some producers are being made to assume primary responsibility for the recycling and disposal of their waste products at the end of their life spans (such as for batteries, packaging, automobiles, and electrical and electronic products). This new market-based approach to waste policy, known as 'producer responsibility', is intended to create a market feedback mechanism to stimulate a reduction in the quantity and the hazardous content of waste without the need for excessive legislation (Lifset, 1993).

This report presents the findings of a study that investigated the purchase, use and disposal of household appliances by UK households. This waste stream is at present the focus of a draft EU Directive on Waste Electrical and Electronic Equipment (the

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'WEEE Directive'), proposed in July 2000 (COM[2000] 347 – 2000/0158[COD]). It seeks to identify and explain complex issues surrounding product consumption and disposal that previously have received little attention and yet are fundamental to the success of policy initiatives in this area.

The research was undertaken to inform policy-makers, non-government organisations, industry and academia on the nature and importance of consumer behaviour in relation to household appliances. The background to this study is discussed in greater detail below.

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1.1 The need to reduce Waste from Electrical and Electronic Equipment

As the principal background to this research is the perceived need, political and societal, to reduce waste, the current EU initiative requires further introduction. The proposed Directive on Waste Electrical and Electronic Equipment (WEEE) reflects increasing concern over the impact of waste from discarded electrical and electronic equipment on the environment. The Directive is intended to address the increasing quantities of WEEE being generated, the need for appropriate treatment of any hazardous substances it may contain and the potential for increased reuse and recycling. The need for such legislation has been under discussion since the early 1990s (e.g. Roy, 1991; Poll, 1993; ENEA, 1995).

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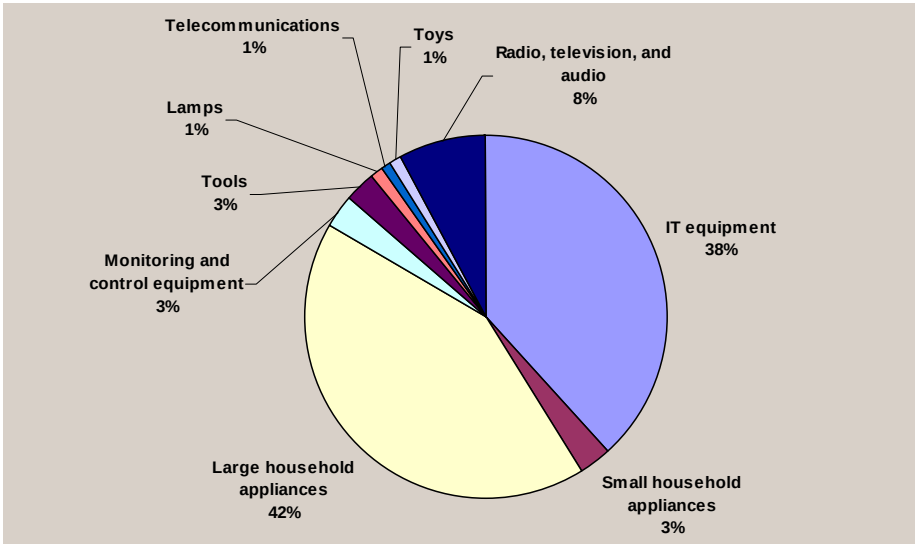
It has previously been estimated that around 12 million items of electrical and electronic equipment reach "end-of-life" each year in the UK (DOE, 1995: 81). Past estimates of the total mass of this waste vary between 0.6-0.9 million tonnes per year (ICER, 1998, 2000; AEA Technology, 1997). Although this is only 1.3-1.7%, by mass, of industrial, commercial, and domestic wastes (DOE, 1995), the waste stream has received attention from policy makers due to its potential toxicity, opportunities for recycling and expected future increase in volume. Mayers and France (1999) and Cooper (2000) have provided insights into problems created by this waste steam and the development of producer responsibility legislation in response.

Figure 1.1: ICER estimate of electrical and electronic waste arisings in the UK (by mass)



Source: ICER, 2000

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According to research by ICER (2000), general household appliances (including large "white" goods such as refrigerators and washing machines) make up the largest proportion of this waste stream at 43% by mass, and telecommunications the smallest at only 1% by mass (Fig. 1.1). Information technology products account for 39% of the waste stream, videos and televisions ("brown" goods) make up 8%, small household appliances and tools each account for 3%, with the balance accounted for by toys, lamps and monitoring equipment.

It has been estimated that approximately 77% of "white goods", 10-11% of "grey goods", and 1% of "brown goods" and telecoms are currently recycled (ICER, 2000). The remaining "end-of-life" electrical and electronic equipment is either sent to landfill or incinerated.

Estimates of the quantity of WEEE arising in the UK have until now been calculated from estimated product life spans, sales volumes and market saturation levels. These estimates do not necessarily reflect actual quantities of discarded household appliances, as they are based on assumptions about purchasing behaviour and rely on disparate, sometimes unpublished, industry data. There is no authoritative data available on the life span of household appliances in Britain and much relevant data is from overseas and out of date (Pennock and Jaeger, 1964; Ruffin and Tippett, 1975; Dahl, 1978; OECD, 1982). Reliable data would be useful in planning and developing more effective approaches to concerns about waste and the respective product take-back, treatment and recycling processes for WEEE.

One of the means by which waste can be reduced is through appliances that last longer. Concern about the effects of what has been termed the 'throwaway society' is long established. Early critics expressed particular concern about problems posed by 'planned obsolescence' (Packard, 1960; Papanek, 1984), although others have responded that obsolescence is the 'engine of technological progress' (Fishman *et al*, 1993) and argued that 'the consumer is the real villain' (Grathwohl, 1978). The potential for improving the design of appliances in order to reduce their environmental impact is well documented (e.g. Mackenzie, 1991; Burall, 1996; Fiksel, 1996). As the debate on sustainable consumption has evolved, interest in the potential for increasing the life span of appliances has grown (Stahel and Jackson, 1993; Cooper, 1994a, 1994b; Heiskanen, 1996; van Hinte, 1997; Kostecki, 1998). This has highlighted a need to address consumer behaviour in addition to product design.

1.2 The effect of consumer and social attitudes and behaviour

In theory, quantities of waste electrical and electronic equipment could be reduced through product design changes such as:

- Design for recycling, to reduce the number of plastic polymers used in new products and thus facilitate recycling at end-of-life.
- Design for disassembly, to reduce disassembly time and ensure hazardous components can be easily removed for treatment.
- Design for repair and future upgrades, to maximise the utility of a product before final disposal.
- Design for durability, to allow for extended product use (Fiksel, 1996).

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The proposed WEEE Directive may eventually lead to the development of new services by producers as they attempt to address WEEE by a variety of means, including:

- Post-sales product support for longer periods, for example by extending product warranties.
- Increased repair and reuse.
- Provision of product take-back, treatment and recycling services.

Consumer and social attitudes and behaviour regarding the acquisition, use and disposal of products are likely to have a major influence on the success or failure of these initiatives. For example, in response to producer responsibility legislation producers may invest additional capital and energy in designing products with greater durability, reduced disassembly time, increased materials quality and reduced materials diversity. If consumers then chose to replace their products prematurely (i.e. while still functioning) and not to return them for recycling (for example, by putting them in bins or skips), producers' efforts would be wasted and the objectives of legislation remain unfulfilled.

There is already evidence to demonstrate the significant influence that consumer behaviour may have on the success of product take-back schemes. In the UK various organisations have completed pilot collection and recycling schemes for electrical and electronic equipment in preparation for producer responsibility legislation (as shown in Table 1.1). Complicated patterns of use and disposal appear to have limited the success of these pilot operations. For example, a project completed by the European Telecommunications and Professional Electronics Industries (ECTEL) group only recovered around 1% by mass of products sold two years previously through retail outlets in the UK and Sweden (ECTEL 1997).[1] A related survey showed that 55% and 47% of people respectively retained their old mobile phones in storage after they had finished using them, in the belief that they still retained some value.

This and other research studies conducted on the disposal of electrical and electronic equipment suggest that people deal with unwanted products in a variety of ways (as shown in Table 1.2). However, these studies were not statistically representative on a large scale and focussed on specific regions, product types or operations.

Some researchers investigating consumer disposal (Boyd and McConocha, 1996) and post-sales behaviour (Harrell and McConocha, 1992) for durable products have similarly identified the existence of specific patterns of behaviour (explained further in Section 2.2). Furthermore, they have argued that these different forms of post-sales behaviour have substantial implications for policy-making, product marketing, product development and product distribution. It is suggested that better understanding of such behaviour could create opportunities to develop products of better value to customers.

Mayers *et al* (1999) have conducted research on the use and disposal of redundant IT equipment by UK companies. In total, 151 companies were investigated using a combined telephone and mailed questionnaire survey method. This study concluded that:

[1] It would have been more appropriate to compare products disposed with those sold 4 years previously (the lifetime of mobile phone and pagers identified in this study) (Section 6.1). Even so, this is a very low rate of recovery.

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Table 1.1: Electronics recycling pilot projects in the UK

Scheme	Location	Project duration and date	Products collected	Coverage	Quantity recovered (tonnes)	% of products discarded [2]	References
ECTEL (European Telecommunications and Professional Electronics Industry)	UK and Sweden	6 months (1997)	Mobile phones	110 retail outlets in the UK	5633(UK) 879 (Sweden)	<1%	ECTEL, 1997
LEEP (Lothian and Edinburgh Environmental Partnership)and EMERG (Electronic Manufacturers Equipment Recycling Group)	Lothian region and Edinburgh	15 months (1996)	Mainly IT and office equipment. Some domestic appliances.	128 workplaces, 5 civic amenity sites	107	<1%	LEEP, 1997
ICER (the Industry Council for Electronic equipment Recycling)	West Sussex and Croydon	19 months (1995 to 1997)	Mainly domestic appliances.	Civic amenity sites, and doorstep collections using grey bags.	27	Approx-imately 2% for region investigated	Information provided by ICER in 1998.
SWAP (Save Waste and Prosper)	Leeds, Bradford, and the Humber	6 months (1997)	Information technology	Larger organisations and companies	17	Not known	SWAP, 1997.

- Very few companies (5%) used IT products for less than two years before replacing them. Given the rapid rate of month-on-month technological development and obsolescence within the IT sector, the commercial market for new technology appears to be relatively constrained.

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- Although 80% of companies disposed of some equipment as waste, most companies also disposed of equipment through routes in which they were reused (such as transfer to employees). It is therefore inappropriate to consider all discarded or redundant IT equipment arising from the commercial sector as waste (Table 1.2).

- There may be opportunities for producers to provide redundant IT disposal services to larger business customers (77% of respondents identified a need for improved services). Future research should investigate the market for such services, including specific market segments (such as the financial services sector, with significantly different disposal needs to other sectors), service pricing, and the effectiveness of different service delivery methods.

Finally, more extensive market and social research has been conducted in the general area of municipal waste recycling (reviewed by Schultz *et al* 1995; Thøgersen, 1996). However no detailed and statistically representative research on the use and disposal of household appliances in the UK could be found. The methodologies used in the studies introduced above are reviewed below (Section 2) in order to explain the development of the methodology in this research.

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[2] Estimated % products collected out of total discarded from commercial and domestic sources. The percentages for the EMERG and ICER trials were calculated using the following data from ICER (1998) - 9.25 kg electronics waste per person p.a., 0.75 m tonnes total waste generated p.a., 70% of total electronics waste from domestic sector (48% accounted for by domestic appliances) - and assumes 50% data/office products are for domestic use and a GB population of 56.75 million (Office for National Statistics, 1996).

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Table 1.2: End-of-life pathways of electronic products in households and businesses

Household end-of-life options	Business end-of-life options
(a) Sell privately second-hand	(a) Transfer or sell to employees
(b) Give to family and friends	(b) Dispose of as waste
(c) Store within the home	(c) Donate to public institutions, charities, and schools
(d) Return to retailers and manufacturers	(d) Sell to second-hand brokers
(e) Take to local authority civic amenity sites as "scrap" for recycling	(e) Return to manufacturers or distributors
(f) Dispose of as waste	(f) Dispose of as waste
	(g) Store in offices or warehouse
Sources: 1. ECTEL (1997) 2. VROM Miniserie (1993) cited in Voute (1993) 3. Information provided in 1998 from research by Domestic and General, Comet and ICER.	Sources: 1. Corporation of London (1996) 2. SWAP (1998) 3. Information provided in 1998 from research by Hewlett-Packard GmbH

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1.3 Research summary

This manuscript is the official technical report for the E-SCOPE (Electronics Industry – Social Considerations of Product End-of-life) project. The aim of the study, as agreed by the project partners, was to gain an understanding of the patterns of use and disposal of household appliances from the consumer perspective in order to evaluate their effective management, and to make information available publicly and to relevant interest groups.

The study focused specifically on the acquisition, use and disposal of household appliances in the United Kingdom. However, the results are of broad interest and relevance, with a variety of potential benefits for consumers, the environment, and commerce (Table 1.3). More specifically, the objectives of this research were to:

1. Investigate the purchase, use and disposal of household appliances from the consumer perspective.
2. Provide quantitative information on product ownership, lifetime, use, and disposal representative of the UK as a whole.
3. Identify the likely effectiveness of different approaches to addressing the need to reduce WEEE.

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Table 1.3: Potential benefits of the E-SCOPE project

Area of contribution	Potential benefits
Consumers / householders	• Better consideration by producers of needs of consumers after sale • • Improved waste collection services and new products • Socially acceptable and efficient take-back schemes • Personal satisfaction through increased recycling • Fewer problems related to waste disposal • Consumer views better addressed in legislation • Information needs relating to product acquisition and disposal identified
Reuse and recycling	• Increased reuse / recycling activity • Less loss of usable products / material through improved disposal behaviour • Waste streams for reuse / recycling markets clearly identified • Efficiency of waste collection increased • • Increased contribution to sustainable development
Industry	• Development of producer responsibility legislation based on sound assumptions • Competitive advantage in product-take-back through improved market understanding • Access to unique and valuable market research information • New perspectives on consumer / end-user view of producer responsibility

Data collection was completed during December 1998 and April 1999. The project was funded with a budget of £37,700, provided by both private commercial sponsors (£13,700) and through landfill tax sponsorship (£24,000). The project involved 12 partners from a wide range of stakeholder groups:

- Two producers (Hewlett-Packard and Philips Electronics)
- A high-street retailer (the Dixons Stores Group)
- Two UK universities (the University of Surrey and Sheffield Hallam University)
- A local authority (the City and County of Cardiff)
- Two waste management organisations (Cleanaway and the Greenbank Trust)
- An electronics recycler (Intex Computers)
- A major warranty support and product insurance company (Domestic & General)
- Two charitable non-governmental organisations (Urban Mines and Save Waste and Prosper).

The project also sub-contracted two research agencies to assist with survey and focus group development and completion:

- Quality Fieldwork Limited (fieldwork specialists)

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- Surrey Social and Market Research, the University of Surrey (project management specialists)

The contributions of the various researchers and agencies involved in the completion of this research have been summarised in Table 1.4. The research itself was carried out *jointly* between the academic partners of the project, Kieren Mayers and Tim Cooper. More specifically, Kieren Mayers's unique contributions to knowledge were the analysis of product ownership and disposal discussed in Sections 4.2, 4.5, 4.6, 4.7.3, 5.1, 5.3, 5.5, 5.6, 5.7.3, 5.7.5-5.7.7, 6.5, 6.7.3 and 7.2.3. Tim Cooper's unique contributions to knowledge were the analysis of issues of product lifetime and repair discussed in Sections 4.3, 4.7.2, 4.7.4, 4.7.6, 5.2, 5.7.2, 6.1-6.4, 6.7.1, 6.7.2 and 7.2.2. Sections completed jointly were 1-3, 4.1, 4.4, 4.7.1, 4.7.5, 5.4, 5.7.1, 5.7.4, 6.6, 7.1, 7.2.1, 7.2.4 and 7.3.

Table 1.4 Research participation

Project aspect	Kieren Mayers	Tim Cooper	Elaine Kerrel (SWAP)	SSMR	Quality Fieldwork
Project management	X	X			
Overall project co-ordination	X				
Management of survey and focus group work				X	X
Survey questionnaire development	X	X		X	X
Completion of household survey					X
Recruitment for focus groups					X
Focus group facilitation		X	X		
Focus group protocol development	X	X	X	X	X
Results analysis	X	X			
Technical report	X	X			
Results dissemination	X	X			

The full methodology and results of the project are provided in the following sections. In Section 2 methodologies used in previous studies are reviewed and useful approaches evaluated with regard to the research conducted. In Section 3 the research methodology used is explained in detail. Sections 4, 5, and 6 present and discuss the results and key findings of the study. The overall conclusions are presented in Section 7.

This is the most comprehensive and detailed investigation of the use and disposal of Waste Electrical and Electronic Equipment undertaken to date in the UK. The findings will be useful for future product design and development, the creation of improved collection, treatment, reuse and recycling services, and the implementation of appropriate UK 'producer responsibility' legislation.[4] The research approach and results are also relevant to other countries, some of which have already implemented such legislation.

[4] The Department of Trade and Industry is using the results of this study to aid its assessment of the proposed WEEE Directive.

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Table 1.3: Potential benefits of the E-SCOPE project¶
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Area of contribution ... [2]

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2. Considerations for methodology development

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Project aspect ... [3]

Relatively little research has been conducted on use and disposal behaviour relating to household appliances. However, many studies have been conducted on the relationships between social behaviour, attitudes and motivational factors in the area of waste management and recycling (as noted in the previous section). In addition, several studies have been conducted on post-sales consumer behaviour to understand better how products are used, maintained, and disposed of within households (Jacoby *et al*, 1977; Hanson, 1980; Box, 1983; Boyd and McConocha, 1996; Harrell and McConocha, 1992; Kollman, 1992). Recent studies involving life span data (e.g. AEA Technology, 1997; ICER, 2000) have been based on sales estimates and designed to calculate waste volumes rather than explain attitudes and behaviour.

Whereas the background to the research is discussed in the previous section, including an overview of existing knowledge on the use and disposal of household appliances, this section focuses on the development of an appropriate research methodology. The above studies are reviewed below both in terms of the methodology used and the conclusions reached. Past literature indicated that both quantitative and qualitative approaches may be employed, either separately or in combination, in researching the use and disposal of household appliances:

These general approaches are outlined in further detail in Sections 2.1 and 2.2 and a summary is provided in Section 2.3.

2.1 Quantitative survey research

The quantitative survey research identified was mainly concerned with the relationship between householder attitudes and behaviour with regard to the recycling of waste. This type of study was used to determine the extent to which householders' attitudes to either recycling or environmental issues related to, and affected, their recycling behaviour.

One such quantitative study was conducted through a mail survey of 197 households in two different communities in Illinois, USA (Vining and Ebreo, 1990). Differences between the attitudes and behaviour of "recyclers" and "non-recyclers" and the effectiveness of different motivators on increasing recycling rates among non-recyclers were examined. Using this methodology the study found that recyclers were better informed and more knowledgeable about materials that are recyclable and local recycling facilities than non-recyclers. It concluded that recycling among non-recyclers could be increased through increased education, improving the convenience of recycling arrangements, or the use of economic incentives such as charges on waste disposal.

A similar study was conducted of 748 households in 1987 in New York, using face-to-face interviews to investigate the different waste management service requirements of "recyclers" and "disposers" (Lansana, 1992). Using a quantitative survey method, this study found that householders preferred kerbside recycling schemes due to increased convenience, but also concluded that distinct recycling programmes and information strategies should be developed to address the specific needs of different communities.

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Another study in the area of consumer behaviour research used a mail survey to investigate the product disposal tendencies of consumers (Harrell and McConocha, 1992). This study was undertaken in a major mid-West American town, using a sample of 811 participants selected systematically[1] from the residential pages of a local telephone directory. The authors used the results to classify respondents into either "planner disposers" or "spontaneous disposers" and evaluated their behaviour with respect to keeping, throwing away, selling, deducting (donating for tax-deduction purposes), donating, and passing to subsequent users. The paper concluded that further research into these different behaviour patterns could be used to evaluate their implications for logistics management, marketing, tax policy, charitable organisations, macroeconomics and the environment. It also suggested that the implications for the disposal of durable and semi-durable products (which potentially still function) are distinctly different from those for consumable wastes such as packaging.

In the field of electronics recycling, two studies have been examined. The first was conducted on mobile phone users in the UK and Sweden. In the UK, 500 individuals entering or leaving mobile phone retail outlets were interviewed, while in Sweden 203 random telephone interviews were conducted with cellular phone users. The aim was to determine consumer attitudes and behaviour relating to the disposal of end-of-life telephones (ECTEL, 1997). This study concluded that without public awareness, the success of product take-back schemes would be limited, as householders would be less likely to return products. In addition, it found that an important barrier to returning electronic products for recycling was their perceived value. The second study, an unpublished industry survey in the UK investigating the use and disposal of televisions and videos, was conducted by mail on 1,632 individuals who had taken out an extended warranty on their new products.[2] One significant finding of this study was that around 10% of the televisions and videos owned by householders were held in storage.

In each of these studies, the degree to which findings were statistically representative on a national scale was not described and in some cases the sample was very small. In order better to understand the use and disposal of household appliances in respect of the proposed WEEE Directive, the E-SCOPE study is statistically representative of the UK population (as described in Section 3).

The importance of understanding the relationship between attitudes and behaviour in relation to environmental concerns is recognised (Ölander and Thøgersen, 1995). Quantitative survey research can clearly be useful in investigating attitude and behaviour relationships in waste management. However, the results of such studies should be interpreted with care, as householder's perceptions of their behaviour in any given circumstance may not reflect their actual behaviour and further research may be required to understand the underlying reasons behind different attitudes and behaviour. In addition, attitudes may differ depending on the degree of specificity used in survey questions and the context within which the survey is conducted.

Motivational research is commonly used in quantitative waste management research to investigate the effectiveness of different policy interventions in motivating recycling

[1] A systematically selected sample is non-randomly selected using a predefined selection sequence, e.g. every tenth member of a sample. It is not advisable to use such a method where a sample is likely to display periodicity.

[2] Information provided in 1998 by Domestic and General, Comet and the Industry Council for Electronic Equipment Recycling.

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behaviour (Thørgesen, 1996). For example, a study of 309 households was conducted in Utah, USA, investigating the effect of different information strategies and motivators on public participation in a new kerb-side recycling programme (Werner *et al*, 1995). Four streets with similar socio-economic profiles were each given different levels of treatment to encourage participation:

- Flyers only
- Telephone calls and flyers
- Telephone, flyers, and face to face contact
- Telephone, flyers, face-to-face contact, and signature commitment.

Responses were observed directly through the level of participation in the scheme (measured by mass recycled). In addition, a questionnaire was administered to assess householder attitudes and opinions in relation to the introduction of the service. The study found that respondents making written commitments were most likely to increase their level of recycling. This is important, as attitude is often investigated as a determinant of recycling behaviour without reference to evidence of level of commitment.

Another study, a survey of 257 randomly selected individuals, was conducted using telephone interviews in the Fairfax County area of Virginia, USA in 1991. This study relied on self-reported activities and behaviour, but also combined quantitative survey approaches to determine the respondents' attitudes and particular social environment. Results were used to test a simple hypothetical social model of the combined influence of attitudes and external factors on recycling behaviour (Guagnano, 1995). It was found that access to recycling bins and awareness of the social and environmental consequences of recycling could help to stimulate increased levels of recycling. The study concluded that the use of such models in analysis of recycling policies would be helpful in clarifying the likely influence of any planned incentives on recycling behaviour.

Data collected from self-reported household behaviour is collected indirectly and so may be regarded as a form of secondary data. As such, great care must be taken to minimise any inaccuracies in reporting, and the ability of the respondents to report on their behaviour has to be carefully assessed. Although primary data collected and observed directly by the researcher is often preferable, use of self-reporting can be very useful when primary data is either unavailable or unobtainable.

Such motivational studies enable household behaviour in response to different recycling programme interventions to be studied. However Schultz *et al* (1995), in a comprehensive overview of 23 motivational studies, concludes that the effectiveness of research of this nature is at present limited. Their paper argues that commonly only single variable assessments of recycling behaviour are used (such as quantities of paper recycled), and consequently important influences such as the external environment in which recycling programmes are based and the characteristics of populations under study are often ignored.

Few studies have been undertaken on the life span of household goods. Early American studies were based on the construction of actuarial tables using information collected from households as part of a large national census survey (Pennock and Jaeger, 1964; Ruffin and Tippett, 1975). Households were asked to identify goods that they owned or had recently discarded, whether the item had been acquired new or used, and the year in which it had been acquired. This enabled data on the service life of appliances to be

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calculated and trends analysed. Other studies have been based on laboratory testing on equipment under conditions of accelerated use, although such tests are often designed to identify minimum goals for product durability rather than determine the technical life of the item (OECD, 1982).

2.2 Qualitative research

Qualitative research is typically used to examine behaviour through narrative accounts, as opposed to quantitative survey and motivational methods that are used to identify statistically significant relationships or trends. Qualitative research is especially useful when little is known about the situation under study.

One recent qualitative research study on consumer behaviour investigated the use and disposal of products within households. In order to explore a hypothesised model of consumer behaviour (described as the "inventory ownership cycle"), 130 individuals were interviewed (120 undergraduates and 10 non-student adults). Descriptive "anecdotes" were formulated to illustrate and identify evidence for the existence of certain forms of consumer behaviour, which included information gathering preceding product acquisition, possession, storage, maintenance, reuse, disposition and transportation (Boyd and McConocha, 1996). It highlighted the fact that different householders do not display the same behaviour, and that people derive value from products beyond their physical function and operation. The authors concluded that consideration of post-sales consumer behaviour could help manufacturers develop products and services of better value for consumers and society as a whole.

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In the areas of waste management and recycling, qualitative investigations have also been used to investigate complex patterns of product reuse and waste reduction. For example, 100 households in Hermosillo, a middle-sized city in North-West Mexico, were interviewed using samples or photographs of products as visual aids (Corral-Verdugo, 1996). This helped to focus and prompt descriptive responses. The findings, to be interpreted in the context of a lesser-developed country, suggested that both situational and demographic factors influence conservation behaviour. Reuse behaviour was found to be an altogether more inconspicuous and inclusive behaviour than recycling: clothing, cardboard and paper were almost all reused, with very little materially recycled. Access to storage space did not appear to influence reuse or recycling behaviour. There was evidence that higher income households recycled less material, and access to a television appeared to reduce reuse and recycling behaviour, perhaps due to the promotion of consumer culture within the media.

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The use of visual aids in this way was particularly suitable for exploring product disposal in lesser-developed countries due to the extent of reuse of waste materials which is difficult to observe directly. It is similarly likely to be useful in investigating the patterns of use and disposal of household appliances in more developed countries when reuse is evident.

Qualitative research can be used to provide insight into the existence of particular attitudes and behaviour, and the likely reasons and motivators behind their existence. It may be particularly effective in exploring new areas of possible research, and enhance understanding of findings from quantitative surveys and motivational research. However

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it is limited in that it does not provide evidence of the extent of particular patterns of disposal behaviour or attitudes.

2.3 Useful methodologies

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The combination of research approaches described above could provide in-depth insight into different aspects of householder attitudes and behaviour regarding the use and disposal of appliances. A good example of such research within waste management is a study conducted following a public outreach programme in East Harlem in New York (Margai, 1997). This used a combination of two focus groups followed by 181 interviews with randomly selected households. Using this combination of quantitative and qualitative methods, it was concluded that people needed to be educated on the benefits of recycling if they were to recycle more and that householders were not as successful at waste prevention as they were at recycling. It was also suggested that recycling and waste prevention involve fundamentally different kinds of behaviour and, indeed, that waste prevention may be interpreted as a form of environmentally conscious consumption.

Overall, from a review of available literature it can be concluded that:

- Among the various research methods used in the study of household consumption and disposal behaviour, interviews are especially common. Interview approaches may be considered effective due to the interaction between the interviewee or participants and the interviewer or facilitator respectively, allowing clarifications and follow-up queries to be made.

- Various approaches have been used in the investigation of "difficult to observe" household behaviour. These include the use of visual aids to prompt and stimulate relevant answers, and self-reporting of household activities.

- A good balance of quantitative and qualitative information can be useful in gaining a full understanding of household behaviour, as the effects of different patterns of behaviour can be quantified and the reasons for their occurrence analysed. A combination of research techniques could be used in attaining this balance.

In Section 3, having evaluated various methodological approaches, the methodology chosen for this research is discussed in detail.

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3. Research methodology

This research utilised a combination of approaches used in quantitative survey and qualitative research in order to facilitate increased understanding of household attitudes and behaviour.

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The first part of the research was conducted through a series of interviews on 802 householders. This included quantitative survey research into attitudes relating to the purchase, ownership, use and disposal of household appliances. It also investigated actual household behaviour through self-reporting of product ownership, use and disposal. As the use and disposal of household appliances is both complex and occurs over extended periods of time, self-reporting was essential in quantifying these activities.

In the second part of the research, a series of five focus groups was held to explore specific issues of interest in greater depth. Focus group research involves conducting a facilitated discussion with groups of respondents, using open-ended questions to probe and explore a range of issues in depth. As explained in Section 2, the use of such qualitative research can provide insights that assist the interpretation of results from quantitative survey research. It was decided not to start with focus groups, on the grounds that some qualitative research had already been conducted in product use and disposal (described in Section 2.3) and because its primary purpose was to supplement and illustrate the quantitative data.

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Samples for both the household survey and focus groups were selected using a stratified quota sampling method (Parasuraman, 1991).[1] Samples were stratified according to socio-economic status, sex, age and ethnicity to ensure that they were proportionately representative of the UK population. The use of quota sampling, as opposed to random or systematic sampling, was essential in preventing a distortion of sample stratification by refusals, and also in reducing non-sampling errors[2] (Section 3.4 below discusses measures taken to ensure the sample used in the survey was statistically representative).

The use of household socio-economic status is appropriate, as previous research has shown that social and economic factors are key determinants of environmentally related behaviour (Greenbaum, 1995: 140-141). In addition, with respect to the purchase and ownership of household appliances, socio-economic status is of interest.

Fifteen different product categories were selected in order to investigate a range of household appliances (see Appendix 4 for the product identification chart used):

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- Electric cookers (all types)
- Microwave ovens (all types)
- Refrigerators and freezers (all types)
- Washing machines, dishwashers and tumble dryers (all types)
- Vacuum cleaners and carpet cleaners (all types including mini)
- Small work or personal care appliances (including kitchen appliances, irons, clocks, hair dryers, shavers, deep fat fryers and sewing machines)

[1] Stratified sampling is where a selected sample is designed to have the same demographic proportions as (and is representative of) the population under study. Quota sampling is a method by which a sample is selected non-randomly to fit the predetermined sample requirements.

[2] This approach was formulated and recommended by the project's survey management and fieldwork agents (see Section 1).

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- Hi-fi and stereo (including portables, excluding personal stereos)
- Radios, and personal radios, stereos and CDs (all types)
- Televisions (all types)
- Video equipment (including camcorders)
- Telephones, faxes and answer machines (excluding mobiles)
- Mobile phones and pagers (all types)
- Computers and peripherals (excluding games consoles, including portables and scanners etc.)
- Toys (including games consoles and electronic pianos, excluding battery only toys)
- Home and garden tools (including garden and DIY tools)

These product categories allowed consideration of the following classifications:

- Legal classification: To enable a comparison with relevant categories listed in the proposed EU Directive on WEEE.[3]
- Physical classification: To include a comprehensive range of large and small appliances.
- Technical and functional classification: To include a comprehensive range of product technologies and products with different functions and applications.

Estimated average masses for each product category (Appendix 13) were used to calculate the total mass of appliances in tonnes discarded by UK households annually between 1993 and 1998 (Appendix 14). Mass is typically used to measure quantities in waste management. Household appliances vary considerably in size, however, and results based on mass will therefore show different patterns when compared with the number of items discarded. For example, large white goods might account for a high share of waste by mass compared with small work or personal care appliances, whereas by number of units the reverse might be true. This is important because the environmental impact of waste encompasses more than the disposal of products in landfill, including problems not necessarily proportional to product mass, such as product distribution, shopping and the use of toxic materials. Product disposal data is also analysed by frequency (i.e. number of units discarded annually) (Appendix 14). This enables comparative analysis relating to product ownership, use and disposal.

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In Sections 3.1 and 3.2, the household survey and focus group methods used are described. The effectiveness of this research methodology is revised in Section 3.3 and the statistical methods used are explained in Section 3.4. Finally, a summary of the research methods used is provided in Section 3.5.

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3.1 Survey research methodology

In this section the methods used are described in detail.

3.1.1 Survey method

The household survey involved in-depth face-to-face interviews with 802 householders in the UK, each lasting for 45 minutes on average. These were conducted in the first two weeks of December 1998. The survey protocol and questionnaire used in these interviews was developed in a series of stages:

[3] The draft Directive includes: large household appliances; small household appliances; IT and telecommunications equipment; consumer equipment; lighting equipment; electrical and electronic tools; toys; medical equipment systems; monitoring and control instruments; automatic dispensers.

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1. Initial drafting

- initial drafting of questionnaire as a basis for development
- revision of draft questionnaire following review by project partners

2. Pilot survey

- development of questionnaire format and further revision of survey questions
- testing of questionnaire in pilot survey

3. Main survey

- final questionnaire developed utilising feedback from the pilot study
- user instructions included, questions confirmed and final editing

A pilot survey or "pre-test" was used to test the effectiveness of the chosen methodology and questionnaire. This initial investigation was conducted on 30 homes in mid-October 1998 in 3 different areas of the UK (Liverpool, Ilford and Halesowen). The survey pre-test was important in the verification and refinement of the methodology used and in the development and finalisation of the questionnaire (summarised in Table 3.1). It also ensured that sufficient time was allowed for the interview in order to reduce the risk of unreliable data through observer error.

Table 3.1: Evaluation of the household survey pre-test

Factor	Lessons from the pre-test
Visual aids	Extremely effective in prompting and encouraging a wealth of in-depth quantitative data on patterns of appliance ownership and disposal. Appropriate use of colour and legible text and images required on visual aids for the visually impaired.
Participation	High, majority of participants completed survey in full. Prize incentives effective in encouraging participation and reducing non-response rate to individual questions (prize was conditional on completion of questionnaire).
Questionnaire	Counting instructions included for interviewers to ensure consistent data. Appropriate wording of questions essential to avoid confusion, leading questions, and non or neutral responses (e.g. don't know'). Additional "other" responses included in multiple response questions.
Project letter	Use of an official project explanation on headed paper encouraged confidence in the legitimacy of the study.

The final questionnaire used in the survey (shown in Appendix 3) was divided into five main sections, covering:

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- Attitudes to the environment and material well-being
- The purchase and use of household appliances
- The disposal of household appliances
- Future demand for products designed for extended lifetimes, and for improved household appliance disposal services
- Demographic information.

The final questionnaire included:

- 17 quantitative survey attitudinal and behavioural questions with multiple response answers.
- 23 quantitative questions relying on self-reporting of current product ownership and disposal for up to five years previously.
- 10 general demographic questions.

As discussed in Section 2.2, self-reporting can be used effectively as a means of observing household disposal and recycling behaviour (Guagnano, 1995). Due to their diverse and detailed nature, questions were posed using a variety of visual aids to prompt appropriate levels of response. As discussed in Section 2.3, the use of visual aids has been used effectively to evaluate patterns of household reuse (Corral-Verdugo, 1996). Visual aids included multiple response cards and the use of pictorial classifications of product types (included in Appendix 4). These picture cards enabled very detailed information to be gathered on self-reported behaviour for different product types within a short space of time. For example, it was possible to collect 195 different pieces of data on the disposal of 15 product categories via 13 different disposal routes in less than five minutes.

3.1.2 Sampling method

Householders were selected for the survey on a "door-to-door" basis across the UK by around eighty field researchers, each given responsibility for finding and interviewing ten householders in designated areas "to quota" (the quota specification sheet used is shown in Appendix 6). Each householder was offered free entry into a prize draw to encourage participation. If the response was positive, the in-house interview proceeded immediately. Measures were taken to ensure respondents were confident in the legitimacy of the study and integrity of the researchers which included:

- The use of an official letter stating involvement and sponsorship of all project partners (see example included in Appendix 7).

- The use of independent professional field workers to guide respondents through the survey questions and prompt responses.

- The use of field researchers trained and operating under the Market Research Society Interviewer Quality Control Scheme, and with official identification.

- Confirmation that the address and contact details of respondents would not be passed on to third parties (not included in Appendices).

- Provision of information on the project in the cover letter (included in Appendix 11), and on the market research agency used in the form of a leaflet (not included here).

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- Use of colour printed and laminated visual aids during the course of the interview.

The 802 households surveyed were interviewed in 188 city, town and village locations (listed in Appendix 8). The quota specification used resulted in a sample that was demographically representative of the UK as a whole (Table 3.2). In the development of this sampling strategy, the UK Department of Trade and Industry was approached to ensure that the sample could be considered broadly representative of the UK for the purposes of regulatory impact assessment. Its conclusion was that the sample would be representative of the UK as a whole (although not of specific individual regions).

Table 3.2: Household survey sample compared to quota specification and UK population

	Sample result	**Minimum quota**	**UK population**
Gender			
Male	44.8%	4 / 10 (40%)	49.0% †
Female	55.2%	4 / 10 (40%)	51.0% †
Age			
16-34	35.3%	3 / 10 (30%)	34.8% (ages 15-34) †
35-54	41.8%	3 / 10 (30%)	39.9% (ages 35-59) †
55+	22.9%	2 / 10 (20%)	25.3% (ages 59+) †
Socio-Economic Grouping			
AB	23.6%	2 / 10 (20%)	20.8%†
C1C2	51.8%	4 / 10 (40%)	49.4%†
DE	24.8%	2 / 10 (20%)	29.8%†
Ethnic grouping			
Non-white	7.2%λ	1 / 10 (10%)	6.2% †

† Source: Advertising Association (1999).
λ The minimum sample quota for ethnic grouping was not met. This was due to the uneven distribution of ethnic groupings across the UK, making sampling problematic. However, the sample result was seen as acceptable, being very close to the percentage of non-whites in the UK population overall.

3.2 Focus group research methodology

As above, in this section the focus group research methods used are described in detail.

3.2.1 Focus group method

The household survey was followed by a series of five focus groups, each lasting around two hours, which were used to explore householder attitudes and behaviour in greater depth at a qualitative level. As discussed in Section 2.3 above, focus groups can be used effectively in community-level waste management research (Margai, 1997).

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A focus group discussion schedule was developed with a similar structure to the questionnaire used for the household survey. There were ten open-ended questions (included in Appendix 5).

The focus group questions covered:

- Recent experience with products and product life spans
- Product replacement
- Products discarded while still functioning
- Disposal route preferences
- Attitudes to reused parts and second-hand products

These were based on a sequence designed to progress the discussion logically and with maximum participation (Krueger, 1994). A "practice run" was conducted at Sheffield Hallam University, which was used to refine the facilitators' approach and the focus group schedule.

The responses of participants were recorded in full on tape, which was subsequently transcribed, and with the aid of hand-written notes taken by assistants to the facilitators during the focus group discussions. Quotations used were taken *verbatim* from the transcripts.

3.2.2 Sampling method

Stratified quota sampling was again used in the sample selection for the focus group research (Table 3.3).

Table 3.3: Focus group quota specification compared to UK population

	Quota	**UK population**
Gender		
Male	Minimum 4 / 10 (40%)	49.0% †
Female	Minimum 4 / 10 (40%)	51.0% †
Age		
16-24	Minimum 1 / 10 (10%)	15.1% (ages 15-24) †
25-44	Minimum 2 / 10 (20%)	37.1% †
45-64	Minimum 2 / 10 (20%)	28.3% †
65+	Maximum 3 / 10 (30%)	19.5% †
Socio-Economic Grouping (required for South Wales groups only)		
AB	Minimum 1 / 10 (10%)	20.8%†
C1	Minimum 2/ 10 (20%)	27.5%†
C2	As they come	21.9%†
D	As they come	18.2%†
E	Maximum 2 / 10 (20%)	11.6%†

† Source: Advertising Association (1999).

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The sample obtained met the required quota. However, a different procedure was used to that in the household survey. Three of the five focus groups were selected to explore any differences between householders of different socio-economic groups (AB, C1C2D, and E). These focus groups were held in Sheffield (to reduce unnecessary travel and accommodation costs of the facilitator). The remaining two focus groups were selected to explore any differences between urban and rural (remote) dwellers. These were held in Cardiff (as an urban location) and Porth (as a remote / rural location) in South Wales (an area of particular interest to one of the project partners). The choice of these locations was adequate for the purposes of the study.

Samples were stratified according to age and gender, and, in the South Wales groups, socio-economic status. Ten participants were recruited "to quota" for each group (the quota specifications are included in Appendices 9 and 10). These were recruited from high street or main shopping areas by field researchers in each location. In order to encourage attendance an incentive of £20 per participant was offered (for receipt only on completion of the focus group). Measures were again taken to encourage participants to be confident in the legitimacy of the study and integrity of the recruiters and facilitators:

- The use of an official brochure describing the E-SCOPE project in detail (included in Appendix 11).

- The use of qualified field researchers trained and operating under the Market Research Society Interviewer Quality Control Scheme, and with official identification, to:
  - Recruit participants
  - Make arrangements for participants to attend the focus group at the agreed time
  - Introduce participants to the focus group facilitator.

- The use of experienced focus group facilitators to guide participants through the discussion topics.

- Scheduling of focus groups such that participants with jobs or with childcare responsibilities could attend (e.g. late afternoon/early evening).

- The use of well-equipped facilities (hotels in South Wales, and Sheffield Hallam University), and the provision of drinks and a buffet for the comfort and convenience of participants.

- Provision of free taxis to those limited in mobility due to personal circumstances.

- Signed confirmation that the address and contact details of respondents would not be passed on to third parties.

- Provision of information on the project in the cover letter (included in Appendix 11), and on the market research agency used (Quality Fieldwork) in the form of a leaflet (not included here).

- Use of colour printed visual aids during the course of the focus group.

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Hand written notes were taken on the sequence of speakers and the main content of their comments to enable accurate transcripts to be prepared from the audio-tapes. (resources available were insufficient for the use of video cameras, which make preparation of transcripts easier in terms of linking comments to individual participants).

3.3 The combination of research methods

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Combining the research methods added to the quality of the findings. Quantitative data from the survey questionnaire demonstrated the prevalence of different attitudes and behaviour, but was less helpful for understanding the underlying reasons or causes. Qualitative research using focus groups proved useful in exploring people's attitudes and explaining their behaviour.

For example, the quantitative research revealed a degree of dissatisfaction about product life spans, while the statement below from a focus group participant provides insights into the complexity of people's expectations regarding product life:

> *"I don't think they ever last as long as you'd like... When you buy something, obviously you want to get the maximum amount of use out of it and whenever it goes wrong - even if it's after a good length of time - you always want it to last longer"* - Roger, age 52, telecommunications engineer

An example relating to mobile phones further reveals the benefit of combining research methods. One focus group comment was as follows:

> *"I bought a mobile phone. I bought it especially for the wife, as an emergency measure. I expect it to last forever because we don't use it very often."* – Malcolm, age 56, retired factory foreman

The quantitative survey showed that, on average, only 1 in 2 households owned a mobile phone and that around 1 in 3 owners were dissatisfied with the lifetime of mobile phones. It could thus be inferred that a substantial proportion of householders are unhappy with the current rate of product obsolescence for mobile phones because they only require basic product functionality. This suggests that there may be scope for the development of "emergency communications" products.

3.4 Statistical methods

It was important to ensure a large enough sample was selected in order that the results of the household survey were statistically representative of UK householders. The guideline applied in this study was the degree of confidence and precision commonly used in UK government polls, confirmed as statistically representative for policy research by the Department of Trade and Industry (DTI).[4] In these studies, the minimum sample size required is that needed to ensure with 95% confidence that any sample result will lie within ±3% of the result that would be found for the total UK population.[5]

[4] Private correspondence with the DTI.

[5] This is achieved assuming a population proportion of 50%, corresponding to the point of greatest sample variability according to binomial statistics (as shown in Appendix 1).

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Minimum sample size can be determined using binomial statistics (Churchill, 1996: 532-559; Parasuraman, 1991: 494-503). Using binomial statistics, it was calculated that a minimum sample size of 1,070 would be needed to achieve the desired 95% confidence limits of ±3% (example calculations given in Appendix 1). Given resource limitations, a sample size was selected at 800, giving 95% confidence limits of ± 3.5%. This was then stratified to represent UK demographics and the sample selected by quota.

National statistics on waste volumes were calculated from the survey data using a total UK population in Spring 1998 of 24,209,000 according to Government data (Office for National Statistics, 1999).

Survey results were tested and, where appropriate, compared for statistically significant differences. Statistical comparisons were made using simple Chi^2 tests for one variable factor and contingency tables (an expansion of the Chi^2 method) for tests involving more than one variable factor. Both measures can be used to test for statistically significant differences between an observed population distribution against an expected population distribution:

> *"A measure of the discrepancy existing between observed and expected frequencies is supplied by the statistic χ^2 (read chi-square)"* – Spiegel 1972: 201

For example, a Chi^2 test could be used to investigate whether there are statistically significant differences between the number of computers owned by different age groups in a population compared with expected frequencies or probabilities assuming that age does not affect ownership. Degrees of freedom must also be calculated in order to determine the statistical significance of a Chi^2 result using the appropriate statistical tables (White *et al*, 1979: 17-18). Significance tests relating to product life were undertaken using the SPSS statistical package, whereas others were calculated by hand.

The following standard statistical notation has been used below to describe the statistical significance of any tests conducted:

N.S.	No significant differences found
*	Significant difference found at the 95% level (between 1% and 5% chance that differences are due to random sample variation)
**	Significant difference found at the 99% level (between 0.1% and 1% chance that differences are due to random sample variation)
***	Significant difference found at the 99.9% confidence level or above (less than 0.1% chance that differences are due to random sample variation)

The equations used in the above calculations are provided in Appendix 1 and a worked example of the use of the Chi^2 method is presented in Appendix 12.

3.5 Research methodology - summary

The methods used in this research involved household interviews and focus groups. The survey questionnaire was developed in various stages including initial drafting, piloting and pre-testing, and development of the final household survey protocol. Similarly, the focus group protocol was developed in several stages, including a practice run at Sheffield Hallam University.

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The survey questionnaire was divided into five main sections, including questions on relevant householder attitudes, appliance ownership and use, appliance disposal, future products and services, and demographic information. The survey relied on self-reporting of aspects, such as disposal behaviour and product ownership, and used visual aids to focus respondents' answers. Self-reporting was used because respondents had the best knowledge of their own product ownership and disposal behaviour, over periods of time too long to be directly observed (i.e. five years). The use of independent field workers minimised the possibility of unreliable data through observer bias.

The focus group protocol used "open-ended" questions relating to those in the survey questionnaire and designed to increase understanding of people's attitudes and behaviour. Focus group discussions were transcribed in full and relevant quotes taken *verbatim* for use in qualitative analysis.

The combination of approaches in quantifying and exploring household attitudes and behaviour helped to build a better understanding of the purchase, use and disposal of household appliances in the UK.

For both the household survey and focus groups, samples were selected using quota sampling and sample stratification to represent the demographics of the UK population. Incentives, including prizes or monetary rewards, good quality stationery, accredited fieldworkers, and experienced focus group facilitators were used to encourage adequate participation and responses throughout. In total 802 households were surveyed from 188 locations across the UK, and 50 people participated in a series of five focus groups held in Sheffield and South Wales. The sample size used in the household survey was selected to give 95% confidence limits of ±3.5%, slightly less than the sample size required to be statistically representative at the level of confidence of a government poll (95% confidence limits of ±3%), due to limited resources.

In determining the statistical significance of the results of the quantitative study, Chi^2 and contingency tests were used. This was particularly suitable as all of the results were recorded as frequency data, from which observed and expected results could be calculated.

In the following sections (Section 4 to 6), the results of research are presented and discussed in terms of:

- Product ownership and use
- Product disposal
- New product and service development.

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Table 1.1: Electronics recycling pilot projects in the UK

Scheme	Location	Project duration and date	Products collected	Coverage	Quantity recovered (tonnes)	% of products discarded [1]	References
ECTEL (European Telecommunications and Professional Electronics Industry)	UK and Sweden	6 months (1997)	Mobile phones	110 retail outlets in the UK	5633(UK) 879 (Sweden)	<1%	ECTEL, 1997
LEEP (Lothian and Edinburgh Environmental Partnership)and EMERG (Electronic Manufacturers Equipment Recycling Group)	Lothian region and Edinburgh	15 months (1996)	Mainly IT and office equipment. Some domestic appliances.	128 workplaces, 5 civic amenity sites	107	<1%	LEEP, 1997
ICER (the Industry Council for Electronic equipment Recycling)	West Sussex and Croydon	19 months (1995 to 1997)	Mainly domestic appliances.	Civic amenity sites, and doorstep collections using grey bags.	27	Approx-imately 2%	Information provided by ICER in 1998.
SWAP (Save Waste and Prosper)	Leeds, Bradford, and the Humber	6 months (1997)	Information technology	Larger organisations and companies	17	Not known	SWAP, 1997.

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Table 1.3: Potential benefits of the E-SCOPE project

Area of contribution	Potential benefits
Consumers / householders	Better consideration by producers of needs of consumers after sale Improved waste collection services and new products Socially acceptable and efficient take-back schemes Personal satisfaction through increased recycling Fewer problems related to waste disposal Consumer views better addressed in legislation Information needs relating to product acquisition and disposal identified
Reuse and recycling	Increased reuse / recycling activity Less loss of usable products / material through improved disposal behaviour Waste streams for reuse / recycling markets clearly identified Efficiency of waste collection increased

[1] Estimated % products collected out of total discarded from commercial and domestic sources. The percentages for the EMERG and ICER trials were calculated using the following data from ICER (1998) - 9.25 kg electronics waste per person p.a., 0.75 m tonnes total waste generated p.a., 70% of total electronics waste from domestic sector (48% accounted for by domestic appliances) - and assumes 50% data/office products are for domestic use and a GB population of 56.75 million (Office for National Statistics, 1996).

	Increased contribution to sustainable development
Industry	Development of producer responsibility legislation based on sound assumptions Competitive advantage in product-take-back through improved market understanding Access to unique and valuable market research information New perspectives on consumer / end-user view of producer responsibility

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Table 1.4 Research participation

Project aspect	**Kieren Mayers**	**Tim Cooper**	**Elaine Kerrel (SWAP)**	**SSMR**	**Quality Fieldwork**
Project management	X	X			
Overall project co-ordination	X				
Management of survey and focus group work				X	X
Survey questionnaire development	X	X		X	X
Completion of household survey					X
Recruitment for focus groups					X
Focus group facilitation		X	X		
Focus group protocol development	X	X	X	X	X
Results analysis	X	X			
Technical report	X	X			
Results dissemination	X	X			

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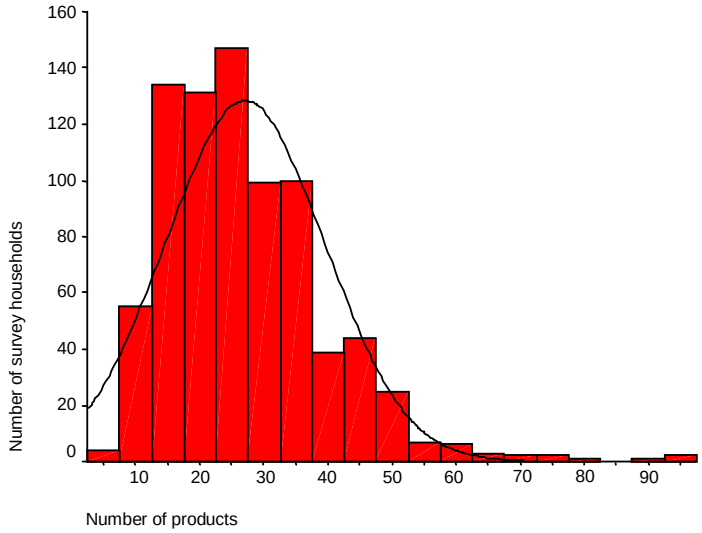
4. Results and discussion: product ownership and use

In this section, results and key findings are presented relating to the ownership and use of household appliances. This includes results on patterns of appliance ownership, age, storage, repair, reuse and rental. In addition comparisons are made by investigating differences between product type and age, socio-economic status and attitude to material wealth.

4.1 The current stock of household appliances

Respondents identified a median of 25 products in their homes, including products in use and in storage, with an inter-quartile range of 16 (50% of households owning between 18 and 34 products). As the mean was 27 products, the number of products owned was found to follow a positively skewed distribution (Fig. 4.1).

Figure 4.1: Number of appliances per UK household, 1998



As could be expected, small work or personal care appliances were found to be the most common type of household appliance, with an median of around six products per household. Large white goods and home and garden tools were also relatively common, with around three per household in both categories. Products subject to technological innovation, such as mobile phones and pagers, and computers and peripherals were less common, each owned by around 60% of households (Table 4.1).

The data suggests that, on average, each household increased its ownership of products by around 60% over the five-year period from 1993 to 1998 (Table 4.2).[1] Increased ownership of mobile phones and pagers, computers and peripherals, toys, and

[1] This estimate is calculated from data on the current stock (i.e. December 1998), the number of products discarded over the past 5 years, and the number of products less than 5 years old within each household. It should be interpreted with a degree of caution due to possible rounding by respondents and because some products may have been purchased and discarded within the 5 year period and others acquired second-hand when already over 5 years old.

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telephones, faxes and answer-phones accounted for much of the growth. The number of small work or personal care appliances, and home and garden tools increased the most, though the rate of growth was less.

Table 4.1: Number of household appliances, 1998

Product category	Number owned[2] per 1,000 households
Electric cookers	685
Microwave ovens	897
Refrigerators and freezers	1,475
Washing machines, dishwashers, and tumble dryers	1,529
Vacuum cleaners and carpet cleaners	1,332
Small work or personal care appliances	6,227
Hi-fi and stereo	1,599
Radio and personal radio, stereo, and CD	2,050
Televisions	2,382
Video equipment	1,448
Telephones, faxes, and answer machines	1,890
Mobile phones and pagers	601
Computers and peripherals	620
Toys	929
Home and garden tools	3,388

Table 4.2: Change in the number of appliances owned per household (1993-1998)

Product category	Average number owned, 1998 (median)	Net change since 1993
Electric cookers	0.7	-8%
Microwave ovens	0.9	+31%
Refrigerators and freezers	1.5	+11%
Washing machines, dishwashers and tumble dryers	1.5	+19%
Vacuum cleaners and carpet cleaners	1.3	+38%
Small work or personal care appliances	6.3	+58%
Hi-fi and stereo	1.6	+81%
Radio and personal radio, stereo and CD	2.1	+96%
Televisions	2.4	+58%
Video equipment	1.4	+90%
Telephones, faxes and answer machines	1.9	+125%
Mobile phones and pagers	0.6	+325%
Computers and peripherals	0.6	+202%
Toys	0.9	+133%
Home and garden tools	3.4	+62%
ALL PRODUCTS	**25.0**	**+61%**

[2] Includes rented items.

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Respondents reported that the overwhelming majority of their appliances (88%) were less than 10 years old, and more than half (57%) under five years old (Table 4.3). Over two-thirds (67%) did not have any appliances over 15 years old and 10% did not have any over 5 years old.

There was considerable variation in the age of products of different type (Fig. 4.2). Products which tended to remain in use for longer included cookers, refrigerators and freezers, and home and garden tools. Around 26% of the stock of cookers, 21% of refrigerators and freezers, and 19% of home and garden tools were reported as over 10 years old. Around 63% of cookers and 57% of refrigeration appliances were more than 5 years old. Home and garden tools and microwave ovens were the only other product categories for which more than half of appliances were over 5 years old.

In contrast, a low proportion of radios and personal stereos, video equipment, telephones, faxes and answer-phones, mobile phones and pagers, computers and peripherals and toys were found to be over 10 years old. At least three-quarters of the stock of mobile phones and pagers, computers and peripherals, and toys was under 5 years old.

Table 4.3: Age of household appliances (1998)

Product category	**Aged <5 years**	**Aged 6-10 years**	**Aged 10-15 years**	**Aged >15 years**
Electric cookers	37%	37%	15%	11%
Microwave ovens	48%	38%	11%	3%
Refrigerators and freezers	43%	37%	14%	7%
Washing machines, dishwashers, and tumble dryers	50%	36%	11%	3%
Vacuum cleaners and carpet cleaners	55%	32%	9%	4%
Small work or personal care appliances	57%	33%	8%	2%
Hi-fi and stereo	58%	29%	9%	4%
Radio and personal radio, stereo, and CD	63%	29%	6%	2%
Televisions	54%	33%	10%	4%
Video equipment	62%	31%	6%	1%
Telephones, faxes, and answer machines	67%	26%	5%	2%
Mobile phones and pagers	85%	13%	2%	0%
Computers and peripherals	75%	21%	4%	0%
Toys	77%	20%	3%	1%
Home and garden tools	48%	34%	12%	7%
ALL PRODUCTS	**57%**	**31%**	**9%**	**3%**

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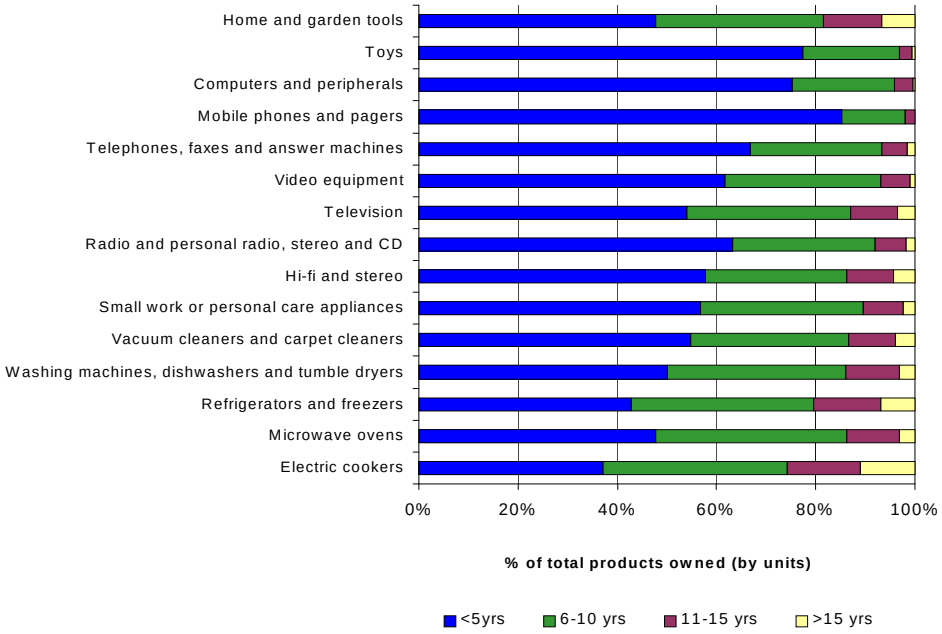
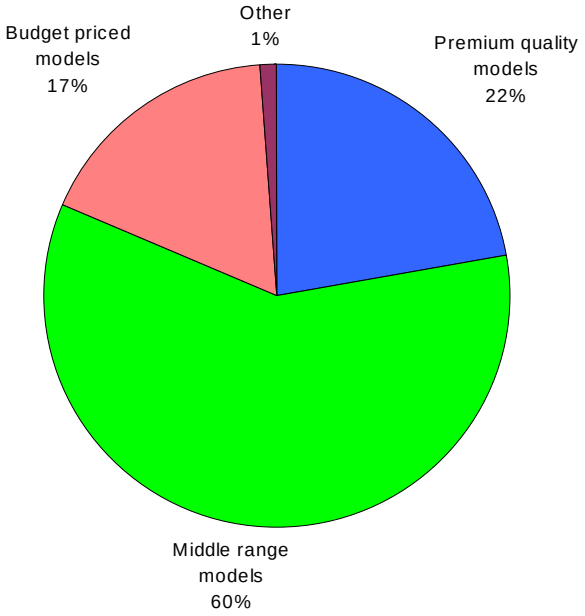
Figure 4.2: Age of household appliances owned by households (1998)



Householders were asked to identify the quality of products that they generally purchased. Over one fifth (22%) claimed to purchase *"premium quality models"*, 59% replied *"middle range models"* and 17% *"budget priced models"* (Fig. 4.3). Possible connections between the quality of products and product life are considered further in Section 6.2, below.

Figure 4.3: Models of appliances generally purchased by householders



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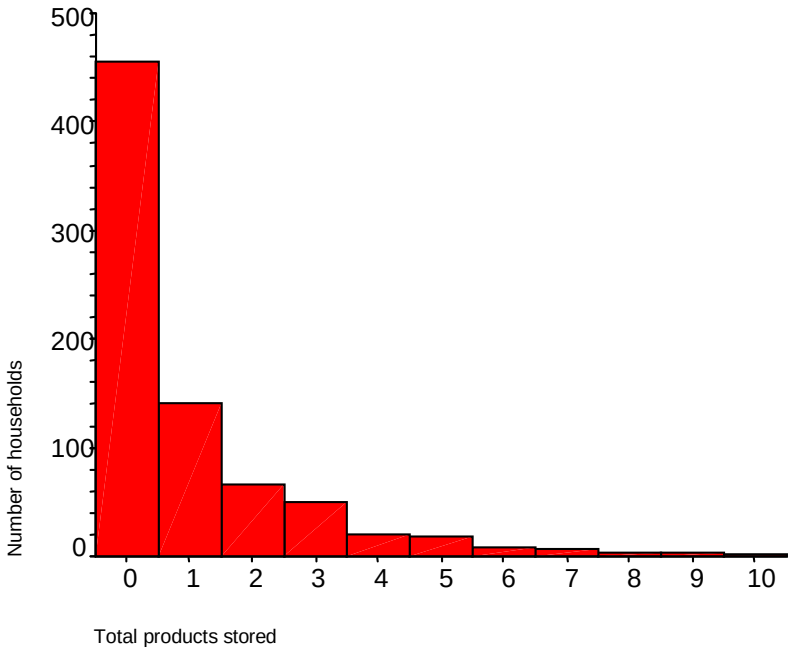
4.2 The extent of product storage

The number of products in storage had a positively skewed distribution (Fig. 4.4). Around 60% of respondents reported that they did not hold any products in storage. The proportion of products stored out of the total owned was low, between 1% and 7% depending on product category (Fig. 4.5). At least 50% of stored items in most product categories were still functional and the proportion for mobile phones and pagers and computers and peripherals was over 80%. The exceptions were wet appliances (i.e. washing machines, dishwashers and tumble dryers) and video equipment and even for these over 40% still functioned.

Figure 4.4: Number of appliances stored per household



Highly significant differences were found in the number of products stored when comparing product categories with overall appliance ownership (Fig. 4.5). These differences appeared to be dependent on product size. For example, small work and personal care appliances were most commonly stored (7% of products owned), whereas electric cookers and cold appliances were least commonly stored (between 1% and 2% of products owned).

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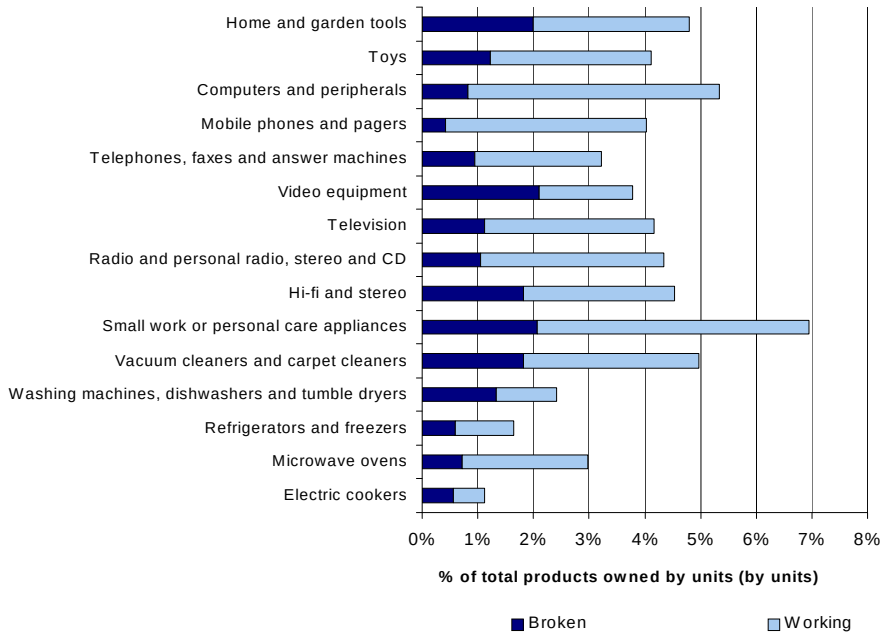
Figure 4.5: Stored household appliances, by condition



Statistical evaluation

χ^2 = chi-square score, p = degree of statistical significance.
For total products in storage: $\chi^2 = 130$, **$p<0.001^{***}$**
Degrees of freedom = 14.
For calculation, see Table A.1 in Appendix 15.
See Section 3.4 for an explanation of this method.

Examining the results of the focus groups in light of this data, it was found that in certain circumstances appliances were stored while awaiting disposal, sometimes due to a lack of knowledge over what to do with old appliances:

> *"I've got a tumble drier in the garage…what do I do? You see that's just standing there, it's no good, and I'll get sick to death of seeing it… you push it in the corner…it will drive me mad!"* – Sue, age 44, motor company managing director

> *"Where my son lives now they put a skip in a certain area…The thing is with the small items… like kettles and toasters, you have to keep them and put them in the shed. Then when the skip comes round you can get them out and put it all in there."* – John, age 52, stage decorator

> *"You clutter things, like strimmers and lawn mowers. I've got this hedge cutter that's broken. I don't now how you'd ever repair it. To be truthful, it might be repairable, but it's in the shed just stood there doing nothing from year to year. I suppose I could throw it away."* – Margaret, age 56, unemployed

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These examples suggest that products may be accumulated in storage before disposal, either intentionally or without deliberation. However, it was also found that householders frequently store equipment for future use, for example by family or friends or for repair. It would therefore appear that products are not always or necessarily stored with the intention of disposing of them:

> *"I've got a stereo under the stairs, a television upstairs on my chest of drawers that doesn't work, I've got two irons and a kettle in a cupboard in the kitchen, and I've also got a kettle out on the side and another iron… I don't like throwing anything away that might be of some use."* – Sandra, age 40, unemployed

> *"I've got a toaster and I very rarely use it unless my son comes in and has a mad moment. He's got to have a "toastie". It's very rarely used."* – Anne, age 45, retired heavy goods driver

> *"I did buy a new iron, but I kept the old one because it works… I keep it really as an emergency, because I couldn't do without an iron. It's a nuisance, but I've still got it"* – Elaine, age 52, administration assistant

In addition, in some cases it appeared that respondents stored items for future use outside of the immediate household. For example, some parents held products in storage for their children to use second-hand in university or when setting up new homes.

> *"I've got 2 kettles stored because I've got 2 grown-up children. One's married now, but the other one's still at home, and he will want one of his own. I've made mistakes of getting rid of things like that, and then needing them!"* – Carol, age 51, telephone engineer

Thus products may be stored for a variety of reasons. However, given the number of functional products in storage, and considering the majority of comments from the focus groups, on the whole it appears that products are stored for future use and reuse rather than disposal. The non-functional products were stored either awaiting repair or disposal.

4.3 The repair of household appliances

The tendency of respondents to have faulty appliances repaired is shown in Fig. 4.6. Information on the amount of repair work undertaken nationally is lacking in the available literature. Concern that repair work appears to be in decline (e.g. McLaren *et al*, 1998), especially on smaller, less valuable appliances, is given weight through the survey by the fact that a high proportion of householders said that they *"rarely"* or *"never"* get products repaired (38%), while only 26% *"usually"* get them repaired. The reason cited most often was cost, accounting for almost one-half of responses (45%), followed by anticipated residual life, accounting for around 1 in 7 responses (13%) (Fig. 4.7). Householders were able to cite more than one factor and over two-thirds of them (68%) cited cost as one of the factors (Table 4.4).

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Figure 4.6: Frequency with which householders repair broken appliances

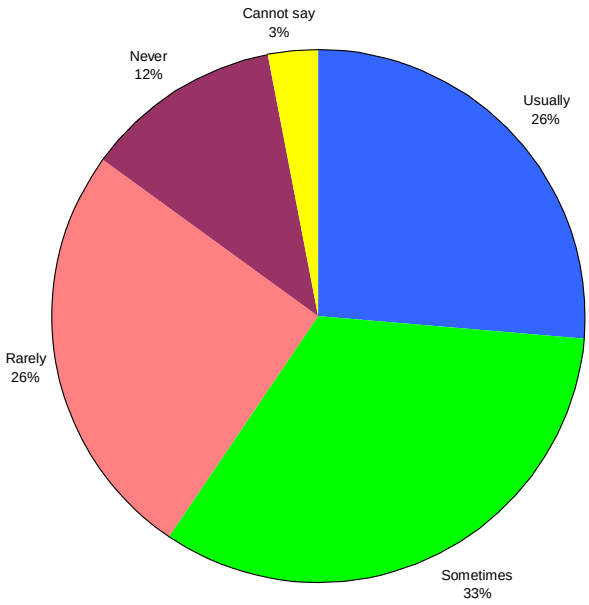

Figure 4.7: Factors discouraging repair of broken appliances (% of all factors cited)

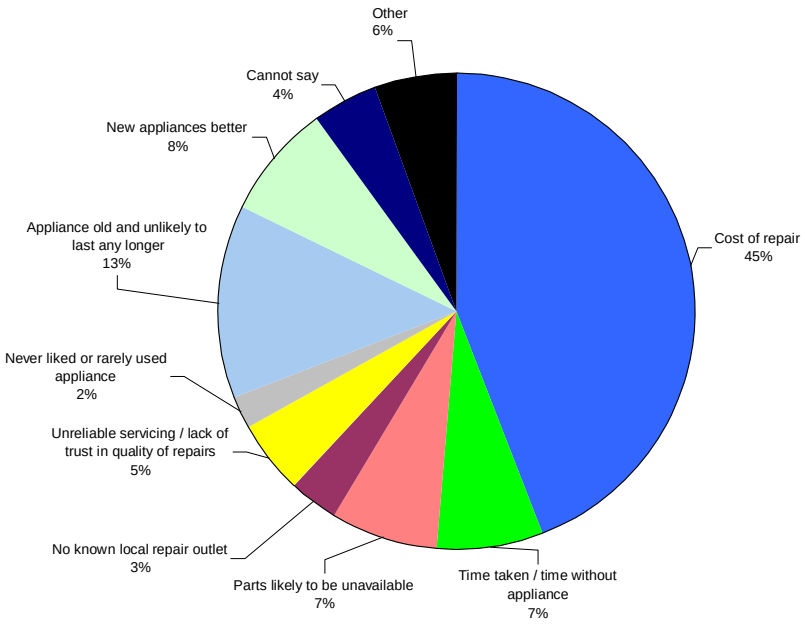

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Table 4.4: Factors discouraging repair of appliances (% of all respondents citing factor*)

Factors discouraging repair	% of all respondents citing factor
Cost of repair	68.3%
Time taken / time without appliance	11.2%
Parts likely to be unavailable	11.1%
No known local repair outlet	4.9%
Unreliable servicing / lack of trust in quality of repairs	8.1%
Never liked or rarely used appliance	3.1%
Appliance old and unlikely to last any longer	20.3%
New appliances better	12.1%
Cannot say	6.7%
Other	8.6%

*Respondents were able to cite multiple factors

Older people, notably those aged 55-64, were significantly more likely to get products repaired than people in other age groups (Table 4.5). The same was true for people in socio-economic group AB (Table 4.6). There was no significant relationship by gender, nor were people who described the need to reduce or recycle waste as *"important"* significantly more likely to repair products.

Table 4.5: Frequency with which householders repair broken appliances, by respondents' age

Crosstab

			Frequency with which products are repaired					
			Usually	Sometimes	Rarely	Never	Cannot say	Total
AGE	16-24	Count	9	13	14	11	6	53
		Expected Count	14.0	17.4	13.6	6.3	1.6	53.0
		% within AGE	17.0%	24.5%	26.4%	20.8%	11.3%	100.0%
	25-34	Count	47	75	64	28	12	226
		Expected Count	59.9	74.4	57.9	27.0	6.8	226.0
		% within AGE	20.8%	33.2%	28.3%	12.4%	5.3%	100.0%
	35-44	Count	52	63	55	27	3	200
		Expected Count	53.0	65.8	51.3	23.9	6.0	200.0
		% within AGE	26.0%	31.5%	27.5%	13.5%	1.5%	100.0%
	45-54	Count	44	48	30	10	2	134
		Expected Count	35.5	44.1	34.3	16.0	4.0	134.0
		% within AGE	32.8%	35.8%	22.4%	7.5%	1.5%	100.0%
	55-64	Count	38	38	21	10	1	108
		Expected Count	28.6	35.5	27.7	12.9	3.3	108.0
		% within AGE	35.2%	35.2%	19.4%	9.3%	.9%	100.0%
	65-99	Count	21	25	20	9	0	75
		Expected Count	19.9	24.7	19.2	9.0	2.3	75.0
		% within AGE	28.0%	33.3%	26.7%	12.0%	.0%	100.0%
Total		Count	211	262	204	95	24	796
		Expected Count	211.0	262.0	204.0	95.0	24.0	796.0
		% within AGE	26.5%	32.9%	25.6%	11.9%	3.0%	100.0%

Statistical evaluation

$\chi^2 = 43.911$, **0.001<p<0.01****

Degrees of freedom = 20

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Table 4.6: Frequency with which householders repair broken appliances, by socio-economic group

Crosstab

			Frequency with which products are repaired					
			Usually	Sometimes	Rarely	Never	Cannot say	Total
Socio-economic group (SEG)	AB	Count	63	63	43	15	4	188
		Expected Count	49.7	61.7	48.3	22.6	5.7	188.0
		% within SEG	33.5%	33.5%	22.9%	8.0%	2.1%	100.0%
	C1	Count	58	88	62	20	7	235
		Expected Count	62.1	77.2	60.4	28.3	7.1	235.0
		% within SEG	24.7%	37.4%	26.4%	8.5%	3.0%	100.0%
	C2	Count	37	59	45	29	8	178
		Expected Count	47.1	58.4	45.7	21.4	5.4	178.0
		% within SEG	20.8%	33.1%	25.3%	16.3%	4.5%	100.0%
	D	Count	30	33	27	12	3	105
		Expected Count	27.8	34.5	27.0	12.6	3.2	105.0
		% within SEG	28.6%	31.4%	25.7%	11.4%	2.9%	100.0%
	E	Count	23	19	28	20	2	92
		Expected Count	24.3	30.2	23.6	11.1	2.8	92.0
		% within SEG	25.0%	20.7%	30.4%	21.7%	2.2%	100.0%
Total		Count	211	262	205	96	24	798
		Expected Count	211.0	262.0	205.0	96.0	24.0	798.0
		% within SEG	26.4%	32.8%	25.7%	12.0%	3.0%	100.0%

Statistical evaluation

$\chi^2 = 30.379$, **$p<0.05$***

Degrees of freedom = 16

Focus group participants were aware of both the economic and technical obstacles to repair.

> *"I think that's the main problem these days; it costs so much to get these things repaired, you might as well throw it and buy a new one."* - Charles, age 69, retired

> *"If it breaks down and you don't look after it, you think 'Oh it's gone' and you go and buy a new one. I think that's how people think, nowadays, it costs just as much to have it repaired as it is to buy a new one."* - Barry, age 61, unemployed

> *"You can't repair things: electric irons they say it's not worth repairing, hairdryers are not worth repairing. It's cheaper to buy a new one that have it repaired."* - Clare, age 26, local government officer

> *"I think manufacturers...make it very difficult for you to have your machines repaired."* - Ann, age 42, lecturer

> *"A lot of these products now, a certain part of them contains a sealed unit and once that has gone, that's it. Before you could take them to pieces and put them back again, but not now - once it's gone, it's gone."* - Barry, age 61, unemployed

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4.4 The ownership of second-hand household appliances

Second-hand product ownership followed a positively skewed distribution and accounted for around one in twenty products (5%). The majority of respondents (60%) did not own any second-hand appliances (Fig. 4.8). However, nearly a third (31%) of respondents owned between one and four, and almost one in ten (9%) owned five or more.

Highly significant differences were found in ownership of second-hand appliances between different product categories compared to overall appliance ownership (Fig. 4.9). Appliances most frequently owned second-hand were electric cookers, refrigerators and freezers (over 10%), followed by wet appliances, televisions and microwave ovens (around 8%) (Table 4.7). Compared to other product categories, smaller appliances (including small work or personal care products, telecommunications products, and radios and personal stereos) were not frequently owned second-hand (between 1% and 3%).

Figure 4.8: Ownership of second-hand household appliances

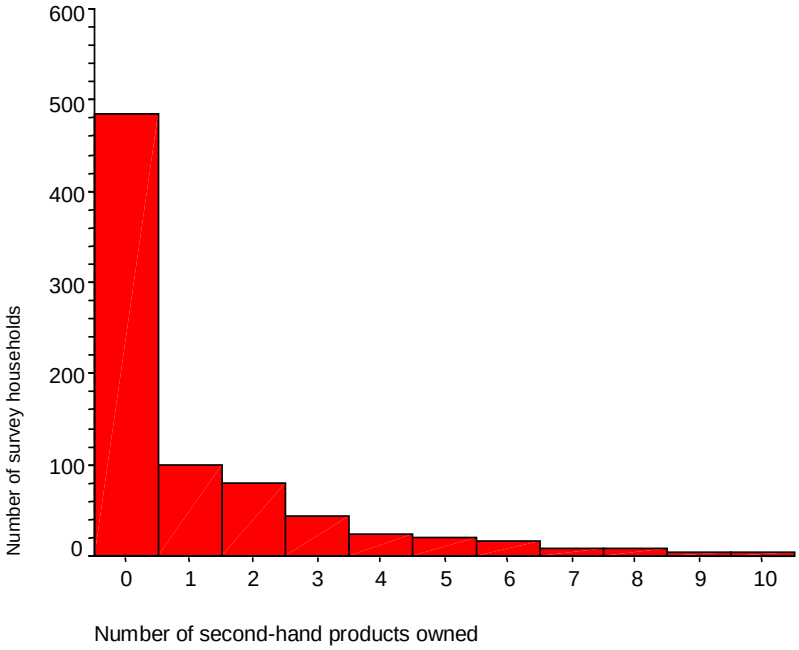

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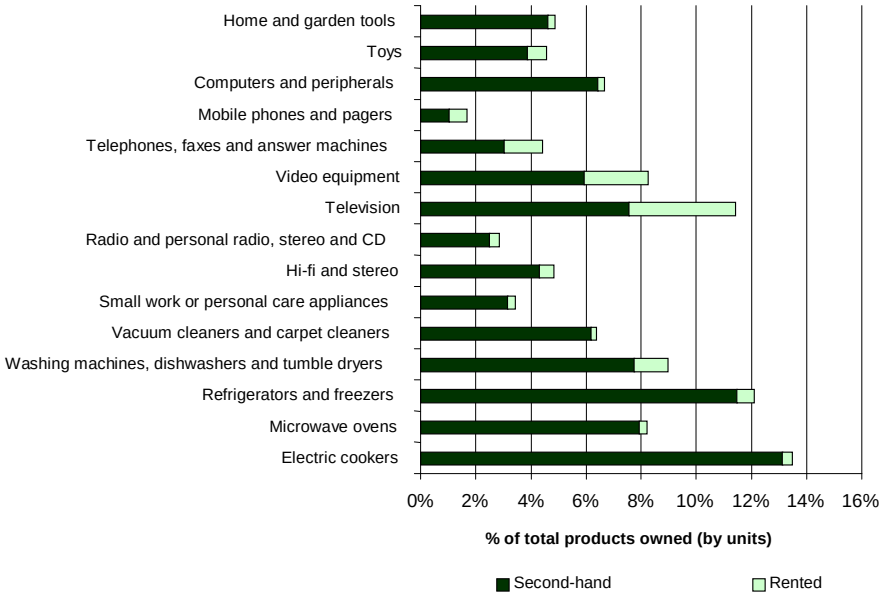
Figure 4.9: Proportion of household appliances owned second-hand or rented



Statistical evaluation

For total second-hand products owned:
$\chi^2 = 306$, **$p<0.001^{***}$**
Degrees of freedom = 14
For calculation, see Table A.2 in Appendix 15.

For total products rented:
$\chi^2 = 283$**, $p<0.001^{***}$**
Degrees of freedom = 14
For calculation, see Table A.3 in Appendix 15.

Table 4.7: Proportion of household appliances owned second-hand

Product category	% owned second-hand
Electric cookers	13
Microwave ovens	8
Refrigerators and freezers	11
Washing machines, dishwashers and tumble driers	8
Vacuum cleaners and carpet cleaners	6
Small work or personal care appliances	3
Hi-fi and stereo	4
Radio and personal radio, stereo and CD	2
Televisions	8
Video equipment	6
Telephones, faxes and answer machines	3
Mobile phones and pagers	1
Computers and peripherals	6
Toys	4
Home and garden tools	5
ALL PRODUCTS	**5**

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Discussion in the focus groups revealed that many participants were not comfortable with purchasing second-hand appliances, which could explain why many households own none at all. They explained their reluctance in terms of issues of product reliability, trust in "suppliers" and the lack of guarantees (see also Section 6.6 below):

"I don't think I'd want to buy something that was somebody's cast-off. They've got rid of it for a reason; it's either out of date or there's something wrong with it." – Roger, age 52, telecommunications engineer

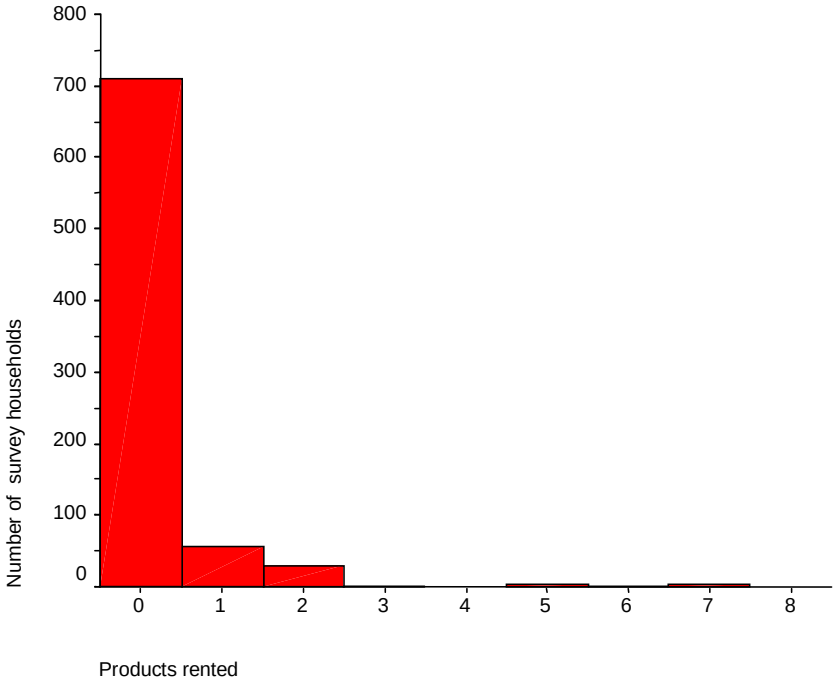
"I bought an electrical saw from a car boot sale, and the chap plugged it in and it worked. When I got it home and used it, it didn't. You've got to be a little bit careful when you buy second-hand goods." – Charles, age 69, retired

"It's a gamble, you buy something second-hand and it goes wrong after a few weeks. To go back to that person is hard then. They just buy them as seen really." - John, age 52, decorator

4.5 Product rental

Rental was found to be not very common. Only around one in ten respondents reported that they rented any products and most of these rented only 1 or 2 appliances (Fig. 4.10). As with product storage and ownership of second-hand appliances, highly significant differences were found in the number of appliances rented between product categories (Fig. 4.9, above). Products most commonly rented included televisions and video equipment (between 3% and 4% of the total), followed by telephones and answer machines, and wet appliances (between 1% and 2% of the total). In all other categories rented products comprised less than 1% of the total.

Figure 4.10: Possession of rented household appliances



4.6 Variations in product ownership and age composition

Possible variations were investigated in total ownership, ownership of second-hand appliances, rented appliances, the number of appliances stored and the age composition of appliances compared with the socio-economic group and attitude to material wealth of householders. As shown below, significant differences were found in most cases.

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4.6.1 Product ownership with socio-economic grouping

Predictably, the possession of household appliances increased significantly with Socio-Economic Grouping (SEG) (Table 4.8). For example, respondents in group AB had 12% more household appliances than would be expected from the overall distribution of households as suggested by SEG. In contrast, those in group E had 28% fewer appliances than expected.

Table 4.8: Appliance ownership patterns with socio-economic grouping

Socio-economic grouping	AB	C1	C2	D	E	n	χ^2
Number of households	189	236	178	106	92	801	
Appliances owned							
Appliances owned (observed)	5735.0	6600.0	4899.0	2665.0	1798.0	21697	
Appliances owned (expected)	5119.5	6392.6	4821.6	2871.3	2492.0		**p<0.001*** **
$(Oj-Ej)^2/Ej$	74	7	1	15	193		$\chi^2 = 290.1$
Appliances stored							
Appliances stored (observed)	255.0	322.0	243.0	75.0	81.0	976	
Appliances stored (expected)	230.3	287.6	216.9	129.2	112.1		**p<0.001*** **
$(Oj-Ej)^2/Ej$	3	4	3	23	9		$\chi^2 = 41.3$
2nd-hand appliances owned							
2nd-hand appliances (observed)	157.0	324.0	273.0	120.0	258.0	1132	
2nd-hand appliances (expected)	267.1	333.5	251.6	149.8	130.0		**p<0.001*** **
$(Oj-Ej)^2/Ej$	45	0	2	6	126		$\chi^2 = 179.9$
Appliances rented							
Appliances rented (observed)	18.0	50.0	42.0	58.0	21.0	189	
Appliances rented (expected)	44.6	55.7	42.0	25.0	21.7		**p<0.001*** **
$(Oj-Ej)^2/Ej$	16	1	0	44	0		$\chi^2 = 60$

Statistical evaluation
$\chi^2 = \Sigma(Oj-Ej)^2/Ej$
p = degree of statistical significance
Degrees of freedom = 4
Expected values are calculated for product ownership, storage etc., by number of households, assuming SEG has no influence.
See Section 3.4 for explanation of use of the chi-square statistical test.

Significant differences were also found in product storage by SEG. The number of appliances in storage generally increased with socio-economic status. Respondents in groups D and E stored 42% and 28% fewer appliances than expected, respectively.

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Groups AB, C1 and C2 had 4.4%-5% of appliances in storage, whereas groups D and E had only 2%-4.5%.

Ownership of second-hand appliances was found to decrease significantly with SEG. Respondents in group AB owned 42% fewer second-hand appliances than would be expected if socio-economic group had no effect, while respondents in group E owned almost 100% more second-hand appliances than expected. Finally, possession of rented appliances also increased significantly for group AB through to group D. Group AB rented 60% fewer products than expected and group D 132% more appliances than expected. Group E rented as many appliances as expected. In summary, people in higher SEGs owned more appliances, stored more, and had fewer that were second-hand or rented. In each of these cases the relationships were highly significant.(i.e. at least at the 1% level).

4.6.2 Product ownership with attitude to material wealth

Differences in respondents' attitudes to material wealth were not found to have a significant effect on the overall number of products owned. However, significant differences were found when comparing possession of second-hand appliances, rented appliances, and appliances in storage with attitude to material wealth (Table 4.9).

Householders believing material wealth to be important were found to own relatively few second-hand appliances. Those who considered material wealth to be "*extremely important*" owned around 27% fewer second-hand appliances than would be expected if attitudes to material wealth had no effect. In contrast, respondents stating material wealth was "*not important*" owned 59% more second-hand appliances than expected.

The proportion of products that respondents held in storage increased significantly with attitude to material wealth. Respondents describing material wealth as "*extremely important*" were found to store 22% more products than expected. Those not placing importance upon material wealth, with responses of "*fairly important*" and "*not important*", were found to have relatively fewer products in storage, 7% and 1% less than expected, respectively.

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Respondents who rented appliances appeared most likely to place moderate importance upon material wealth (those responding "*fairly important*" rented 42% more appliances than expected).

In summary, respondents viewing material wealth as important stored more appliances, but owned fewer second-hand appliances and rented fewer appliances.

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Table 4.9: Appliance ownership patterns with attitude to material wealth

Stated importance of material wealth to households	Extremely important	Very important	Fairly important	Households with mixed opinions	Not important	No opinion	n	χ^2
Number of households	87	234	358	50	71	2	802	
Appliances owned								
Appliances owned (observed)	2409	6470	9585	1320	1903	46	21733	
Appliances owned (expected)	2358	6341	9701	1355	1924	54		**p>0.05** NS
$(Oj-Ej)^2/Ej$	1.1	2.6	1.4	0.9	0.2	1.2		χ^2 =7.5
Appliances stored								
Appliances stored (observed)	130	315	407	41	85	0	978	
Appliances stored (expected)	106	285	437	61	87	2		**0.001<p<0.01****
$(Oj-Ej)^2/Ej$	5	3	2	7	0	2		χ^2 = 19.5
2nd-hand appliances owned								
2nd-hand appliances (observed)	90	254	553	78	159	0	1134	
2nd-hand appliances (expected)	123	331	506	71	100	3		**p<0.001*****
$(Oj-Ej)^2/Ej$	9	18	4	1	34	3		χ^2 = 68.8
Appliances rented								
Appliances rented (observed)	8	47	119	8	7	0	189	
Appliances rented (expected)	20	55	84	12	17	0		**0.001<p<0.01****
$(Oj-Ej)^2/Ej$	7.4	1.2	14.1	1.2	5.7	0.5		χ^2 = 30.2

Statistical evaluation
$\chi^2 = \Sigma(Oj-Ej)^2/Ej$
p = degree of statistical significance.
Degrees of freedom = 5
Expected values are calculated for product ownership, storage etc., by number of households, assuming attitude has no influence.
See Section 3.4 for an explanation of the use of the chi-square statistical test.

4.6.3 Age of appliances with socio-economic group

A highly significant relationship was found between the age composition of products and the socio-economic group of householders (Fig. 4.11). It was evident that householders in group E not only owned fewer appliances (Section 4.6.1, above), but also owned a lower proportion of newer products than those in higher SEGs.

Although respondents in groups AB, C1C2 and D reported that between 55% and 60% of their products were under 5 years old, for group E the figure was significantly lower, just over 40%. Likewise, respondents in group E also owned a much greater proportion of products over 10 years old than those in other groups. Only around 9% to 13% of appliances owned by respondents in groups AB C1C2 and D were older than 10 years, whereas for group E the figure was higher, around 20%.

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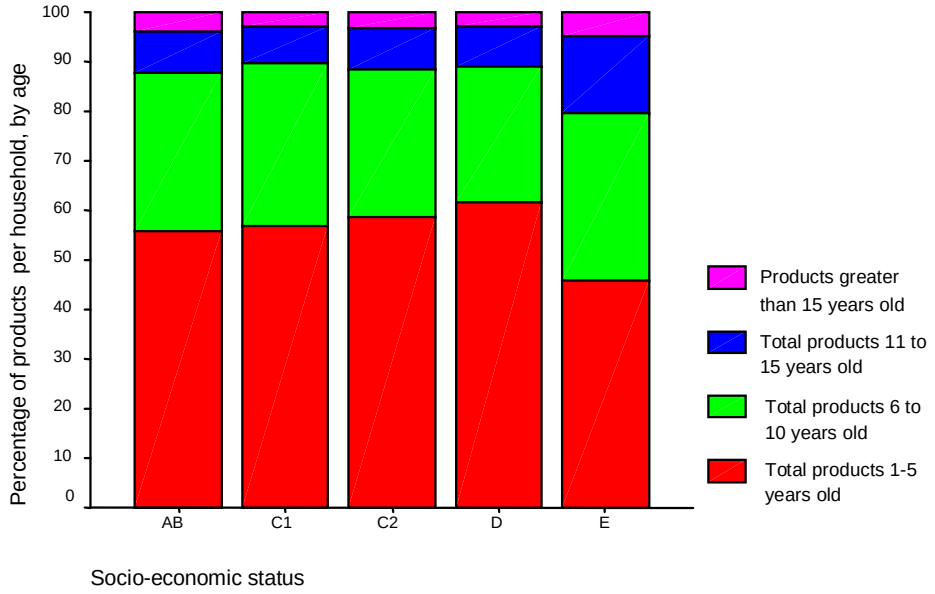
Figure 4.11: Age of household appliances with socio-economic group



Statistical evaluation
For ownership of products of different age by socio-economic group:
$\chi^2 = 221.7$, **$p<0.001^{***}$**
Degrees of freedom = 12
For calculation, see Table A.4 in Appendix 15.

4.7 Discussion: product ownership and use

Sections 4.1 to 4.6 have provided an overview of the survey results on the ownership of appliances by UK households, including information on the quantities in use, stored, second-hand and rented. Appliance ownership has also been examined by product type, socio-economic group and product age. The results are now analysed in more detail.

4.7.1 Number of products owned

Ownership of appliances varies considerably between households. This appears to reflect differences in wealth, suggested by the fact that ownership levels increase significantly with socio-economic group (Section 4.6.1). No other data of this kind has been reported in the available literature, although data is available on the proportion of UK households that own specific appliances (Office for National Statistics, 1998).

The accumulation of products in recent years may be attributed to a combination of cultural, psychological, economic and technological factors, such as:

- Increased affluence, changes in spare time and higher material aspirations
- Relatively low interest rates and readily available financial credit, making products easier to purchase
- Increased product diversity, particularly through technologically innovative products.

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Although these factors were not investigated further, increased ownership suggests that future volumes of waste will grow as these appliances are discarded. This is discussed further within Section 5.7.3, which focuses on disposal.

The claim by over one fifth of householders generally to purchase *"premium quality models"* should be interpreted as a perception.

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The fact that respondents viewing material wealth as important stored significantly more of their appliances and owned fewer second-hand appliances suggests that personal pride in material possessions, as well as socio-economic group, influences appliance ownership patterns.

4.7.2 Age of products owned

Data on the age of the stock of household appliances could not be found in the available literature. The survey found that most products in people's homes were less than 10 years old, but the age of products differed significantly between product types. Thus while almost three-quarters of cookers were over 5 years old, mobile phones and pagers tended to be much newer, only around 15% being over 5 years old. It is evident that the age of the overall stock is being affected by a growth in the acquisition of products subject to rapid technological advancement.

It was noted above (Section 4.6.3) that respondents in socio-economic group E owned a significantly higher number of older products. This is consistent with lower levels of affluence and purchasing power, and greater ownership of second-hand products in these households.

The overall age of the stock of appliances owned by householders depends on the rate of acquisition of new products and the duration of product life spans. The latter is in turn is influenced by a combination of factors that include design, technological development, user satisfaction and attachment to products, and economic factors, including the degree of household affluence. These are explored in greater depth in Section 6.

4.7.3 Product storage

Over one half of householders did not store any appliances. The fact that households storing a higher proportion of their products appear to be more affluent (Section 4.6.1 above) may reflect the fact that affluent householders tend to have larger houses with more space for storage. Data on product storage had in the past been reported in aggregate and not investigated by socio-economic group, so this distinction had not been identified.

It has also been assumed that stored products are destined for eventual disposal and storage is often the last step in the process by which appliances become "waste":

> *"It has been suggested that up to 30% of obsolete equipment may be initially stored, rather than discarded immediately, and will therefore not enter the waste stream for some years after it has ceased to be used"* – ICER, 2000: 19

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In some circumstances this was found to be true; stored products were discarded because they were no longer useful, but their owners had not known how to get rid of them or they were small items being collected for disposal in bulk. However, a high proportion of products stored were found to be still functioning (from 40% to 90%), especially products using relatively new technologies such as computers and peripherals. Closer examination revealed that householders also store products for future use, including:

- Use by children entering university or setting up a new home
- Occasional use as a "back-up" for products usually used
- In case of unforeseen need
- For use after repair.

Product storage thus appears to be an integral element in product ownership, rather than simply a final step before disposal. This finding supports studies that regard household behaviour such as storage as adjunct and essential to product ownership and use (Harrell and McConocha, 1992; Boyd and McConocha, 1996). Products entering storage should not be considered in terms of their potential to become waste, but as items which may well be used again. Programmes providing incentives for householders to dispose of stored appliances, such as designated "clear-out" days organised with the intention of encouraging householders to dispose of stored appliances, may not be desirable unless directing products into reuse.

4.7.4 Product repair

The proportion of householders who reported that they *"rarely"* or *"never"* get products repaired was high. Factors inhibiting repair work include a dissuasive regulatory framework (European Consumer Law Group, 1988) and the fact that consumers do not consider operating costs at the time of purchase (Kollman, 1992).

The main reason cited by survey respondents was cost, cited by almost one half of respondents, followed by anticipated residual life. The cost of repair work is doubtless considered in relation to the price of replacement products. The minimum charge for repairs levied by high street electrical retailers prohibits the repair of most small work or personal care appliances and increasingly other products such as microwave ovens and video recorders:

> *"If something goes wrong with your washer or your cooker, the call out fee's about £30 before they even attempt to repair it, so you might as well just go and get a new one anyway."* - Shirley, age 45-64, retired

There are several contributory causes of relatively high costs, including the following:

- Labour costs in Britain, where repairs are undertaken, are much greater than those overseas, where many replacement products are made
- Components are often in sealed units which must be replaced as a whole and are therefore expensive
- Products are not always designed with ease of repair as a priority, making disassembly time consuming and thus costly
- The basis for spare parts pricing is unclear but is not always based on the marginal costs of increased production runs.

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The fact that no significant relationship between attitudes to waste and the incidence of repair was identified suggests that demographic factors exert a greater influence upon repair than environmental values.

4.7.5 Second-hand household appliances

Historically, the reuse of products has not attracted much research interest (Scitovsky, 1994; Gregson and Crewe, 1994) and the only data identified is limited to charity shops (Horne, 1998). Many householders did not own any second-hand appliances (Section 4.4) and that those owning them tended to be in lower SEGs and placed less importance on material wealth (Section 4.6.2). This was predictable, but empirical data is important to validate such expectations and reveal the detailed patterns of appliance reuse. The finding that almost one in ten householders owned five or more second-hand appliances indicates that the market for such appliances is segmented, with one group of householders having a greater acceptance or need of such items.

The appliances most often bought second-hand tended to be the larger and more expensive products (Section 4.4, above). Smaller and less expensive products, for which life span expectations were lower, were reused less often (discussed later, in Section 5.4).

Although second-hand products provide an alternative option to buying new, it should not be assumed that these always compete directly with new products. For example:

- The fact that householders of lower SEG were most likely to own second-hand appliances suggests that decisions to use such appliances are often based on economic circumstances.
- Second-hand products were obtained from entirely different sources than new products, such as family and friends, through classified columns in local newspapers, and car boot sales (described below in Section 5.4).
- Consumers sometimes expect their products to retain at least some economic value when they are discarded so that resale is possible. The focus groups results revealed that householders expected some form of payment or discount from retailers on passing on their old appliances (Section 6.5, below).

It thus appears that the market for second-hand products differs from that for new products. Householders who buy second-hand may not have the option of buying new.

4.7.6 Product rental

Very few householders reported that any of their products were rented and those that did were mostly in lower socio-economic groups (Section 4.6.1, above). As with second-hand appliances, rental appears to provide an alternative option to new product purchase for householders that tend not to buy new due to their socio-economic circumstances or other motives (Durgee and O'Connor, 1995).

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Products rented were mostly televisions and videos (Section 4.5, above). This reflects a historic legacy of household behaviour and may partly be explained by the attraction of products embracing the latest technology, sometimes linked with concern about the potential unreliability of new models. ¶

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Table 4.8: Appliance ownership patterns with socio-economic grouping

Socio-economic grouping	AB	C1	C2	D	E	n	χ^2
Number of households	189	236	178	106	92	801	
Appliances owned (observed)	5735.0	6600.0	4899.0	2665.0	1798.0	21697	
Appliances owned (expected)	5119.5	6392.6	4821.6	2871.3	2492.0		**p<0.001*****
$(Oj-Ej)^2/Ej$	74	7	1	15	193		$\chi^2 = 290.1$
Appliances stored (observed)	255.0	322.0	243.0	75.0	81.0	976	
Appliances stored (expected)	230.3	287.6	216.9	129.2	112.1		**p<0.001*****
$(Oj-Ej)^2/Ej$	3	4	3	23	9		$\chi^2 = 41.3$
2nd-hand appliances (observed)	157.0	324.0	273.0	120.0	258.0	1132	
2nd-hand appliances (expected)	267.1	333.5	251.6	149.8	130.0		**p<0.001*****
$(Oj-Ej)^2/Ej$	45	0	2	6	126		$\chi^2 = 179.9$
Appliances rented (observed)	18.0	50.0	42.0	58.0	21.0	189	
Appliances rented (expected)	44.6	55.7	42.0	25.0	21.7		**p<0.001*****
$(Oj-Ej)^2/Ej$	16	1	0	44	0		$\chi^2 = 60$

Statistical evaluation

$\chi^2 = \Sigma(Oj-Ej)^2/Ej$
p = degree of statistical significance
Degrees of freedom = 4
Expected values are calculated for product ownership, storage etc., by number of households, assuming SEG has no influence.
See Section 3.4 for explanation of use of the chi-square statistical test.

Products rented were mostly televisions and videos (Section 4.5, above). This reflects a historic legacy of household behaviour and may partly be explained by the attraction of products embracing the latest technology, sometimes linked with concern about the potential unreliability of new models.

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5. Results and discussion: product disposal

This section presents results and key findings relating to the disposal of household appliances and includes data on average product life spans. Particular attention is given to the potential for reuse and recycling. The impact of sociological and attitudinal differences on disposal behaviour is then considered.

5.1 The disposal of household appliances

It was possible to estimate the total mass of discarded appliances arising from households throughout the UK per year using an estimated average mass in each product category (Appendix 13) (Fig. 5.1). Product disposal frequencies in units per 1,000 households per year were also calculated (Fig. 5.2). Figures were based on annual averages over a five year period. The disposal of end-of-life appliances is a highly complex process compared to processes for consumable wastes such as packaging and organic waste, for which householders have a limited number of disposal options. The survey investigated thirteen different disposal routes. These accounted for 97% of appliances (by mass) discarded by householders, indicating the most important disposal routes were included (Fig. 5.3).

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Figure 5.1: Quantity of household appliances discarded annually in the UK (1993-1998, by mass)

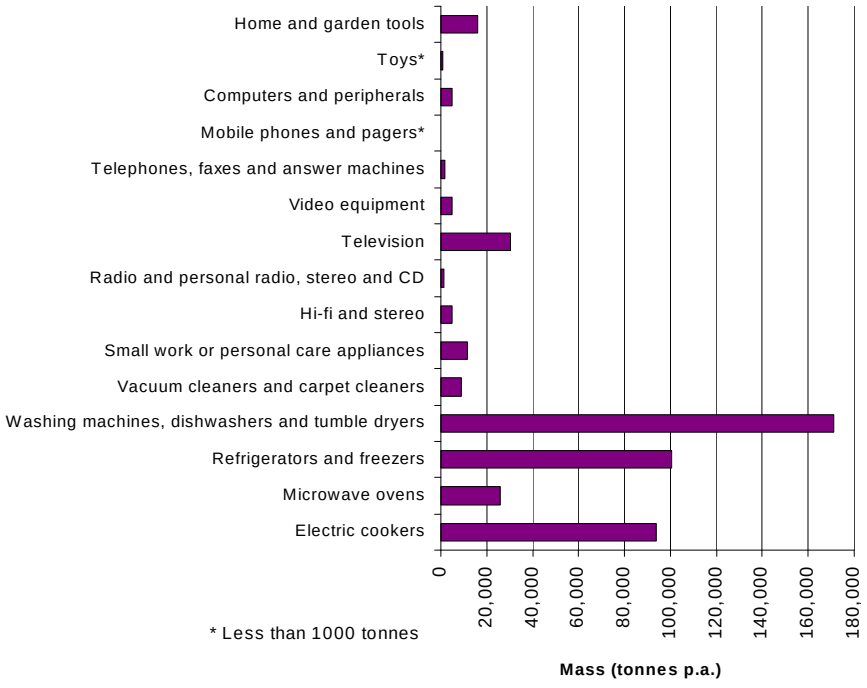

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Figure 5.2: Number of appliances discarded annually in the UK (1993-1998, by units)

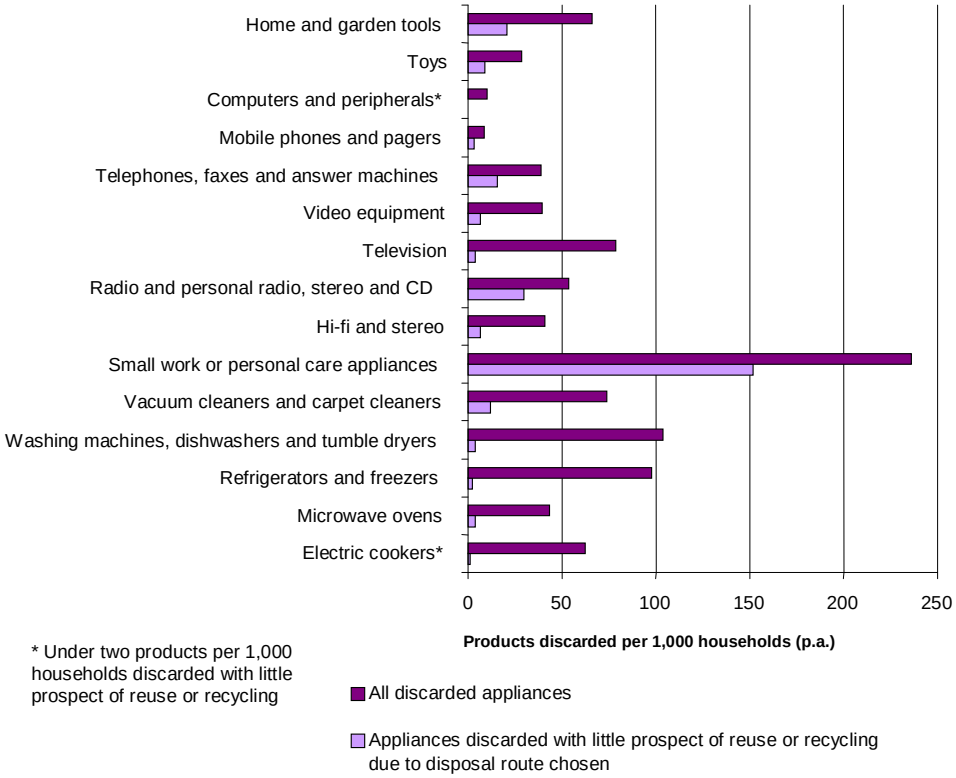
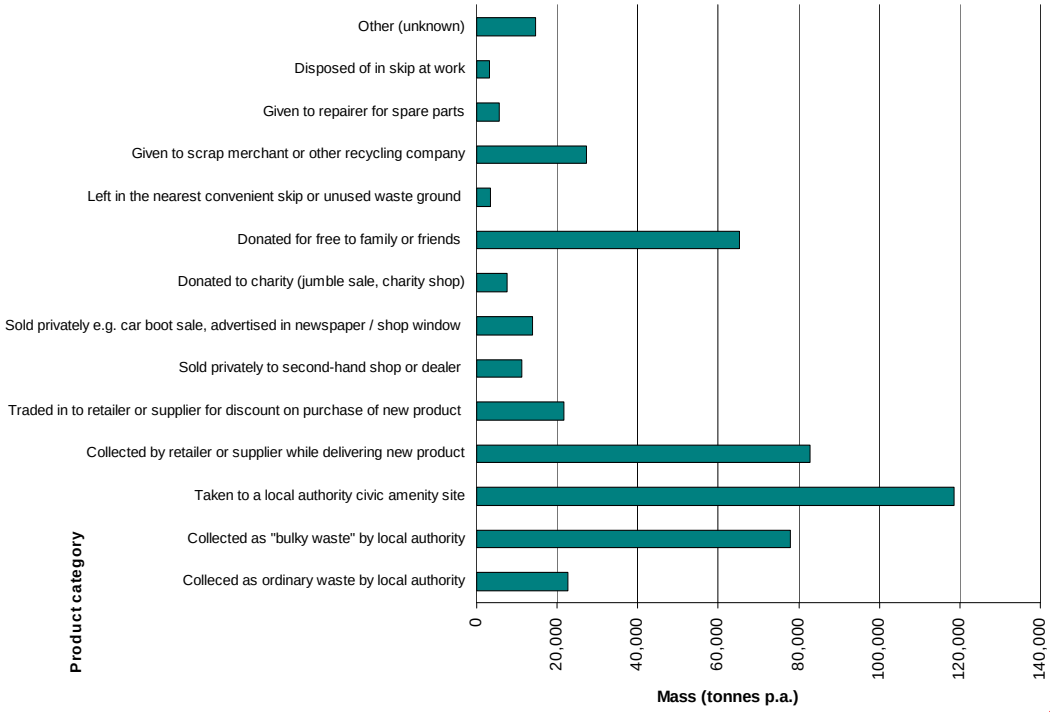


Figure 5.3: Quantity discarded annually in the UK through specified disposal routes (1993-1998, by mass)



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It was estimated that at least 476,000 tonnes of household appliances were discarded annually between 1993 and 1998, totalling over 23 million units. The figure might be underestimated, as respondents may not have recalled every single product that they threw away during this period.[1] Large white goods constituted the greatest proportion of the waste stream by mass (77%) and small appliances[2] by number of units (37%).

Around 104,000 tonnes (22% of appliances discarded, by mass) were reused, two thirds of which was donated to family or friends with most of the remainder being sold. Appliances most frequently reused were computers and peripherals, hi-fi and stereo, microwave ovens and video equipment. Around 328,000 tonnes (69%) were taken to civic amenity sites by householders, collected as "bulky waste" by local authorities, or collected by retailers or recycling companies, some of which is recycled (Section 5.3, below).

The remaining appliances for which a disposal route was identified, totalling 29,224 tonnes (6%), were disposed of through routes likely to preclude reuse and recycling, being collected as "ordinary waste" by local authorities (i.e. from dustbins, wheelie bins or rubbish sacks) or left in a skip at the owner's workplace or, illegally, on the nearest convenient skip or waste ground.

Of the latter, only 22,751 tonnes (just under 5% of the total) was collected as ordinary waste by local authorities. Around 80% of this comprised small work or personal care appliances, home and garden tools, large white goods and microwave ovens (Fig. 5.4). Around 62% of small work or personal care appliances were discarded in this way, but the proportion for other products was much smaller (for example, only 12% to 13% of video equipment, vacuum cleaners, and hi-fi and stereo). A comment from one focus group participant helped to explain how larger appliances are occasionally discarded through this route.[3]

> *"If I had a Hoover I was trying to get rid of, I would put it by the side of the bin…I think that's what most people would do. But they change their mind a lot, the Council, one-minute they'll take the garden rubbish then the next they won't."*
> – Les, age 44, vehicle administrator

The balance (6,473 tonnes) was accounted for by waste put in skips at respondents' workplaces (3,144 tonnes) or, illegally, on the nearest convenient skip or area of waste ground (3,329 tonnes). The quantity disposed of illegally was probably greater, given a likely reluctance of householders to admit to criminal activity. Participants of the focus groups acknowledged the problem of illegal disposal of appliances:

"One of the things that occurs is that people just dump them on waste ground…It's getting bad at the moment. They just can't be bothered…It's done by small building firms that won't pay the cost of taking it up the tip...I can think of a site just 10 minutes from here where they do it regularly and it's a Council site that has to be cleared." – Phil, age 61, motor mechanic

[1] It is rather more unlikely that products were included in error. This was confirmed when responses to different questions were cross-checked.
[2] Defined here as small work or personal care appliances, radio and personal radio, stereo and CD, telephones, faxes and answer-phones, mobile phones and pagers, and toys.
[3] It is possible that the figure included some products discarded in skips hired by households, but this was not investigated further.

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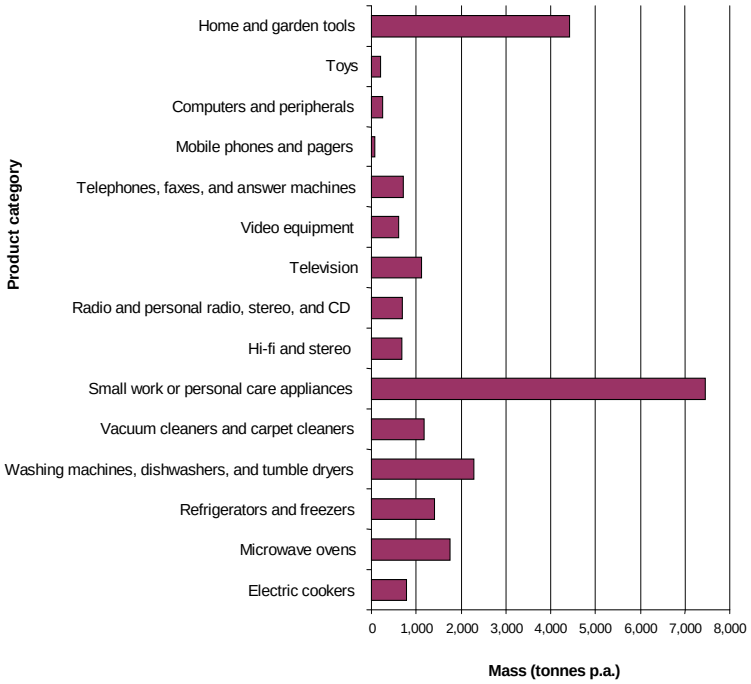
In summary, discarded products not intended for reuse were most likely to be taken to civic amenity sites (32%, by mass) or collected as bulky waste by local authorities (21%). Just over one third was collected by retailers or recycling companies (35%), with the remainder (12%) either collected as ordinary waste by local authorities or left on skips or waste ground.

Figure 5.4: Quantity of household appliances collected by local authorities as "ordinary waste" (1993-1998, by mass)



5.2 The age and condition of discarded products

The average age of household appliances when discarded ranged between 4 and 12 years depending on the type of product.[4] Predictably, larger products generally lasted longer than smaller products, a finding consistent with data on the age of products in the currently stock. On average, large white goods, televisions and hi-fi systems lasted longest (9 to 12 years), whereas small work or personal care appliances, mobile phones and pagers, and toys were discarded after only 4 years (Table 5.1).

Overall, around one third of discarded appliances (33%) were reported as *"still functioning"*, notably cookers, hi-fi and stereo, mobile phones and pagers, and computers and peripherals. Just over one in five discarded appliances (21%) were described as *"in need of repair"*, while less than one half were considered *"broken beyond repair"* (46%). Thus around one-third of those appliances discarded in a state of disrepair were considered to be reparable.

[4] The average was calculated as the mean.

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The proportion of discarded appliances that were functional differed between product categories. The proportion of computers and peripherals and mobile phones and pagers still functioning when discarded was around 60%, and of hi-fi systems and cookers almost 50%. Small work and personal care appliances, home and garden tools, and wet appliances were least likely to still work when discarded, only around 15% to 25% being reported as still functional (Fig. 5.5). The average age of discarded products did not vary substantially by their condition (Table 5.2).

Table 5.1: Age of discarded appliances and proportion of current stock over 10 years old

Product category	Average age of discarded appliances (1993-1998) (years)	% current stock over 10 years old (1998)
Electric cookers	12	26%
Microwave ovens	7	14%
Refrigerators and freezers	11	21%
Washing machines, dishwashers and tumble driers	9	14%
Vacuum cleaners and carpet cleaners	8	13%
Small work or personal care appliances	4	10%
Hi-fi and stereo	9	14%
Radio and personal radio, stereo and CD	5	8%
Televisions	10	13%
Video equipment	7	7%
Telephones, faxes and answer machines	6	7%
Mobile phones and pagers	4	2%
Computers and peripherals	6	4%
Toys	4	3%
Home and garden tools	7	19%

Table 5.2: Average age and condition of discarded household appliances

Product category	Average age of all discarded appliances (years)	Average age of appliances "broken beyond repair" (years)
Electric cookers	12	12
Refrigerators and freezers	11	11
Televisions	10	10
Hi-fi and stereo	9	9
Washing machines, dishwashers and tumble dryers	9	9
Vacuum cleaners and carpet cleaners	8	7
Video equipment	7	7
Home and garden tools	7	7
Microwave ovens	7	7
Computers and peripherals	6	8
Radio and personal radio, stereo and CD	6	5
Telephones, faxes and answer machines	6	5
Mobile phones and pagers	4	4
Small work or personal care appliances	4	4
Toys	4	3

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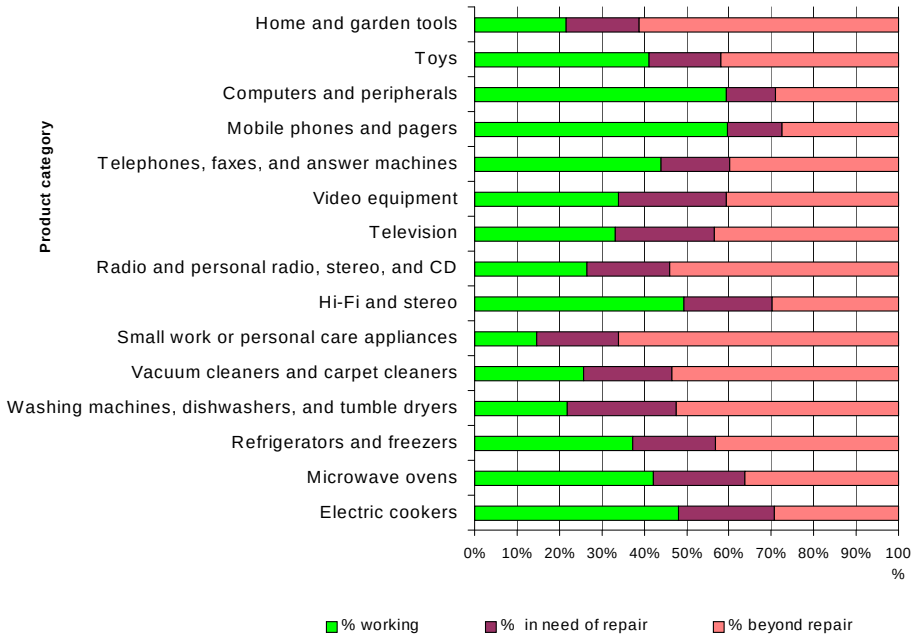
Figure 5.5: Condition of discarded household appliances



5.3 Disposal routes and the recycling of appliances

As noted above (section 5.1), most household appliances (328,000 tonnes, equivalent to 69%, by mass, of the total) were disposed of through routes in which they are kept separate from other waste and can be treated and sent for recycling (Fig. 5.3). This data may be disaggregated as follows:

- Taken to local authority civic amenity site (25% of total waste by mass)
- Collected by retailer or supplier on delivery of new product (17%)
- Collected by local authority as bulky waste (16%)
- Given to scrap merchant or recycling company (6%)
- Traded in to retailer for discount on purchase of new product (5%).

Most of the appliances disposed of through these routes were large white goods (84%, by mass, amounting to 276,000 tonnes). It appears from other research (ICER, 2000) that products entering these routes are likely to be sent for recycling (discussed below in Section 5.7.3). However, focus group participants had varying levels of awareness of what happened to their discarded products, some being aware of recycling and others not:

> *"When the Council take big items you don't know what happens to them. Do they break them down or do they maybe sell them for parts? They could be selling them on to retailers!"* – Rachel, age 24, administrative officer

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"It becomes a bit of a nightmare…you think that the Government or your Council have got things in hand…and then you hear of things like in Russia where they leave all these nuclear submarines all rotting in the sea or somewhere. So it does make you wonder really what does happen to them. Are they disposed of responsibly?" – Margaret, age 56, unemployed

The total volume of discarded appliances destined for landfill or incineration is likely to be around 81,000 tonnes annually, excluding any large white goods that may not be recycled. This consists of around 52,000 tonnes of appliances that, although collected separately by retailers, local authorities or recycling companies, have no net recycling value: products such as televisions, microwave ovens, home and garden tools, and vacuum cleaners. In addition, it includes 22,751 tonnes of appliances collected as ordinary waste by local authorities and 3,144 tonnes discarded in skips at their owner's workplace and 3,329 tonnes left, illegally, on the nearest convenient skip or waste ground.

Several focus group participants indicated that "totters"[5] or other would-be opportunists often reclaimed for reuse or resale appliances that they had discarded:

> *"I put my cooker outside and rang the Council up and somebody had taken it before the Council had got there."* – Sandra, age 40, unemployed
>
> *"There's a tip at Loth in Lincolnshire. You drive round and it's like a mound, and behind this mound there's a workmen's hut and they sell televisions, fridges, freezers, all lined up for sale. They might not be any good, so they're going to end up going back and forth aren't they?"* – Shirley, age 64, retired
>
> *"The rag and bone men are back off holiday now. Anything electrical, or anything that can be recycled, it goes in the back of their van…We do have recycling schemes and there's a place you can take things where they repair them and pass them on to people who are in need…I've passed on nothing electrical."* – Julie, age 45, upholsterer
>
> *"I had a mixer/blender and I wasn't sure really what to do with it…I put it in a carrier bag…and put a sticker on saying 'This is a mixer.' It was gone as soon as the rubbish van came round."* – Jackie, age 42, dental technician

Some participants expressed concern about environmental and health considerations relating to the disposal of their appliances:

> *"I had a microwave oven, I cut its wires off and I put it in the bin… I wouldn't anybody messing with it. It's like fridges, people used to leave them outside, children have gone in them and died."* – Elaine, age 52, administrative assistant
>
> *"Some things, like fridges and gas cookers, have to be collected specially because they are environmentally dangerous."* – Jeff, age 33, TV presenter

Others admitted that they did not care:

"Most of the time you are not really bothered what they do with it afterwards because it's gone now and that's it." – Richard, age 24, unemployed

[5] Self-employed individuals reclaiming appliances and other valuable waste from civic amenity sites under rights in law.

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5.4 The reuse of household appliances

Almost a quarter of discarded appliances (24%, by units) were reused (the proportion by mass was just over 22%, amounting to 104,000 tonnes). Most of these were donated (18%); the remainder were sold (6%). The most common process of reuse was donation to family and friends (15% of the total, by units), followed by private sales (e.g. through a second-hand dealer, newspaper, car boot sale, or shop window) (6%), donation to charity (2%) and given to a repairer for spare parts (1%).

Appliances most often reused[6] included computers and peripherals (67% of discarded items), followed by hi-fi and stereos (44%), and video equipment (36%) (Table 5.3). Wet appliances (12%), small work or personal care appliances (16%), and radio and personal stereos (19%) were least often reused.

Table 5.3: Discarded household appliances reused (1993-98)

Product category	% discarded items reused
Electric cookers	24%
Microwave ovens	35%
Refrigerators and freezers	22%
Washing machines, dishwashers and tumble driers	12%
Vacuum cleaners and carpet cleaners	22%
Small work or personal care appliances	16%
Hi-fi and stereo	44%
Radio and personal radio, stereo and CD	19%
Televisions	30%
Video equipment	36%
Telephones, faxes and answer machines	33%
Mobile phones and pagers	33%
Computers and peripherals	67%
Toys	35%
Home and garden tools	22%
ALL PRODUCTS	**24%**

Several participants in the focus group research indicated that they preferred to resell or find new homes for their old appliances before resorting to disposal:

> *"Generally, if you get the local advertiser, everybody likes the free advertising. It's no problem just to pop it in. If anybody comes, that's all well and good, but if they don't it just gets chucked in the bin."* – Charles, age 69, retired

> *"A couple of things we tried to sell to a dealer…He wouldn't buy them…so the Council came and picked them up. We do try to sell things first, if they're worth anything, or give it to a youngster who has just started up a home."* – Peter, age 60, retired steelworker

[6] Excludes parts reused through repair.

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> *"Sometimes we sell things at car boot sales…A friend of the family was actually moving into another flat, so I gave her a fridge-freezer. At least you know that they were working, and you don't feel as bad as if you sell them."* – Jackie, age 42, dental technician

The preferred routes for obtaining second-hand products appeared to be from family or friends, although this was not always without problems:

> *"I think if you buy it from a friend they are not going to sell you something that's not going to work."* – Margaret, age 56, unemployed

> *"In the past I've bought stereos and things like that second-hand from friends, so you know that you've got some comeback. If you buy second-hand off someone you don't know, you've got no comeback."* – Steve, age 24, technical development manager

> *"If I knew whom I was buying it off, like, a friend or relative, and they were just replacing it because they had a new one, I would buy it if I needed the item."* – Anne, age 45, retired HGV driver

> *"We bought a fridge freezer off my friend's husband, who bought himself second-hand things and so called...repaired them. It wasn't cheap. From the moment I brought it home, it was faulty. Because he sold it, he didn't want any comeback. I wouldn't fall out with my friend, but I could have done very easily...I would never buy from a friend again because it could cause so many problems and I'm not the type to go off ranting and raving and get my money back."*– Sue, age 44, motor company managing director

5.5 Disposal behaviour for different types of product

Disposal routes varied highly significantly between different product types (shown in Fig. 5.6 and, in more detail, Appendix 14). A comparison of the proportion of appliances in each category disposed of as ordinary waste, disposed of illegally, collected for recycling, or reused revealed that:

- Computers and peripherals, hi-fi and stereos, and video equipment were most likely to be reused (around 67%, 44% and 30% of items discarded, by mass, respectively).

- Smaller products (including small work or personal care appliances, radio and personal radio, stereo and CD, telephones, faxes, and answer machines, and mobile phones and pagers) were most likely to be collected as ordinary waste by local authorities (63%, 53%, 36% and 33% of items discarded, by mass, respectively).

- Hi-fi and stereos, radio and personal radio, stereo and CD, and vacuum cleaners were most likely to be disposed of illegally on the nearest convenient skip or waste-ground (over 2% of products within each category).

- Larger appliances were most likely to be collected separately and recycled. As suggested above (Section 5.3), 81% of wet appliances, 73% of cold appliances, 68% of electric cookers and 61% of televisions (by mass) were disposed of through routes in which recycling was likely.

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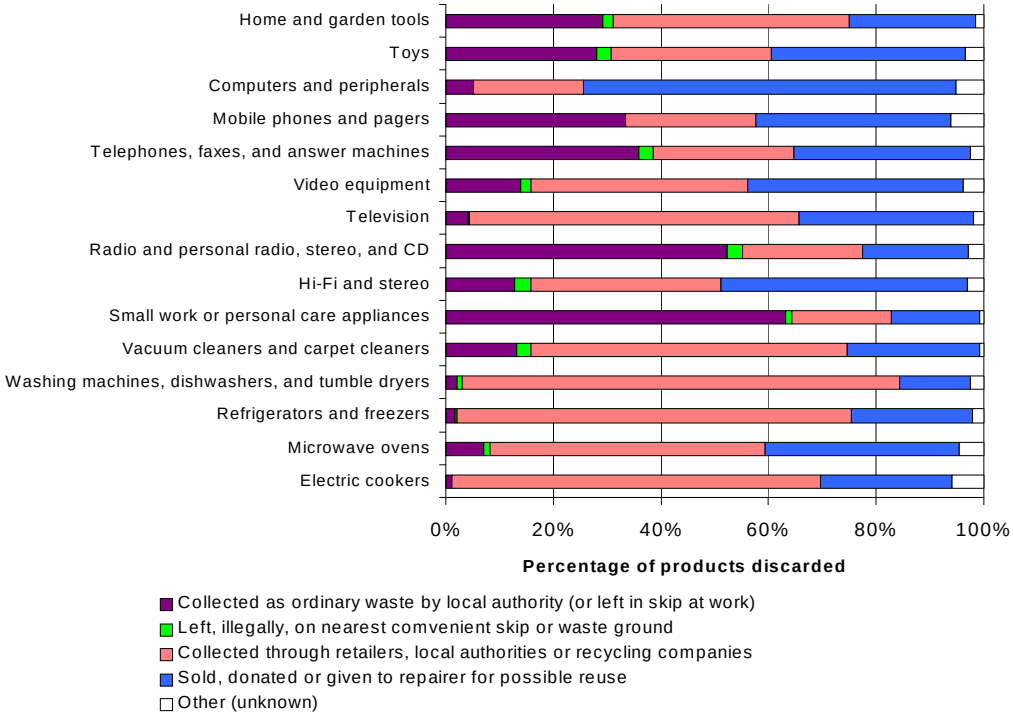
Figure 5.6: Disposal routes used for household appliances



Statistical summary

$\chi^2 = 1602.6$, **$p<0.001$*****
Degrees of freedom = 56
χ^2 calculated from data expressed as total number of products.
Expected frequencies derived from overall rates of disposal by product type, assuming disposal routes have no influence.

The focus group research provided additional insights into the use of different disposal routes:

> *"The brutal truth is, if it was a fridge or something heavy or a washing machine, you've got to get rid of it, if it's hairdryer you can stick it in the dustbin."* – Phil, age 65, retired computer analyst

> *"There are only 1, 2, or 3 categories. If it's tiny, throw it away or sell it. If it's something like a fridge or cooker, you know you've got to ring the Council to take it. I think most people will know that now."* – Jeff, age 33, TV presenter

> *"If it's small it's too easy to put it in the bin isn't it?"* – Malcolm, age 56, retired factory foreman

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Some participants indicated that collection by suppliers delivering a new product represented a convenient service for larger white goods:

> *"Anything like a cooker, that large, I would try and get the firm I was buying a new one from to take off my hands."* – Roger, age 52, telecommunications engineer

> *"Well, the last fridge we bought, the people who delivered it took the old one away with them, so I didn't have to!"* - George, age 70, retired fitter

5.6 Variations in disposal behaviour

Potential differences in disposal behaviour between households according to socio-economic status, car ownership and attitudes to environmental issues, recycling and waste reduction were explored.

The differences in disposal behaviour by socio-economic group and car ownership were highly significant (Figs. 5.7 and 5.8). At the same time, car ownership increased, highly significantly, with socio-economic status, from 37.0% in group E to 93.5% in group AB (Table 5.4).

Households of higher socio-economic status and those owning a car were significantly less likely to discard products as ordinary municipal waste and more likely to deliver products to civic amenity sites. For example, those in group AB disposed of around 10% fewer of their appliances as ordinary municipal waste than group E and delivered 5% more of their appliances to civic amenity sites. Similarly, car owners discarded around 5% fewer of their appliances as ordinary municipal waste than householders without cars and delivered around 8% more of their appliances to civic amenity sites.

Respondents in group E disposed of far more of their appliances illegally (around 5%, by number of units) than those in other socio-economic groupings (around 1%). Respondents in group E also only gave around 10% of their discarded appliances to family or friends, compared to around 15% for other socio-economic groupings. Car owners disposed of 2% of their appliances illegally, whereas householders without cars disposed of only 1% in this manner.

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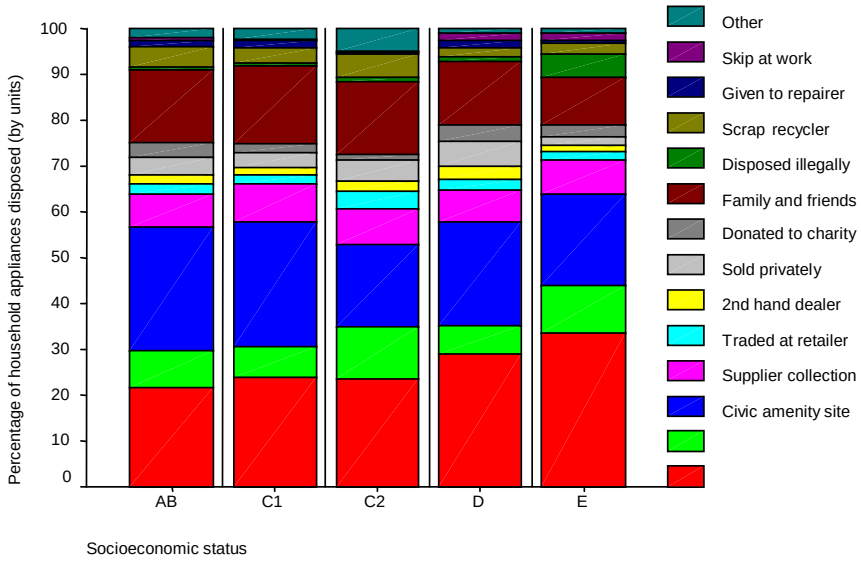
Figure 5.7: Disposal route of household appliances, by socio-economic group[7]



Statistical summary

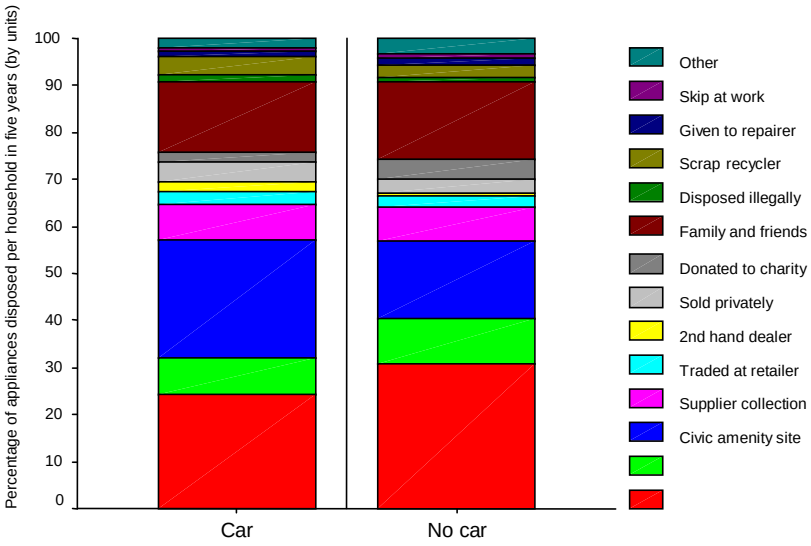
$\chi^2 = 228.3$, **$0.001<p<0.01$****

Degrees of freedom = 52

χ^2 calculated from data expressed as total number of products (i.e. units).

Expected frequencies derived from number of households of different socio-economic status assuming disposal routes have no influence.

Figure 5.8: Disposal route of household appliances , by car ownership



Statistical summary

$\chi^2 = 54.4$, **$0.001<p<0.01$****

Degrees of freedom = 13

χ^2 calculated from data expressed as total number of products.

Expected frequencies derived from number of households owning/not owning cars assuming disposal routes have no influence.

[7] 'Disposal as waste' refers to ordinary municipal waste in this and subsequent figures.

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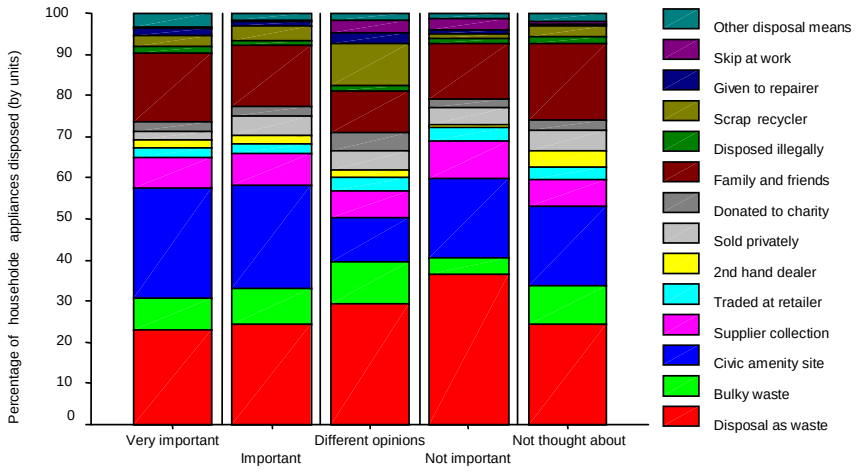
Table 5.4: Car ownership, by socio-economic status

Socio-economic grouping	AB	C1	C2	D	E	Total
Number of households	186	235	178	106	92	797
Respondents with car (observed)	174.0	210.0	154.0	73.0	34.0	645
Respondents with car (expected)	150.5	190.2	144.1	85.8	74.5	
Respondents without car (observed)	12.0	25.0	24.0	33.0	58.0	152
Respondents without car (expected)	35.5	44.8	33.9	20.2	17.5	
$(Oj-Ej)^2/Ej$	3.7	2.1	0.7	1.9	22.0	**0.001<p<0.01****
$(Oj-Ej)^2/Ej$	15.5	8.8	2.9	8.1	93.3	$\chi^2 = 158.9$
% car ownership	93.7%	89.4%	86.5%	68.9%	37%	

Degrees of freedom = 4
Expected frequencies derived from number of households owning/not owning cars, assuming socio-economic status has no influence.

Respondents' attitudes to the importance of recycling and waste reduction were related to disposal behaviour (Figs. 5.9, 5.10 and 5.11). Respondents believing waste recycling and reduction to be *"very important"* only disposed of 22% to 25% (by units) of their household appliances as ordinary municipal waste, which is unlikely to be recycled, whereas those considering these issues *"not important"* disposed of between 30% and 35% of their appliances in this way. Tests revealed these differences, and those relating attitudes to environmental issues with disposal behaviour, to be highly significant.

Figure 5.9: Relationship between attitude to recycling and disposal route



Statistical summary

$\chi^2 = 202.4$, **0.001<p<0.01****
Degrees of freedom = 56
χ^2 calculated from data expressed as total number of products.
Expected frequencies derived from number of households using specified disposal routes, assuming different attitudes have no influence.

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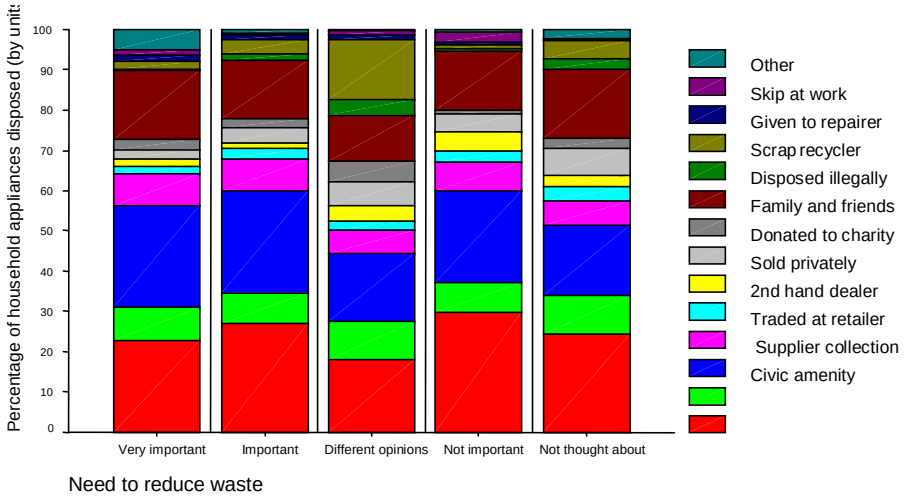
Figure 5.10: Relationship between attitude to waste reduction and disposal route



Statistical summary

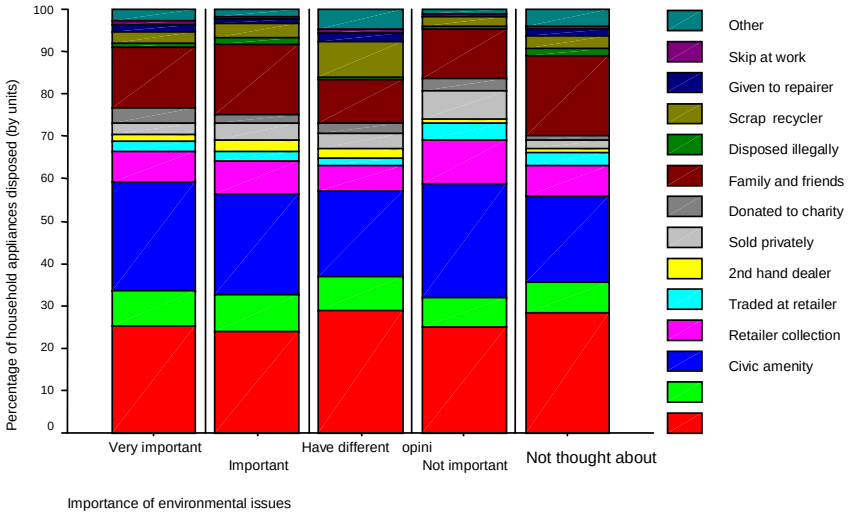
$\chi^2 = 300.6$, **$0.001<p<0.01$****

Degrees of freedom = 56

χ^2 calculated from data expressed as total number of products.

Expected frequencies derived from number of households using specified disposal routes, assuming different attitudes have no influence.

Figure 5.11: Relationship between attitude to environmental issues and disposal route



Statistical summary

$\chi^2 = 131.1$, **$0.001<p<0.01$****

Degrees of freedom = 56

χ^2 calculated from data expressed as total number of products (i.e. units).

Expected frequencies derived from number of households using specified disposal routes, assuming different attitudes have no influence.

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5.7 Discussion: Product disposal

The results presented in Sections 5.1 to 5.6 reveal the quantity of appliances being discarded, their age and the use of different disposal routes by householders. This section analyses these results in more detail and considers some implications for future producer responsibility legislation.

5.7.1 Quantity and condition of discarded products

The identification of 23 million appliances discarded annually, itself considered to be a minimum estimate (Section 5.1), suggests that an earlier Government figure of 12 million was a serious underestimate (Section 1.1).

The mass of waste identified, around 476,000 tonnes per year, is lower than the amount (915,000 tonnes) identified by ICER (2000) (Section 1, above). Moreover, the E-SCOPE data included discarded appliances that were reused.

This is the result of different methodologies. The ICER data is based on estimates of product replacement derived from estimates of product sales and levels of market saturation, whereas the E-SCOPE data is based on information on discarded products supplied directly by householders (i.e. self-reported data). The following are specific explanations for the different totals:

- ICER data includes computer, telecommunications and audio-visual equipment sold into the commercial sector, whereas E-SCOPE data does not (N.B. This accounts for most of the difference).
- ICER data is based on product replacement, which may have led to an overestimate as it is unclear whether the data took full account of appliances that are kept rather than discarded on replacement (e.g. for use in other rooms or as a back-up).
- ICER data includes items from estates of the deceased which may not be covered by E-SCOPE data.
- ICER data is based on recent sales data, whereas E-SCOPE data refers to products discarded between 1993 and 1998, which would have been sold in an earlier time period.
- ICER data includes items returned under warranties that retailers discard as waste rather than repair and resell, whereas E-SCOPE data does not.

Reasonable consistency was found with ICER's earlier investigation of quantities of WEEE recycled through UK recycling companies (ICER, 1998). This estimated that 310,000 tonnes of large household appliances were recycled within the UK in 1997, of which 49% was collected through local authorities (including civic amenity sites and bulky goods collections) and 51% through retailers and distributors.[8] E-SCOPE results revealed that around 276,000 tonnes of large white goods were discarded through routes likely to lead to recycling, involving local authorities (57%), retailers and distributors (35%) and donation or sale direct to recycling companies (8%).

[8] ICER's later report estimated total arisings from large household appliances at 392,000 tonnes (ICER, 2000).

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The quantitative side of this study did not address the disposal of appliances of the deceased, being a highly sensitive topic. It is not known how many products are discarded in this way. Given the tendency of householders to accumulate appliances over time, it may constitute a substantial volume of waste. One comment from the focus groups is noteworthy:

> *"When my grandmother died, my mother phoned the Council up and said; 'There's a fridge, a freezer, a washing machine, and a cooker. Can you fetch them?' …they said 'put them out the back, and we will be there within 4 weeks.' They were there for two days fetching them out of the house."* – Sandra, age 40, unemployed

Data on the condition of discarded appliances revealed that more than a half of computers and peripherals and mobile phones and pagers were still functional when discarded. It is likely that they were replaced as a result of rapid technological change before being subject to technical failure. Almost 50% of discarded cookers were still functional and this may be due to a trend towards replacement of all appliances during renovation:

> *"Most people if they are having their kitchens revamped for instance would have a complete set of units; you would have a new cooker, a new fridge, new washing machine to fit into the units."* - Phil, age 61, motor mechanic

A third of appliances discarded in the UK were *"still functioning"* (Section 5.2, above), confirming anecdotal evidence (Hunkin, 1988) and supporting a 1985 study by Wilkie and Dickson (cited in Bayus, 1988 and Ziebarth, 1992) and a 1982 Dutch survey of large kitchen appliances and televisions cited by Antonides (1990) that gave figures consistent with the E-SCOPE data, although slightly fewer items had been discarded while still functional. An earlier study by Box (1983) found that 65% of products were described by their owners as usable at the time of disposal. Such behaviour highlights the ability of affluent people to update their appliances periodically and social pressure that encourages them to acquire the latest products.

The fact that the average age of discarded products did not vary substantially according to their condition (Section 5.2) appears to support claims that in many cases technical failure is not the primary reason why people discard and replace appliances (Box, 1983; Garling, 1995).

5.7.2 Product life spans

The data revealed the average age of discarded appliances is between 4 and 12 years old, depending on product category (Section 5.2, above). Larger, more expensive products such as white goods were oldest when discarded, while computers, mobile phones and pagers, and smaller products are discarded after shorter periods.[9]

The data on product life in this study is the most authoritative available. Estimates from earlier research, which used different methodologies, appear to over-estimate life spans. AEA Technology (1997), for example, estimated the average life span of many items (cookers, microwave ovens, vacuum cleaners, televisions, video equipment, home and

[9] Although there is a tendency for respondents to round the age of appliances to the nearest five years, Bayus (1988) cites research suggesting that this should not cause concern.

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garden tools and small work or personal care appliances) to be three years longer than that indicated by E-SCOPE data.

Past research has indicated that product life spans are dependent on a wide range of factors, involving producers and consumers alike. They include the quality of design and production, the development of new technologies, the cost of repair and availability of spare parts, fashion, and residual product values (to allow for resale) (Cooper, 1994b; Heiskanen, 1996; Kostecki, 1998). There is no comprehensive and directly comparable historic data relating to the UK which would demonstrate a trend in product life spans. Bayus (1988) cites evidence that product reliability is increasing. If this is true, data which indicates that product life spans are not increasing and, in the case of cookers and freezers, possibly declining (OECD, 1982, Ruffin and Tippett, 1973, cf. Pennock and Jaeger, 1964), strengthens the argument that functionality alone does not determine product life.

This argument is reinforced by survey evidence that many appliances discarded in the UK were *"still functioning"*. Although over one third of appliances discarded were still functioning, only one quarter actually entered reuse. It can thus be deduced that around one in ten discarded appliances still functioned but, even so, were discarded for recycling or final disposal (i.e. landfill or incineration). It is estimated that over 2 million products for which life spans could be extended are currently "lost" within the current waste disposal system.

Further analysis of the data with respect to consumer expectations and satisfaction concerning product life spans is provided below (Section 6).

5.7.3 Disposal routes and the recycling of appliances

Most large household appliances are disposed of in ways that allow them to be sent for recycling (Section 5.3, above). They are discarded and collected separately from ordinary municipal waste and so are already under the kind of control required for producers to comply with future producer responsibility legislation. However, tighter environmental standards under this legislation may require that current recycling systems are improved substantially and extended to include smaller appliances. This may benefit householders, who in the focus groups revealed concern over the safe and environmentally responsible disposal of appliances (Section 5.3, above, and 6.5, below).

Enhanced collection and recycling processes and infrastructure are likely to be required to meet the targets for recycling in proposed EU legislation. In particular, new collection and recycling processes will be required for smaller products (most of which are currently discarded as ordinary municipal waste), audio-visual equipment and vacuum cleaners. In addition, partnership agreements may be required between industry, distributors, recyclers and local authorities, in order to resolve issues of control and ownership and ensure that producers are able to meet targets. The future development of product collection, treatment and recycling services is discussed further below and in Section 6.5.

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5.7.4 Product reuse

Understanding the reuse of household appliances is important as it enables the remaining utility and residual value of products to be exploited before final disposal. Reuse is an important concern of Government policy, being given priority over recycling in the waste management hierarchy (DETR, 2000). The amount of reuse will influence the age and quantity of items arising for disposal. The impact on reuse of the proposed EU legislation is, however, currently uncertain.

As noted above (Section 4.7.5), the scale of reuse in the UK was not previously known. It was found to vary between product categories, with computers and hi-fi and stereo reused most frequently and wet appliances and small work or personal care appliances least frequently (Section 5.4, above). The extent of computer reuse was in keeping with evidence that a majority still functioned when discarded. The other product category for which a majority of products were discarded in working order was mobile phones and pagers, but these were less often reused. The low level of reuse of wet appliances is consistent with evidence that they are less likely to be functional when discarded. One explanation of low levels of reuse for small work or personal care appliances is the relatively cheap cost of replacement relative to repair. The data confirms that such appliances tended to be broken when discarded (Section 5.2, above).

A comparison is needed to explain the high level of reuse of products discarded between 1993-1998 (24%) in relation to the proportion of the current stock of appliances identified as second-hand (5.2%) (Sections 4.4 and 5.4, above). There are two likely explanations.

First, in markets that are not saturated (e.g. computers and telecommunications products), the total stock is growing at the same time as products are being discarded. In these product sectors, many discarded items still function and there is much reuse, but the share of the current stock that is second-hand is very small because second-hand products have only become available relatively recently. Thus 67% of computers are discarded for reuse but only 6% of the current stock is second-hand. This contrasts with products such as cookers and refrigerators and freezers, which have been reused for many years. Between 20% and 25% of such items are reused when discarded, while over 10% of the stock is second-hand (Tables 4.6 and 5.5, above).

Second, the relatively small stock of second-hand appliances in product sectors where the market is saturated suggests that the residual life of reused items is often low. This is reinforced by data showing that the average age of discarded products described as *"still functioning"* is not dissimilar from that of products disregarded in disrepair (Section 5.2, above).

Focus group participants indicated that the potential for reuse influenced their decisions to dispose of appliances. Participants wanted discarded products to go to a "good home" and would only dispose of appliances in other ways if reuse was not possible (Section 5.4):

> *"I've just got rid of my oven and bought a brand new one. There was nothing wrong with it. I wanted to upgrade to a better one because it was 4 years old. The old one hadn't stopped working, but I sold that to my brother."* – Sharon, age 24, bar person

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As second-hand ownership is related significantly to socio-economic grouping (Section 4.6.1, above) and (it may be safely assumed) new product prices, economic conditions are likely to affect disposal behaviour. For example, greater prosperity may increase the disposal of products that still function and, depending on trends in income distribution, result in reduced demand for second-hand products. This would lead to an increase in the proportion of functional items ending up recycled, incinerated or landfilled.

Finally, evidence from the focus groups suggested that product reuse is strongly influenced by the extent to which the "buyer" or "receiver" trusted the "seller" or "giver" (Section 5.3, above). Some participants expressed concern that appliances sent for disposal at civic amenity sites are sometimes reclaimed and sold.

Reuse can result in substantial environmental benefits when it replaces the manufacture of new products. However, the sale of second-hand items does not necessarily replace the sale of new items. For example, some focus group participants indicated that they obtained second-hand appliances when buying new was not possible due to economic constraints, such as equipping their children when leaving home. In addition, ownership of second-hand appliances was significantly higher with households of lower socio-economic status, who may not otherwise be able to buy new. In such cases reuse increases the total quantity of equipment in use. The net environmental effect of reuse needs to be carefully investigated by studying environmental impacts throughout the product life cycle. For example, one possible outcome of the reuse of ageing refrigerators and freezers could be to increase energy consumption.

The development of remanufactured or reconditioned product resale services is discussed in Section 6.6, below.

5.7.5 Disposal by product type

The study results confirm that disposal behaviour is influenced by appliance type. In focus group discussion two main factors appeared to influence choice of disposal route for any particular product:

- The perceived residual value of the product to be discarded and the actual value recoverable or realisable via any particular disposal route.
- The relative size of the product to be discarded and the convenience of the disposal route used (Section 5.5, above). For example, focus group participants explained that small products were disposed of with ordinary municipal waste because they are small enough to fit into a household bin.

Different collection and disposal processes received significantly different mixes of product types. The implications of this finding for the proposed WEEE Directive are discussed further below in Section 5.7.7.

The rate of technological development explains why many discarded computers and peripherals were functional, many of which enter reuse (almost 70% of those discarded). Given that they are discarded after 6 years, on average, and that the home computing market has only developed substantially within the last decade, the quantity of computer waste discarded annually is certain to rise further.

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5.7.6 Disposition behaviour

An analysis of product ownership and disposal reveals certain overall trends and patterns affecting the "flow" of discarded products within society. One example is an apparent redistribution of products from more affluent households to households in lower socio-economic groupings as appliances get older. This suggests that households of lower socio-economic status are more likely to discard old appliances that are not suitable for reuse. In other words, they will be the last user before final disposal and will therefore play a crucial role in ensuring that products with no reuse value are wherever possible recycled. However, at present such households dispose of significantly more appliances than other households as ordinary municipal waste and through illegal means.

Collection through retail outlets or municipalities (as proposed in the WEEE Directive) may fail to capture a substantial proportion of discarded appliances, because householders of lower socio-economic status, being less likely to have their own means of transport, are less able to return appliances (Section 5.6, above). The requirements of householders disposing of appliances should be addressed if effective disposal services are to be established.

5.7.7 Product disposal and future legislation

The E-SCOPE research has provided a much more detailed overview of the distribution of waste arisings from specific products through various disposal routes (in both units and mass) than existed previously for the UK. The results show variation between the disposal activities of different groups of people within society (Section 5.6, above). This level of detail is important to industry and government in planning compliance with future EU producer responsibility legislation. Take-back schemes should not be set up on the basis of anecdotal evidence. The variations between the disposal behaviour of different households are too great for generalisations to be reliable enough to develop effective processes to meet the proposed recovery and recycling targets.

The data on product disposal will aid the development of collection services through better understanding of the segmentation of the market for such services. It is generally recognised that such an approach may be usefully applied in the field of logistics and distribution management:

> *"Companies may waste resources and alienate customers by applying one logistics system to all customers ('generic' logistics). Just as most businesses can identify distinctive market segments…most companies compete in 'logistically distinct businesses'"* – Murphy and Daley, 1994: 13

Similarly, it has been argued that market segmentation approaches may be of use in developing effective waste collection and recycling schemes and increasing participation rates (Howenstine, 1993). This research has revealed key market segmentation factors for the disposal of household appliances, defining groups of householders with different patterns of behaviour. They include factors relating to the end-user (i.e. the disposer), the service provided and the type of product discarded:

End-user: Household affluence (including car ownership and socio-economic status) and attitudes (including "pride in possessions", waste and the environment).

Deleted: Although research into disposition behaviour began to emerge almost twenty years ago (Jacoby et al, 1977; Hanson, 1980; Thørgesen, 1996), it continues to attract far less attention than purchasing behaviour. The E-SCOPE results offer some important new insights in relation to different social groups.¶
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Service provided: Collection service, disposal method and resale options.

Type of product: Size, function, residual product or materials value, new product prices and degree of technological obsolescence.

As an example, product end-users appear to have a low tolerance of relatively small differences in decision-making factors. Circumstances specific to a household might influence their decision to dispose of an appliance in a particular way. For example, if householders could not find a convenient reuse option for unwanted appliances within a relatively short period, they might dispose of them without further reuse (a service-related factor).

Some of the information required to aid market segmentation decisions is not easy to quantify or interpret (e.g. attitude to material wealth) or might be unpredictable in specific situations (e.g. availability of reuse options). Further research may therefore be necessary in the planning and development of new recycling schemes (for example to determine regional patterns of product disposal).

The quantitative and qualitative information on the disposal of appliances should be useful in helping the European Commission to set achievable collection and recovery targets and to develop effective legislation. It should also help the UK Government in negotiations with the Commission and, ultimately, to transpose the Directive effectively.

As noted above (Section 5.1), the recycling and disposal of appliances is more complex than for "consumables" waste such as packaging or organic wastes. For example, there were over thirteen different methods of disposal for appliances, whereas "consumables" are usually discarded either as ordinary municipal waste in dustbins, wheelie bins or rubbish sacks or taken to a civic amenity site (e.g. for garden waste) or neighbourhood recycling centre (e.g. bottle bank).

The current singular, all-embracing legal classification of discarded products as "waste" could lead to inconsistent interpretations of which sources of WEEE should be treated and recycled between different companies and even different countries. In particular, discarded items destined for reuse may need to be distinguished in the legal definition from items destined for final disposal. The classification of discarded appliances as waste and the emergence in the debate on producer responsibility of the term "end-of-life" is based on an assumption that there is a single "point" at which product life ends. However, this belies the fact that products may enter waste streams and exit them again, passing in and out of use, following a cascade through which they become financially, functionally and materially degraded (Sirkin and ten Houten, 1994).

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5. RESULTS AND DISCUSSION: PRODUCT DISPOSAL . 44¶

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6. Results and discussion: new product and service development

Results and key findings on consumer attitudes and behaviour relating to product life spans, recycling and disposal services, and reconditioning and reuse are presented in this section. As opinions are not easy to capture using quantitative techniques, the focus group results are used more extensively than in the previous sections. Issues relating to product life and understanding obsolescence are explored. The relevance of the findings for producer responsibility legislation is then discussed.

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6.1 Consumer attitudes and product life

Householders' attitudes to product life were explored through several questions. In order to gain insights from their experience, they were asked whether they generally found that appliances lasted as long as they would like. They were also asked to suggest a *"reasonable"* life span for appliances in each product category and to identify the categories for which they thought appliances *"should last longer than at present"*. The quantitative data was then followed up through focus group discussion.

Householders were fairly evenly divided between those who considered that appliances generally last as long as they would like (50%) and those who did not (45%) (the remaining 5% expressed no opinion). There was no significant relationship with their views on the importance of environmental issues, waste reduction or recycling.

Householders considered a reasonable life span for large appliances to be 10-13 years, depending upon the product type. However, over one third of householders thought that cookers, fridges and freezers should last at least 15 years, and in several product categories over 10% of householders thought that the product's life span should exceed 20 years. On the other hand, a reasonable life span for small work or personal care appliances, mobile phones and pagers, and toys was thought to be 6 years. Other types of product were expected to last 7-10 years (Tables 6.1 and 6.2).

The figures were compared with the average age of appliances most recently discarded in disrepair by householders and in all categories discarded appliances did not, on average, achieve the life span considered reasonable. The life span of large kitchen appliances and televisions discarded in disrepair was, on average, within one year of that considered reasonable. However, the average life span of telephones, faxes and answer-phones discarded in disrepair was only 5 years whereas a reasonable life span was thought to be 10 years. In several other product categories the average life span of discarded appliances was less than three-quarters of that considered reasonable.

Table 6.1: Age of appliances discarded in disrepair[1] in relation to life spans considered "reasonable"

Product category	Average age of appliances discarded in disrepair	Life span considered "reasonable"	Shortfall (years)	% of "reasonable" life achieved
Telephones, faxes and answer machines	5	10	5	50
Toys	3	6	3	50
Radio, personal stereo and CD	5	8	3	63
Microwave ovens	6	9	3	67
Small work or personal care appliances	4	6	2	67
Mobile phones and pagers	4	6	2	67
Video equipment	7	10	3	70
Home and garden tools	7	10	3	70
Hi-fi and stereo	8	11	3	73
Vacuum cleaners and carpet cleaners	7	9	2	78
Computers and peripherals	7	9	2	78
Washing machines, dishwashers and tumble dryers	9	10	1	90
Televisions	10	11	1	91
Electric cookers	12	13	1	92
Refrigerators and freezers	11	12	1	92
AVERAGE (all categories)	**(7.0)**	**(9.3)**	**(2.3)**	**(75)**

Table 6.2: Householders' opinions on appliance life spans considered "reasonable"

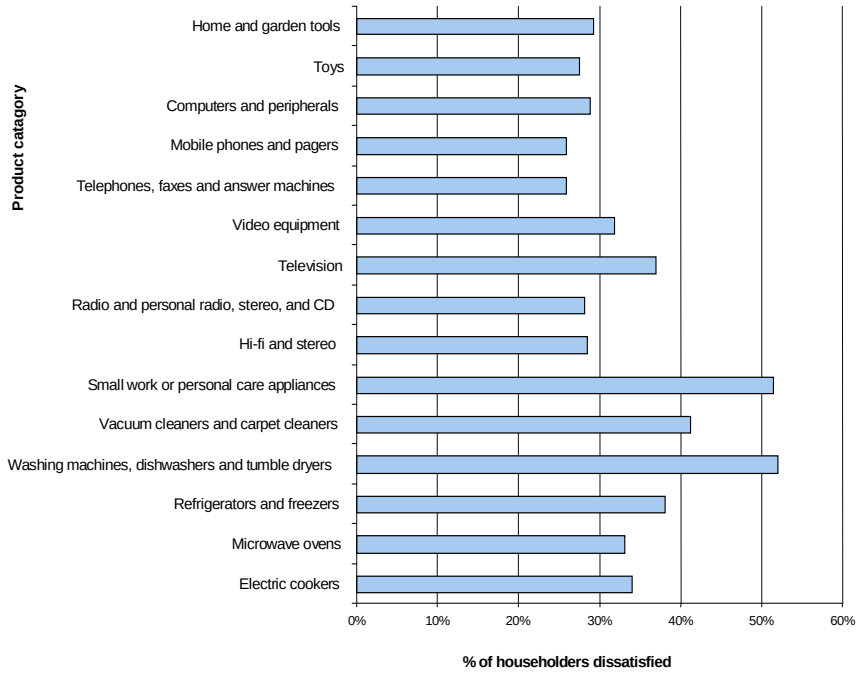
Product category	% all householders		
	Under 5 years	Over 15 years	Over 20 years
Electric cookers	6%	42%	17%
Microwave ovens	23%	14%	4%
Refrigerators and freezers	8%	34%	12%
Washing machines, dishwashers and tumble dryers	20%	18%	4%
Vacuum cleaners and carpet cleaners	36%	15%	6%
Small work or personal care appliances	69%	5%	2%
Hi-fi and stereo	17%	27%	11%
Radio and personal radio, stereo and CD	51%	10%	4%
Televisions	12%	27%	7%
Video equipment	18%	17%	4%
Telephones, faxes and answer machines	31%	26%	14%
Mobile phones and pagers	68%	4%	2%
Computers and peripherals	40%	14%	6%
Toys	67%	3%	1%
Home and garden tools	29%	25%	12%

[1] Either "in need of repair" or "broken beyond repair".

Asked to identify which, if any, types of product *"should last longer than at present"*, 26% to 52% of householders replied positively depending on the product category (Fig. 6.1). Washing machines, dishwashers and tumble driers were named most frequently, by 52% of householders, together with small work or personal care appliances (50%), whereas only 26% named telephones, faxes and answer-phones, and mobile phones and pagers. Over one in five respondents (22%) were evidently completely satisfied, replying that none of the appliances should last longer, whereas one in six respondents (16%) stated that all of them should.

Deleted: vacuum cleaners

Figure 6.1: Householders stating that appliances "should last longer than at present"



Expectations are based in part on past experience and the focus groups explored the historical context. The discussion revealed that many people believe that products do not last as long as in the past:

> *"I think things have changed, I think they are made more disposable these days, and I think probably they have sealed units that can't be repaired. Things used to last a lot longer."* - Margaret, age 56, unemployed

> *"How often have people said 'I wish I had my old one back this one is rubbish?' How many times have we said that? I know I've said it a lot of times."* - Phil, age 65, retired analyst

> *"I've only been married 15 years and I've been through 3 washing machines. And I have been told by manufacturers, each time they have come out to repair them, that they are not made to be used a lot."* - Moira, age 38, company director

> *"I think the problem is, it's not the electrical components, it's the mechanical parts of things that aren't made as sturdy now, they cut corners trying to cut costs, make metal thinner or whatever, I mean the electrical stuff is just as reliable if not more nowadays, it's the mechanical side of things."* - Roger, age 52, telecommunications engineer

Others were less critical:

> *"Things are built better and stronger than ever before."* - Jeff, age 33, TV presenter

> *"I've got two boys. They are always using the kettle and the toaster, and if you think of how much they're used, when they actually go wrong it isn't such a big deal. We've probably had it about four years and it's been used a dozen times every day, every day of its life for 4 years; well, it's not done bad really."* - Les, age 44, vehicle administrator

It is necessary to explore who is responsible for how long products last in order to identify the practical opportunities for reducing waste. In addition householder attitudes are an important consideration when assessing the appropriate design life of appliances. Some focus group participants suggested that they would never be satisfied, while others blamed manufacturers.

> *"I don't think they ever last as long as you'd like...When you buy something, obviously you want to get the maximum amount of use out of it and whenever it goes wrong - even if it's after a good length of time - you always want it last longer."* - Roger, age 52, telecommunications engineer

> *"Well a lot of them are made to break down eventually because otherwise, if they didn't break down, then they wouldn't have a market, would they?"* - Harold, age 68, retired sales supervisor

> *"Video players - I used to have a Betamax one and then all of a sudden you can't get the tapes for those and then you have to buy the VHS one. So you're pushed into buying these things."* - Colin, age 54, carer

6.2 Consumer behaviour and product life

Householders' ability and willingness to choose models designed for longevity and to get products repaired will influence the average life span of appliances. Most householders (78%) did not claim generally to buy *"premium quality"* models (Section 4.1, above). People in socio-economic group AB were more likely than others to purchase premium quality models (Table 6.3), a relationship that was highly significant. The same was true for respondents who considered environmental issues to be *"very important"* (Table 6.4) and those who considered reducing or recycling waste *"very important"*.

The results indicated a significant relationship between people's behaviour and their satisfaction with the life span of products. Consumers who generally purchased premium range appliances were significantly more likely to state that products last as long as they would like (Table 6.5). The relationship between respondents who usually get products repaired and those who find that products last as long as they would like was also highly significant (Table 6.6).

Table 6.3: Models of appliances generally purchased and socio-economic group

Crosstab

			Products generally purchased			
			Premium quality models	Middle range models	Budget priced models	Total
Socio-economic group (SEG)	AB	Count	57	110	20	187
		Expected Count	42.1	112.2	32.7	187.0
		% within SEG	30.5%	58.8%	10.7%	100.0%
	C1	Count	55	157	22	234
		Expected Count	52.7	140.4	40.9	234.0
		% within SEG	23.5%	67.1%	9.4%	100.0%
	C2	Count	37	107	32	176
		Expected Count	39.7	105.6	30.7	176.0
		% within SEG	21.0%	60.8%	18.2%	100.0%
	D	Count	17	61	27	105
		Expected Count	23.7	63.0	18.3	105.0
		% within SEG	16.2%	58.1%	25.7%	100.0%
	E	Count	12	39	37	88
		Expected Count	19.8	52.8	15.4	88.0
		% within SEG	13.6%	44.3%	42.0%	100.0%
Total		Count	178	474	138	790
		Expected Count	178.0	474.0	138.0	790.0
		% within SEG	22.5%	60.0%	17.5%	100.0%

χ^2 = 64.375, **p<0.001*****
Degrees of freedom = 8

Table 6.4: Model of appliances generally purchased and importance attached to environmental issues

Crosstab

			Products generally purchased			
			Premium quality models	Middle range models	Budget priced models	Total
Importance of environmental issues	Very important	Count	63	108	24	195
		Expected Count	44.0	116.9	34.1	195.0
		% within degree of importance	32.3%	55.4%	12.3%	100.0%
	Important	Count	78	258	66	402
		Expected Count	90.7	241.0	70.3	402.0
		% within degree of importance	19.4%	64.2%	16.4%	100.0%
	Have different opinions	Count	16	49	13	78
		Expected Count	17.6	46.8	13.6	78.0
		% within degree of importance	20.5%	62.8%	16.7%	100.0%
	Not important	Count	9	40	25	74
		Expected Count	16.7	44.4	12.9	74.0
		% within degree of importance	12.2%	54.1%	33.8%	100.0%
	Don't really think about them	Count	12	18	10	40
		Expected Count	9.0	24.0	7.0	40.0
		% within degree of importance	30.0%	45.0%	25.0%	100.0%
Total		Count	178	473	138	789
		Expected Count	178.0	473.0	138.0	789.0
		% within degree of importance	22.6%	59.9%	17.5%	100.0%

χ^2 =34.377, **p<0.001*****
Degrees of freedom = 8

Table 6.5: Model of appliances generally purchased and satisfaction with appliance life spans

Crosstab

			Appliances generally last as long as you would like?			
			Yes	No	No opinion	Total
Products generally purchased	Premium quality models	Count	95	71	12	178
		Expected Count	88.7	79.9	9.5	178.0
		% within category	53.4%	39.9%	6.7%	100.0%
	Middle range models	Count	242	207	26	475
		Expected Count	236.6	213.2	25.2	475.0
		% within category	50.9%	43.6%	5.5%	100.0%
	Budget priced models	Count	57	77	4	138
		Expected Count	68.7	61.9	7.3	138.0
		% within category	41.3%	55.8%	2.9%	100.0%
Total		Count	394	355	42	791
		Expected Count	394.0	355.0	42.0	791.0
		% within category	49.8%	44.9%	5.3%	100.0%

$\chi^2 = 9.636$, **p<0.05***
Degrees of freedom = 4

Table 6.6: Repair of appliances and satisfaction with appliance life spans

Crosstab

			Appliances generally last as long as you would like?			
			Yes	No	No opinion	Total
Frequency with which products are repaired	Usually	Count	123	81	7	211
		Expected Count	104.6	95.3	11.1	211.0
		% within category	58.3%	38.4%	3.3%	100.0%
	Sometimes	Count	121	132	10	263
		Expected Count	130.3	118.8	13.8	263.0
		% within category	46.0%	50.2%	3.8%	100.0%
	Rarely	Count	91	102	12	205
		Expected Count	101.6	92.6	10.8	205.0
		% within category	44.4%	49.8%	5.9%	100.0%
	Never	Count	50	39	7	96
		Expected Count	47.6	43.4	5.0	96.0
		% within category	52.1%	40.6%	7.3%	100.0%
	Cannot say	Count	11	7	6	24
		Expected Count	11.9	10.8	1.3	24.0
		% within category	45.8%	29.2%	25.0%	100.0%
Total		Count	396	361	42	799
		Expected Count	396.0	361.0	42.0	799.0
		% within category	49.6%	45.2%	5.3%	100.0%

$\chi^2 = 32.841$, **p<0.001*****
Degrees of freedom = 8

The need for responsible care of household appliances by users was noted by at least one focus group participant:

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> *"I suppose it depends on how often you clean them. Keep them clean and keep them working and they last longer, a lot of them."* - Richard, age 24, unemployed

Some participants thought that consumers would be willing to pay more for longer lasting products, although not all were convinced that more expensive products necessarily last longer:

> *"People will pay if it's good quality and they know it's a good product."* - Phil, age 65, retired computer analyst

> *"It doesn't matter what model you buy, the average life span of a washing machine is between 5 and 7 years."* - Lorraine, age 39, general manager

> *"I can't see a good one lasting longer than a basic."* - Shirley, age 45-64, retired

Others thought that consumer choice would depend on the product:

> *"I think cookers and washers, if they were guaranteed to last 25 years, then you would possibly pay that little bit more...but if it's a hi-fi system, or something like that, then there is a chance that you might not be able to get the disks or the tape, so you won't."* - Sue, age 36, self employed groom

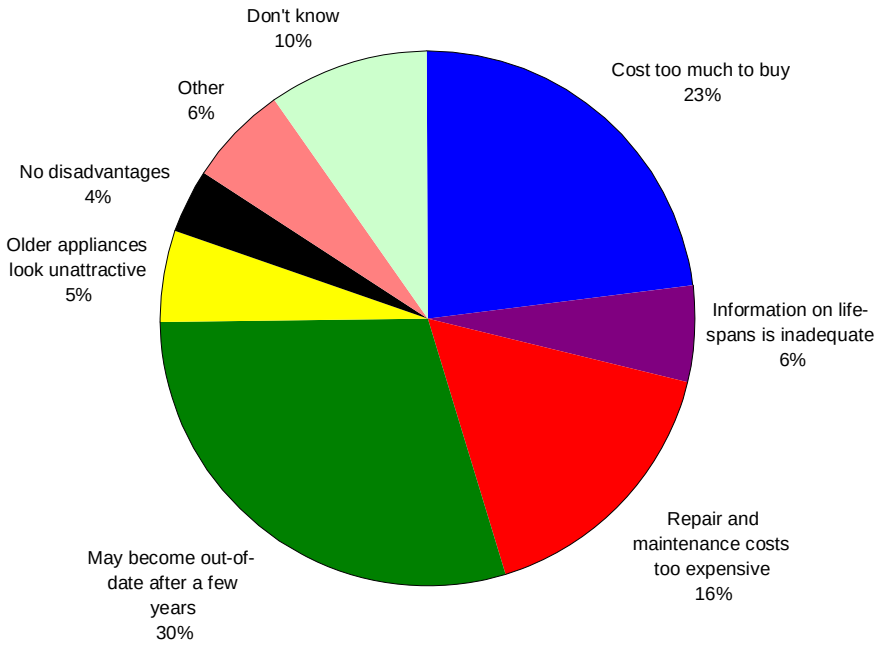
> *"It probably depends on the total price of the item. If it was a high priced item you would pay more. If it was a hairdryer or something you might think, well, I can throw it away after a year if it's not up to it - or a kettle or an iron, they're not in the same league are they? - but a TV, I think you would pay more for longer life span."* - Pete, age 52, computer programmer

Some participants were concerned that higher prices were charged for additional features that were not always required:

> *"You get these extras on there which you are paying for and yet you don't use half of them."* - Harold, age 68, retired sales supervisor

In the quantitative survey householders were asked to identify the main disadvantage to purchasing products designed to last a long time and the reason cited most often (30%) was concern that they *"may become out of date after a few years"* (Fig. 6.2). This was more than the proportion citing either price (24%) or repair and maintenance costs (17%).

Figure 6.2: Main disadvantages to purchasing appliances designed to last a long time



This finding was explored in the focus groups. In particular, it was necessary to understand how the phrase *"out of date"* was interpreted. Discussion revealed that many participants viewed technological change and fashion as problematic:

> *"I was told in a computer shop...'They are manufacturing another one to take its place'...Every time you're buying one they're ready to bring another one out, and now I think that is so unfair."* - Elaine, age 52, administration assistant

> *"The trouble with computers is as soon as you've bought one they are out of date, so you never get on top of them."* - Steve, age 24, technical development manger

> *"I just thought it looked a bit dated and the other one looks nice, but it doesn't work as well."* - Ann, age 67, retired

> *"When that television goes out of fashion you've gotta change, otherwise you're talked about."* - Peter, age 60, retired steel worker

> *"I don't buy anything new unless it breaks down or stops. I don't buy anything for fashion but if I had young children it might be different."* - Phil, age 61, motor mechanic

Some felt that new products were developed too frequently and that extra functions were unnecessary or likely to decrease reliability:

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> *"There's so many new gadgets and things on them and so much more to go wrong."* - Sue, age 36, self employed groom

> *"Sometimes...the ones that are leading the edge in technology are the ones that are at the back of the queue when it comes to how long the goods will last."* - Betty, age 68, retired

6.3 Variations in attitudes and behaviour

Potential differences in householders' attitudes and behaviour towards product life according to gender, age and socio-economic status were explored. Women were significantly more inclined than men to be dissatisfied when asked whether appliances generally last as long as they would like (Table 6.7). Relationships between the gender of respondents and life spans considered *"reasonable"* for specified products were mainly not significant. An exception was the life span of washing machines, dishwashers and tumble driers and cookers considered reasonable, which was significantly higher for men (Table 6.8).

Deleted: Focus group discussion suggested that the kitchen might be an area in which women are more likely to want to update items regularly:¶
¶
"I'm quite happy to buy something that lasts forever and keeps going. I've got a wife that says 'I want a change'...I think the wife's influence is a little bit different to mine. I just want a kettle that boils cup of water. She wants one that looks nice as well." - Les, age 44, vehicle administrator ... [1]

The disadvantages perceived by women to purchasing appliances designed to last a long time differed from those of men. Women were significantly more concerned about economic factors, such as the cost of purchase and repair, whereas men feared that the products may become *"out of date"* (Table 6.9).

Analysed by socio-economic group, the factor most likely to deter respondents in social groups AB and C1 from buying appliances designed to last a long time was a fear that they may become out of date. In contrast, those in groups D and E (and to a lesser extent C2) were deterred by the cost of purchase (Table 6.10). These variations were highly significant.

People aged 55-64 years appeared less satisfied with product life spans than those in other age groups. They were significantly more likely to state that products generally do not last as long as they would like (Table 6.11) and had significantly higher expectations of what constituted a *"reasonable"* life in many of the product categories.[2]

Table 6.7: Satisfaction with appliance life spans, by gender

Crosstab

			Appliances generally last as long as you would like?			
			Yes	No	No opinion	Total
Gender	Male	Count	182	151	26	359
		Expected Count	177.9	162.2	18.8	359.0
		% within Gender	50.7%	42.1%	7.2%	100.0%
	Female	Count	215	211	16	442
		Expected Count	219.1	199.8	23.2	442.0
		% within Gender	48.6%	47.7%	3.6%	100.0%
Total		Count	397	362	42	801
		Expected Count	397.0	362.0	42.0	801.0
		% within Gender	49.6%	45.2%	5.2%	100.0%

$\chi^2 = 6.538$, **$p<0.05$***
Degrees of freedom = 2

[2] All except televisions, video equipment, mobile phones and pagers, computers and toys.

Table 6.8: Life span of wet appliances considered "reasonable", by gender

Crosstab

			Wet appliances - 'reasonable' life span				
			1-5yrs	6-10yrs	11-15yrs	>15yrs	Total
Gender	Male	Count	68	197	79	11	355
		Expected Count	71.3	206.1	61.8	15.8	355.0
		% within Gender	19.2%	55.5%	22.3%	3.1%	100.0%
	Female	Count	90	260	58	24	432
		Expected Count	86.7	250.9	75.2	19.2	432.0
		% within Gender	20.8%	60.2%	13.4%	5.6%	100.0%
Total		Count	158	457	137	35	787
		Expected Count	158.0	457.0	137.0	35.0	787.0
		% within Gender	20.1%	58.1%	17.4%	4.4%	100.0%

χ^2 =12.381, **0.001<p<0.01****
Degrees of freedom = 3

Table 6.9: Disadvantages to purchasing appliances designed to last a long time, by gender[3]

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Crosstab

			Disadvantages to products lasting a long time					
			Cost to buy / repair	Information on life span in inadequate	May become out of date	Look unnattractive when older	Other	Total
Gender	Male	Count	130	19	127	22	15	313
		Expected Count	144.3	21.8	109.1	20.0	17.8	313.0
		% within Gender	41.5%	6.1%	40.6%	7.0%	4.8%	100.0%
	Female	Count	194	30	118	23	25	390
		Expected Count	179.7	27.2	135.9	25.0	22.2	390.0
		% within Gender	49.7%	7.7%	30.3%	5.9%	6.4%	100.0%
Total		Count	324	49	245	45	40	703
		Expected Count	324.0	49.0	245.0	45.0	40.0	703.0
		% within Gender	46.1%	7.0%	34.9%	6.4%	5.7%	100.0%

χ^2 = 9.646, **p<0.05***
Degrees of freedom = 4

[3] Two categories, cost to buy and cost to repair, were originally separate and only when combined produced a significant result.

Table 6.10: Disadvantages to purchasing appliances designed to last a long time, by socio-economic group

Crosstab

			Disadvantages to products lasting a long time						
			Cost too much	Information on life span in inadequate	Repair too expensive	May become out of date	Look unnattractive when older	Other	Total
Socio-economic group (SEG)	AB	Count	36	13	32	65	15	8	169
		Expected Count	45.7	11.8	32.5	58.9	10.6	9.6	169.0
		% within SEG	21.3%	7.7%	18.9%	38.5%	8.9%	4.7%	100.0%
	C1	Count	42	17	42	82	12	10	205
		Expected Count	55.4	14.3	39.4	71.4	12.8	11.7	205.0
		% within SEG	20.5%	8.3%	20.5%	40.0%	5.9%	4.9%	100.0%
	C2	Count	45	7	28	58	8	14	160
		Expected Count	43.2	11.2	30.7	55.8	10.0	9.1	160.0
		% within SEG	28.1%	4.4%	17.5%	36.3%	5.0%	8.8%	100.0%
	D	Count	28	6	20	24	5	5	88
		Expected Count	23.8	6.1	16.9	30.7	5.5	5.0	88.0
		% within SEG	31.8%	6.8%	22.7%	27.3%	5.7%	5.7%	100.0%
	E	Count	39	6	13	16	4	3	81
		Expected Count	21.9	5.6	15.6	28.2	5.1	4.6	81.0
		% within SEG	48.1%	7.4%	16.0%	19.8%	4.9%	3.7%	100.0%
Total		Count	190	49	135	245	44	40	703
		Expected Count	190.0	49.0	135.0	245.0	44.0	40.0	703.0
		% within SEG	27.0%	7.0%	19.2%	34.9%	6.3%	5.7%	100.0%

$\chi^2 = 38.42$, **0.001<p<0.01****
Degrees of freedom = 20

Table 6.11: Satisfaction with appliance life spans, by age

Crosstab

			Appliances generally last as long as you would like?			
			Yes	No	No opinion	Total
Age	16-24	Count	22	26	6	54
		Expected Count	26.7	24.5	2.8	54.0
		% within age	40.7%	48.1%	11.1%	100.0%
	25-34	Count	104	110	14	228
		Expected Count	112.7	103.3	12.0	228.0
		% within age	45.6%	48.2%	6.1%	100.0%
	35-44	Count	96	93	11	200
		Expected Count	98.9	90.6	10.5	200.0
		% within age	48.0%	46.5%	5.5%	100.0%
	45-54	Count	70	60	4	134
		Expected Count	66.2	60.7	7.0	134.0
		% within age	52.2%	44.8%	3.0%	100.0%
	55-64	Count	50	55	3	108
		Expected Count	53.4	48.9	5.7	108.0
		% within age	46.3%	50.9%	2.8%	100.0%
	65-99	Count	53	18	4	75
		Expected Count	37.1	34.0	3.9	75.0
		% within age	70.7%	24.0%	5.3%	100.0%
Total		Count	395	362	42	799
		Expected Count	395.0	362.0	42.0	799.0
		% within age	49.4%	45.3%	5.3%	100.0%

$\chi^2 = 24.180$, **p<0.05***
Degrees of freedom = 10

6.4 Information on expected product life

Consumers need information on the design life of products if they are to be able to select longer lasting models in addition to price, features and other criteria,

Almost three-quarters of consumers (73%) considered accurate information on the expected life span of appliances before making a purchase to be either *"extremely important"* or *"very important"* (Fig. 6.3). Only 4% stated that it was *"not important"*. However, the majority of consumers considered the information in life spans currently available to be either *"barely adequate"* (24%) or *"inadequate"* (30%), suggesting a need for improvement (Fig. 6.4).

No significant relationships were found between demographic factors and the importance or adequacy of life span information. However, respondents who believe that environmental issues are very important were significantly more likely to consider that accurate information on expected product life spans is extremely important or very important (Table 6.12). Similar results were found for respondents who believed waste reduction and recycling are very important. Respondents who believe that appliances generally do not last long enough were significantly more likely to consider current information on expected product life spans inadequate (Table 6.13).

More generally, focus group participants were asked whether information on the environmental impact of appliances is important. The few who replied referred to energy use, CFCs and waste:

> *"I think, like, with water saving and energy saving we are all a lot more aware and I think, subconsciously, though you don't think you are taking it in, you do when you read 'less water'."* - Ann, age 42, lecturer

Table 6.12: Importance of accurate information on expected life spans and importance attached to environmental issues

Crosstab

			Importance of having accurate information on expected life span				
			Extremely important	Very important	Fairly important	Not important	Total
Importance of environmental issues	Very important	Count	92	82	22	4	200
		Expected Count	64.7	82.6	44.8	7.8	200.0
		% within category	46.0%	41.0%	11.0%	2.0%	100.0%
	Important	Count	118	177	95	11	401
		Expected Count	129.8	165.7	89.9	15.7	401.0
		% within category	29.4%	44.1%	23.7%	2.7%	100.0%
	Have different opinions	Count	21	26	30	3	80
		Expected Count	25.9	33.0	17.9	3.1	80.0
		% within category	26.3%	32.5%	37.5%	3.8%	100.0%
	Not important	Count	17	26	22	9	74
		Expected Count	24.0	30.6	16.6	2.9	74.0
		% within category	23.0%	35.1%	29.7%	12.2%	100.0%
	Don't really think about them	Count	9	17	9	4	39
		Expected Count	12.6	16.1	8.7	1.5	39.0
		% within category	23.1%	43.6%	23.1%	10.3%	100.0%
Total		Count	257	328	178	31	794
		Expected Count	257.0	328.0	178.0	31.0	794.0
		% within category	32.4%	41.3%	22.4%	3.9%	100.0%

χ^2 =61.568, **p<0.001*****
Degrees of freedom = 12

Figure 6.3: Importance to consumers of information on expected life span of appliances

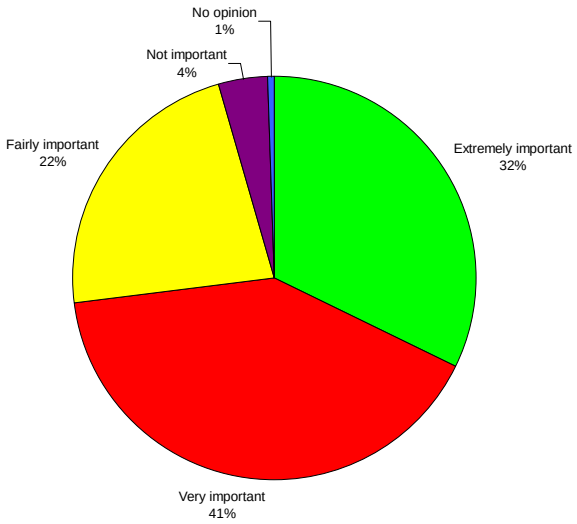


Figure 6.4: Adequacy of information currently available on expected life span of appliances

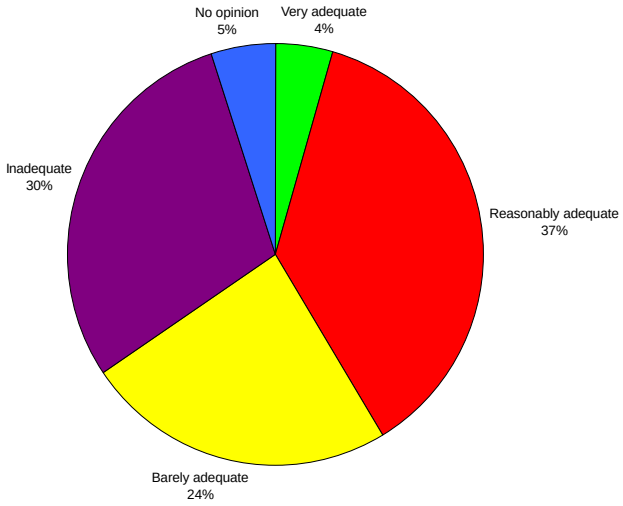


Table 6.13: Importance of having accurate information on expected life spans and satisfaction with appliance life spans

Crosstabs

			Appliances generally last as long as you would like?			
			Yes	No	No opinion	Total
Information on expected life span of appliances currently available	Very adequate	Count	23	10	2	35
		Expected Count	17.3	15.8	1.8	35.0
		% within category	65.7%	28.6%	5.7%	100.0%
	Reasonably adequate	Count	176	98	23	297
		Expected Count	147.0	134.4	15.6	297.0
		% within category	59.3%	33.0%	7.7%	100.0%
	Barely adequate	Count	81	105	7	193
		Expected Count	95.5	87.4	10.1	193.0
		% within category	42.0%	54.4%	3.6%	100.0%
	Inadequate	Count	92	138	8	238
		Expected Count	117.8	107.7	12.5	238.0
		% within category	38.7%	58.0%	3.4%	100.0%
	No opinion	Count	25	12	2	39
		Expected Count	19.3	17.7	2.0	39.0
		% within category	64.1%	30.8%	5.1%	100.0%
Total		Count	397	363	42	802
		Expected Count	397.0	363.0	42.0	802.0
		% within category	49.5%	45.3%	5.2%	100.0%

χ^2 =49.163, **p<0.001*****
Degrees of freedom = 8

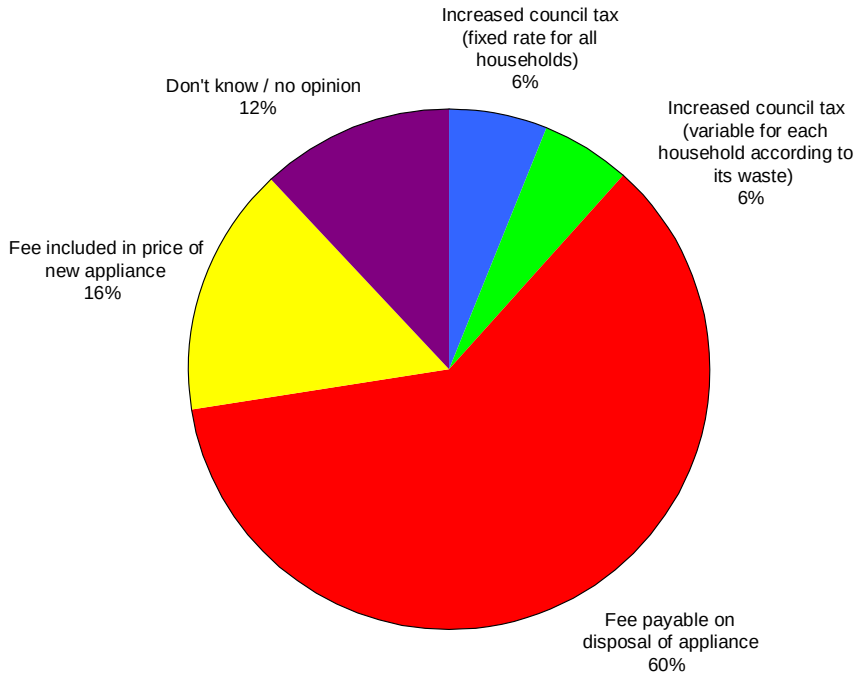
6.5 New recycling and disposal services

Householders were asked how they would like to pay for a collection and recycling service for appliances on the basis that payment was mandatory. At present, the collection, recycling and disposal of many household appliances involves a net cost, although for white goods (and where refurbishment and resale is possible, computers) such activities are generally profitable. The European Commission has estimated that the total cost of recycling under the proposed WEEE Directive will be 500-900 million euro per year (European Commission, 2000: 20-21).

The results showed that few wanted the cost of this service included in the price of new products (16%) or to pay through a local tax (12%, around one half of whom preferred a variable rate and the other half a fixed rate). Most respondents (60%) stated that they would prefer to pay at the point of disposal (Fig. 6.5). This is most likely explained by the belief that it would delay payment as long as possible, or perhaps a desire to maintain a degree of choice over the means of disposal used.

The focus groups provided important insights into the level of satisfaction with current disposal arrangements, ideas on how such services could be improved to increase recycling and the likely effectiveness of different product collection systems and services.

Figure 6.5: Preference for payment of collection and recycling services (no other choice)



Several of the focus group participants in Sheffield in socio-economic group AB indicated dissatisfaction with current arrangements offered by the Council. In particular, they complained that collections were not possible outside of normal working hours and were not frequent enough:

> *"You can't get them to come if you work. They say 'Well, I'm sorry but I can't give a time'… it's their hours of work too."* – Anne, age 39, general manager

> *"You can only ring the Council between 9 and 5, which is not good if you work…and you don't want some answer phone that's going to cost you while they play Greensleeves 54 times while getting through!"* – Ann, age 42, sports lecturer

> *"They say will be there within 10 days…Now if you've got kids running about, they could be playing with it, so I say to my husband, come on you'll have to take that. I can't wait 10 days…anybody could reclaim it or pinch it."* – Lorraine, age 43, personal assistant

Although providing useful insights, such comments were unique to participants from one particular area and socio-economic group, whose experiences may not be representative of the UK as a whole. Other participants, particularly from the City of Cardiff, were unsure of the value of developing improved recycling services and felt that existing services were already sufficient:

> *"I think it's very similar to calling out the Council to take a crisp packet away - would you really expect or want a service to dispose of a hairdryer? What could be recycled with hairdryers…? You are only going to throw away one kettle year, a hairdryer; we are not talking about a huge amount of products, yet we are comparing it with newspapers and bottles."* - Jeff, age 33, TV presenter

"Whatever needs doing, you can put your smaller articles in the bin, and the larger ones they can come and pick it up. There is no problem at the moment is there? If there was a problem, then you would look for alternative routes to dispose of it." – John, age 49, social worker

The focus groups discussed how to improve collection and disposal arrangements, including the suitability of kerbside collection and bring schemes such as recycling banks, collection through retail outlets, and information requirements. Suggestions for improved bring systems, where the owner delivers appliances to a centralised collection point, included the use of a trailer by the local authority and recycling banks for smaller appliances:

"Perhaps if they had a trailer at the local Council and said 'We will pick up your appliance and take it to the tip'…or we could have a trailer that comes around your area...if anyone wanted to book it." – Ann, age 42, sports lecturer

"Like bottles and paper and things, they should have recycling bins that people could take their old kettles and small appliances to. I don't mean that you would have one in every car park, like bottles and things, but if it was at the dump-site or at a specific place you take your electricals when you've got a bag full." – Sue, age 36, self employed groom

Participants also suggested that door-to-door collections could be arranged for recycling smaller appliances using separate bins, different coloured bags or a well-publicised help-line:

"If you're talking about Mr. Public in general, you've got to have it laid on a plate…if necessary you've got to have 3 separate bins, and they've got to have 3 different sections on the lorry." – Phil, age 65, retired computer analyst

"If there was a help-line number that we could easily phone, and they were willing to come and pick the appliance up, then it is suitable. Because most of us work, they would collect more at night than during the day. Even if they come before you go to work, between 7 and 9, that would suit me better." – Lorraine, age 39, general manager

"With the smaller items maybe you could have a different colour bag. When they come round once a fortnight to pick up your papers or clothes or anything for recycling, maybe they could pick up these smaller electrical items at the same time, like hairdryers and kettles." – Lesley, age 39, electrician

Several participants thought that retail outlets should take back old appliances, noting that it was a particularly convenient service for larger appliances. Some thought that it should be provided free of charge, while others believed they should either receive a discount on new product purchases or money for their old appliances:

"You can make it a condition of the sale. You can say 'Well, if you collect the old washer, fair enough' and if they say 'Oh no, we can't do that', you can go elsewhere." – Phil, age 65, retired computer analyst

"If the retailers took them back, it would be a lot better. You would know exactly when they are delivering…you'd be ready and waiting…it would be more convenient." – Sue, age 44, motor company managing director

"If the shop where you bought your appliance from would take it in part exchange, for a price of £10 or whatever…when they delivered the new one, then that would be a great service and you would go for that." – Malcolm, age 56, retired factory foreman

"I think the best would be for the retailer to take the old appliance away. They could put £3 on the price of item that you're buying, and give you £5 minimum for your old machine. You would certainly say yes wouldn't you, that would cover the retailer's cost, and that would be the end." – Phil, age 61, motor mechanic

Other focus group participants in Cardiff were sceptical of the potential effectiveness of these disposal service improvements:

"Sometimes, though, say you were going to buy a toaster or something, you wouldn't really go to back to the shop and take the toaster back, would you? For a big item yes, but with a smaller item?" - Jackie, age 42, dental technician

"What's stopping some person actually picking this up and actually selling it at car boot sales? I don't feel safe about that…As people are lazy they will just leave things on the side...it would be like a tip." – Jackie, age 42, dental technician

"You couldn't even have a special bag…You know some people would pinch it, seeing electrical things and thinking they could get something out of it." – John, age 52, painter and decorator

"At 9 in the evening when they're putting out the black bags, I shouldn't be thinking 'Blimey, I ought to be taking these irons and toasters to the tip!' You just want to get back in and watch the TV. It's a throwaway society." – George, age 70, retired fitter

In most of the focus groups there was agreement on the need for more and higher quality information on how to dispose of household appliances safely. Participants believed that this would enable them to make better decisions on how to dispose of appliances. They suggested that manufacturers, recyclers, retailers and local authorities each have a role in providing such information:

"Well, we would like to know what happens to it when it is being disposed of. Is it safe to dispose of? Is it safe for you to break it up and dispose of it in pieces? You haven't got that information. Take a microwave for instance, can you take the door and the inside panel out? You can't because it is not safe to do so." – Leslie, age 77, retired

"My neighbour took a strip light down out of kitchen, dropped it in the bin and it exploded! It's the same with televisions, they won't always do it, but they will explode…There could be leaflets that went round, reminding you that the Council will come and fetch things." – Elaine, age 52, administration assistant

"We don't know the companies that recycle these things…Why can't they put that information in a booklet, just on a couple of pages, saying this is how we are going to dispose of this, and this is what we do?" – Les, age 44, vehicle administrator

"If you walk into an electrical store, they could have a notice board, 'Recycle your goods here'…then it's up to the public themselves to go forward and pick up a leaflet…If we had more awareness of what could happen, then we might think twice." – Lorraine, age 39, general manager

"The manufacturers could give a number with their adverts, saying 'If you're gonna buy our new product, and you've got an old one to dispose of, ring this number.' Then you could have some kind of a help-line that will tell you how to dispose of your old stuff. The manufacturers are the ones earning all the money, so they have got some responsibility…They should take it off you, and put as much research into how to dispose as they put into manufacturing new ones. Half as much would still find a lot of answers to the problem." – Margaret, age 56, unemployed

"If there's something in there that's dangerous, or something that's going to affect you, then put a warning sign on it." – Malcolm, age 56, retired factory foreman

6.6 New markets for second-hand and reconditioned appliances

The quantitative survey found that almost one quarter of discarded products were donated or sold privately for reuse (Section 5.4, above). Three quarters of these were donated to family or friends or to charity, the remainder being sold. The focus group discussions explored attitudes towards appliances sold second-hand or reconditioned (i.e. fully serviced and sold with refurbished parts).

As noted earlier (Sections 4.4 and 5.4), focus group participants were generally wary of buying second-hand appliances. Reliability was seen as a major risk when purchasing such products.

"At least if you buy new you know it's going to last for a considerable length of time." - Clare, 26, local government officer

Some participants, however, indicated that they would purchase second-hand appliances from a credible high-street outlet with an adequate product warranty, preferably one backed by manufacturers:

"If they market it as a new product with the same sort of rights and guarantees…and it was brand new looking…I don't see the problem" – John, age 49, social worker

"Even if it were a very good make, I still wouldn't buy it from a boot sale. Whereas if you went to Curry's and they had a section with second-hand goods then perhaps you would." – Clare, age 26, local government officer

"There is a retailer in Cardiff...which part-exchanges, reconditions and resells audio appliances, amplifiers and things like that. They are good products and they do a 6 months guarantee on them. You get quality products at around half price." – George, age 70, retired fitter

Focus group participants were less wary of products with reconditioned parts, provided they had acceptable warranties and were cheaper than new products. However, they evidently had different impressions of whether the casing or the internal parts should be reconditioned:

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"Market it as a new product with the same sort of rights and guarantees and everything and...I don't see the problem." – John, age 49, social worker

"If it had gone through all the tests required and you knew that that's what the situation was and that it had got some refurbished parts in it, then it would give you another choice in the market, wouldn't it?" - Margaret, 56, unemployed

"If it was a phone, if the plastic case was reused and completely new inside, then there would be not reason not to buy it. I wouldn't pay a new price, I would expect it to be cheaper, but there's no reason why you shouldn't get a second-hand case is there?" - Roger, age 52, telecommunications engineer

In general, focus group participants only saw a potential market for second-hand or reconditioned appliances if they represented good value and had an acceptable warranty. There may be market opportunities for producers and distributors to supply such products, but careful evaluation should be made of the extent to which sales of such products might reduce sales of new products and develop their business strategy accordingly.

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6.7 Discussion: New product and service development

Sections 6.1-6.6 examined householder views on new product development and the development of "end-of-life" services. Attitudes towards product life are now discussed in more detail and the implications for understanding obsolescence explored. The implications of the research findings for producer responsibility legislation are then discussed.

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6.7.1 The potential for increased product life

Governments and industry, as well as environmental organisations, have acknowledged the potential for longer lasting products to reduce the environmental impact of modern consumerism (DOE, 1995; Falkman, 1996). However, realising this potential depends on people's attitudes and behaviour towards product life and, specifically, their willingness to purchase products designed for longer life spans which may be relatively expensive and become technologically obsolete before they fail.

Focus group participants were generally of the opinion that appliances lasted longer in the past, although no historic data for the UK with which to compare trends could be found. The quantitative study found that many householders are dissatisfied about the present life span of appliances. Whatever the truth about past life spans, householders are divided on the issue of whether appliances today last "long enough". In each of the product categories at least a quarter of householders indicated that such products should last longer (Section 6.1). Such a level of dissatisfaction suggests that businesses should consider the potential for products designed for increased longevity (Cooper, 1994a; Falkman, 1996; Kostecki, 1998).

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One half of householders stated that small work or personal care appliances *"should last longer"*, which is consistent with the fact that their average life span when discarded as *"broken beyond repair"* was only two-thirds of that considered to be *"reasonable"*. The level of dissatisfaction with the life span of wet appliances is less easy to interpret, as their average age when discarded was close to the life span considered reasonable; it may reflect the fact that such appliances tend to be broken when discarded. It is also possible that respondents interpreted *"reasonable"* within the context of current norms rather than their ideal; *"should last longer"* is by contrast more prescriptive. Although there was less dissatisfaction with the life span of other products, the proportion of dissatisfied householders was typically 25% to 40%.

Householders who purchased premium quality appliances were significantly more likely to be satisfied with product life spans (Section 6.2). This relationship was not strong, however, reflecting evidence that the relationship between price and quality is not always clear (Sproles 1977; Dardis and Gieser, 1980). A stronger relationship was found between respondents who usually undertake repairs with those stating that appliances usually last as long as they would like.

People's expectations of product life spans appear to be influenced by technological developments. Expectations were lowest in the IT and telecommunications sectors: relatively few respondents thought that telephones, faxes and answer-phones, mobile phones and pagers, and computers and peripherals should last longer. This was despite the fact that the telephones, faxes and answer-phones disregarded in disrepair achieved, on average, only half of the life span considered reasonable. This suggests that householders have adapted their expectations to the likelihood of continual technological advance for these products. The potential for longer lasting appliances may thus be limited, unless they are upgradable. Men, in particular, are concerned that products subject to technological advance will become out of date (Section 6.3).

A large proportion of householders considered information on expected product life spans to be inadequate (Section 6.4). These findings are comparable with data from a survey undertaken a decade earlier by the National Consumer Council (1989) in which respondents expressed a desire for more information, indicating that this is an aspiration that remains unfulfilled. It was apparent from focus group discussion, however, that most consumers regard life span as an issue of product quality as distinct from an environmental concern. Consumers often decide not to repair products because of uncertainty about residual life and Antonides (1990) concludes that information about the average life span of appliances would enable better choices.

Overall, the results suggest that many consumers would like new products to last slightly longer than their previous items, particularly small work or personal care appliances, and sense a need for more information to guide their choices. However, in order to optimise product life, householder attitudes and behaviour during the entire product life cycle, from acquisition through to disposal, must be considered. Further research is required to understand the effect of householder attitudes and behaviour upon product life spans.

6.7.2 Implications for understanding obsolescence

The life span of products is determined by a combination of factors. They include design, technological development, user satisfaction with product quality, the cost of repair and availability of parts, fashion, the residual resale value and the degree of household affluence (OECD 1982; Cooper, 1994b; Heiskanen, 1996; van Hinte, 1997; Granberg 1997; Kostecki, 1998). These factors are shaped by both producers and consumers.

Various typologies for understanding product life have been proposed. Packard (1960) distinguished between obsolescence of function (caused by improvements in new products), obsolescence of quality (caused by product failure) and obsolescence of desirability (caused by styling or other change). More recently Heiskanen (1996) reformulated the established categories of technical, economic and psychological obsolescence as obsolescence by failure, obsolescence by dissatisfaction and obsolescence by a change in consumer needs. Granberg (1997) highlighted the difference between absolute obsolescence, based on technical life, and relative obsolescence,

determined by factors relating to quality, cost and needs. Kostecki (1998) preferred to distinguish forms of durability as functional (effectiveness of the product), economic (performance/cost ratio relative to new products) and symbolic (ability of product to meet abstract needs).

Results from the E-SCOPE research provided new insights into these different forms of obsolescence. They suggest that life span is not determined by technical failure for a majority of household appliances. In only five of the 15 product categories was more than 50% of discarded items described as *"broken beyond repair"* (Section 5.2). A third of those products that were discarded in need of repair were not considered to be *beyond* repair, reinforcing survey evidence that the cost was a major deterrent to repair work. Meanwhile, a third of discarded appliances still functioned. Using Granberg's typology, "absolute" obsolescence, in the form of technical failure, appears less of a problem than "relative" obsolescence. Relative obsolescence is complex, with many interacting influences.

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"Economic obsolescence", disposal influenced by cost considerations, is clearly important. In some product categories higher quality appliances with potentially longer life spans are available but consumers are deterred because the products are often more expensive and, as noted above (Section 6.7.1), the link between prices and quality is not always certain. Only a fifth of householders purchased products that they considered to be *"premium quality"* and those that did were significantly more likely to be in a higher socio-economic group (Section 6.2), which suggests that people either do not prioritise such products or cannot afford them. The large number of householders who *"rarely"* or *"never"* get products repaired, with cost cited as the main reason, suggests that many products become obsolete because the cost of repair relative to new products is excessive (Section 4.3).

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The survey findings and focus group discussions also draw attention to the importance of "technological obsolescence". The results provide firm evidence that a substantial proportion of householders do not buy longer lasting products because of a concern that they would become *"out of date"* (Section 6.3). Analysis by product category suggested an acceptance by householders that appliances subject to rapid technological change cannot be expected to last longer than at present. It also revealed that they are more inclined to discard while *"still functioning"* those appliances most subject to technological change (Section 5.2). Several focus group participants expressed dissatisfaction with the frequency with which appliances have to be replaced to keep pace with changes in technology.

Focus group discussions also highlighted several forms of "psychological obsolescence" created when an owner no longer senses a desire or need to keep a product. Some participants mentioned their need to replace products either for aesthetic reasons (notably kitchen appliances during renovation) or to maintain a particular self-image. (Sections 6.2, 6.3). Others evidently owned products primarily for functional reasons, expressing frustration with those that had features superfluous to their requirements. This kind of dissatisfaction might reduce the sense of "attachment" between owner and product, making premature disposal more likely.

The results thus provided data on the different types of obsolescence. Further research investigation is now required to understand better the relative influence of different forms of obsolescence by product category.

6.7.3 Implications for producer responsibility legislation

The research findings have implications for developing effective producer responsibility legislation in the context of the proposed EU Directive on Waste Electrical and Electronic Equipment (cf. Cooper, 2000; Mayers and France, 1999). Aspects of the research covering possible financing and logistical arrangements are now evaluated. These are:

- Householders' preferences for different approaches to financing
- The need to establish adequate incentives for producers to improve the environmental performance of their products.
- Consideration for the development of collection, treatment, and recycling processes.

Householders indicated a strong preference for a fee payable on disposal, as opposed to increased product prices or local taxes, in order to pay for appliance collection, treatment and recycling services (Section 6.5). This may increase the already excessive amount of illegal disposal and would not provide sufficient financial incentive to producers to increase the recyclability of their products. Householder attitudes may change, however, as debate on the WEEE Directive reaches the public domain.

One objective of producer responsibility legislation is to encourage "design for the environment" and thus reduce the environmental impact of appliances. The evidence indicating consumer dissatisfaction with product life spans (discussed in Section 6.1) suggests that consumers may be attracted to longer lasting appliances, particularly for those not subject to rapid technological change. The development of longer lasting products could therefore help producers to reduce their waste-related obligations under producer responsibility legislation, while better addressing consumer expectations.

The legislation needs to be drafted in such a way as to provide manufacturers with the necessary financial incentive to supply products designed for durability, ease of repair and recycling and thereby minimise disposal costs. In other words, it must allow for differentiation between products. There are likely to be few benefits from the legislation if increases in product costs are indiscriminate (Mayers and France, 1999). In addition, legislation should address householders' needs for better information on the safe disposal of products, which could influence purchasing and disposal behaviour.

The detailed quantitative and qualitative behavioural information gained in this study is critical in the development of effective reverse logistics and appliance reuse and recycling processes.

Firstly, it identifies the manner in which different appliances are discarded (in terms of disposal routes) and thus indicates sources of WEEE for future recycling (Section 5.3). Secondly, it suggests the type of collection and reuse or recycling services that producers will have to develop to meet the requirements of producer responsibility legislation:

- 'Take-back' schemes through retail outlets are only likely to be successful if discounts are received on new products or the old product is an inconvenience and a free collection service is provided on sale of new items (Section 6.5).

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- There may be regional differences in householders' requirements for disposal, which should be investigated through more specific future research.

- Partnerships should be established between industry, retailers and local authorities in order to meet requirements of producer responsibility legislation effectively.

- New collection, treatment and recycling infrastructure is required to collect small appliances currently discarded of as ordinary municipal waste (i.e. in dustbins, wheelie bins or rubbish sacks) and the vacuum cleaners, televisions and videos not currently recycled.

- The specific needs of households in lower socio-economic groups, who are less likely to buy new products through retailers or to possess their own means of transport, must be addressed if their appliances are to be disposed of appropriately.

- Improved information on safe disposal is needed to enable householders to change their disposal behaviour. Manufacturers, retailers, local authorities and recycling companies each have a role in providing such information (Section 6.5).

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- Municipal collection arrangements should be made more convenient by offering specific dates and times and providing services outside of normal working hours.

Such initiatives merit further research. For example, research could be used to determine whether better information on the safe disposal of appliances would result in more appropriate household disposal behaviour (e.g. a reduction in illegal waste disposal). Motivational research methods, of the type used to determine effective interventions to stimulate increased household recycling, could be used in such an investigation (see Section 2.1 for examples).

The degree of satisfaction with different disposal services appeared in the focus group discussions to be affected by both socio-economic and regional factors. This may be because each local authority in the UK provides unique arrangements for disposing of appliances (some are free, while others are not). Thus future research could usefully investigate regional differences in disposal services and householder satisfaction.

In the field of logistics management, it has been argued that the development of distribution channels is best undertaken with full understanding of the way in which customers with different service requirements can be segmented (Murphy and Daley, 1994). Better understanding of householder requirements for disposal services could aid the development of effective waste collection and recycling schemes by increasing participation (Howenstine, 1993). Thus the identification through this research of key market segmentation factors for the disposal of appliances, including end-user, service and product related factors, could be used for future service development (Section 5.7.7).

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7. Conclusions and recommendations

In this section the methodology and key findings are summarised, conclusions drawn, recommendations made and future research proposed.

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This study is the most comprehensive and detailed investigation of the use and disposal of household appliances undertaken to date in the UK. The results could be of significant value as market reference data for a wide variety of interested parties, including designers, producers, retailers, policy makers, environmental specialists and researchers. The findings will be useful for future product development and design, the creation of improved collection, treatment, reuse and recycling services and the implementation of appropriate producer responsibility legislation in the UK.

The aim of this study was to improve understanding of patterns of use and disposal of household appliances from the consumer perspective, in order to evaluate their effective management, and to make information available publicly and to relevant interest groups. The principal objectives were to:

- **Investigate the purchase, use and disposal of household appliances from the consumer perspective.**
- **Provide quantitative information on product ownership, lifetime, use and disposal, representative of the UK as a whole.**
- **Identify the likely effectiveness of different approaches to addressing the need to reduce WEEE.**

7.1 Methodology

In developing the research methodology, previous studies investigating consumer behaviour and the disposal of waste by households were reviewed and quantitative and qualitative approaches were selected, using face-to-face interviews with householders and a series of focus groups.

Two specific methods used in previous studies were found to be particularly effective in the household survey (Section 2.3). These were self-reporting of product ownership and disposal behaviour and the use of product picture identification cards to aid rapid and accurate data collection.

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In a house-to-house survey, 802 households were selected for interview in over 180 locations across the UK during December 1998. This sample was demographically representative of the UK population. The questionnaire and protocol used was developed through a pilot survey of 30 households outside of the main sample. Five focus groups were held, with householders of different socio-economic status and from urban and rural locations. Experienced facilitators were used and a survey protocol was developed through pre-testing on a pilot group. The focus groups were conducted in April 1999.

7.2 Key statistics and main findings

The key statistics are summarised below, followed by an outline of the main findings of the research focussing on their implications for product life, resale, recycling and disposal services, and Government policy.

7.2.1 Key statistics

The following is a summary of the key statistics:

- Households owned, on average, 25 appliances. Ownership of products within the households studied was estimated to have increased by around 60% over the last five years. The product stock was relatively young, most products (88%) being under 10 years old and more than half (57%) under 5 years old.

- The proportion of appliances in storage was low, ranging from 1% to 7% between product types. Storage of appliances appeared primarily to be associated with potential reuse rather than disposal.

- Almost one in ten households (9%) owned at least five second-hand appliances.

- At least 476,000 tonnes of household appliances, totalling over 23 million units, were discarded annually in the UK between 1993 and 1998. Large 'white goods' constituted the greatest proportion of the waste stream by mass (77%) and small appliances by number of units (37%).

- The average age of household appliances when discarded ranged from 4 years to 12 years, depending on the type of product. Nearly one quarter of discarded products (24%) were either donated or sold for reuse.

- Almost one half of householders interviewed (45%) were of the opinion that, in general, products do not last as long as they would like. Householders most frequently identified wet appliances, small work or personal care appliances and vacuum cleaners as products that they would like to last longer.

- More than a third of householders (38%) said that they rarely or never got products repaired. One in ten discarded products (10%) still functioned but were not donated or sold to others for reuse.

- The main disadvantage that householders saw to purchasing longer lasting products was that they may become 'out of date'. Many (73%) regarded information on expected product life as very important and more than half (54%) were dissatisfied with currently available information on life spans.

7.2.2 Product life

The research findings indicate a need to reconsider the future development and design of products and their use:

- There is an apparent desire among householders for longer lasting household appliances. Around one half of those interviewed said that they would like

products to have greater life spans. People appeared to accept that products most subject to technological advance would have to be regularly replaced, although focus group results suggested that many were inclined to view this negatively.

- In practice, consumers may be reluctant to purchase products designed for longer life spans because of concern that they become *"out of date"* and higher cost. Some products that are subject to rapid technological change could be designed for upgradability.

- The life span of products is determined not only by their design life but also by the behaviour of consumers. Thus in order to optimise product life it is essential that consumer behaviour throughout the product life cycle is considered. The fact that many products that still function are discarded needs to be addressed through further research and public education.

- There is a reluctance among many consumers to have products repaired, for which the main explanation is cost. The potential use of public policy and new private sector initiatives to encourage people to get products repaired should be investigated.

- Consumers expressed a desire for clearer information on the planned design life of products in order to assist their choices in the market. Some producers of premium brand white goods have already taken a lead and provide such information, which may give them a competitive advantage.

7.2.3 Product resale, recycling and disposal services

The findings on the use and disposal of household appliances will be helpful in the development of new resale, recycling and disposal services:

- Product recovery ('take-back') schemes should not be set up on the basis of assumptions made from anecdotal evidence. Variations in the disposal behaviour and requirements of different householders were found to be too great for generalisations to be considered reliable. For example, 'bring' schemes are only likely to have limited success because certain sections of society are less able to use them.

- The effectiveness of product take-back services will be determined by a combination of factors relating to the householder ('end-user' related factors), the specific disposal service provided (service related factors) and the appliance type to be collected (product related factors).

- Focus group results suggested that householders have a preference for disposal services offering convenient collection arrangements and financial incentives for returning products. Specific regional differences in householder requirements for product disposal services should be investigated through further research.

- New collection and recycling processes will be required to meet future recycling targets, particularly for smaller products (most of which are currently discarded in dustbins, wheelie bins or rubbish sacks) and brown goods such as televisions and video equipment (most of which are not currently recycled). Partnerships need to

be established between stakeholders before the necessary infrastructure and processes can be developed.

- 'Bring' systems, whether based on civic amenity sites or retail outlets (on the sale of new products), may in particular fail to capture second-hand appliances discarded by householders of lower socio-economic status, as they are less likely to possess their own means of transport or buy products new.

- It appeared from the focus group results that householders will only change their disposal behaviour if provided with easy to understand information that explains and justifies any new disposal arrangements. Householders want better information on how to dispose of appliances safely.

- Householders in the focus groups appeared to be more willing to purchase second-hand appliances and 'new' appliances containing refurbished parts if they were perceived as good value and had adequate product warranties.

- Many products are not disposed of by their original owners as they are redistributed through reuse. The collection of products through retail outlets, where old products are traded in for new, will not capture a substantial proportion of such waste and thus has only limited potential.

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7.2.4 Government policy

The results of the study should be useful in developing effective public policy on waste, particularly in relation to WEEE:

- As storage of appliances appears primarily to be associated with potential reuse, policy initiatives encouraging the disposal of such appliances may not be desirable from a societal perspective unless they are specifically directed into reuse.

- The recycling and disposal of household appliances is more complex than for 'consumable' wastes, as they tend to pass in and out of use, following a cascade of use through which they become financially, functionally and materially degraded. The interpretation of the legal definition of waste in respect of WEEE may need to be re-examined in the light of current and prospective reuse.

- Waste legislation needs to be drafted in such a way as to provide an incentive mechanism through which products that are designed for durability, ease of repair and recycling attract relatively lower disposal costs and consumers see benefits in purchasing them.

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- In the development of legislation on WEEE, measures of both the weight and number of products discarded must be considered, disaggregated by product type. This is necessary in order to take account of the volume of waste for collection and disposal and also the wider environmental impacts of consumption.

- Although a majority of householders indicated a preference for a fee payable on disposal to fund enhanced collection and recycling services (as opposed to increased product prices or local taxes), this may not be acceptable as it may further encourage illegal disposal.

- The growth of organisations refurbishing discarded household appliances forms an important part of the 'social economy'.[1] Reuse can result in substantial environmental benefits where it displaces the manufacture of new products. However, this may not always be the case for household appliances. This is because reuse predominates in households of lower socio-economic status, which due to financial circumstances may only have the option to purchase more expensive larger appliances second-hand. The reuse of appliances is a complex process which merits further investigation.

7.3 Future research

Various areas were identified where future research would contribute to a deeper understanding of the use and disposal of household appliances. These included:

- **Further investigation into the relative influence of different forms of obsolescence by product category.**
- **The residual life span and performance of second-hand products.**
- **Potential measures to increase the reparability and upgradability of products in different categories.**
- **The degree of consistency in householder behaviour affecting product life spans throughout the life cycle.**
- **The disposal of appliances owned by the deceased.**
- **Regional variations in appliance disposal behaviour with different regional disposal arrangements.**
- **The effect of information on the safe disposal of appliances on disposal behaviour.**
- **The identification of further market segmentation factors relating to the disposal of appliances by different groups of product end-users.**

As the debate on the environmental impact of consumer products evolves and the draft directive on WEEE is finalised and implemented, such research is likely to become of increasing importance. The methodology developed and results gained through this research could be used effectively in planning and conducting such studies.

In the following chapter of the research portfolio (Chapter 4, Vol. 1), summary papers on the various research undertaken are presented. This includes a paper on the development of Producer Responsibility in Europe (Mayers and France, 1999).

[1] Department of Trade and Industry (1998, 1999).

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Focus group discussion suggested that the kitchen might be an area in which women are more likely to want to update items regularly:

> *"I'm quite happy to buy something that lasts forever and keeps going. I've got a wife that says 'I want a change'...I think the wife's influence is a little bit different to mine. I just want a kettle that boils cup of water. She wants one that looks nice as well."* - Les, age 44, vehicle administrator

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Glossary of terms

Brown goods:	General term for entertainment electronics e.g. Hi-fi, televisions and video equipment**.**
EEE:	EU definition "equipment which is dependent on electric currents or electromagnetic fields in order to work properly and equipment for the generation, transfer and measurement of such currents and fields" [DG XI.E3/FE D(97)].
Electrical products:	Products relying on the supply of electricity e.g. vacuum cleaners.
Electronic products:	(1) Products containing integrated circuitry e.g. computers.
	(2) Used more generally to include electrical and electronic products.
Electronic wastes:	Abbreviated and convenient term for WEEE used in this article.
End-of-Life (EOL):	EU definition: electrical or electronic equipment which is a waste within the meaning of Article 1(a) of Directive 75/442/EEC. Proposed definition: a process by which electrical or electronic equipment devalues, degrades and disperses throughout society
End-users:	Users of a product at end-of-life.
Grey goods:	General term for IT electronics e.g. computers, photocopiers, & phones.
Producer:	A manufacturer or importer of a product or service within a country.
Recycling:	The reuse of materials or even products (when used more ambiguously) reclaimed from waste or at end-of-life.
Reuse:	The effective re-deployment of functional components and products reclaimed from waste or at end-of-life e.g. microchips & second-hand washing machines.
White goods:	General term for convenience electronics e.g. refrigerators & kettles.
WEEE:	Waste from Electrical and Electronic Equipment - official EU working term. European definition of waste applies to EEE (defined above) in the definition of WEEE

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Appendix 1: Statistical methods

Calculation of minimum sample size using binomial statistics:

$$n_{\min} = \frac{z^2 \pi (1 - \pi)}{H^2}$$

Where:

$n_{\min}$	Minimum sample size required
z	Z-score (level of confidence, at 95% z = 1.96)
H	Difference required to be detected as significant (e.g 0.035, where the true population proportion is required to lie within ±3.5% of any sample result)
π	Population proportion (0.5 is the proportion at which the standard deviation is the greatest, as explained below)

Table A1.1: The curve of binomial variation

π	0.001	0.005	0.01	0.05	0.10	0.20	0.30	0.50	0.70	0.80	0.90
σ_p^2	0.001	0.005	0.010	0.048	0.090	0.160	0.210	0.250	0.210	0.160	0.090

Source: Kish, 1965: 260

For complex studies, where expected results cannot be initially estimated, a population proportion of 0.5 is used in the calculation of sample size as "worst case". This is because where the population proportion is 0.5, sample variation is the greatest due to the curve of binomial variation (as shown in Table A1.1 above).

Put simply, where a sample proportion is, for example, above 0.8 or below 0.2, the probability that the result occurred by chance is less than when the result is between these values. The variance of a sample result of 0.5 is highest and therefore a value of 0.5 represents a statistical "worst case" for determining the required sample size.

Example calculations for sample used in study:

$$1067_{\min} = \frac{1.96^2 0.5(1-0.5)}{0.03^2}$$

$$784_{\min} = \frac{1.96^2 0.5(1-0.5)}{0.035^2}$$

The Chi^2 value can be calculated by

$$\chi^2 = \sum_j \frac{(o_j - e_j)^2}{e_j}$$

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Where:

χ^2 = Chi^2 value
o_j = observed frequencies
e_j = expected frequencies

For Chi^2 tests, the degree of freedom is given by

$$v = k - 1$$

Where:
v = Degrees of freedom
k = Number of columns

For contingency tests, the degree of freedom is given by

$$v=(h-1)(k-1)$$

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Where:
v = Degrees of freedom
h = Number of rows
k = Number of columns

Spiegel (1972: 201-3):

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Appendix 2: Questionnaire development

VERSIONS 1 & 2: Initial drafting stage.

Developed between two academic partners as an initial basis for discussion.

- Various types of survey questions included
- Full range of questions addresses

VERSION 3 & 4: Second drafting stage

Developed from feedback and new ideas from all project partners on the first draft, and subsequently two academic partners for submission to field research consultants.

- Additional questions included in all areas
- Questions edited
- Product categories reviewed and revised
- Continued refinement of questions.
- New questions added
- Demographics section added
- Sections re-organised into specific issue related areas, such as disposal.

VERSION 5 & 6: Pilot survey drafting stage.

Developed between two academic partners and field research consultants in preparation for survey pretest.

- Questionnaire reformatted
- Consistent question layout developed using tables
- Multiple response categories refined
- Questions refined
- Question sequence revised
- Leading questions removed
- Questionnaire protocol developed and included as interviewer instructions accompanying questions

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VERSION 7: Pilot survey stage.

Final protocol submitted to and revised by fieldwork consultants ready for use in pilot study of thirty households.

- More detailed interviewer instructions included, such as an introduction and prize offering, and the appropriate use of visual aids provided
- Final formatting, question sequence, and question revisions made

VERSION 8: Main survey drafting stage.

Final questionnaire developed by academic partners based on feedback from fieldwork consultants and project partners.

- Questions revised according to results from pilot study and feedback from fieldwork consultants.
- Added new "other" options suggested by respondents to multiple responses.
- Cross check (count) introduced to reporting of quantitative self-reported data.

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Appendix 3: Main survey questionnaire

NB: Pagination in Appendix does not reflect actual pagination of survey document.

E-SCOPE Questionnaire - FINAL 6th Nov 1998

Introduction: "My name is ……. and I work for an independent market research company called Quality Fieldwork (SHOW ID)
We are working with Surrey University to help a broad consortium of household appliance manufacturers and suppliers, to conduct a survey investigating how households use and throw away appliances. The aim of the consortium is to improve this by understanding more about households' behaviour at the use and disposal stage, but they need to understand more about individual household's usage in order to move forward. I would be very grateful for your help."

"YOUR NAME WILL BE ENTERED INTO A DRAW. *There will be nine prizes WHICH WILL BE a first prize of £200 worth of Dixons vouchers, 2 second prizes of £75 worth of Dixons vouchers, and 6 runner-up prizes of £25 worth of Dixons vouchers."*

ASSURE OF CONFIDENTIALITY.
ACTUAL NAMES AND ADDRESSES WILL BE HELD AT QUALITY FIELDWORK.
ONLY THE IDENTITY OF THE PRIZE WINNERS WILL BE NOTIFIED TO OUR CLIENTS.

Section 1: General questions

READ OUT: "This first section includes some general questions about your household. There are five sections altogether."

Q1 SHOW CARD A: "How important do you think material wealth is to your household's quality of life?"
READ OUT Excluding "No opinion"
SINGLE CODE ONLY

Extremely important	01
Very important	02
Fairly important	03

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We have different opinions 04
Not important 05
No opinion 06
Other (write in):

_____

_____

___

Q2 SHOW CARD B: "How important are environmental issues to your household?"
SINGLE CODE ONLY

Very important 01
Important 02
We have different opinions 03
Not important 04
We don't really think about them 05
Other (write in):

_____

___

Q3 SHOW CARD B: "How important is the need to reduce waste in the UK to your household?"
SINGLE CODE ONLY

Very important 01
Important 02
We have different opinions 03
Not important 04
We don't really think about it 05
Other (write in):

_____

___

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Q4 SHOW CARD B: "How important is the need to recycle waste in the UK to your household?"
SINGLE CODE ONLY

Very important	01
Important	02
We have different opinions	03
Not important	04
We don't really think about it	05
Other (write in):	

_____

___

Section 2: Purchase, possession and use of electrical & electronic appliances

READ OUT: "This section covers the purchasing and possession of household appliances"

Q5 SHOW CARD C: "In general, which models of appliances do you purchase?"
SINGLE CODE ONLY

Premium quality models	01
Middle range models	02
Budget priced models	03
Other models (write in):	

_____

___

SHOW PICTURE CARD

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READ OUT : "Please look at this list of electrical and electronic appliances. Please tell me how many of each… "
(Ask Q6 etc…)

Enter the number of appliances under the appropriate LETTER (corresponding to the Letter next to the picture on the card).

REMEMBER --- NUMBERS… NO TICKS !!!!!
REMEMBER TO ADD UP Q6 AND Q7 PRODUCTS

If a question does not apply to ANY product then please circle 'XX'

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	Null code
Q6 "Are IN USE currently in your home? (excluding those stored)" **Write in number of appliances**																**XX**
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**	Null code
Q7 "Are in your home but are stored and NO LONGER USED (including working and broken appliances)? Please think carefully in case you have forgotten about anything" **Write in number of appliances**																**XX**
Add products at Q6 and Q7 : TOTALS																
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**	
Q8 "How many are stored and BROKEN? Please think carefully in case you have forgotten about anything" **Write in number of appliances**																**XX**
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**	Null code

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Q9 "How many are second hand (either bought second-hand or passed on to you)?" **Write in number of appliances**																**XX**
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**	Null code
Q10 "How many are privately rented/hired (excluding those coming with rented accommodation)?" **Write in number of appliances**																**XX**

No other categories of equipment should be coded if volunteered by the respondent.

SHOW PICTURE CARD

READ OUT : "I would like you to think of all the appliances that <u>are in your home at the moment</u>" (those at Q6 and at Q7).

TAKE EACH PRODUCT CATEGORY ONE AT A TIME.

READ OUT: "You said you had [number of product A at Q6 & Q7] -- Electric cookers. How many are ….." (Ask Q11 etc)
Repeat for Product B etc etc etc

Enter the number of appliances under the appropriate LETTER (corresponding to the Letter next to the picture on the card).

REMEMBER --- NUMBERS… NO TICKS !!!!!

	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**	**Null code**
Q11 "Are over 15 years old?" **Write in number of appliances**																**XX**
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**	**Null code**
Q12 "Are 10-15 years old?" **Write in number of appliances**																**XX**
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**	**Null code**
Q13 "Are 5-10 years old?" **Write in number of appliances**																**XX**

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	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	Null code
Q14 "Are under 5 years old?" **Write in number of appliances**																**XX**
Add products at Q11,Q12,Q13,Q14 : TOTALS TOTAL MUST AGREE WITH TOTAL OF Q6 & Q7																

If a question does not apply to ANY product then please circle 'XX'

Q15 SHOW CARD D: "What do you perceive is the main DISADVANTAGE to purchasing appliances designed to last a long time?"
SINGLE CODE ONLY

They cost too much to buy	01
The information on life spans is inadequate	02
Repair and maintenance costs are too expensive	03
They may become out of date after a few years	04
They look unattractive as they get older	05
Other(write in):_____	
Don't know	50

SHOW PICTURE CARD
READ OUT : "Using the list of appliances please answer the following questions on product life for each:"

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	Null code
Q16 "What would be a reasonable life-span for these products?" **Write in number of YEARS**																**XX**

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	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	Null code
Q17 "How old was your last appliance of each type when you discarded it? If second-hand or unsure of purchase date please estimate product age. " **Write in number of YEARS old. Simultaneously Code Q18. If NONE discarded Code XX**																**XX**
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**	**Null code**
Q18 "When you discarded this appliance was it still functioning, in need of repair, or broken beyond repair?" **Code 1 for** "still functioning" **Code 2 for** "in need of repair" **Code 3 for** "broken beyond repair" **REMINDER: LAST PRODUCT DISPOSED OF ONLY**																**XX**

Q19 "How often do you attempt to get broken appliances repaired?"
SINGLE CODE ONLY

Usually	1
Sometimes	2
Rarely	3
Never	4
Cannot say	5

Q20 "Have any factors discouraged you from seeking to get appliances repaired?"

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DO NOT PROMPT MULTICODE POSSIBLE
If "not worth repairing" response given, ask why and code accordingly.

Cost of the repair	01
Time taken. Time without appliance would have been unacceptable	02
Parts were likely to be unavailable	03
No known local repair outlet	04
Unreliable servicing or repair firms / lack of trust in quality of repairs	05
Never liked it or rarely used it	06
Appliance was old / unlikely to last much longer	07
New appliances are better	08
Other (write in): _____	
Cannot say	50

Section 3: Disposal

READ OUT: "This next section is covering the disposal of products"

SHOW PICTURE CARD
"Please quickly scan the household appliance list, and for each product category state how many within the last 5 years you can remember :"

REMEMBER… NUMBERS… NO TICKS !!!

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	Null code
Q21 Disposing of in household dustbin, wheelie bin, or rubbish sack **Write in number of appliances**																**XX**

If a question does not apply to ANY product then please circle 'XX'
continued on next page

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	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	Null code
Q22 Being collected as "bulky waste" by the local authority **Write in number of appliances**																**XX**
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**	**Null code**
Q23 Taking to a local authority civic amenity site **Write in number of appliances**																**XX**
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**	**Null code**
Q24 Being collected by retailer or supplier when delivering new product (without discount) **Write in number of appliances**																**XX**
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**	**Null code**
Q25 Traded in to retailer or supplier for discount on purchase of new product **Write in number of appliances**																**XX**
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**	**Null code**
Q26 Selling privately to second-hand shop or dealer **Write in number of appliances**																**XX**
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**	**Null code**
Q27 Selling privately e.g. car boot sale, advertised in newspaper / shop window **Write in number of appliances**																**XX**
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**	**Null code**
Q28 Donating to charity (jumble sale, charity shop) **Write in number of appliances**																**XX**
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**	**Null code**

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Q29 Donating for free to family or friends **Write in number of appliances**																**XX**
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**	
Q30 Being forced to leave in the nearest convenient skip or unused waste ground **Write in number of appliances**																**XX**

If a question does not apply to ANY product then please circle 'XX'

continued on next page

	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**	**Null code**
Q31 Giving to scrap merchant or other recycling company **Write in number of appliances**																**XX**
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**	**Null code**
Q32 Giving to repairer for spare parts **Write in number of appliances**																**XX**
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**	**Null code**
Q33 Disposing of in skip at work **Write in number of appliances**																**XX**
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**	**Null code**
Q34 Other means of disposal (write in): _____ **Write in number of appliances**																**XX**

If a question does not apply to ANY product then please circle 'XX'

Section 4: Future services and solutions

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READ OUT: "This section briefly covers your opinions on future service requirements and expectations."

Q35 SHOW CARD E:
"If you HAD TO PAY for a collection and recycling service for appliances (there was no choice), how would you prefer to pay?"
SINGLE CODE ONLY

Increased council tax (fixed local rate for all households)	1
Increased council tax (variable for each household according to its waste)	2
Fee payable on disposal of appliance	3
Fee included in price of new appliance	4
Don't know / no opinion	5

Q36 SHOW CARD F
"How adequate do you consider the information on the expected life span of appliances which is currently available?"
READ OUT Excluding 'No Opinion'
SINGLE CODE ONLY

Very adequate	1
Reasonably adequate	2
Barely adequate	3
Inadequate	4
No opinion	5

Q37 SHOW CARD G
"How important do you think it is to have accurate information about the expected life span of appliances before you make a purchase?"
READ OUT Excluding 'No Opinion'
SINGLE CODE

Extremely important	1
Very important	2

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Fairly important	3
Not important	4
No opinion	5

Q38 SHOW PICTURE CARD
"Which of the following appliances, if any, do you think should last longer than at present?"

A	01
B	02
C	03
D	04
E	05
F	06
G	07
H	08
I	09
J	10
K	11
L	12
M	13
N	14
O	15
P	16
Q	17
R	18
S	19
T	20
NONE OF THEM	21
ALL OF THEM	X

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Q39 "In general, do you find that appliances last as long as you would like? (from purchase to being beyond repair). Please respond yes or no."
SINGLE CODE

Yes	1
No	2
No opinion	3

Q40 SHOW CARD H
"If a service was made available to cover all repair bills for an additional five years over the guarantee period of the product, would it be likely to influence your decision to purchase one brand rather than another?"
READ OUT Excluding 'No Opinion'
SINGLE CODE

Definitely	01
Likely	02
Unlikely	03
Not at all	04
No opinion	50

Section 5: Demographics

READ OUT: "I would finally like to ask you some general information on you and your household"

C1 Gender

Male	1
Female	2

C3 Ethnic origin
SHOW CARD I

White British	01
White Other (Write in)	02

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C2 Age last birthday (Write in and Code) ___

16-24	1
25-34	2
35-44	3
45-54	4
55-64	5
65+	6

Black African	03
Black Caribbean	04
Black other	05
Pakistani	06
Bangladeshi	07
Indian	08
Chinese	09
Asian Other (Write in) _____	10
Other (Write in) _____	11
Refused	12

C4 Adults in Household (Aged 16+)
Write in number

C5 Children in Household (Under 16)
Write in number

C6 Total in Household (Add C4+C5)
Write in number

C7 Does household own a car? (Yes / No)

C8 Occupation of CWE

NB. If retired and in receipt of work related pension grade on last

C9 Total Household income SHOW CARD J (Ask for a letter)

A	Under £15k per annum	1
B	£15k - £20k per annum	2
C	£21k - £25k per annum	3
D	£26k - £30k per annum	4
E	£31k - £40k per annum	5
F	£41k - £50k per annum	6
G	£51k+ per annum	7
	Refused	8

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occupation
Qualifications

_____
Staff responsible for

_____

AB	1
C1	2
C2	3
D	4
E	5

C10: Town and county of household (please write): _____

Respondent's Name (Mr/Mrs/Miss/Ms) + Forename	
Address	
Post Code	
Telephone	

Remind about prize draw

Interviewer Name	
Date of interview	

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GIVE THANK YOU LEAFLET AND LETTER

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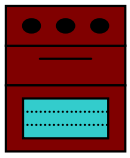
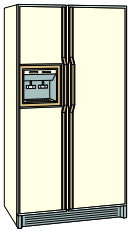
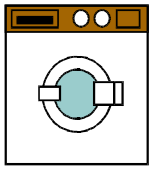
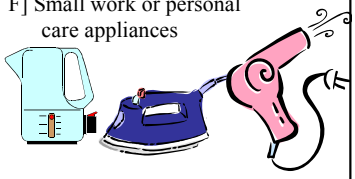
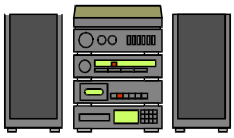
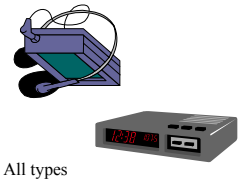
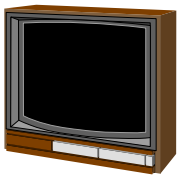
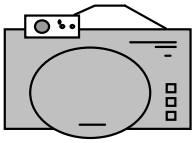
Appendix 4: Product types

Product Identification Chart

A] Electric cookers  All types	B] Microwave ovens  All types	C] Refrigerators and freezers  All types
D] Washing machines, dishwashers, and tumble dryers  All types	E] Vacuum cleaners and carpet cleaners  All types inc. minis	F] Small work or personal care appliances  Including kitchen appliances, irons, clocks, hair driers, shavers, deep fat friers, and sewing machines.
G] HI-FI and stereo  Including portables. Excluding personal stereos	H] Radio, personal radio, stereo & CD  All types	I] Television  All types
J] Video equipment  Including camcorders	K] Telephones, faxes, and answer machines  Excluding mobiles	L] Mobile phones and pagers  All types
M] Computers and peripherals  Excluding game consoles, including portables and scanners etc.	N] Toys  Including games consoles & electronic pianos. Excluding battery only toys	O] Home and garden tools  Including garden and DIY

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Appendix 5: Focus group questions

Facilitator checklist

List of contacts
Questionnaire from main survey
Product identification cards
Tape recorder and microphone (tested)
Blank audio cassettes
Participant payments
Participant signature sheet for payments received
Notebook and pen
A3 flipchart

6.45 HOT DRINKS AVAILABLE (buffet for later)

7.00 WELCOME

Welcome lead by recruitment agent provided by Quality Fieldwork.
(Wednesday – mention that taxis home have been arranged if requested.)

2. Facilitator introduces himself/herself, their work, and role as facilitator (to guide the discussion and ensure everyone is heard). Introduce any assistants/observers.

3. Ask participants to introduce themselves in turn, briefly.

4. Facilitator provides brief explanation of the E-SCOPE project. Refer to project hand-out.

The purpose of the project is to gain an understanding of the use and disposal of household appliances from the consumer's perspective. Through this research we hope to evaluate how effectively such products are managed throughout their life spans. Broadly the research has addressed 3 questions:

Why do people stop using their products?
What do people do with old products and why?
How could waste be reduced?

5. Outline of procedure. Explain the number, type and range of questions. Show product identification cards.

6. Describe desirable input:
equal contributions from all
personal experience and opinions
comments to be product specific where possible
identifiable contributions
there are no 'right' or 'wrong' answers

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7. Stress that second names will not be used to preserve anonymity

8. Mention buffet at around 8.50. Payments to be made at the end.

ENSURE TAPE RECORDER IS SWITCHED ON TO "RECORD" AND CORRECTLY SET UP BEFORE PROCEEDING

Question guide

Main question: (in bold and numbered)
Probe: to solicit more information if not forthcoming (in normal text below main questions)
Prompt: reminder to facilitator (in bold and numbered)

(*Remind participants to identify themselves and speak clearly; refer to product identification card)*

(7.10)
1. NEW PRODUCT PURCHASE AND EXPECTATIONS
What household appliances have you purchased in the past six months?

How long do you think it will last?
Why do you suggest this figure?
How long do you think it should last?
Do you generally find that appliances last as long as you would like?

2. NEW PRODUCT INFORMATION
When purchasing an appliance how important to you is information on its environmental impact?

What kind of information would be helpful?
(e.g. recycling or intended life spans)

3. OUT OF DATE PRODUCTS
Do you ever replace household appliances because they have become 'out of date'?
(ensure product is specified)

What makes a product 'out of date'?
Does fear that a product will become 'out of date' deter you from purchasing products designed to last longer than average?

(7.40)
4. PREMATURE DISPOSAL
Can anyone give an example of an appliance that they disposed of recently even though it still worked?

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What led you to get rid of it?
Do you generally keep household appliances until they no longer function?

5. STORAGE
Can anyone who has an appliance in storage explain why it is not being used but has not been discarded?

Under what circumstances would you dispose of it, or bring it back into use?

6. DISPOSAL OPTIONS
When getting rid of household appliances, what leads you to choose one means of disposal rather than another?
(ensure product is specified)

Has anyone encountered any problems in disposing of an appliance?
Is transport a problem? *(for urban/rural groups)*

(8:10)

7. FUTURE DISPOSAL SERVICES

Can you think of any disposal arrangements which you would find more convenient than those you have used in the past?
(e.g. delivery to local recycling bank/unit, household waste/civic amenity site, retailer in exchange for new product, railway station)

What sort of information do you need to get rid of products more easily?
How should it be provided?
(e.g. leaflets, posters, telephone hotline etc.
provided by local authority, manufacturer, retailer, or centralised information service)

8. REUSED PARTS
Under what circumstances would you consider purchasing a new appliance containing parts that have been reclaimed and refurbished?

9. SECOND-HAND PRODUCTS
Can anyone who has recently purchased a second-hand appliance describe where they got it from?

Why did you choose to get it from this source?

In what way (if at all) did the product's brand and price influence your choice?

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10. WASTE IN SOCIETY
How satisfactory are the ways in which household appliances are currently disposed of?
(to be asked only if there is time)

8.45 THANKS

Buffet to follow
Remind people to collect fee before departure.
Each participant should signed the payments form and will then receive payment (£20.00 per head).
Wednesday - Taxi services home are now available if they were requested.

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Appendix 6: Quota sampling specification: main survey

E- SCOPE - WASTE MANAGEMENT

QUOTA SHEET

Interviewer : _____

Total interviews **10**

GENDER		
Male	Minimum 4	O O O O
Female	Minimum 4	O O O O
AGE		
Under 34	Minimum 3	O O O
35 - 54	Minimum 3	O O O
55+	Minimum 2	O O
SEG		
AB	Minimum 2	O O
C1C2	Minimum 4	O O O O
DE	Minimum 2	O O
ETHNIC		
Non White	Minimum 1	O

PLEASE RETURN WITH WORK

THANK YOU

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Appendix 7: Example of E-SCOPE survey cover letter

Dear Madam / Sir,

Thank you for showing your interest in the "E-SCOPE" research project[1]. The aim of the project is to develop an understanding of the use and disposal of electrical and electronic appliances in UK households. This research is vital as the European Union is currently developing a Directive (WEEE-27/7/98) to ensure that manufacturers and suppliers of electronic and electrical goods recycle a minimum proportion of the products they sell after they have become waste.

By participating you will be contributing to unique and essential environmental, social, and market research. You will also be entered into a *free* prize draw for £100 worth of Dixons vouchers (first prize), or £25 worth of Dixons vouchers (two runner-up prizes). There will only be 30 households entered into this competition in total! If you win you will be notified and will receive your prize within the next 21 days.

The E-SCOPE project has been jointly funded by Dixons Stores Group (retail), Domestic and General PLC (insurance), Hewlett-Packard Limited (manufacturing), Intex Computers Limited (recycling), Philips Electronics UK Limited (manufacturing), and Urban Mines Limited (environmental trust).

Research work is being co-ordinated by academic researchers from Sheffield Hallam University (Tim Cooper), and Brunel & Surrey Universities (Myself). Survey work is being managed and carried out by SSMR (Surrey Social and Market Research) at the University of Surrey, and the research company Quality Fieldwork respectively.

Thank you once again for your interest and time.

Yours sincerely

Kieren Mayers
Environmental Research Engineer
Hewlett-Packard Limited

[1] "E-SCOPE" stands for "The Electronics Industry – Social Considerations of Product End-of-life".

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Appendix 8: Areas investigated in main survey

	Frequency	Percent	Cumulative Percent
1. Hillsborough	1	.1	1.5
2. Abernyte	1	.1	1.6
3. Acocks Green	1	.1	1.7
4. Ancrum	1	.1	1.9
5. Armadale	2	.2	2.1
6. Ashburton	3	.4	2.5
7. Ashford	8	1.0	3.5
8. Ballyclare	1	.1	3.6
9. Barkingside	1	.1	3.7
10. Barnehurst	1	.1	3.9
11. Barnes	1	.1	4.0
12. Barnsley	10	1.2	5.2
13. Bathgate	4	.5	5.7
14. Battersea	1	.1	5.9
15. Beckenham	1	.1	6.0
16. Beckleyheath	2	.2	6.2
17. Belfast	2	.2	6.5
18. Berwick	4	.5	7.0
19. Bexley	1	.1	7.1
20. Birmingham	3	.4	7.5
21. Bishop Auckland	9	1.1	8.6
22. Blackburn	23	2.9	11.5
23. Boncath	1	.1	11.6
24. Bournemouth	9	1.1	12.7
25. Bow	1	.1	12.8
26. Brampton	1	.1	13.0
27. Bransgone	1	.1	13.1
28. Breadsall	1	.1	13.2
29. Brighton	1	.1	13.3
30. Bristol	20	2.5	15.8
31. Bromley	1	.1	16.0
32. Bromsgrove	3	.4	16.3
33. Buckhurst Hill	4	.5	16.8
34. Byrness	2	.2	17.1
35. Canterbury	1	.1	17.2
36. Cardiff	9	1.1	18.3
37. Cardigan	2	.2	18.6
38. Carlisle	9	1.1	19.7
39. Carnoustie	1	.1	19.8
40. Carrickfergus	1	.1	20.0
41. Chaddeston	6	.7	20.7
42. Chadwell St. Mary	2	.2	20.9
43. Chatham	2	.2	21.2
44. Cheadle Hume	8	1.0	22.2
45. Chelmsford	1	.1	22.3
46. Chishurst	1	.1	22.4
47. Christchurch	1	.1	22.6
48. Cilgerran	3	.4	22.9
49. Coatbridge	1	.1	23.1
50. Coldstream	1	.1	23.2
51. Corby	10	1.2	24.4
52. Cotgrave	20	2.5	26.9
53. Coventry	10	1.2	28.2
54. Cradley Heath	1	.1	28.3
55. Dagenham	13	1.6	29.9
56. Dalston	1	.1	30.0
57. Darlington	5	.6	30.7
58. Dartford	8	1.0	31.7
59. Debden	2	.2	31.9
60. Dechmont	1	.1	32.0
61. Devonglass	1	.1	32.2
62. Dotchet	1	.1	32.3

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63. Dromara	3	.4	32.7
64. Dudley	1	.1	32.8
65. Dundee	2	.2	33.0
66. Dunmurry	1	.1	33.2
67. Duns	1	.1	33.3
68. Eaglefield Green	1	.1	33.4
69. East London	1	.1	33.5
70. Eastleigh	7	.9	34.4
71. Elm Park	2	.2	34.7
72. Eltham	2	.2	34.9
73. Enderby	4	.5	35.4
74. Erdington	1	.1	35.5
75. Falkirk	1	.1	35.7
76. Fareham	8	1.0	36.7
77. Feltam	1	.1	36.8
78. Forest Gate	1	.1	36.9
79. Gilford	1	.1	37.0
80. Gillingham	10	1.2	38.3
81. Giltbrook	1	.1	38.4
82. Glasgow	6	.7	39.2
83. Gloucester	10	1.2	40.4
84. Gravesend	2	.2	40.6
85. Grays	1	.1	40.8
86. Greenfield	1	.1	40.9
87. Hackney	6	.7	41.6
88. Haindult	2	.2	41.9
89. Halesowen	20	2.5	44.4
90. Hall Green	2	.2	44.6
91. Hampton Hill	5	.6	45.3
92. Harrow	10	1.2	46.5
93. Harvington	1	.1	46.6
94. Hatton	4	.5	47.1
95. Hawick	10	1.2	48.4
96. Heaton	1	.1	48.5
97. Heddon on the Wall	1	.1	48.6
98. Hereford	1	.1	48.8
99. Hillsborough	1	.1	48.9
100. Hornchurch	2	.2	49.1
101. Ilford	11	1.4	50.5
102. Killwinnie	1	.1	50.6
103. Kingennie	1	.1	50.7
104. Kings Heath	1	.1	50.9
105. Kings Norton	1	.1	51.0
106. Kirby in Ashfield	4	.5	51.5
107. Langland	1	.1	51.6
108. Leamington Spa	5	.6	52.2
109. Leaminton Spa	5	.6	52.9
110. Livingston	1	.1	53.0
111. Loughton	8	1.0	54.0
112. Louth	10	1.2	55.2
113. Lye	1	.1	55.4
114. Maenychlogddu	1	.1	55.5
115. Maryport	4	.5	56.0
116. Moira	3	.4	56.4
117. Monifieth	1	.1	56.5
118. Monikie	1	.1	56.6
119. Monkseaton	1	.1	56.7
120. Morpeth	4	.5	57.2
121. Moseley	3	.4	57.6
122. Mumbles	4	.5	58.1
123. Narborough	7	.9	59.0
124. New Bigging	3	.4	59.4
125. New Milton	9	1.1	60.5
126. Newark	29	3.6	64.1
127. Newcastle on Tyne	1	.1	64.2
128. Newcastle upon Tyne	9	1.1	65.3
129. Newry	1	.1	65.5
130. Newthorpe	4	.5	66.0

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131. Newton Abbot	7	.9	66.8
132. North Shields	3	.4	67.2
133. Oakwood	3	.4	67.6
134. Oldham	20	2.5	70.1
135. Orpington	6	.7	70.8
136. Peterhead	10	1.2	72.1
137. Plymouth	10	1.2	73.3
138. Pontefract	10	1.2	74.6
139. Poole	8	1.0	75.6
140. Prud Hoe	8	1.0	76.6
141. Rainham	14	1.7	78.3
142. Redbridge	1	.1	78.4
143. Ringwood	11	1.4	79.8
144. Roath	1	.1	79.9
145. Romford	5	.6	80.5
146. Rowley Regis	5	.6	81.2
147. Rugeley	6	.7	81.9
148. Sainsborough	1	.1	82.0
149. Salem	1	.1	82.2
150. Seaton	1	.1	82.3
151. Selkirk	1	.1	82.4
152. Shard End	1	.1	82.5
153. Shildon	1	.1	82.7
154. Shirley	1	.1	82.8
155. Sidcup	2	.2	83.0
156. Slough	2	.2	83.3
157. Small Heath	1	.1	83.4
158. Solihull	2	.2	83.7
159. Southampton	2	.2	83.9
160. St Dogmaels	2	.2	84.2
161. Stafford	1	.1	84.3
162. Stockfield	2	.2	84.5
163. Stockport	3	.4	84.9
164. Stone	2	.2	85.2
165. Stourbridge	2	.2	85.4
166. Sutton Coldfield	7	.9	86.3
167. Sutton in Ashfield	1	.1	86.4
168. Swanley	2	.2	86.7
169. Tamworth	1	.1	86.8
170. Thamesmead	10	1.2	88.0
171. Tividale	2	.2	88.3
172. Twickenham	2	.2	88.5
173. Tynemouth	2	.2	88.8
174. Upminster	4	.5	89.3
175. Wallsend	20	2.5	91.8
176. Warrenpoint	4	.5	92.3
177. Warwick	10	1.2	93.5
178. Wednesfield	1	.1	93.6
179. Welling	1	.1	93.8
180. West Cross	4	.5	94.3
181. Whiteley	1	.1	94.4
182. Whitley Bay	11	1.4	95.8
183. Wickford	1	.1	95.9
184. Winchester	2	.2	96.1
185. Windsor	6	.7	96.9
186. Woodford	2	.2	97.1
187. Workington	3	.4	97.5
188. Wrexham	20	2.5	100.0
Total	802	100.0	

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Appendix 9: Recruitment questionnaire: Sheffield

RECRUITMENT QUESTIONNAIRE

This form is the property of Quality Fieldwork, 86 Aldridge Rd, Perry Barr, Birmingham B42 2TP, 0121 344 4848, and is CONFIDENTIAL.

JOB : SSMR/521 **E-SCOPE - WASTE MANAGEMENT**

SHEFFIELD
RECRUIT 10

	CODE			
GROUP	**1**	**AB**	**Monday 12th April**	**7pm**
GROUP	**2**	**C1C2D**	**Tuesday 13th April**	**7pm**
GROUP	**3**	**E**	**Wednesday 14th April**	**7pm**

ALL : Aged 25-65
50% Male 50% Female

RESPONDENTS NAME : _____

ADDRESS _____

_____

POST CODE _____

PHONE NUMBER _____

INTERVIEWER _____

TAXI REQUIREMENTS _____

APPROX COST £_____

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Introduction :
My name is ……. and I work for an independent market research company called Quality Fieldwork (SHOW ID)
We are working with Surrey University to help a broad consortium of household appliance manufacturers and suppliers, to conduct a survey investigating how households use and throw away appliances. The aim of the consortium is to improve this by understanding more about households' behaviour at the use and disposal stage, but they need to understand more about individual household's usage in order to move forward. I would be very grateful for your help."

SCREEN
Do you or any of your close friends or family work in any of the following types of organisation ? **READ OUT**

MARKET RESEARCH
UNIVERSITY
WASTE MANAGEMENT (Council or private)
(IF NONE, CONTINUE)

RECRUITMENT

Are you the householder/joint householder ?

Yes	1	**Recruit to quota**
No	2	**Thank and Close**

GENDER

MALE	1	**Recruit 5**
FEMALE	2	**Recruit 5**

AGE (Write in) _____

Under 25	1	**Minimum 1**
25 - 44	2	**Minimum 2**
45 - 64	3	**Minimum 2**
65+	4	**Maximum 3**

SEG :
Occupation (or former occupation) of CWE _____
(If retired) Works related or Private pension received ? _____
Qualifications _____
Staff resp for _____

AB	1	**Group 1**
C1	3	**Group 2**
C2	4	**Group 2**
D	5	**Group 2**
E	6	**Group 3**

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Appendix 10: Recruitment questionnaire: South Wales

RECRUITMENT QUESTIONNAIRE

This form is the property of Quality Fieldwork, 86 Aldridge Rd, Perry Barr, Birmingham B42 2TP, 0121 344 4848, and is CONFIDENTIAL.

JOB : SSMR/521 **E-SCOPE - WASTE MANAGEMENT**

WALES
RECRUIT 10

	CODE			
GROUP	**4**	**Urban Dwellers**	**Tuesday 13th April**	**7pm**
GROUP	**5**	**Rural Dwellers**	**Wednesday 14th April**	**7pm**

ALL : Aged 25-65
50% Male 50% Female

RESPONDENTS NAME : _____

ADDRESS _____

_____

POST CODE _____

PHONE NUMBER _____

INTERVIEWER _____

TAXI REQUIREMENTS _____

APPROX COST £_____

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Introduction :
My name is ……. and I work for an independent market research company called Quality Fieldwork (SHOW ID)
We are working with Surrey University to help a broad consortium of household appliance manufacturers and suppliers, to conduct a survey investigating how households use and throw away appliances. The aim of the consortium is to improve this by understanding more about households' behaviour at the use and disposal stage, but they need to understand more about individual household's usage in order to move forward. I would be very grateful for your help."

SCREEN
Do you or any of your close friends or family work in any of the following types of organisation ? **READ OUT**

MARKET RESEARCH
UNIVERSITY
WASTE MANAGEMENT (Council or private)
(IF NONE, CONTINUE)

RECRUITMENT

1	Are you the householder/joint householder ?		
	Yes	1	**Recruit to quota**
	No	2	**Thank and Close**

2	Lives in an URBAN area (ie Cardiff. Built up area)	1	**Group 4**
	Lives in a RURAL area (ie Out of Town. Not built up. Village)		**Group 5**

GENDER

MALE	1	**Recruit 5**
FEMALE	2	**Recruit 5**

AGE (Write in) _____

Under 25	1	**Minimum 1**
25 - 44	2	**Minimum 2**
45 - 64	3	**Minimum 2**
65+	4	**Maximum 3**

SEG :
Occupation (or former occupation) of CWE _____
(If retired) Works related or Private pension received ? _____
Qualifications _____
Staff resp for _____

AB	1	**Minimum 1**
C1	3	**Minimum 2**
C2	4	**As they come**
D	5	**As they come**
E	6	**Maximum 2**

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Appendix 11: E-SCOPE general information brochure

Kieren Mayers
E-SCOPE Project Coordinator
Hewlett-Packard Limited
Eskdale Road
Winnersh Triangle
Wokingham
RG44 5DZ

T: 0118 927 4445
F: 0118 927 4049

E-SCOPE: General Information

Executive Summary

Within the next few years producer responsibility will make electronics producers responsible for their products at end-of-life. Very little is known about what happens to end-of-life electronics, and the infrastructures available for treating and recycling these wastes are underdeveloped. Although various pilot projects have been set up in the UK to investigate the feasibility of different product-take-back arrangements, many of these have been unsuccessful due to unforeseen market and sociological factors (especially for the domestic sector). Some research has been conducted into sociological and market factors affecting end-of-life electronics, but this is limited to specific product types, regions, or sectors of society.

In view of these expected developments and the issues it raises, various stakeholders (listed on the right) have initiated a joint market and social research project to investigate product end-of-life in different sectors of society, known as the "E-SCOPE" project.

The E-SCOPE project aims to research the use and disposal of household appliances by UK households. Broadly the research has addressed 3 questions:

Why do people stop using their products?
What do people do with old equipment and why?
Which solutions would lead to effective waste reduction?

This has been investigated in 2 parts, a survey of 800 households in over 100 locations in the UK (with in-home interviews, completed in December 1998), and five focus groups (completed March 1999).

The project has been funded jointly by five commercial partners, and from landfill tax monies. Two academic researchers with a good background in closely related areas

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(from Surrey and Sheffield Hallam Universities) also participate in the project. Various research consultants have been contracted to carry out most of the survey work.

The results of the E-SCOPE project will be made publically available sometime after the completion of the project in March. This will be in the form of a written report.

E-SCOPE mission statement and benefits

Mission Statement

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To gain an understanding of the patterns of use and disposal of electronic products from the consumer perspective, in order to evaluate their effective management, and to make information available publically and to relevant interest groups.

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Potential Consumer Benefits

- Better consideration of consumer needs after sale
- Craft the consumer message to encourage recycling
- Improved services and products
- Reduced on-costs
- Socially acceptable and efficient schemes
- Personal satisfaction from recycling
- Reduced waste disposal problems
- Consumer views better considered in legislation

Potential Environmental Benefits

- Existing recycling / reuse activity enhanced
- Disposal behaviours improved
- New reuse / recycling markets identified
- Efficiency of collection increased
- Consumer awareness needs better understood
- Consumer awareness improved through survey
- Better consideration of sustainable development

Potential Commercial Benefits

- Competitive advantage in product-take-back through improved market understanding
- Access to unique, valuable and essential market research information
- New perspectives on consumer / end-user view of producer responsibility
- Full access to results
- Involvement in a published report
- Communication of findings to government
- Development of legislation based on sound assumptions

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Appendix 12: Worked example of chi-squared test

The Chi^2 test

	Group A	Group B	Group C
Observed	3	2	4
Expected	4	5	6
χ^2 calculation	1	1.8	0.7

v = 3 – 1
v = 2

$\chi^2 = 3.5$ N.S.

The Contingency Method

Observed	**Group A**	**Group B**	**Group C**
Group 1	3	2	4
Group 2	5	3	8
Group 3	5	3	7
Expected	**Group A**	**Group B**	**Group C**
Group 1	5	8	6
Group 2	5	7	8
Group 3	7	9	5
χ^2 calculation	**Group A**	**Group B**	**Group C**
Group 1	0.8	4.5	0.7
Group 2	0	2.3	0
Group 3	0.6	4	0.8

v = (3 – 1)(3 – 1)
v = 4

$\chi^2 = 13.7$ **

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Appendix 13: Average product masses used

Product category	Kg Mass
Electric cookers	62
Microwave ovens	25
Refrigerators and freezers	42[†]
Washing machines, dishwashers and tumble dryers	60
Vacuum cleaners and carpet cleaners	5
Small work or personal care appliances	2
Hi-fi and stereo	5
Radio and personal radio, stereo and CD	1
Televisions	16
Video equipment	5
Telephones, faxes and answer machines	2
Mobile phones and pagers	1
Computers and peripherals	20
Toys	1
Home and garden tools	10

[†] Refrigerators at 35 kg (1/3rd of units disposed of) combined fridge freezers at 60 to 65 kg (2/3rd of units disposed of). (35/3*2)+(62.5/3) = 42 Kg.

Source: Adapted from ICER, 1998

Appendix 14: Household appliance disposition matrices

Product		Collected as ordinary waste by local authority	Collected as "bulky waste" by local authority	Taken to a local authority civic amenity site	Collected by retailer or supplier while delivering new product	Traded in to retailer or supplier for discount on purchase of new product	Sold privately to second-hand shop or dealer	Sold privately e.g. car boot sale, advertised in newspaper / shop window	Donated to charity (jumble sale, charity shop)	Donated for free to family or friends	Left in the nearest convenient skip or unused waste ground	Given to scrap merchant or other recycling company	Given to repairer for spare parts	Disposed of in skip at work	Other (uknown)	TOTAL
Electric cookers	Weight (kg)	749	17,967	22,458	13,101	3,743	2,994	3,369	3,369	12,352	0	6,737	749	374	5,615	93,576
	% (by weight)	0.8%	19.2%	24.0%	14.0%	4.0%	3.2%	3.6%	3.6%	13.2%	0.0%	7.2%	0.8%	0.4%	6.0%	
Microwave ovens	Weight	1,660	3,924	6,490	1,509	302	604	906	453	7,245	302	1,057	151	151	1,207	25,960
	% (by weight)	6.4%	15.1%	25.0%	5.8%	1.2%	2.3%	3.5%	1.7%	27.9%	1.2%	4.1%	0.6%	0.6%	4.7%	
Refrigerators and freezers	Weight	1,283	19,757	25,145	19,500	3,849	2,822	3,592	770	15,138	257	5,388	257	513	2,053	100,322
	% (by weight)	1.3%	19.7%	25.1%	19.4%	3.8%	2.8%	3.6%	0.8%	15.1%	0.3%	5.4%	0.3%	0.5%	2.0%	
Washing machines, dishwashers, and tumble dryers	Weight	2,481	31,429	40,114	44,249	11,993	2,895	2,481	827	13,647	1,654	11,166	2,895	1,242	4,135	171,209
	% (by weight)	1.4%	18.4%	23.4%	25.8%	7.0%	1.7%	1.4%	0.5%	8.0%	1.0%	6.5%	1.7%	0.7%	2.4%	
Vacuum cleaners and carpet cleaners	Weight	1,117	634	3,773	211	272	151	211	121	1,479	241	332	241	60	60	8,905
	% (by weight)	12.5%	7.1%	42.4%	2.4%	3.1%	1.7%	2.4%	1.4%	16.6%	2.7%	3.7%	2.7%	0.7%	0.7%	
Small work or personal care appliances	Weight	7,124	133	1,751	0	48	24	266	386	1,159	133	181	36	85	97	11,423
	% (by weight)	62.4%	1.2%	15.3%	0.0%	0.4%	0.2%	2.3%	3.4%	10.1%	1.2%	1.6%	0.3%	0.7%	0.8%	
Hi-Fi and stereo	Weight	634	272	1,358	0	30	241	362	181	1,389	151	91	91	0	151	4,950
	% (by weight)	12.8%	5.5%	27.4%	0.0%	0.6%	4.9%	7.3%	3.7%	28.0%	3.0%	1.8%	1.8%	0.0%	3.0%	
Radio and personal radio, stereo, and CD	Weight	664	12	235	12	0	6	78	36	127	36	30	6	12	36	1,292
	% (by weight)	51.4%	0.9%	18.2%	0.9%	0.0%	0.5%	6.1%	2.8%	9.8%	2.8%	2.3%	0.5%	0.9%	2.8%	
Television	Weight	1,063	3,091	10,046	3,574	1,159	580	966	773	6,858	97	676	676	193	580	30,331
	% (by weight)	3.5%	10.2%	33.1%	11.8%	3.8%	1.9%	3.2%	2.5%	22.6%	0.3%	2.2%	2.2%	0.6%	1.9%	
Video equipment	Weight	574	181	1,087	332	121	211	272	0	1,238	91	181	181	91	181	4,739
	% (by weight)	12.1%	3.8%	22.9%	7.0%	2.5%	4.5%	5.7%	0.0%	26.1%	1.9%	3.8%	3.8%	1.9%	3.8%	
Telephones, faxes, and answer machines	Weight	676	24	314	97	36	97	157	48	314	48	24	0	0	48	1,884
	% (by weight)	35.9%	1.3%	16.7%	5.1%	1.9%	5.1%	8.3%	2.6%	16.7%	2.6%	1.3%	0.0%	0.0%	2.6%	
Mobile phones and pagers	Weight	66	12	12	6	18	0	18	0	48	0	0	6	0	12	199
	% (by weight)	33.3%	6.1%	6.1%	3.0%	9.1%	0.0%	9.1%	0.0%	24.2%	0.0%	0.0%	3.0%	0.0%	6.1%	
Computers and peripherals	Weight	241	0	483	241	121	362	724	241	1,811	0	121	121	0	241	4,709
	% (by weight)	5.1%	0.0%	10.3%	5.1%	2.6%	7.7%	15.4%	5.1%	38.5%	0.0%	2.6%	2.6%	0.0%	5.1%	
Toys	Weight	193	6	175	6	18	24	72	66	78	18	0	6	0	24	688
	% (by weight)	28.1%	0.9%	25.4%	0.9%	2.6%	3.5%	10.5%	9.6%	11.4%	2.6%	0.0%	0.9%	0.0%	3.5%	
Home and garden tools	Weight	4,226	483	5,071	60	60	241	483	362	2,354	302	1,268	302	423	241	15,878
	% (by weight)	26.6%	3.0%	31.9%	0.4%	0.4%	1.5%	3.0%	2.3%	14.8%	1.9%	8.0%	1.9%	2.7%	1.5%	
TOTAL	Weight	22,751	77,925	118,512	82,899	21,770	11,253	13,959	7,634	65,238	3,329	27,252	5,717	3,144	14,682	476,065
	% (by weight)	4.8%	16.4%	24.9%	17.4%	4.6%	2.4%	2.9%	1.6%	13.7%	0.7%	5.7%	1.2%	0.7%	3.1%	

Product		Collected as ordinary waste by local authority	Collected as "bulky waste" by local authority	Taken to a local authority civic amenity site	Collected by retailer or supplier while delivering new product	Traded in to retailer or supplier for discount on purchase of new product	Sold privately to second-hand shop or dealer	Sold privately e.g. car boot sale, advertised in newspaper / shop window	Donated to charity (jumble sale, charity shop)	Donated for free to family or friends	Left in the nearest convenient skip or unused waste ground	Given to scrap merchant or other recycling company	Given to repairer for spare parts	Disposed of in skip at work	Other (unkown)	TOTAL
Electric cookers	Units	12,074	289,784	362,229	211,300	60,372	48,297	54,334	54,334	199,226	0	108,669	12,074	6,037	90,557	1,509,289
	% (by units)	0.8%	19.2%	24.0%	14.0%	4.0%	3.2%	3.6%	3.6%	13.2%	0.0%	7.2%	0.8%	0.4%	6.0%	
Microwave ovens	Units	66,409	156,966	259,598	60,372	12,074	24,149	36,223	18,111	289,784	12,074	42,260	6,037	6,037	48,297	1,038,391
	% (by units)	6.4%	15.1%	25.0%	5.8%	1.2%	2.3%	3.5%	1.7%	27.9%	1.2%	4.1%	0.6%	0.6%	4.7%	
Refrigerators and freezers	Units	30,186	464,861	591,641	458,824	90,557	66,409	84,520	18,111	356,192	6,037	126,780	6,037	12,074	48,297	2,360,528
	% (by units)	1.3%	19.7%	25.1%	19.4%	3.8%	2.8%	3.6%	0.8%	15.1%	0.3%	5.4%	0.3%	0.5%	2.0%	
Washing machines, dishwashers, and tumble dryers	Units	36,223	458,824	585,604	645,976	175,078	42,260	36,223	12,074	199,226	24,149	163,003	42,260	18,134	60,372	2,499,406
	% (by units)	1.4%	18.4%	23.4%	25.8%	7.0%	1.7%	1.4%	0.5%	8.0%	1.0%	6.5%	1.7%	0.7%	2.4%	
Vacuum cleaners and carpet cleaners	Units	223,375	126,780	754,645	42,260	54,334	30,186	42,260	24,149	295,821	48,297	66,409	48,297	12,074	12,074	1,780,961
	% (by units)	12.5%	7.1%	42.4%	2.4%	3.1%	1.7%	2.4%	1.4%	16.6%	2.7%	3.7%	2.7%	0.7%	0.7%	
Small work or personal care appliances	Units	3,561,923	66,409	875,388	0	24,149	12,074	133,150	193,189	579,567	66,409	90,557	18,111	42,260	48,297	5,711,483
	% (by units)	62.4%	1.2%	15.3%	0.0%	0.4%	0.2%	2.3%	3.4%	10.1%	1.2%	1.6%	0.3%	0.7%	0.8%	
Hi-Fi and stereo	Units	126,780	54,334	271,672	0	6,037	48,297	72,446	36,223	277,709	30,186	18,111	18,111	0	30,186	990,094
	% (by units)	12.8%	5.5%	27.4%	0.0%	0.6%	4.9%	7.3%	3.7%	28.0%	3.0%	1.8%	1.8%	0.0%	3.0%	
Radio and personal radio, stereo, and CD	Units	664,087	12,074	235,449	12,074	0	6,037	78,483	36,223	126,780	36,223	30,186	6,037	12,074	36,223	1,291,952
	% (by units)	51.4%	0.9%	18.2%	0.9%	0.0%	0.5%	6.1%	2.8%	9.8%	2.8%	2.3%	0.5%	0.9%	2.8%	
Television	Units	66,409	193,189	627,864	223,375	72,446	36,223	60,372	48,297	428,638	6,037	42,260	42,260	12,074	36,223	1,895,667
	% (by units)	3.5%	10.2%	33.1%	11.8%	3.8%	1.9%	3.2%	2.5%	22.6%	0.3%	2.2%	2.2%	0.6%	1.9%	
Video equipment	Units	114,706	36,223	217,338	66,409	24,149	42,260	54,334	0	247,523	18,111	36,223	36,223	18,111	36,223	947,834
	% (by units)	12.1%	3.8%	22.9%	7.0%	2.5%	4.5%	5.7%	0.0%	26.1%	1.9%	3.8%	3.8%	1.9%	3.8%	
Telephones, faxes, and answer machines	Units	338,081	12,074	156,966	48,297	18,111	48,297	78,483	24,149	156,966	24,149	12,074	0	0	24,149	941,797
	% (by units)	35.9%	1.3%	16.7%	5.1%	1.9%	5.1%	8.3%	2.6%	16.7%	2.6%	1.3%	0.0%	0.0%	2.6%	
Mobile phones and pagers	Units	66,409	12,074	12,074	6,037	18,111	0	18,111	0	48,297	0	0	6,037	0	12,074	199,226
	% (by units)	33.3%	6.1%	6.1%	3.0%	9.1%	0.0%	9.1%	0.0%	24.2%	0.0%	0.0%	3.0%	0.0%	6.1%	
Computers and peripherals	Units	12,074	0	24,149	12,074	6,037	18,111	36,223	12,074	90,557	0	6,037	6,037	0	12,074	235,449
	% (by units)	5.1%	0.0%	10.3%	5.1%	2.6%	7.7%	15.4%	5.1%	38.5%	0.0%	2.6%	2.6%	0.0%	5.1%	
Toys	Units	193,189	6,037	175,078	6,037	18,111	24,149	72,446	66,409	78,483	18,111	0	6,037	0	24,149	688,236
	% (by units)	28.1%	0.9%	25.4%	0.9%	2.6%	3.5%	10.5%	9.6%	11.4%	2.6%	0.0%	0.9%	0.0%	3.5%	
Home and garden tools	Units	422,601	48,297	507,121	6,037	6,037	24,149	48,297	36,223	235,449	30,186	126,780	30,186	42,260	24,149	1,587,772
	% (by units)	26.6%	3.0%	31.9%	0.4%	0.4%	1.5%	3.0%	2.3%	14.8%	1.9%	8.0%	1.9%	2.7%	1.5%	
TOTAL	Units	5,934,525	1,937,927	5,656,816	1,799,073	585,604	470,898	905,906	579,567	3,610,220	319,969	869,351	283,746	181,137	543,344	23,678,085
	% (by units)	25.1%	8.2%	23.9%	7.6%	2.5%	2.0%	3.8%	2.4%	15.2%	1.4%	3.7%	1.2%	0.8%	2.3%	

Appendix 15: Chi-square calculations

For a fuller explanation of the Chi-square statistical method, see Section 3.4.

Table A.1: Storage of household appliances by UK households (1998)

	Electric cookers	Microwave ovens	Refrigerators and freezers	Washing machines, dishwashers, and tumble dryers	Vacuum cleaners and carpet cleaners	Small work or personal care appliances	Hi-Fi and stereo	Radio and personal radio, stereo, and CD	Television	Video equipment	Telephones, faxes, and answer machines	Mobile phones and pagers	Computers and peripherals	Toys	Home and garden tools	n
Appliances owned	549	719	1183	1227	1069	5047	1283	1645	1912	1162	1517	482	498	746	2720	21759
Total stored (observed)	6	21	19	30	55	349	55	75	80	38	48	19	26	30	127	978
Total stored (expected)	25	32	53	55	48	227	58	74	86	52	68	22	22	34	122	978
$(Oj-Ej)^2/Ej$	14	4	22	11	1	66	0	0	0	4	6	0	1	0	0	130

For total products in storage $\chi^2 = 130$, **$p<0.001$*****
Degrees of freedom = 14
Expected values calculated from overall number of appliances owned and overall proportion of products in storage

Table A.2: Ownership of second-hand appliances by product type

	Electric cookers	Microwave ovens	Refrigerators and freezers	Washing machines, dishwashers, and tumble dryers	Vacuum cleaners and carpet cleaners	Small work or personal care appliances	Hi-Fi and stereo	Radio and personal radio, stereo, and CD	Television	Video equipment	Telephones, faxes, and answer machines	Mobile phones and pagers	Computers and peripherals	Toys	Home and garden tools	n
Appliances owned	549	719	1183	1227	1069	5047	1283	1645	1912	1162	1517	482	498	746	2720	21759
Total 2nd-hand (observed)	72	57	136	95	66	160	55	41	145	69	46	5	32	29	126	1134
Total 2nd-hand (expected)	29	37	62	64	56	263	67	86	100	61	79	25	26	39	142	1134
$(Oj-Ej)^2/Ej$	66	10	90	15	2	40	2	23	21	1	14	16	1	3	2	306

For total products in storage $\chi^2 = 306$, **$p<0.001$*****
Degrees of freedom = 14
Expected values calculated from overall number of appliances owned and overall proportion of second-hand products

Table A.3: Possession of rented appliances by product type

	Electric cookers	Microwave ovens	Refrigerators and freezers	Washing machines, dishwashers, and tumble dryers	Vacuum cleaners and carpet cleaners	Small work or personal care appliances	Hi-Fi and stereo	Radio and personal radio, stereo, and CD	Television	Video equipment	Telephones, faxes, and answer machines	Mobile phones and pagers	Computers and peripherals	Toys	Home and garden tools	
Appliances owned	549	719	1183	1227	1069	5047	1283	1645	1912	1162	1517	482	498	746	2720	2
Total rented (observed)	2	2	7	15	2	12	7	6	73	27	21	3	1	5	6	
Total rented (expected)	5	6	10	11	9	44	11	14	17	10	13	4	4	6	24	
$(Oj-Ej)^2/Ej$	2	3	1	2	6	23	2	5	192	28	5	0	3	0	13	

For total products rented, $\chi^2 = 283$, **$p<0.001^{***}$**
Degrees of freedom = 14
Expected values calculated from overall number of appliances owned and overall proportion of products rented

Table A.4: Age composition of household appliances by socio-economic status

Socio-economic grouping		Total products 1-5 years old	Total products 6 to 10 years old	Total products 11 to 15 years old	Total products greater than 15 years old	n
Total products		**12126**	**6713**	**1851**	**738**	**21428**
AB	Observed	3181	1815	473	228	5697
	Expected	3224	1785	492	196	
	$(Oj-Ej)^2/Ej$	0.57	0.51	0.74	5.15	
C1	Observed	3688	2145	476	195	6504
	Expected	3681	2038	562	224	
	$(Oj-Ej)^2/Ej$	0.01	5.66	13.11	3.76	
C2	Observed	2853	1444	413	158	4868
	Expected	2755	1525	421	168	
	$(Oj-Ej)^2/Ej$	3.50	4.31	0.13	0.56	
D	Observed	1584	704	210	73	2571
	Expected	1455	805	222	89	
	$(Oj-Ej)^2/Ej$	11.45	12.78	0.66	2.73	
E	Observed	820	605	279	84	1788
	Expected	1012	560	154	62	
	$(Oj-Ej)^2/Ej$	36.37	3.59	100.43	8.16	

For ownership of products of different age by socio-economic status:
$\chi^2 = 221.7$, **$p<0.001^{***}$**
Degrees of freedom = 12
Expected values calculated from overall number of appliances owned by socio-economic status and overall proportion of products owned of different age.

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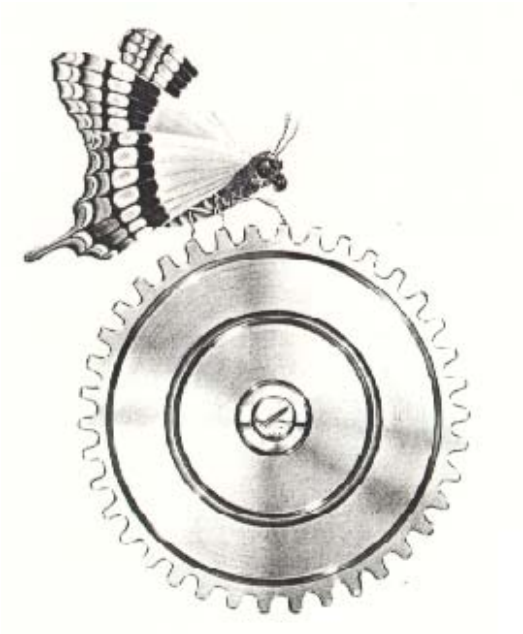
Chapter 4, Vol. 1

An Investigation of the Implications and Effectiveness of Producer Responsibility for the Disposal of WEEE.



Research papers

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Foreword

This report presents various papers published in the course of the research, completed as part of the Engineering Doctorate programme in Environmental Technology at Brunel and Surrey Universities. The report forms the fourth and final chapter of the first volume of the Research Engineer's project Portfolio (Chapter 4, Vol. 1). The previous section in this thesis (Chapter 3, Vol. 1) presented a summary of research on the use and disposal of household appliances by UK householders. An overall summary of the portfolio, including reader's guidelines, is presented in the Executive Summary, Vol. 1.

Contents

Prospects for household appliances

A full report on this study can be found in Chapter 3, Vol. 1. of the research portfolio.

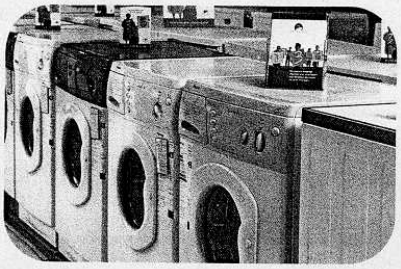
Reference:

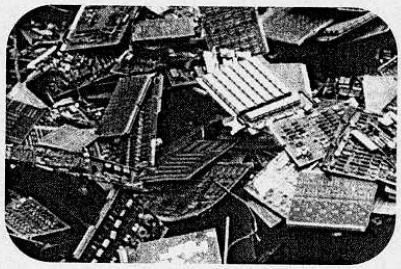
Cooper, T., and Mayers, K., *Prospects for Household Appliances*, Urban Mines: Bradford, 2000. ISBN: 086339 913 4.

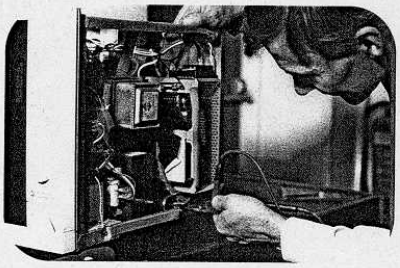
Prospects

for household appliances

Tim Cooper
Kieren Mayers

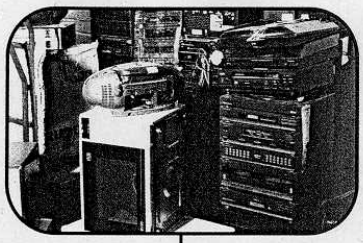






E-SCOPE

(Electronics industry – Social Considerations of Product End-of-life project)



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Philips Electronics UK Limited

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Save Waste and Prosper Limited
The City and County of Cardiff
Urban Mines Limited

The project was co-ordinated by Kieren Mayers, a Research Engineer on the Engineering Doctorate Programme at the University of Surrey (Centre for Environmental Strategy). Research was conducted jointly by Tim Cooper, Head of the Centre for Sustainable Consumption at Sheffield Hallam University, and Kieren Mayers.

This study has been produced and distributed with the help of the following:

Associate Parliamentary Sustainable Waste Group, British Retail Consortium, Convention of Scottish Local Authorities, European Environmental Bureau, Federation of the Electronics Industry, Industry Council for Electronic Equipment Recycling, Local Authority Recycling Advisory Committee, Sheffield Hallam University, Sony International (Europe) GmbH, Waste Watch.

Acknowledgments also go to Surrey Social and Market Research Limited and Quality Fieldwork Limited, who co-ordinated and managed survey work, and to Dr. Christopher France, Dr. Zoe Jackson, Dr. Kate Burningham, Dr. Elaine Kerrell, Sian Evans and Anne Cleverly for their assistance during the course of the study and for reviewing the final report of the project.

Contents

Foreword

Good policies and effective action are best built on high quality research.

Producer Responsibility legislation is increasingly being used to develop a more sustainable approach to the use of our natural resources. At the forefront of the mechanisms for change is the attitude and behaviour of consumers.

The research carried out in this E-SCOPE project has been directed at identifying the consumer attitude and behaviour with accurate quantitative information on household appliances and their use and disposal.

I welcome this report, which is an excellent tool for determining the ways in which consumers and manufacturers alike can address the problems of reducing our household electrical and electronic waste and improving the sustainable use of our natural resources.

The report has been funded partly by manufacturing and retail organisations and partly from landfill tax credits. It is a demonstration of the positive use of the tax in assisting the environment and encouraging sustainability.

Barry Sheerman MP

Chairman
Urban Mines Ltd.

Secretary
Associate Parliamentary Sustainable Waste Group

Executive Summary

This report presents the findings of a study (known as the E-SCOPE[1] study) investigating the purchase, use and disposal of household appliances in the UK. It represents the most comprehensive and detailed investigation of the use and disposal of Waste Electrical and Electronic Equipment ('WEEE') undertaken to date in the UK. Given that the European Union is likely to adopt legislation requiring producers to recover and recycle waste electrical and electronic equipment, this area of research is particularly timely. The findings will be useful for future product design and development, the creation of improved collection, treatment, reuse and recycling services, and the preparation of appropriate UK 'Producer Responsibility' legislation.

The principal objectives of the study were to:

1. Investigate the purchase, use and disposal of household appliances from the consumer perspective.

2. Provide quantitative information on product ownership, lifetime, use and disposal, representative of the UK as a whole.

3. Identify the likely effectiveness of different approaches to addressing the need to reduce WEEE.

The research methods used included face-to-face interviews and focus groups. In total, 802 households were interviewed in over 180 locations across the UK and five focus groups were held involving a total of 50 participants. Issues of product ownership, use and disposal and consumer views on future product and service development were investigated.[2] In summary, it was found that:

- Households owned, on average, 25 appliances. Ownership of products within the households studied was estimated to have increased by around 60% over the last five years. The product stock was relatively young, most products (88%) being under 10 years old and more than half (57%) under 5 years old.

- The proportion of appliances in storage was low, ranging from 1% to 7% between product types. Storage of appliances appeared primarily to be associated with potential reuse rather than disposal.

- Almost one in ten households (9%) owned at least five second-hand appliances.

- At least 476,000 tonnes of household appliances, totalling over 23 million units, were discarded annually in the UK between 1993 and 1998. Large 'white goods'[3] constituted the greatest proportion of the waste stream by mass (77%) and small appliances[4] by number of units (37%).

- Householders wanted better information on how to dispose of appliances safely.

- The average age of household appliances when discarded ranged from 4 years to 12 years, depending on the type of product. Nearly one quarter of discarded products (24%) were either donated or sold for reuse.

- Almost one half of householders interviewed (45%) were of the opinion that, in general, products do not last as long as they would like. Householders most frequently identified wet appliances[5], small work or personal care appliances and vacuum cleaners as products that they would like to last longer.

1 Electronics industry - Social Considerations Of Product End-of-life.
2 The statistics on product ownership and disposal are based on self-reported data. Fifteen product categories were used, as listed in Table 1.
3 i.e. Kitchen appliances.
4 Defined here as small work or personal care appliances, radio and personal radio, stereo and CD, telephones, faxes and answer phones, mobile phones and pagers and toys.
5 Primarily washing machines, dishwashers and tumble dryers.

- More than a third of householders (38%) said that they rarely or never got products repaired. One in ten discarded products (10%) still functioned but were not donated or sold to others for reuse.
- The main disadvantage that householders saw to purchasing longer lasting products was that they may become 'out of date'. Many (73%) regarded information on expected product life as very important and more than half (54%) were dissatisfied with currently available information on life spans.
- Householders appeared to be more willing to buy second-hand products and new products containing refurbished parts if they were perceived as good value and had adequate product warranties.
- New collection and recycling processes are required for small appliances (most of which are currently disposed of in dustbins, wheelie bins or rubbish sacks) and 'brown goods'[6] (most of which are not currently recycled).
- The recycling and disposal of household appliances is more complex than for 'consumables' waste and the effectiveness of any new product recovery ('take-back') services will be determined by a combination of factors relating to the end-user (i.e. disposer), the service provided and the type of product discarded.

The remainder of this report provides a more detailed overview of the project and its key results.

6 i.e Audio-visual equipment, such as televisions and video equipment.

i) Introduction

The effect that consumption has on the environment has become a major concern within the developed world. In response, policy makers are increasingly implementing legislation forcing polluters to pay for the environmental damage they cause. 'Producer Responsibility' legislation, making producers responsible for the treatment and recycling of products at the end of their lives, is one example of such an approach. The principal aim of such legislation is to encourage, by financial means, reductions in the quantity and hazardous content of waste (Lifset, 1993).

This report presents the findings of a study (known as the E-SCOPE study) investigating the purchase, use, and disposal of household appliances in the UK. The research is particularly timely in the light of proposed EU Directives on Waste Electrical and Electronic Equipment ('WEEE')[7], which will apply Producer Responsibility to this waste stream (Mayers and France, 1999; Cooper, 2000). It is hoped that our findings will promote understanding on the life span of household appliances (Cooper, 1994a; Kostecki, 1998) and aid the success of policy initiatives relating to the disposal of WEEE.

A summary of the E-SCOPE project is provided below, including details of the methodology, key research findings and overall conclusions.

ii) The E-SCOPE project

The E-SCOPE project was initiated in February 1998. The principal objectives of this study were to:

1 Investigate the purchase, use and disposal of household appliances from the consumer perspective.

2. Provide quantitative information on product ownership, lifetime, use and disposal, representative of the UK as a whole.

3. Identify the likely effectiveness of different approaches to addressing the need to reduce WEEE.

The study was funded through a combination of private donations from project partners and landfill tax sponsorship.[8] The twelve project partners represented a broad range of stakeholders, each with an interest in the adoption of Producer Responsibility legislation for Waste Electrical and Electronic Equipment in the UK:

- The City and County of Cardiff (local authority)
- Cleanaway Limited (waste management)
- Dixons Stores Group (electrical and electronics goods retail)
- Domestic & General PLC (break-down cover and warranty support)
- The Greenbank Trust (not-for-profit organisation)
- Hewlett-Packard Limited (IT producer)
- Intex Computers Limited (electronics resale and recycling)
- Philips Electronics UK Limited (consumer electronics producer)
- Save Waste and Prosper Limited (not-for-profit organisation)
- Sheffield Hallam University (Centre for Sustainable Consumption)
- University of Surrey (Centre for Environmental Strategy)
- Urban Mines Limited (not-for-profit organisation).

7 Proposal for a Directive of the European Parliament and of the Council on Waste Electrical and Electronic Equipment, Proposal for a Directive of the European Parliament and of the Council on the restriction of the use of certain hazardous substances in electrical and electronic equipment, Commission of the European Communities, 13th June 2000.
8 The total funding of the project was £37,700, of which £13,700 was funded privately and £24,000 provided through landfill tax sponsorship.

iii) Research methodology

The research methods used in this study included face-to-face interviews and focus groups. In a house-to-house survey, 802 households were selected for interview in over 180 locations across the UK during December 1998. This sample was both demographically and statistically representative of the UK population as a whole.[9] The questionnaire and protocol used was developed through a pilot survey of 30 households outside of the main sample. Altogether five focus groups were held, with householders of different socio-economic status and from urban and rural locations. Experienced facilitators were used for each group, using a survey protocol developed through pre-testing on a pilot group. The focus groups were conducted in April 1999.

iv) Results summary

The key results of this research are summarised below, covering product ownership and use, product disposal, and consumer views on new product and service development.

a) Product ownership and use

It was found that, on average, UK households owned 25 electrical or electronic appliances[10] (detail shown in Table 1). Overall, appliance ownership was estimated to have increased by around 60% in the households studied over the last five years. The product stock was relatively young, most appliances being under 10 years old (88%) and more than half (57%) under 5 years old. The stock of cookers, refrigerators and freezers, and home and garden tools contained the highest proportion of older products (see Figure 1).

Significant differences in patterns of appliance ownership were found, depending on the type of appliance and the socio-economic group[11] of the householder. Respondents in higher socio-economic groups and those viewing material wealth as important owned a higher proportion of newer appliances, stored more appliances and owned fewer second-hand appliances.

An important issue in the development of Producer Responsibility policy is the disposal of old products accumulated in storage within households. The proportion of appliances in storage was low (less than 5% of all products, ranging from 1% to 7% by units according to product type, as shown in Figure 2). Over one half of households (60%) did not store any products. Between 40% and 90% of stored appliances were reported as 'still functioning', depending on the product type. Focus group participants indicated that they were likely to be destined for reuse:

> *"I've got 2 kettles stored because I've got 2 grown-up children. One's married now, but the other one's still at home, and he will want one of his own. I've made mistakes of getting rid of things like that, and then needing them!" - Carol, age 51, telephone engineer*

> *"I've got a stereo under the stairs, a television upstairs on my chest of drawers that doesn't work, I've got two irons and a kettle in a cupboard in the kitchen, and I've also got a kettle out on the side and another iron... I don't like throwing anything away that might be of some use." - Sandra, age 40, unemployed*

The storage of household appliances appears not to be as critical an issue as previously thought (one recent report (ICER, 2000) cites an estimate that up to 30% of appliances are in storage).

9 After determining a minimum sample size of 800 using binomial statistics (to ensure adequate statistical representation), the sample was stratified to represent UK demographics. The sample was then selected by quota.

10 Based on self-reported data (i.e. products identified in the interviews) and including rented products. The figure is the median. The inter-quartile range was 16 (50% of households owned between 18 and 34 products). The mean (27) was higher than the median (25), the distribution being skewed.

11 Socio-economic groups were classified as A (higher managerial, administrative or professional), B (intermediate managerial, administrative or professional), C1 (supervisor or clerical and junior managerial, administrative or professional), C2 (skilled manual workers), D (semi and unskilled manual workers) and E (state pensioners, etc. with no other earnings).

Most stored products are evidently being accumulated for future use. More significant than storage, however, is the fact that because appliance ownership has increased there is a growing stock of items that will eventually be discarded. The survey covered discarded appliances from existing households, but some items are only discarded at the end of the owner's life. They may be numerous and their disposal route is unknown:

"When my grandmother died, my mother phoned the council up and said: 'There's a fridge, a freezer, a washing machine, and a cooker. Can you fetch them?'... They said 'Put them out the back and we will be there within four weeks.' They were there for two days fetching them out of the house."
- Sandra, age 40, unemployed

The survey revealed around one in twenty household appliances owned to be second-hand. As shown in Figure 3, these were, in particular, large kitchen appliances and televisions. Although over one half of households (60%) did not own any second-hand appliances, nearly one third (31%) owned between one and four, and almost one in ten households (9%) owned five or more. The proportion of second-hand appliances owned was significantly higher amongst householders of lower socio-economic status. In contrast, only 10% of households overall possessed any rented products.

The survey also investigated the extent of repair work and found that a substantial proportion of householders (38%) rarely or never got their products repaired. Younger people, under 45 years, were significantly less likely to get products repaired. The main reasons cited were the cost of repairs (45%) and a low anticipated residual product life (13%). For example, one focus group participant commented:

"I think that's the main problem these days; it costs so much to get these things repaired, you might as well throw it and buy a new one." - Charles, age 69, retired

A third of discarded products that were broken were described as 'in need of repair', while the other two thirds were considered 'broken beyond repair'. The focus groups revealed that some consumers would like to be able to undertake repairs themselves. However, this has important safety implications that should be considered carefully before such practices are promoted:

"A lot of these products now, a certain part of them contains a sealed unit and once that has gone, that's it. Before you could take them to pieces and put them back again, but not now - once it's gone, it's gone."
- Barry, age 61, unemployed

Table 1: Ownership of household appliances by UK households

Product category	Number per 1,000 households
Electric cookers	685
Microwave ovens	897
Refrigerators and freezers	1,475
Washing machines, dishwashers and tumble dryers	1,529
Vacuum cleaners and carpet cleaners	1,332
Small work or personal care appliances	6,277
Hi-fi and stereo	1,599
Radio and personal radio, stereo and CD	2,050
Televisions	2,382
Video equipment	1,448
Telephones, faxes and answer machines	1,890
Mobile phones and pagers	601
Computers and peripherals	620
Toys	929
Home and garden tools	3,388

Figure 1: Age of household appliances owned by UK households

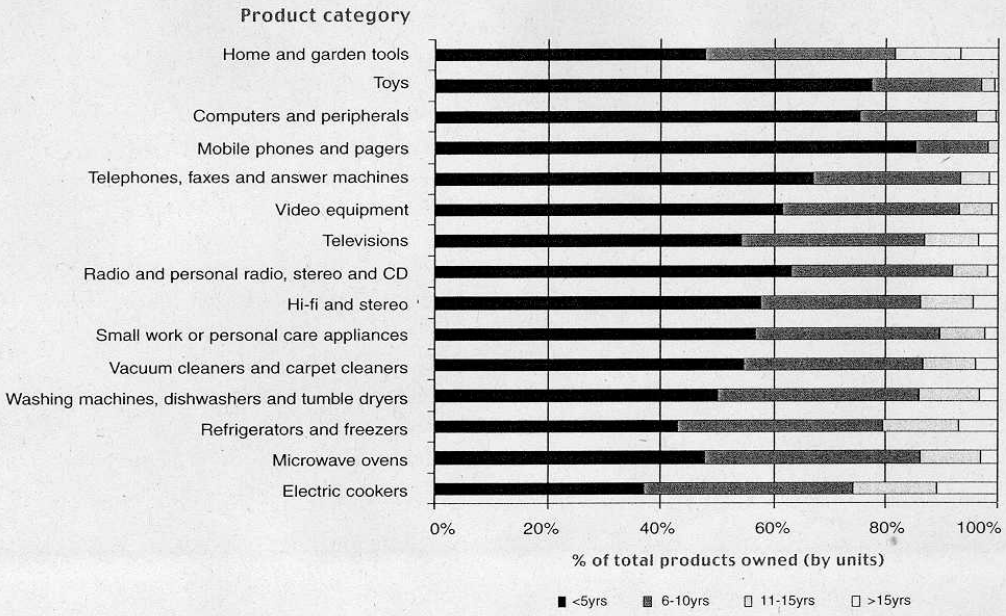


Figure 2: Condition of stored household appliances in UK households

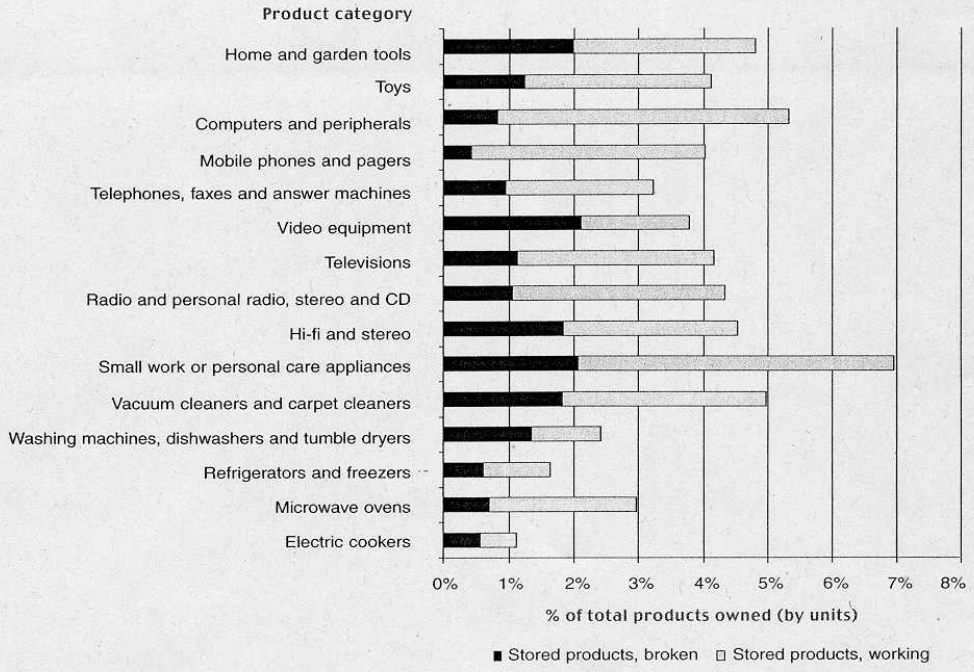
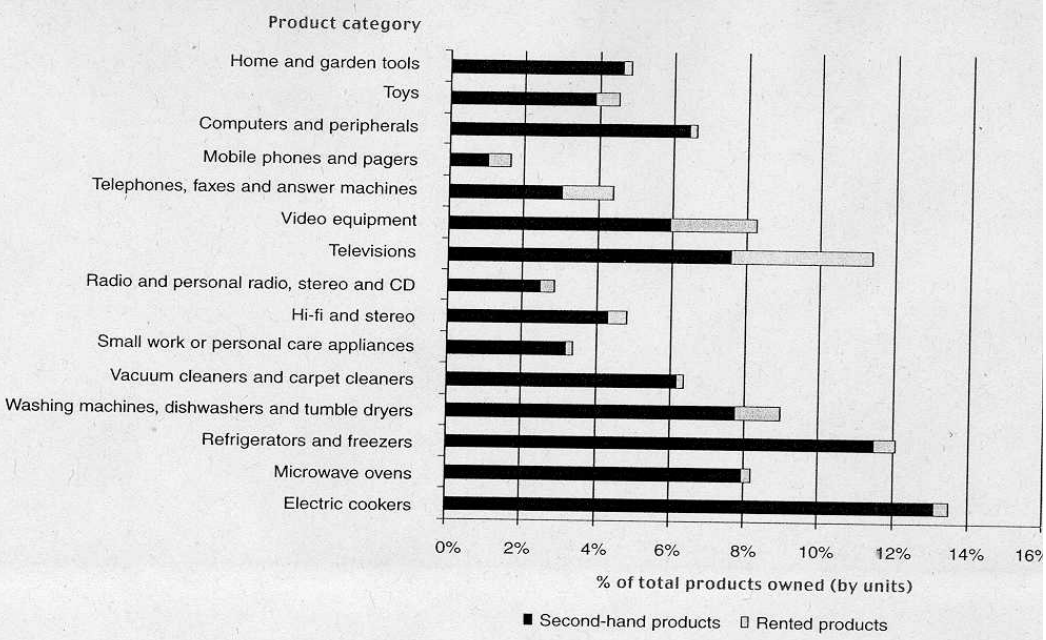


Figure 3: Second-hand and rented appliances in UK household



b) Product disposal

The average age of household appliances when discarded ranged from 4 to 12 years, depending on the type of product, as shown in Table 2.

Overall, one third of discarded appliances were reported as 'still functioning' (notably cookers, hi-fi and stereo, mobile phones and computers). As only around 24% of discarded appliances were intended for reuse (by units), being donated or sold, it can be deduced that around one in ten (10%) still functioned but, even so, were discarded for recycling or final disposal (i.e. landfill or incineration). Discarded products intended for reuse were, on average, as old as those identified as 'broken beyond repair'.

Based on self-reported disposal data, it was estimated that at least 476,000 tonnes of household appliances, totalling over 23 million units, were discarded annually in the UK between 1993 and 1998. This is sometimes described as 'end-of-life' equipment.[12] Whereas large white goods constitute the greatest proportion of appliances discarded by mass (77%), small appliances[13] make up the most significant proportion by number of units (37%), as shown in Figures 4 and 5. Over 60% of small work or personal care appliances were disposed of in dustbins, wheelie bins or rubbish sacks, effectively preventing reuse or recycling.

Thirteen different disposal routes were investigated (as shown in Figures 6 and 7 and, in further detail, Appendices 2 and 3), accounting for all but 3% of appliances discarded (by mass). In summary:

- Around 104,000 tonnes (22%) of discarded appliances were reused, two thirds of which was donated to family or friends with most of the remainder being sold. Appliances most frequently reused were computers, hi-fi and stereo, microwave ovens and video equipment.

12 The term 'end-of-life' often includes products which are subsequently reused. The data is based on product disposals in the past five years. See appendices for further detail.

13 Defined as small work or personal care appliances, radio and personal radio, stereo and CD, telephones, faxes and answer phones, mobile phones and pagers, and toys.

- Around 328,000 tonnes (69%) of discarded appliances were taken to civic amenity sites by householders, collected as 'bulky waste' by local authorities, or collected by retailers or recycling companies. Over 276,000 tonnes of this consisted of large white goods mainly destined for recycling. It is likely that much of the remaining 52,000 tonnes (mostly televisions, microwave ovens, home and garden tools, and vacuum cleaners) was incinerated or ended up in a landfill.

- The remaining 29,200 tonnes (6%) of discarded appliances were collected as 'ordinary waste' by local authorities (i.e. from dustbins, wheelie bins or rubbish sacks) or left in a skip at the owner's work-place or, illegally, on the nearest convenient skip or waste ground (the latter accounting for around 3,330 tonnes). This is destined either for incineration or landfill.

Significant differences were found in the disposal routes used, according to the type of appliance (as shown in Figure 7), socio-economic group, car ownership and householder attitudes. For example, householders of higher socio-economic status, who were significantly more likely to have access to their own means of transport and owned a significantly higher number of newer appliances, discarded a greater proportion of their appliances by donations to family and friends, collection by retailers, or taking them to civic amenity sites. In contrast, householders of lower socio-economic status disposed of a significantly higher proportion of their appliances through municipal waste collections, in a skip at their work-place or, illegally, on the nearest convenient skip or waste ground.

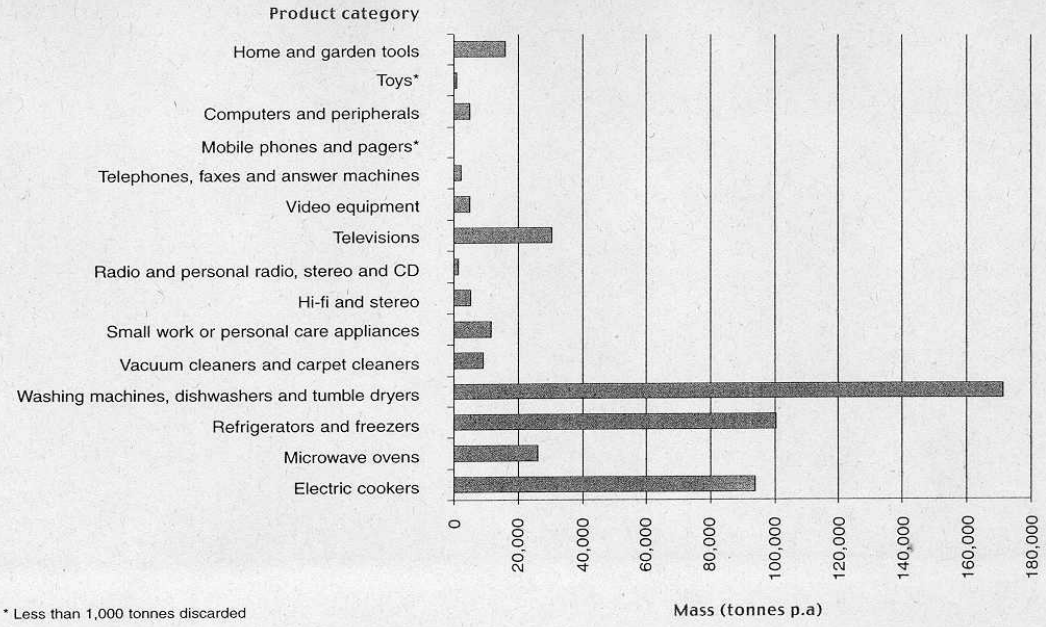
Discarded products not intended for reuse were most likely to be taken to civic amenity sites (32%, by mass) or collected as bulky waste by local authorities (21%). Just over one third was collected by retailers or recycling companies (35%), with the remainder (12%) either collected as ordinary waste by local authorities or left on skips or waste ground.

Table 2: Average age of household appliances when discarded by UK households

Product category	Age of appliances 'broken beyond repair' (years)[14]	Age of all discarded appliances (years)[15]
Electric cookers	12	12
Refrigerators and freezers	11	11
Televisions	10	10
Hi-fi and stereo	9	9
Washing machines, dishwashers and tumble dryers	9	9
Vacuum cleaners and carpet cleaners	7	8
Video equipment	7	7
Home and garden tools	7	7
Microwave ovens	7	7
Computers and peripherals	8	6
Radio and personal radio, stereo and CD	5	6
Telephones, faxes and answer machines	5	6
Mobile phones and pagers	4	4
Small work or personal care appliances	4	4
Toys	3	4

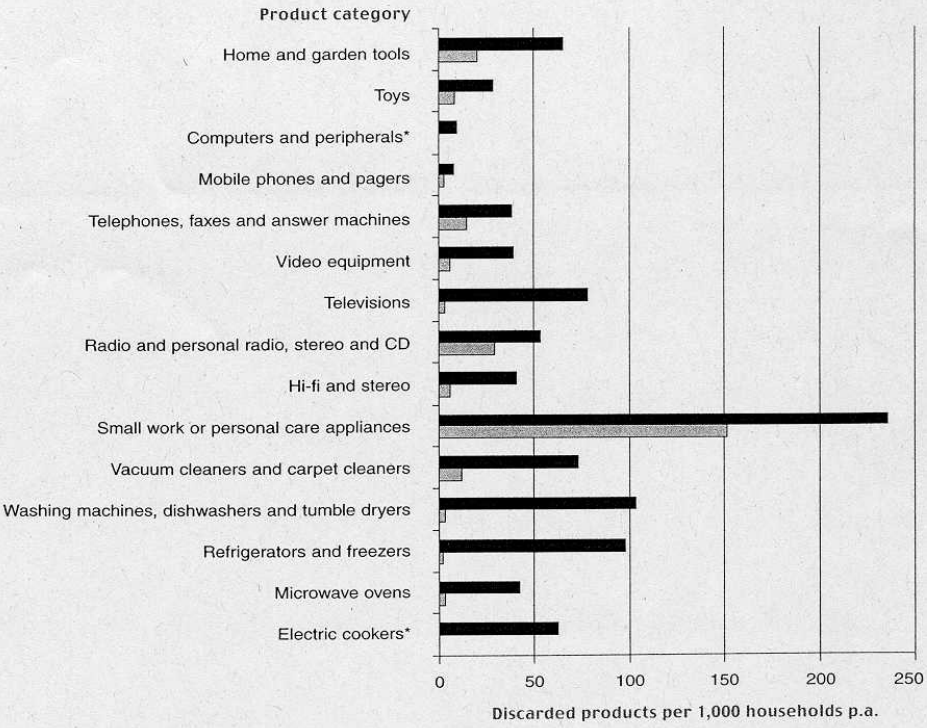
14 The data in this column shows the age of those products discarded due to 'functional' obsolescence. The relatively high figure for computers suggests that they are rarely discarded due to technical failure. Figures in some product categories are lower than in the next column, suggesting that such products are not considered repairable.
15 The data includes products donated or sold and subsequently reused, as well as products discarded as 'in need of repair' or 'broken beyond repair'.

Figure 4: Quantity of household appliances discarded in the UK (by mass)



* Less than 1,000 tonnes discarded

Figure 5: Number of household appliances discarded in the UK (by units)



* Less than 2 products per 1,000 households discarded with little prospect of reuse or recycling

Figure 6: Quantity of waste in specified disposal routes in the UK (by mass)

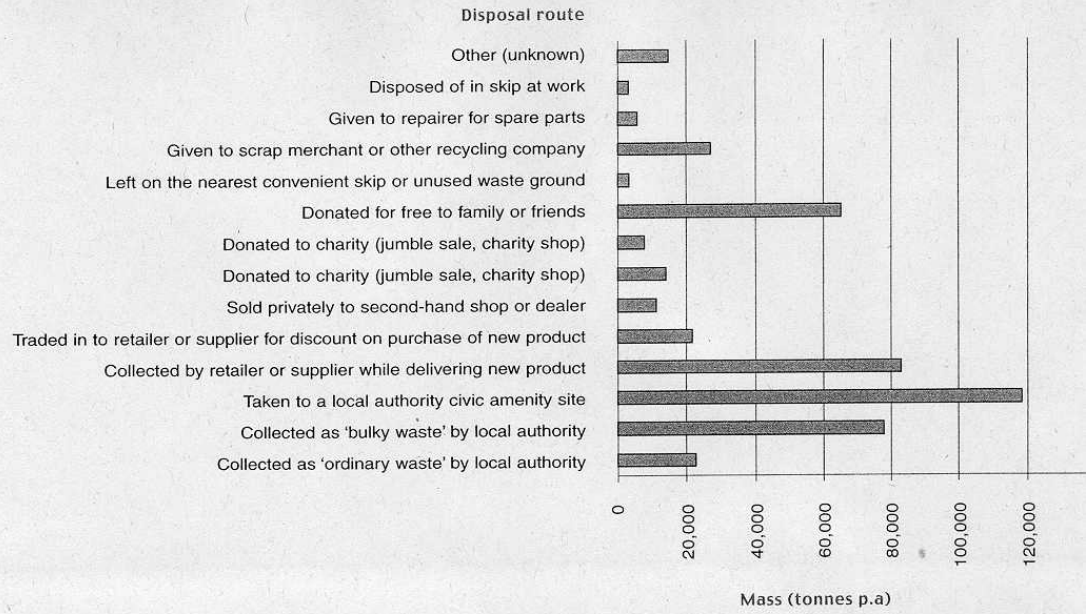
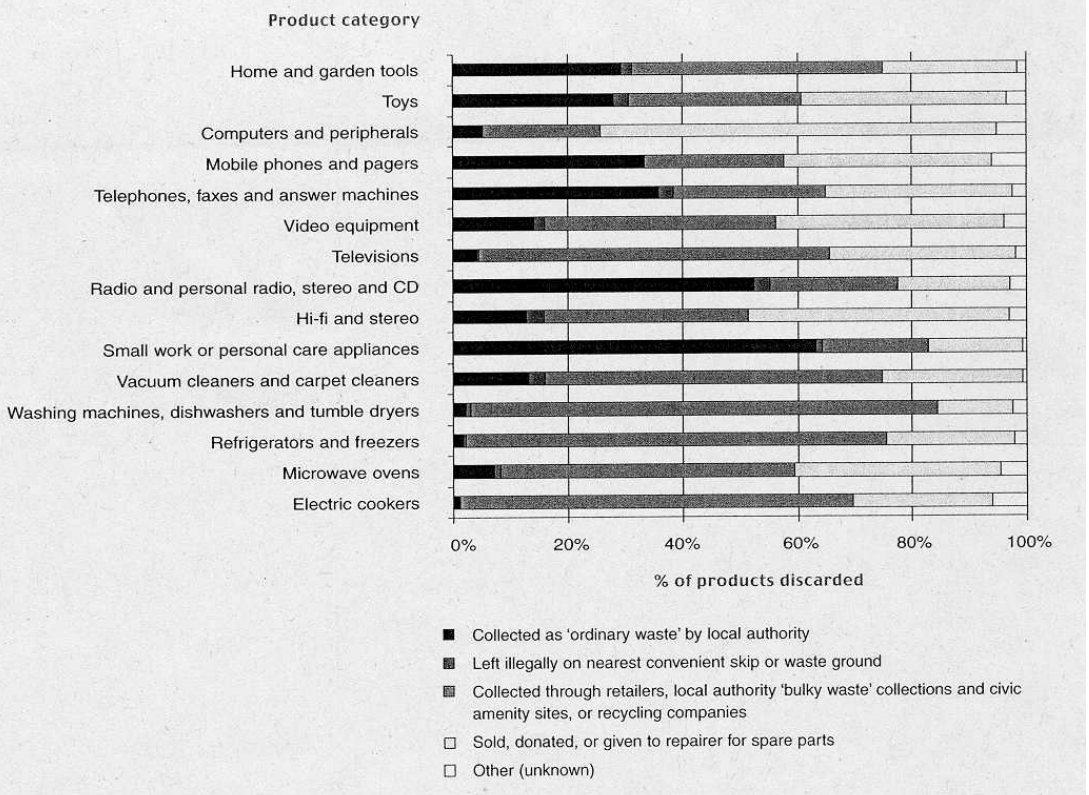


Figure 7: Disposable routes for household appliances in the UK



c) Consumer views on new product and service development

Consumer and household attitudes and behaviour were evaluated in detail using the quantitative data in conjunction with the focus group studies. Three principal areas of interest were addressed: product life spans, product recycling and disposal services, and product resale and reuse.

Product life spans

Almost one half of householders (45%) were of the opinion that, in general, products do not last as long as they would like. Women were significantly more inclined than men to be dissatisfied with product life spans. The following focus group comments summed up the perceptions of many participants:

"I think things have changed, I think they are made more disposable these days...Things used to last a lot longer." - Margaret, age 56, unemployed

"I've only been married 15 years and I've been through three washing machines. And I have been told...each time they have come out to repair them, that they are not made to be used a lot." Moira, age 38, company director

"How often have people said 'I wish I had my old one back - this one is rubbish'? How many times have we said that? I know I've said it a lot of times." - Phil, age 65, retired analyst

Other participants, however, were less critical:

"I don't think they ever last as long as you'd like... When you buy something, obviously you want to get the maximum amount of use out of it and whenever it goes wrong - even if it's after a good length of time - you always want it to last longer." - Roger, age 52, telecommunications engineer

"I've got two boys. They are always using the kettle and the toaster and, if you think of how much they're used, when they actually go wrong it isn't such a big deal. We've probably had it about four years and it's been used a dozen times every day, every day of its life for four years; well, it's not done bad really." - Les, age 44, vehicle administrator

Householders considered a 'reasonable' life span for large appliances to be 10 to 13 years, depending on product type. However, over one third of householders thought that cookers, refrigerators and freezers should last at least 15 years. A reasonable life for small work or personal care appliances, mobile phones and toys was thought to be 6 years. Other types of products were expected to last 7 to 10 years.

Wet appliances, small work or personal care appliances, and vacuum cleaners were most frequently identified as products that householders would like to last longer. Products for which continual technological advancement is likely, such as telecommunications equipment, were identified less frequently.

Effective consumer choice requires appropriate product information. Almost three-quarters of householders (73%) said that having accurate information about the expected life span of products before making a purchase was 'extremely' or 'very' important. Over one half considered information on life spans currently available to be either 'inadequate' (30%) or 'barely adequate' (24%). Thus producers might gain a competitive advantage by providing such information (Cooper, 1994b).

The main disadvantages to purchasing longer lasting products were concern that they would become 'out of date' after a few years, price, and repair and maintenance costs (as shown in Figure 8). Men and those householders of higher socio-economic status were significantly more inclined to be concerned about products becoming out of date, whereas women and those of lower socio-economic status were more concerned about cost. One focus group participant suggested that the type of product might also be a factor:

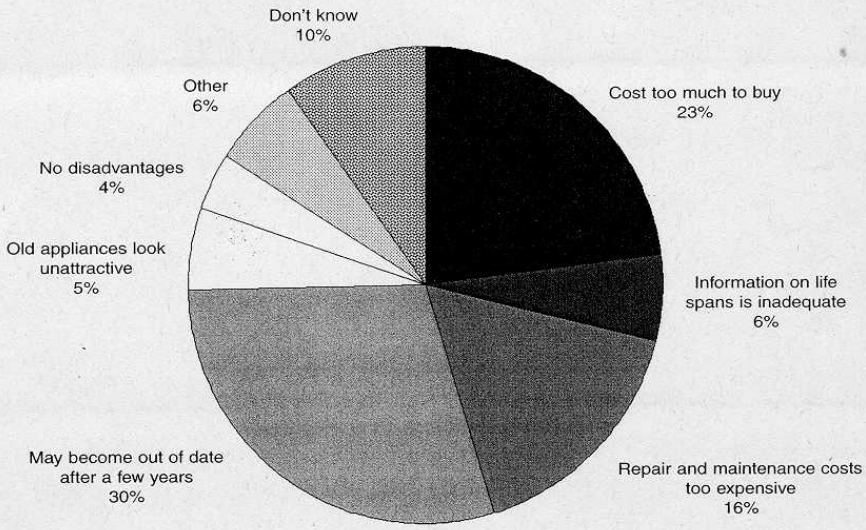
"It probably depends on the total price of the item. If it was a high priced item you would pay more. If it was a hairdryer or something you might think, well, I can throw it away after a year if it's not up to it - or a kettle or an iron, they're not in the same league, are they? - but a TV, I think you would pay more for longer life span." - Pete, age 52, computer programmer

Although participants were aware of product improvements, many were inclined to view technological advance as problematic, criticising the frequency with which new models are brought out and features regarded as unnecessary:

"I was told in the computer shop...'They are manufacturing another one to take its place.'...Every time you're buying one they're ready to bring another one out, and now I think that is so unfair." - Elaine, age 52, administration assistant

"You get these extras on there which you are paying for and yet you don't use half of them." - Harold, age 68, retired sales supervisor

Figure 8: Main disadvantages to purchasing appliances designed to last a long time



Product recycling and disposal services

Focus group participants expressed a range of opinions on the potential effectiveness of the various disposal arrangements for their appliances, which appeared to reflect regional differences. Some said that they did not always know what to recycle and mentioned obstacles to recycling small appliances. Others admitted that they did not care:

"Most of the time you are not really bothered what they do with it afterwards because it's gone now and that's it." - Richard, age 24, unemployed

There was common agreement on the need for information from producers, retailers, local authorities and recycling companies on how to dispose of household appliances safely. Posters, leaflets, improved product labelling and telephone help-lines were all suggested as possible means of supplying such information:

"Well, we would like to know what happens to it when it is being disposed of. Is it safe to dispose of? Is it safe for you to break it up and dispose of it in pieces? You haven't got that information. Take a microwave for instance, can you take the door and the inside panel out? You can't because it is not safe to do so." - Leslie, age 77, retired

"My neighbour took a strip light down out of kitchen, dropped it in the bin, and it exploded! It's the same with televisions, they won't always do it, but they will explode…There could be leaflets that went round, reminding you that the council will come and fetch things." - Elaine, age 52, administration assistant

"Some things, like fridges and gas cookers, have to be collected specially because they are environmentally dangerous." - Jeff, age 33, TV presenter

Some householders saw a need for more convenient disposal services, such as collections outside of normal working hours:

"You can only ring the council between 9 and 5, which is not good if you work…and you don't want some answer phone that's going to cost you while they play Greensleeves 54 times while getting through!" - Ann, age 42, sports lecturer

Although householders appeared willing to dispose of appliances through retail outlets, they expected either economic compensation or increased convenience over other means of disposal:

"Well, the last fridge we bought, the people who delivered it took the old one away with them, so I didn't have to!" - George, age 70, retired fitter

"If the shop where you bought your appliance from would take it in part exchange for a price of £10 or whatever…when they delivered the new one, then that would be a great service and you would go for that." - Malcolm, age 56, retired factory foreman

When asked about financing the separate collection and recycling of WEEE, most householders (60%) stated a preference for separate disposal fees over increased product prices or local taxes (as shown in Figure 9).

Product resale and reuse

Almost one quarter of discarded products (24%, by units) were donated or sold privately for reuse. Most were donated to family and friends or charity shops (18%); the other 6% were sold. The fact that, by comparison, only around 5% of the current stock of products is second-hand suggests that such products do not have long residual lives.

Product reliability was seen as a major risk when purchasing second-hand products:

"I bought an electrical saw from a car boot sale, and the chap plugged it in and it worked. When I got it home and used it, it didn't. You've got to be a little bit careful when you buy second-hand goods." - Charles, age 69, retired

"I don't think I'd want to buy something that was somebody's cast-off. They've got rid of it for a reason; it's either out of date or there's something wrong with it." - Roger, age 52, telecommunications engineer

"In the past I've bought stereos and things like that second-hand from friends, so you know that you've got some come-back. If you buy second-hand off someone you don't know, you've got no come-back." - Steve, age 24, technical development manager

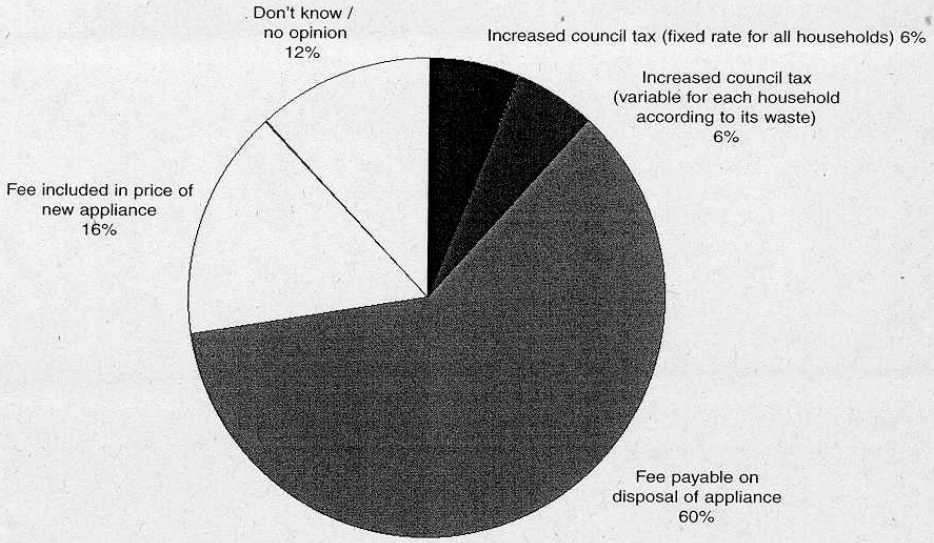
Some householders indicated that they would prefer to purchase second-hand appliances from a credible high street outlet:

> *"There is a retailer in Cardiff…which part-exchanges, reconditions, and resells audio appliances, amplifiers and things like that. They are good products and they do a 6 month guarantee on them. You get quality products at around half price." - George, age 70, retired fitter*

In general, householders expected second-hand items or 'new' products containing remanufactured parts to represent good value and have an acceptable warranty.

Some focus group participants indicated that they obtained second-hand products when buying new was not possible due to economic constraints - for example, to equip children leaving home. In such cases the effect of product reuse would be to increase the accumulation of products in use as distinct from reducing the manufacture and sale of new products.

Figure 9: Preference for payment of collection and recycling services (with no other choice)



v) Conclusions and recommendations

This represents the most comprehensive and detailed investigation of the use and disposal of Waste Electrical and Electronic Equipment undertaken to date in the UK. The findings will be useful for future product design and development, the creation of improved collection, treatment, reuse and recycling services, and the preparation of appropriate UK Producer Responsibility legislation.[16] The research approach and results are also relevant to other countries, some of which have already implemented such legislation.

16 The results of this study have already been submitted to the Department of Trade and Industry for use in assessing the implementation of the WEEE Directive.

The main practical implications of the research are presented below.

a) Product life

The research findings indicate a need to reconsider the future development and design of products and their use:

- There is an apparent desire among householders for longer lasting household appliances. Around one half of those interviewed said that they would like products to have greater life spans (particularly wet appliances and small work or personal care appliances). People appeared to accept that products most subject to technological advance would have to be regularly replaced, although focus group results suggested that many were inclined to view this negatively.

- In practice, consumers may be reluctant to purchase products designed for longer life spans because of concern that they become 'out of date' and cost.

- The life span of products is determined not only by their design life but also by the behaviour of consumers. Thus in order to optimise product life it is essential that consumer behaviour throughout the product life cycle is considered. The fact that many products that still function are discarded needs to be addressed through further research and public education.

- There is a reluctance among many consumers to have products repaired, for which the main explanation is cost. The potential use of public policy and new private sector initiatives to encourage people to get products repaired should be investigated.

- Consumers expressed a desire for clearer information on the planned design life of products in order to assist their choices in the market. Some producers of premium brand white goods have already taken a lead and provide such information, which may give them a competitive advantage.

b) Product resale, recycling and disposal services

The findings on the use and disposal of household appliances will be helpful in the development of new resale, recycling and disposal services:

- Product recovery ('take-back') schemes should not be set up on the basis of assumptions made from anecdotal evidence. Variations in the disposal behaviour and requirements of different householders were found to be too great for generalisations to be considered reliable. For example, 'bring' schemes[17] are only likely to have limited success because certain sections of society are less able to use them.

- The effectiveness of product take-back services will be determined by a combination of factors relating to the householder ('end-user' related factors), the specific disposal service provided (service related factors) and the appliance type to be collected (product related factors).

- Focus group results suggested that householders have a preference for disposal services offering convenient collection arrangements and financial incentives for returning products. Specific regional differences in householder requirements for product disposal services should be investigated through further research.

- New collection and recycling processes will be required to meet future recycling targets, particularly for smaller products (most of which are currently discarded in dustbins, wheelie bins or rubbish sacks) and brown goods such as televisions and video equipment (most of which are not currently recycled). Partnerships need to be established between stakeholders before the necessary infrastructure and processes can be developed.

17 Bring schemes are those in which households deliver items to collection points for disposal.

- 'Bring' systems, whether based on civic amenity sites or retail outlets (on the sale of new products), may fail to capture second-hand appliances discarded by householders of lower socio-economic status, as they are significantly less likely to possess their own means of transport or buy products new.

- It appeared from the focus group results that householders will only change their disposal behaviour if provided with easy to understand information that explains and justifies any new disposal arrangements. Householders want better information on how to dispose of appliances safely.

- Householders in the focus groups appeared to be more willing to purchase second-hand appliances and 'new' appliances containing refurbished parts if they were perceived as good value and had adequate product warranties.

c) Government policy

The results of the study should be useful in developing effective public policy on waste, particularly in relation to WEEE:

- The recycling and disposal of household appliances is more complex than for 'consumable' wastes as such products tend to pass in and out of use, following a cascade of use through which they become financially, functionally and materially degraded. The interpretation of the legal definition of waste in respect of WEEE may need to be re-examined in the light of current and prospective reuse.

- Many products are not disposed of by their original owners as they are redistributed through reuse. The collection of products through retail outlets, where old products are traded in for new, may not capture a substantial proportion of such waste and thus has only limited potential.

- Waste legislation needs to be drafted in such a way as to provide an incentive mechanism through which products that are designed for durability, ease of repair and recycling attract relatively lower disposal costs and consumers see benefits in purchasing them.

- In the development of legislation on WEEE, measures of both the weight and number of products discarded must be considered, disaggregated by product type. This is necessary to take account of the volume of waste for collection and disposal and also the wider environmental impacts of consumption.

- Although a majority of householders indicated a preference for a fee payable on disposal to fund enhanced collection and recycling services (as opposed to increased product prices or local taxes), this may not be acceptable as even now around 3,330 tonnes of equipment is disposed of illegally.

- The growth of organisations refurbishing discarded household appliances forms an important part of the 'social economy'[18]. Reuse can result in substantial environmental benefits where it replaces the manufacture of new products. However, this may not always be the case for household appliances. The reuse of appliances is a complex process which merits further investigation.

- As storage of appliances appears primarily to be associated with potential reuse, policy initiatives encouraging the disposal of such appliances may not be desirable from a societal perspective unless they are specifically directed into reuse.

18 Department of Trade and Industry, 1998, 1999.

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Appendix 1: Product masses for the calculation of disposal data

Product type	Weight (kg)*
Electric cookers	62
Microwave ovens	25
Refrigerators and freezers	42.5
Washing machines, dishwashers and tumble dryers	68.5
Vacuum cleaners and carpet cleaners	5
Small work or personal care appliances	2
Hi-fi and stereo	5
Radio and personal radio, stereo and CD	1
Televisions	16
Video equipment	5
Telephones, faxes and answer machines	2
Mobile phones and pagers	1
Computers and peripherals	20
Toys	1
Home and garden tools	10

* Based on best available data, from ICER (1998) and information provided by E-SCOPE members.

Appendix 2: Number of appliances discarded in the UK, by route and product type (units p.a.)[19]

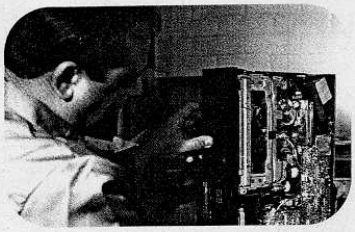
PRODUCT CATEGORY	ROUTE	Collected as 'ordinary waste' by local authority	Collected as 'bulky waste' by local authority	Taken to local authority civic amenity site	Collected by retailer or supplier while delivering new product	Traded in to retailer or supplier for discount on purchase of new product	Sold privately to second-hand shop or dealer	Sold privately e.g. car boot sale, advertised in newspaper/shop window	Donated to charity (jumble sale, charity shop)	Donated for free to family or friends	Left in the nearest convenient skip or unused waste ground	Given to scrap merchant or other recycling company	Given to repairer for spare parts	Disposed of in skip at work	Other (unknown)	ALL ROUTES
Electric cookers	Units	12,074	289,784	362,229	211,300	60,372	48,297	54,334	54,334	199,226	0	108,669	12,074	6,037	90,557	**1,509,289**
	%	0.8%	19.2%	24.0%	14.0%	4.0%	3.2%	3.6%	3.6%	13.2%	0.0%	7.2%	0.8%	0.4%	6.0%	
Microwave ovens	Units	66,409	156,966	259,598	60,372	12,074	24,149	36,223	18,111	289,784	12,074	42,260	6,037	6,037	48,297	**1,038,391**
	%	6.4%	15.1%	25.0%	5.8%	1.2%	2.3%	3.5%	1.7%	27.9%	1.2%	4.1%	0.6%	0.6%	4.7%	
Refrigerators and freezers	Units	30,186	464,861	591,641	458,824	90,557	66,409	84,520	18,111	356,192	6,037	126,780	6,037	12,074	48,297	**2,360,528**
	%	1.3%	19.7%	25.1%	19.4%	3.8%	2.8%	3.6%	0.8%	15.1%	0.3%	5.4%	0.3%	0.5%	2.0%	
Washing machines, dishwashers and tumble dryers	Units	36,223	458,824	585,604	645,976	175,078	42,260	36,223	12,074	199,226	24,149	163,003	42,260	18,134	60,372	**2,499,406**
	%	1.4%	18.4%	23.4%	25.8%	7.0%	1.7%	1.4%	0.5%	8.0%	1.0%	6.5%	1.7%	0.7%	2.4%	
Vacuum cleaners and carpet cleaners	Units	223,375	126,780	754,645	42,260	54,334	30,186	42,260	24,149	295,821	48,297	66,409	48,297	12,074	12,074	**1,780,961**
	%	12.5%	7.1%	42.4%	2.4%	3.1%	1.7%	2.4%	1.4%	16.6%	2.7%	3.7%	2.7%	0.7%	0.7%	
Small work or personal care appliances	Units	3,561,923	66,409	875,388	0	24,149	12,074	133,150	193,189	579,567	66,409	90,557	18,111	42,260	48,297	**5,711,483**
	%	62.4%	1.2%	15.3%	0.0%	0.4%	0.2%	2.3%	3.4%	10.1%	1.2%	1.6%	0.3%	0.7%	0.8%	
Hi-fi and stereo	Units	126,780	54,334	271,672	0	6,037	48,297	72,446	36,223	277,709	30,186	18,111	18,111	0	30,186	**990,094**
	%	12.8%	5.5%	27.4%	0.0%	0.6%	4.9%	7.3%	3.7%	28.0%	3.0%	1.8%	1.8%	0.0%	3.0%	
Radio and personal radio, stereo and CD	Units	664,087	12,074	235,449	12,074	0	6,037	78,483	36,223	126,780	36,223	30,186	6,037	12,074	36,223	**1,291,952**
	%	51.4%	0.9%	18.2%	0.9%	0.0%	0.5%	6.1%	2.8%	9.8%	2.8%	2.3%	0.5%	0.9%	2.8%	
Televisions	Units	66,409	193,189	627,864	223,375	72,446	36,223	60,372	48,297	428,638	6,037	42,260	42,260	12,074	36,223	**1,895,667**
	%	3.5%	10.2%	33.1%	11.8%	3.8%	1.9%	3.2%	2.5%	22.6%	0.3%	2.2%	2.2%	0.6%	1.9%	
Video equipment	Units	114,706	36,223	217,338	66,409	24,149	42,260	54,334	0	247,523	18,111	36,223	36,223	18,111	36,223	**947,834**
	%	12.1%	3.8%	22.9%	7.0%	2.5%	4.5%	5.7%	0.0%	26.1%	1.9%	3.8%	3.8%	1.9%	3.8%	
Telephones, faxes and answer machines	Units	338,081	12,074	156,966	48,297	18,111	48,297	78,483	24,149	156,966	24,149	12,074	0	0	24,149	**941,797**
	%	35.9%	1.3%	16.7%	5.1%	1.9%	5.1%	8.3%	2.6%	16.7%	2.6%	1.3%	0.0%	0.0%	2.6%	
Mobile phones and pagers	Units	66,409	12,074	12,074	6,037	18,111	0	18,111	0	48,297	0	0	6,037	0	12,074	**199,226**
	%	33.3%	6.1%	6.1%	3.0%	9.1%	0.0%	9.1%	0.0%	24.2%	0.0%	0.0%	3.0%	0.0%	6.1%	
Computers and peripherals	Units	12,074	0	24,149	12,074	6,037	18,111	36,223	12,074	90,557	0	6,037	6,037	0	12,074	**235,449**
	%	5.1%	0.0%	10.3%	5.1%	2.6%	7.7%	15.4%	5.1%	38.5%	0.0%	2.6%	2.6%	0.0%	5.1%	
Toys	Units	193,189	6,037	175,078	6,037	18,111	24,149	72,446	66,409	78,483	18,111	0	6,037	0	24,149	**688,236**
	%	28.1%	0.9%	25.4%	0.9%	2.6%	3.5%	10.5%	9.6%	11.4%	2.6%	0.0%	0.9%	0.0%	3.5%	
Home and garden tools	Units	422,601	48,297	507,121	6,037	585,604	24,149	48,297	36,223	235,449	30,186	126,780	30,186	42,260	24,149	**1,587,772**
	%	26.6%	3.0%	31.9%	0.4%	0.4%	1.5%	3.0%	2.3%	14.8%	1.9%	8.0%	1.9%	2.7%	1.5%	
ALL PRODUCTS	**Units**	**5,934,525**	**1,937,927**	**5,656,816**	**1,799,073**	**585,604**	**470,898**	**905,906**	**579,567**	**3,610,220**	**319,969**	**869,351**	**283,746**	**181,137**	**543,344**	**23,678,085**
	%	**25.1%**	**8.2%**	**23.9%**	**7.6%**	**2.5%**	**2.0%**	**3.8%**	**2.4%**	**15.2%**	**1.4%**	**3.7%**	**1.2%**	**0.8%**	**2.3%**	

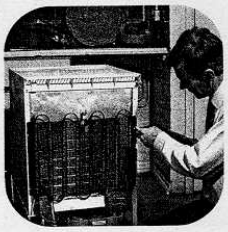
19 Based on disposals during 1993-1998.

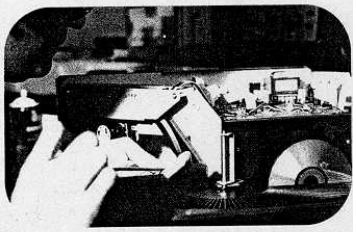
Appendix 3: Mass of appliances discarded in the UK, by route and product type (tonnes p.a.)[20]

PRODUCT CATEGORY	ROUTE	Collected as 'ordinary waste' by local authority	Collected as 'bulky waste' by local authority	Taken to local authority civic amenity site	Collected by retailer or supplier while delivering new product	Traded in to retailer or supplier for discount on purchase of new product	Sold privately to second-hand shop or dealer	Sold privately e.g. car boot sale, advertised in newspaper/shop window	Donated to charity (jumble sale, charity shop)	Donated for free to family or friends	Left in the nearest convenient skip or unused waste ground	Given to scrap merchant or other recycling company	Given to repairer for spare parts	Disposed of in skip at work	Other (unknown)	ALL ROUTES
Electric cookers	Weight	749	17,967	22,458	13,101	3,743	2,994	3,369	3,369	12,352	0	6,737	749	374	5,615	**93,576**
	%	0.8%	19.2%	24.0%	14.0%	4.0%	3.2%	3.6%	3.6%	13.2%	0.0%	7.2%	0.8%	0.4%	6.0%	
Microwave ovens	Weight	1,660	3,924	6,490	1,509	302	604	906	453	7,245	302	1,057	151	151	1,207	**25,960**
	%	6.4%	15.1%	25.0%	5.8%	1.2%	2.3%	3.5%	1.7%	27.9%	1.2%	4.1%	0.6%	0.6%	4.7%	
Refrigerators and freezers	Weight	1,283	19,757	25,145	19,500	3,849	2,822	3,592	770	15,138	257	5,388	257	513	2,053	**100,322**
	%	1.3%	19.7%	25.1%	19.4%	3.8%	2.8%	3.6%	0.8%	15.1%	0.3%	5.4%	0.3%	0.5%	2.0%	
Washing machines, dishwashers and tumble dryers	Weight	2,481	31,429	40,114	44,249	11,993	2,895	2,481	827	13,647	1,654	11,166	2,895	1,242	4,135	**171,209**
	%	1.4%	18.4%	23.4%	25.8%	7.0%	1.7%	1.4%	0.5%	8.0%	1.0%	6.5%	1.7%	0.7%	2.4%	
Vacuum cleaners and carpet cleaners	Weight	1,117	634	3,773	211	272	151	211	121	1,479	241	332	241	60	60	**8,905**
	%	12.5%	7.1%	42.4%	2.4%	3.1%	1.7%	2.4%	1.4%	16.6%	2.7%	3.7%	2.7%	0.7%	0.7%	
Small work or personal care appliances	Weight	7,124	133	1,751	0	48	24	266	386	1,159	133	181	36	85	97	**11,423**
	%	62.4%	1.2%	15.3%	0.0%	0.4%	0.2%	2.3%	3.4%	10.1%	1.2%	1.6%	0.3%	0.7%	0.8%	
Hi-fi and stereo	Weight	634	272	1,358	0	30	241	362	181	1,389	151	91	91	0	151	**4,950**
	%	12.8%	5.5%	27.4%	0.0%	0.6%	4.9%	7.3%	3.7%	28.0%	3.0%	1.8%	1.8%	0.0%	3.0%	
Radio and personal radio, stereo and CD	Weight	664	12	235	12	0	6	78	36	127	36	30	6	12	36	**1,292**
	%	51.4%	0.9%	18.2%	0.9%	0.0%	0.5%	6.1%	2.8%	9.8%	2.8%	2.3%	0.5%	0.9%	2.8%	
Televisions	Weight	1,063	3,091	10,046	3,574	1,159	580	966	773	6,858	97	676	676	193	580	**30,331**
	%	3.5%	10.2%	33.1%	11.8%	3.8%	1.9%	3.2%	2.5%	22.6%	0.3%	2.2%	2.2%	0.6%	1.9%	
Video equipment	Weight	574	181	1,087	332	121	211	272	0	1,238	91	181	181	91	181	**4,739**
	%	12.1%	3.8%	22.9%	7.0%	2.5%	4.5%	5.7%	0.0%	26.1%	1.9%	3.8%	3.8%	1.9%	3.8%	
Telephones, faxes and answer machines	Weight	676	24	314	97	36	97	157	48	314	48	24	0	0	48	**1,884**
	%	35.9%	1.3%	16.7%	5.1%	1.9%	5.1%	8.3%	2.6%	16.7%	2.6%	1.3%	0.0%	0.0%	2.6%	
Mobile phones and pagers	Weight	66	12	12	6	18	0	18	0	48	0	0	6	0	12	**199**
	%	33.3%	6.1%	6.1%	3.0%	9.1%	0.0%	9.1%	0.0%	24.2%	0.0%	0.0%	3.0%	0.0%	6.1%	
Computers and peripherals	Weight	241	0	483	241	121	362	724	241	1,811	0	121	121	0	241	**4,709**
	%	5.1%	0.0%	10.3%	5.1%	2.6%	7.7%	15.4%	5.1%	38.5%	0.0%	2.6%	2.6%	0.0%	5.1%	
Toys	Weight	193	6	175	6	18	24	72	66	78	18	0	6	0	24	**688**
	%	28.1%	0.9%	25.4%	0.9%	2.6%	3.5%	10.5%	9.6%	11.4%	2.6%	0.0%	0.9%	0.0%	3.5%	
Home and garden tools	Weight	4,226	483	5,071	60	60	241	483	362	2,354	302	1,268	302	423	241	**15,878**
	%	26.6%	3.0%	31.9%	0.4%	0.4%	1.5%	3.0%	2.3%	14.8%	1.9%	8.0%	1.9%	2.7%	1.5%	
ALL PRODUCTS	**Weight**	**22,751**	**77,925**	**118,512**	**82,899**	**21,770**	**11,253**	**13,959**	**7,634**	**65,238**	**3,329**	**27,252**	**5,717**	**3,144**	**14,682**	**476,065**
	%	**4.8%**	**16.4%**	**24.9%**	**17.4%**	**4.6%**	**2.4%**	**2.9%**	**1.6%**	**13.7%**	**0.7%**	**5.7%**	**1.2%**	**0.7%**	**3.1%**	

20 Based on disposals during 1993-1998.







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Managing the producer responsibility challenge

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Meeting the 'Producer Responsibility' Challenge

The Management of Waste Electrical and Electronic Equipment in the UK*

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Since the late 1980s, various governments have been moving towards a new market-based approach to waste management known as 'Producer Responsibility'. Through this approach, producers of electrical and electronic equipment will be made responsible for the end-of-life waste management costs of their products.

Focusing on Waste from Electrical and Electronic Equipment (WEEE), this paper examines the environmental rationale behind this new approach to waste management, and discusses its political evolution and development across Europe. Cases for the most effective and workable approaches are argued, and the scope and implications of future legislation in the UK is summarised.

It is concluded that Producer Responsibility will be effective only if legislation is deployed such that *well-defined price mechanisms* result in the appropriate level of *environmental improvement*. This will be achieved in the UK only if producers become more proactive in collaborating with each other, and with policy-makers, in proposing a suitable way forward.

- Producer Responsibility
- Electronic and electrical equipment
- Environmental legislation
- Recycling
- Waste
- End-of-life
- Product take-back

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KIEREN MAYERS AND CHRIS FRANCE

WITHIN THE NEXT THREE TO FIVE YEARS, THE UK 'ELECTRONICS'[1] INDUSTRY COULD be made responsible for the collection, treatment and recycling of electrical and electronic goods currently disposed of as waste. The European Commission is currently developing a directive including such requirements (DGXI.E3/FE D [97], WEEE-21/4/98, WEEE-27/7/98), and many countries throughout Europe, East Asia and the Americas are already drafting and implementing similar national 'Producer Responsibility' legislation. The EU has already implemented similar directives for packaging (94/62 EC) and batteries (91/157 EEC).

The introduction of this legislation is likely to have significant effects on producers. In 1991 it was estimated that the cost of collecting and recycling the 12 million items of end-of-life[2] electrical and electronic equipment disposed of each year (DoE and Welsh Office 1995: 81) in the UK alone would be over £100 million. This has been calculated as 0.4% of the total market value at that time (Roy 1991).

The literature appears generally devoid of detailed discussions on the role of Producer Responsibility in the management of electronics waste. Some authors have evaluated the roles of different stakeholders, such as the harmonisation of standards by the European Union (Welker and Geradin 1996) and the role of industry and industry consortiums (Rodgers 1995). Others have evaluated the merits of different approaches such as shared responsibility (Cramer and Stevels 1996), increased product durability (Cooper 1994), and a view discussed in greater depth in this paper, the importance of collaboration between government and industry (ECTEL 1997). This paper contributes to this debate by proposing a way forward for the implementation of Producer Responsibility for electronics waste in the UK. First, the global development of Producer Responsibility in waste management policy and the potential environmental problems of electronics waste recycling and disposal are discussed below.

Producer Responsibility and the management of waste

The principles of Producer Responsibility

Producer Responsibility is a market-based instrument of government policy, and a direct application of the 'Polluter Pays Principle' (OECD 1975) to waste management (COM [96] 399 final; DoE and Welsh Office 1995). The aim of Producer Responsibility is to encourage more sustainable patterns of production and consumption by internalising the external costs of environmental degradation (such as the cost of waste management) to the costs of products and services (Lifset 1993; Turner and Pearce 1993).

The development and adoption of Producer Responsibility

The Producer Responsibility approach has developed along with support for the Polluter Pays Principle, and recognition of the need to improve the management and recycling of waste (as agreed at the Rio Earth Summit in 1992; Grub *et al.* 1993). In the early 1990s Germany, Canada, Korea and Japan were among the first countries to put Producer Responsibility into practice. With the exception of Korea, where a variety of products were included,[3] these early programmes covered only waste packaging (*Resources Report* 1997; Sprenger 1997; Kursaka 1996; Livington and Sparks 1994).

1 Used in this general sense to include electrical and electronic products.
2 The period in which a product becomes waste.
3 Home electronics, lubricating oils, batteries, tyres, plastics and packaging.

The Producer Responsibility approach has now been implemented more widely across Europe, East Asia and the Americas, and covers an increasing array of product categories. Like Korea, both Japan[4] and Germany[5] have introduced Producer Responsibility legislation that will eventually cover all waste-streams through more specific future regulations.

The electronics industry response to Producer Responsibility has been cautious, often advocating 'shared responsibility' (ORGALIME 1998; Cramer and Stevels 1996), where all involved in the production, sale and use of products share responsibilities for waste products at end-of-life. However, in the 1996 EC waste management strategy (COM [96] 399 final), the European Parliament clearly defined the scope of Producer Responsibility:

> Considering the life cycle of a product from manufacture until the end of its useful life, producers, material suppliers, trade, consumers and public authorities share specific waste management responsibilities. However it is the product manufacturer who has a predominant role since he takes key decisions concerning his product which largely determine its waste management potential (CEC COM [96] 399 final: 1b).

Environmental concerns over electronics wastes

The EU first highlighted WEEE[6] as a potential environmental problem in 1991, when it was designated as a priority waste-stream along with end-of-life vehicles, tyres, chlorinated solvents, construction wastes, and healthcare wastes (DoE and Welsh Office 1995). The reasons given for this included (ENEA 1995):

- Future increases in the volume of electronics waste going to landfill or incineration
- Loss of valuable materials as waste
- Harmful and hazardous materials that could be released on disposal

Estimates of the total quantity of waste electronics arising in the UK vary between 0.65 and 0.9 million tonnes/year (ICER 1998). As this is only 1.3%–1.7% by mass of industrial, commercial and domestic wastes (DoE and Welsh Office 1995: 3), it could be argued that this focus on the recycling and disposal of waste electronic products would make little difference to the overall environmental consequences of their production and use.

Some specific environmental problems related to the disposal of electronic products *have* been identified. For example, ozone-damaging CFCs (chlorofluorocarbons), PCBs (polychlorinated biphenyls) (Niemeyer and Woldt 1997; Poll 1993) and metals (Voute 1993; Yang 1993) can be released to the environment from end-of-life refrigerators, older end-of-life appliances, and discarded cathode ray tubes (CRTs) and printed circuit boards, respectively. In addition, the EU has proposed that the use of lead, mercury, cadmium, hexavalent chromium and halogenated flame-retardants should eventually be phased out of electronic products (WEEE-27/7/98).

4 Through the Recycling Law in 1991 and the Environment Basic Act in 1993.
5 Through the Recycling and Waste Management Act (*Kreislaut Wirtschafts- und Abfallgesetz*) in 1996.
6 Waste Electrical and Electronic Equipment. Defined, under EU definition of waste, that 'waste shall mean any substance or object . . . which the holder discards, intend to discard, or is required to discard' (75/442/EEC); applied to Electrical and Electronic Equipment (EEE), '. . . equipment which is dependent on electric currents or electromagnetic fields in order to work properly and equipment for the generation, transfer and measurement of such currents and fields . . . and designed for use with a voltage rating not exceeding 1000 Volt for alternating current and 1500 Volt for direct current' (WEEE-27/7/98).

Another major environmental concern over the disposal of electronics equipment is the loss of the materials they may contain. For example, it has been estimated that around 7% of plastics consumed in Western Europe are used in the production of electronic products (Wogrolly 1994), and that around 85,000 tonnes of lead were consumed in the production of computer monitors in 1998 (Smith *et al.* 1996). Some rare metals found in electronics components are used almost uniquely by the electronics industry, and have virtually unknown environmental effects, such as tantalum, antimony and gallium (BIfA 1997; Legarth *et al.* 1995).

Finally, many products disposed of may still function, and so could be re-used. For example, British Telecom recovers around 2.5 million telephones for re-use each year (BT 1996).

Recycling can also have significant environmental impacts:

- **Energy consumption.** It has been estimated that shredders and granulators used in the recovery of metals from wastes can consume as much as 37 kWh/tonne of waste processed (ICER 1998). In addition, the collection and transportation of equipment for treatment and recycling could cause increased fuel consumption and pollution compared to disposal as waste.

- **Inorganic pollutants.** Metals found in parts such as printed circuit boards and cathode ray tubes can become mobilised in the environment through recycling processes. For example, metal-rich dusts may become airborne from granulation and smelting operations and contaminate surrounding land.

- **Organic pollutants.** It has been reported that dioxins, a group of persistent and potentially carcinogenic organic chemicals, may be formed and released from small smelting furnaces (BIfA 1997) and shredding and granulating processes (Danish Environmental Protection Agency 1997: 22) when processing equipment containing PVC (polyvinyl chloride). Although ozone-depleting CFCs have now been eliminated from production, older appliances may still contain these gases as a coolant or within insulation foams. It has been estimated that around 1,100 tonnes of these CFCs are released to the environment each year in the UK from within recycling processes (Poll 1993; Niemeyer and Woldt 1997). Although carcinogenic and highly toxic PCBs have been similarly restricted and phased out of production since the late 1980s, in the early nineties it was found that shredder residues could still contain concentrations of up to 16 mg/kg from older appliances (Poll 1993).

In recognition of the significant potential for environmental degradation from electronics recycling operations, some industry bodies have proposed electronics recycling standards (Nordic Office and IT Organisations 1998; ICER 1997; CYCLE 1995). The proposed EU directive includes obligations both on recyclers and waste processors. However, these standards will not guarantee that electronics recycling is of net environmental benefit from a 'life-cycle' perspective.

Producer Responsibility itself is not intended to address the full life-cycle of a product (from extraction and production, to use, recovery and disposal—or 'cradle to grave'), as it largely excludes manufacturing and use. However, the adoption of a life-cycle perspective in the management of electronics waste would allow different product design and waste management options (including incineration and landfill) to be compared and considered together, ensuring the best environmental options are identified. For example, life-cycle studies have been conducted on the take-back of mobile phones as part of a scheme in the UK and Sweden, covering energy use (McClaren *et al.* 1997), and on plastic computer housing from IBM products in the USA (Brinkley *et al.* 1994).

These life-cycle studies have reinforced the orthodox view of the hierarchy of waste management: that, in descending order, re-use, recycling, and incineration with energy recovery are preferable to disposal in landfill. Although they provide interesting conclusions, they are relevant only to the specific electronic products and recycling systems under study. Under future legislation it may be more objective to assess and qualify the environmental benefits of take-back processes on an individual basis using environmental standards incorporating important life-cycle considerations.

In the following sections different approaches to the practical implementation of Producer Responsibility are evaluated and a way forward for the electronics industry in the UK is proposed.

The development of Producer Responsibility for electronics waste

Given the desire for industry self-regulation, what measures must be taken to ensure that producers make the necessary changes to their products and services such that potential environmental benefits are achieved? As the costs of Producer Responsibility in the UK could significantly affect the industry's profit margins, the necessary market stimulus would be present for the Polluter Pays Principle to work. As a market-based instrument, however, it is very important that Producer Responsibility is developed with respect to the complexity of the market it is to affect (Turner and Pearce 1993). For example, failure to consider electronics waste recycling and disposal from a life-cycle perspective could mean that price signals exclude important environmental impacts. These aspects are considered in more detail below through analysis of the adoption of Producer Responsibility for waste management in the UK, and for electronics waste in Europe.

Producer Responsibility in the UK

In the past, the UK government has given priority to voluntary Producer Responsibility initiatives (DoE and Welsh Office 1995). However, prescriptive regulations may be implemented in support of Producer Responsibility under section 93 of the 1995 Environment Act. In developing an electronics recycling programme in the UK, approaches to be adopted elsewhere should be examined. Special note needs to be taken of European efforts that may influence the EU.

Under the UK packaging regulations (SI 1997/648), manufacturers, distributors and retailers have all been assigned individual recovery obligations, irrespective of their role in the supply chain. Arguably, such an approach would be impractical for electronics wastes, as they generally have a longer life, are less consistent in their composition and form, and are disposed of in smaller volumes than packaging wastes. Targets set for newspaper and magazine recycling have been met voluntarily by the newspaper industry through investment into new paper recycling plants, such as the Aylesford Newsprint plant (DoE and Welsh Office 1995). In comparison, proposals for a voluntary battery recycling scheme are still to be put into effect to comply with the EU battery directive (SI 1994/232, 91/156/EEC [b]). The development of Producer Responsibility schemes for WEEE and automobiles is still under discussion.

Producer Responsibility for electronics waste in Europe

The EU abandoned the Priority Waste Streams programme in June 1996. This was after open discussion forums involving industry, regulators and other groups failed to make

sufficient recommendations to the European Commission (WRF 1996). Electronics waste has remained an important political issue as various countries have proposed individual Producer Responsibility programmes. Different approaches have been adopted or proposed in each country. For example, there has been little agreement over the most appropriate categorisation of electrical or electronics waste (see below). The EU proposed definition for Waste Electronic and Electrical Equipment (WEEE) itself is very broad[7] (WEEE-27/7/98).

Differences between national programmes may remain as the current EU draft directive allows for a considerable degree of subsidiarity. A number of articles have been written on European electronics take-back initiatives (AEA 1997; *Product Stewardship Advisor* 1997a; Welker and Geradin 1996; ICER 1999).[8] Existing European proposals and schemes have been reviewed in more detail below.

Stage of development

Different countries are at different stages of setting up national electronics waste recovery schemes and a wide range of voluntary, mandatory and combined approaches have been proposed (see Fig. 1). Italy was the first European country to implement binding legislation in September 1996, requiring producers to set up collection and recycling schemes within three years or face surcharges of 10% on the price of new products. At present, a collection scheme for refrigerators has been developed using 12 national recovery centres. This is expected eventually to be self-funding and will extend to other product types (*Product Stewardship Advisor* 1997b). The Netherlands adopted a draft decree in June 1998, which became effective in January 1999. This requires retailers to take back old products from customers on the sale of new and municipal authorities to collect all waste electronic products free of charge from end-users. Manufacturers must transfer and recycle products collected by retailers, repair shops and local authorities (Central Legal Affairs Department, Netherlands 1995). Some countries have encouraged voluntary industry schemes, as in France, Finland and the UK. In Switzerland a voluntary electronics recycling programme has been in operation for IT products since 1994 (although supporting legislation was implemented in June 1998).

Germany and Denmark have successfully based their draft and proposed legislation on recommendations from industry groups—for example, CYCLE in Germany.[9] In contrast, the voluntary approach failed to bring about proposals from industry in the EU and initially in the Netherlands before legislation was proposed. Other countries have no specific plans for national legislation ahead of an EU directive, as in Greece, Ireland and Spain.

It is planned that the EU working paper on WEEE will be finalised and put before the European Parliament during 1999. It is therefore unlikely that some member states will have implemented binding legislation until after the new millennium, despite actions by others enforcing shorter time-frames. This will give industry time to respond proactively to the challenge of Producer Responsibility in countries with less advanced proposals or 'wait-and-see' approaches, such as the UK.

Collection methods

There appear to be three main approaches suggested for the collection of electronic products from end-users in European countries:

1. Municipal authorities establish collection systems at least partially integrated into existing domestic waste management and recycling schemes.

7 See footnote 6.
8 Up-to-date (1998) information ascertained from Hewlett-Packard international sources.
9 A German collective of IT companies organising take-back and recovery of IT products.

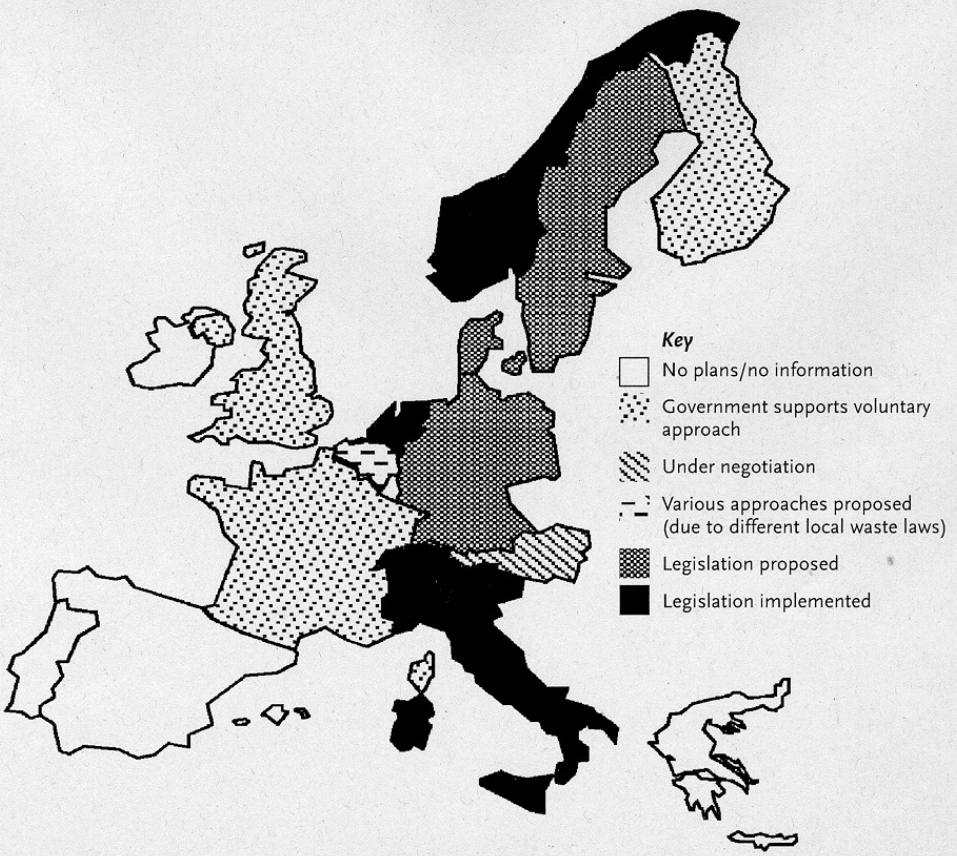

Figure 1: THE IMPLEMENTATION OF PRODUCER RESPONSIBILITY FOR WEEE IN EUROPE

2. Retailers take back old products from customers on the sale of new.
3. Industry establishes collection systems or takes back products directly as part of commercial agreements, such as leasing or product trade-in arrangements.

Some countries have proposed only one of these collection methods, while others have put forward combined approaches. For example, Germany has proposed a municipal collection scheme, whereas Italy has issued legislative mandates requiring industry to establish a network of national collection centres. It appears that the majority of countries have allocated responsibility for collection on a combination of retailers and municipal authorities, as in Denmark, the Netherlands, Norway and Sweden. These schemes have been tried in various countries and can work. For example, a large-scale Dutch scheme was successfully piloted with municipalities and retailers between 1995 and 1997 in the district of Eindhoven (APPARETOUR 1997).

In some countries, co-operative cross-industry schemes have been established to avoid increased costs of setting up duplicate collection systems for different products or brands, such as ICT in the Netherlands, SWICO in Switzerland, CYCLE in Germany and SITO in Sweden (AEA 1997). Companies may also decide to set up their own schemes where there

is a commercial interest in the resale of equipment to second users, or where components or materials are required for company closed-loop recycling processes. In the UK, Dell, ICL and Digital Equipment Corporation (now owned by Compaq) all provide specific product take-back services to customers, Xerox takes back photocopiers as part of leasing agreements (ENDS 1996), and IBM has in the past recycled PVC from old keyboards into new.

As Producer Responsibility is a market-based approach, it is important to ensure legislation is not too restrictive. For example, the EU has currently proposed that retailers must accept old products on the sale of new (WEEE-27/7/98), which could restrict collection activities to point-of-sale transactions within retail outlets. While retailers could play an important role in the collection of electronics waste, legislation should allow greater flexibility in the development of specific collection methods. For example, one scheme in Switzerland uses mainline train stations as collection points for waste electronics (Wägner *et al.* 1997).

Allocations of responsibility: a confusing debate?

In all existing schemes and proposals for electronics recovery in Europe, producers are or will be ultimately responsible for the collection of electronic products from designated collection points and subsequent treatment and recycling. As discussed previously, industry appears keen to ensure that the responsibility (the financial burdens) of developing and running take-back schemes are 'shared' throughout supply chains (including consumers and end-users). Consequently, there is often considerable confusion and overlap in debates relating to the appropriate allocation of responsibility as each part of the supply chain attempts to minimise its exposure. Given the variety of country-specific proposals in Europe and in consideration of the EU proposals to date, it is apparent that responsibility could be placed at three different levels:

- **Financial responsibility:** for example, payment of collection costs through increased local waste taxes to the public, as proposed in Denmark.
- **Responsibility for managing part of a recycling chain:** for example, in many countries it has been proposed that municipalities must manage the collection of electronics wastes.
- **Operational responsibility:** for example, recyclers may be authorised or subcontracted to collect and recycle electronics waste on behalf of producers.

In addition, these areas of responsibility can relate to different aspects of a recovery chain. In order for products to be treated, re-used and recycled, they must first be delivered to an appropriate collection point and then transferred to a centralised processing facility (this recovery chain is shown in Fig. 2). For example, where industry consortia may play a role in managing recycling schemes, they *may* subcontract the operational responsibility to a recycling company, and the responsibility of paying for these costs would fall to individual companies through legislative mandate. In this example, the responsibility for recycling falls on three parties at three different levels. If these levels of responsibility and the different stages of a product-take-back operation are not fully understood, discussions over the allocation of responsibility can occur without common terms of reference and confusion and conflicts are likely to result. It may be better to consider the objectives of the exercise and ask two separate questions:

- Who is best placed to practically and effectively complete and manage a particular task, given economic and environmental constraints?

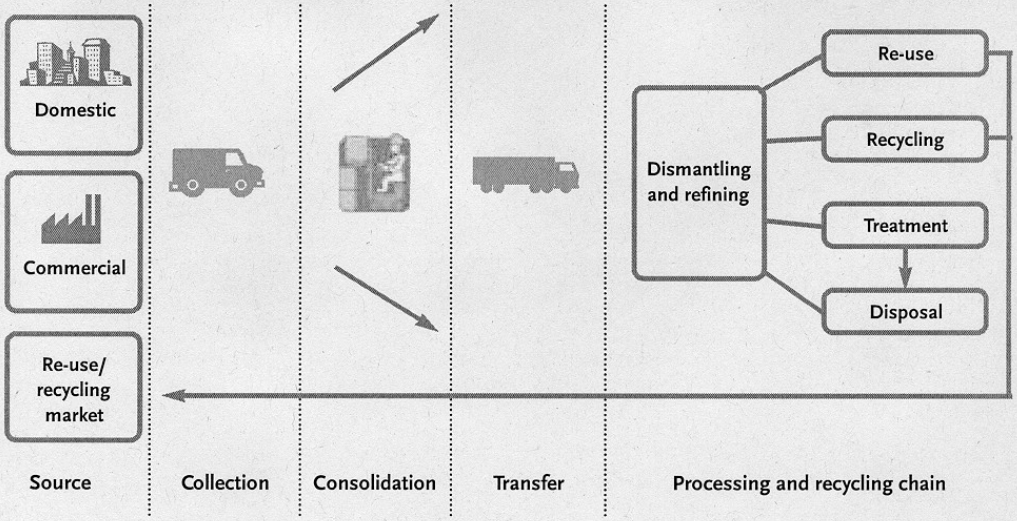

Figure 2: THE PRODUCT RECYCLING CHAIN

- And, given the scope of expected legislation and the need to make the Polluter Pays Principle work in practice, who should finance product collection, treatment and recycling?

Most proposals within Europe to date have distributed ultimate responsibility by having:

- Consumers take responsibility for segregation of wastes and delivery to collection systems
- Retailers collect old products on the sale of new
- Producers redesign products and services, and establish collection and recycling schemes

Funding mechanisms

Three mechanisms for financing the collection and recovery of electronics waste from end-users have been proposed either separately or in combination (ICER 1996):

1. Fee administered to end-users disposing of electronics waste
2. Local taxes charged to the general public.
3. Cost included in product price (either directly or through a levy), and charged to customers on purchase of new products

Italy has enforced legislation requiring industry to set up collection systems 'free of charge' to the end-user. Germany has proposed a combined approach with a fee to end-users to fund municipal collections, and increased product prices to fund industry recovery schemes. Denmark has proposed a similar arrangement, except collection funds are obtained through local taxes. In Sweden's Eco-cycle proposal, local authorities may recover their collection costs through charges to industry.

Neither disposal fees nor increased local taxes are likely to gain government support alone. Fees could result in fly tipping, and taxes may be considered inequitable (as householders

would be charged irrespectively of the volume of electronics waste they generate). More fundamentally, both lack any form of market incentive for industry.

Theoretically, inclusion of collection and recovery costs in product price could provide the competitive price signals required to encourage appropriate design changes and efficient collection, treatment and recycling systems to be established. It could also be considered more equitable (provided price increases reflected 'realistic' or actual disposal costs for a product), which fits within the ethos of Producer Responsibility. However, the inclusion of costs for old products sold before the implementation of a directive, as proposed currently by the EU (WEEE-27/7/98), or other similar retrospective approaches requiring payment of collection and recovery costs at product end-of-life could distort price signals:

- **Price discounting and delayed disposal.** As electronic products remain in use for several years, a price discount rate would apply to *future* take-back costs.[10] This would reduce any *present* incentives for design changes.
- **Time lag and market memory.** In the time between new product sale and end-of-life, some manufacturers will have ceased to exist, whereas other companies may have changed their markets and market share altogether. Consequently, the use of new products sales to fund the collection and recycling of products sold in the past could result in disproportionate cost allocations.
- **Retrospective costing and brand mixing.** Due to practical difficulties and constraints, the sorting of different brands of products from mixed waste-streams may be neither environmentally beneficial nor economically feasible. Therefore it will not necessarily be possible for producers to reap the benefits of any changes made to reduce environmental burdens and costs of their own products at end-of-life. In addition, unless a satisfactory preventative mechanism could be put in place, other companies could easily 'cherry-pick' products and brands that are most economic to treat and recycle at a loss to the companies that produced them.

These practical constraints apply to funding mechanisms for both old and new products, and arise not so much as a result of **retroactive legislation**, but **retrospective costing and obligations**.[11] Product design changes could be stimulated non-retrospectively by setting 'graded' recycling charges on new products. The graded charge would be based on the extent to which predefined product design standards had been met.

If legislation is to be retroactive and include older products sold before implementation, the authors believe that the short-term financial obligations for collecting and recycling these products should be met non-retrospectively. This could be achieved through an equitable distribution of costs across society (through local taxes), or across the electronics industry (based on company turnover).

Non-retrospective approaches to funding could be managed well using a deposit–refund scheme, as has already been adopted for some consumer goods in Korea (Kursaka 1996). In these schemes, industry must pay a deposit to a recycling fund on the sale of a new product, which is redeemable to responsible industries or recyclers operating accredited product recycling schemes. Any approach to funding must be constructed and administered carefully if it is to remain under control. The UK packaging industry's 'tradable

10 Discount rates are used to calculate the rate of return required on capital investments. It reflects the opportunity cost of investment and means that future costs and benefits are viewed as having lower value than current costs and benefits (Jackson 1996).

11 Referring to the inclusion of collection, treatment and recycling costs of products sold in the past *retrospectively* in new product prices, or the payment of product collection, treatment and recycling costs *retrospectively* at end-of-life.

permit' system of Packaging Recycling Notes (PRNs) has currently resulted in overpricing of recycling by the recycling industry, with very few increases in the volumes of packaging recycled (ENDS 1998: 17-19). A solution to this would be for PRNs to be generated and controlled by producers on the production of packaging, as opposed to the current arrangement where accredited recyclers issue and control PRNs on the basis of the volume of packaging they recycle. PRNs could then be allocated to particular recycling schemes in exchange for agreed and tangible recycling services by the producers themselves, or a central administrative body operating on their behalf.

Product recovery targets

The types of product covered and specific waste management obligations included have differed distinctly between proposals (AEA 1997). Italy's Waste Management Decree covers refrigerators, televisions, computers, washing machines and air conditioning units, and requires only that collection and recovery systems are established. In comparison, Sweden's Eco-cycle proposal covers all electronics wastes, and proposes that wastes should be managed in an environmentally responsible manner. Germany's draft Ordinance applies only to end-of-life IT equipment, and does not stipulate any particular recovery or disposal arrangements.

The proposed European directive will do much to standardise product categories and targets. Collection targets of 4 kg per person per year on average (WEEE-27/7/98), and separate recycling targets ranging from 70% to 90% by weight are currently being negotiated by the European Commission (see Table 1). The Commission has proposed these targets to ensure that consistent and equivalent regulation is enforced across member states, thus avoiding the development of barriers to trade and market distortions. To ensure that targets are achievable, they have been based on the weight of waste arising (as opposed to new product sales). The main disadvantage of this is that targets based on weight alone may be too ambiguous and may encourage product designers to focus on overall product weight reduction, rather than the reduction of hazardous or non-recyclable materials content. To overcome this problem, the EU is likely to impose various standards for the design, collection and recycling of products. Unless carefully allocated, it may also lead to problems of retrospective costing (see above) by forcing producers to fund the collection of old products (sold in the past) from new product sales. Therefore, much work has still to be done on developing EU targets if they are to be achievable, and make Producer Responsibility work in practice.

The development of a product take-back system in the UK

The development of a consolidated industry position and product take-back (PTB) system in the UK is dependent both on the industry becoming more proactive and on the government developing an appropriate environment and providing the necessary impetus for change. It is unlikely that any voluntary initiative developed by industry will work well without a supporting legislative framework (to prevent less scrupulous companies from avoiding their responsibilities). The government must ensure that the remit of such legislation is twofold, that **well-defined price mechanisms** support the appropriate level of **environmental improvement**.

The electronics industry is clearly in an advantageous position to negotiate and even propose a product take-back system within the UK. The fundamental elements that must be decided on in the development of a PTB system have been proposed in Table 2 (based on the preceding discussion), along with a range of possible industry positions, and a proposed 'best' position. Although the EU will specify certain elements within this, the develop-

Recycling target (% of that collected by weight)	Reference (WEEE-27/7/98)	Product type
90%	S.7(a)	Equipment containing certain ozone-depleting substances
	S.7(b) Annex 1A (1)	Large household appliances (except those containing certain ozone-depleting substances)
	S.7(d)	Gas discharge lamps
	S.7(e)	Equipment containing cathode ray tubes
70%	S.7(c)	Small household appliances
	Annex 1A (2-11)	IT equipment
		Telecommunication
		Radio, television, electro-acoustic, musical instruments
		Lighting equipment
		Medical equipment systems
		Monitoring and control instruments
		Toys
		Electrical and electronic tools
		Automatic dispensers

Table 1: PROPOSED EC TARGETS FOR WEEE RECOVERY AND RECYCLING

ment of an agreed UK product-take-back system model could provide a stronger basis for member state representation and negotiation within Europe. It is proposed that the development of such an implementation plan should proceed through four stages:

1. **Problem definition.** Identification of the range of fundamental elements of a product take-back system in the UK
2. **Scoping.** Investigation of range of possible approaches under each 'element heading'
3. **Positioning.** Industry positioning and consensus-building on best approaches
4. **Proposal.** Development of PTB system proposal

This basic 'elements-based approach' posited by the author has already been used successfully in the development of an industry-based proposal in the UK, known as the 'PRIMER proposal' (ENDS 1999).[12]

Conclusions

Producer Responsibility legislation is being adopted by countries across the developed world, with the intention of making the protection of the environment, the conserva-

12 The views and positions stated within the PRIMER proposal are not explicitly those of the author.

PTB system element	Range of possibilities	Proposed position
1. Environmental management	► Environmental standards ► Environmental assessments	Life-cycle assessment to qualify best environmental options on a 'case-by-case' basis
2. Operational target date(s)	► Implementation prior to directive ► Implementation subsequent to directive	Phased implementation prior to directive
3. Implementation	► Mandatory ► Voluntary ► Combined	Combined mandatory and voluntary system to ensure cross-industry compliance and flexibility
4. Goals and objectives	► Product classification ► Design targets ► Collection and recycling targets ► Treatment standards	Further clarification needed; should be consistent across EU to avoid trade barriers and market distortions
5. Funding mechanisms	► Charge to end-user ► Local authority tax ► Inclusion in product price	Non-retrospective inclusion in product pricing (levy or variable). Must be carefully designed to result in appropriate levels of environmental improvement.
6. Financial responsibility	► Collection ► Processing and transport	Producer financially and ultimately responsible for transport and processing. Responsibility for collection shared among distributors, local authorities and customers/disposers, or allocated to producers as part of a producer controlled system
7. Management and operational responsibility	► Collection ► Processing and transport	Flexible to allow industry-based solutions to develop and evolve over time
8. Collaborative structure	► Brand only ► Market segment ► Industry-wide	Flexible to allow individual companies to employ combinations of brand-only, market-segment and industry-wide solutions, e.g. for different products
9. Collection methods	► Retailer return ► Local authority ► Manufacturer ► Other	Flexible for all parties and end-user-friendly

Table 2: THE 'ELEMENTS' OF PRODUCT TAKE-BACK AND INDUSTRY POSITIONS

tion of resources, and the reduction of waste important elements of market success. This paper has evaluated the role of Producer Responsibility in the management of electronics waste in the UK.

While there is evidence to suggest that there are environmental benefits to recycling electronics waste, it is argued that this may not be true in every case due to important life-cycle considerations. The potential environmental benefits of individual product redesign changes and recycling processes should be justified from a life-cycle perspective before being developed and adopted under Producer Responsibility. In addition, if environmental benefits are to be achieved, **well-defined price mechanisms** must support the appropriate level of **environmental improvement**. It has been argued that the **'non-retrospective'** inclusion of collection and recycling costs in product price is therefore fundamental to Producer Responsibility.

Under Producer Responsibility, the electronics industry is the subject of what appears to be a difficult and intricate political game. As pioneers in a new age of information technology, they may play a significant role in the development of new approaches to managing resources. However, they could equally well be subject to ill-formed, restrictive and overly bureaucratic legislation with little overall environmental or economic benefit. Both EU and UK policy-makers must do more to create the right environment for change by working more constructively with the electronics industry, and by communicating a clear environmental and economic rationale for their approach. Targets and standards must continue to be refined and harmonised across Europe to ensure the objectives of legislation are achieved, and to prevent the development of market distortions and barriers to trade. In its role as a 'producer', the UK electronics industry still has time to research and develop greater sophistication in the management and recycling of electronics waste before more prescriptive legislation is forced upon it by the government. To achieve this it must recognise the level and scope of its future responsibilities as defined within government policy and act collectively and constructively to propose the best practicable way forward.

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The use and disposal of IT equipment by commercial organisations

A full report on this study can be found in Chapter 2, Vol. 1 of the research portfolio.

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The use and disposal of IT products by commercial organisations

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Abstract

New European environmental legislation requiring producers to recycle electrical and electronics products at so-called "end-of-life" is likely to introduce new areas of competition to the global market for IT products.

This paper presents the findings of a study investigating the use and disposal of IT equipment by 151 companies in the UK. Although 71% of companies disposed of their equipment as waste, other "disposal" routes were found to be of greater significance, such as charitable donations, transfer to employees, and resale to second-hand dealers. Therefore it is argued that the current legal definition of "waste" may be too restrictive to be applied to end-of-life IT equipment within the commercial sector.

In addition, it is argued that the provision of product "end-of-life management" services to commercial customers (in compliance with legislation or otherwise) could help IT producers add-value to their existing support services beyond the immediate production and consumption of new technologies. Where only 5% of companies replaced IT products within 2 years, 76% of respondents identified a need for such services. Specific details of the type of services that would be required have also been investigated, and are evaluated within.

Key words: Environmental issues, Information Technology, recycling, service development, government policy, re-marketing.

Introduction

This paper focuses on the use and disposal of IT equipment within the commercial business-to-business market sector. As the European Commission is presently drafting new environmental legislation forcing producers of electrical and electronic equipment[1] to organise the collection, treatment, and recycling of their equipment at "*end-of-life*" (WEEE - 21/04/98), this in an area of increasing concern to the IT sector.
This "*Producer Responsibility*" legislation has been under development since the early nineties, and has been deployed in many developed nations worldwide. The European Union has already implemented Producer Responsibility Directives on packaging wastes (94/62 EC) and batteries (91/157 EEC), and is currently negotiating similar approaches for automobiles, construction wastes, and tyres. For a more comprehensive survey, see Mayers and France 1999.

Producer Responsibility is a market-based instrument of government policy. More specifically, it is based on the principle that the "*polluter pays*". By internalising the external costs of environmental degradation (in this case waste disposal) to the costs of products and services, it has been argued that consumers would be encouraged to adopt purchasing habits "*better*" for the environment and society (Jacobs, 1991, Pearce, 1992).

To date, in previous EC proposals on Waste Electrical and Electronic Equipment end-of-life has been defined as *"any electronic or electrical equipment which is a waste"*. Using the example of redundant IT equipment in the UK commercial sector, this paper argues that

[1] EU definition "equipment which is dependent on electric currents or electromagnetic fields in order to work properly and equipment for the generation, transfer and measurement of such currents and fields" [DG XI.E3/FE D(97)].

this view belies important and complex post-sales behaviours, and therefore that any opportunities created from juxtaposition of environmental policy with market economics may be limited.

For both domestic and commercial sectors, very little information is available on the patterns of use and disposal of end-of-life electrical and electronic equipment. Various market and social research studies have revealed that people can deal with their end-of-life products in a variety of different ways (as shown in Table 1).

Table 1: End-of-life pathways of electrical and electronic products in households and businesses

Household end-of-life options	**Business end-of-life options**
(a) Sell privately second-hand (b) Give to family and friends (c) Store within the home (d) Return to retailers and manufacturers (e) Take to local authority civic amenity sites as "scrap" for recycling (f) Dispose of as waste	(a) Transfer or sell to employees (b) Dispose of as waste (c) Donate to public institutions, charities, and schools (d) Sell to second-hand brokers (e) Return to manufacturers or distributors (f) Dispose of as waste (g) Store in offices or warehouse
Sources: ECTEL, 1997, VROM Miniserie, 1993 in Voute, 1994. Information on commercial research also provided by Domestic and General, Comet, and ICER, 1998	Sources: The Corporation of London, 1996, SWAP, 1998 (b). Information on commercial research also provided by Hewlett-Packard GmbH, 1997

However, this research typically has not been empirically based or statistically representative on any large scale, and has typically focused on specific regions, product types, or operations. Some researchers similarly investigating consumer disposal (Boyd *et al*, 1996) and post-sales behaviours (Madison *et al*, 1992) for durable products have argued that these activities have substantial implications for policy-making, marketing, product development, and logistics planning. These authors suggest that better understanding of these post-sales behaviours could create opportunities to develop products and services of better value to customers.

Extensive market and social research has been undertaken on domestic recycling programmes (including paper, aluminium, and glass recycling). However, this has focused on attitudinal, motivational, and behavioural factors of public participation, primarily to evaluate how recycling activities could be incentivised and increased (Schultz, Oskamp, and Maineiri, 1995: Thørgesen, 1996). There has been little research on patterns of waste disposal and recycling within commercial sectors altogether.

> *"…although there are many anecdotal reports about recycling efforts in the commercial sector, no systematic empirical studies have described and evaluated this important domain of recycling activity."* Oskamp *et al*, 1994: 478-479

The term "*end-of-life*" and the classification of used electrical and electronic appliances as waste appears to be based on the logical assumption that there is a "*point*" at which these products must be disposed of. However, this does not account for the fact that they may enter waste streams through more complex mechanisms and processes than disposal at end-of-life.

This study examines the use and disposal of end-of-life IT products in the UK commercial sector (including PCs and computers, printers and peripherals, mainframes and servers, office imaging, telecommunications, and point-of-sale equipment). This includes the main categories of electronics used by businesses, and is probably the most lucrative area for producer-organised end-of-life management services due to potential volumes and value of resale (and reuse).

It has been estimated that around 650,000 - 900,000 tonnes of electrical and electronic equipment reaches end-of-life each year in the UK (ICER, 1998 [a]). This may cost the electronics industry a predicted £100 million per year under future Producer Responsibility legislation (Roy, 1990). In the context of the development and adoption of Producer Responsibility approaches world-wide, the results of this study are of relevance for IT producers internationally.
Three core areas of research were identified:

- The causes of product end-of-life
- The current management of end-of-life equipment
- The development of future end-of-life management services.

A summary of the methodology used in this study is given below. This is followed in subsequent sections by an analysis and discussion of results, an outline of possible future research, and some key conclusions for the development of environmental policies and new services by IT producers.

Method

Initially, a pilot survey was conducted on 15 companies to determine the appropriate sampling strategy and refine the survey questions. Key informants with sufficient knowledge of or responsibility for redundant IT equipment were located within each company by telephone, using IT managers as an initial point of contact. In previous studies on the disposal of redundant IT equipment (The Corporation of London 1996) and paper recycling (Oskamp *et al* 1994) such approaches were found to be effective in locating appropriate key informants within large companies.

From the pilot study it was found that most respondents (many of which were IT managers) were not willing to participate in telephone surveys due to time constraints. Therefore, those that agreed to participate were sent questionnaires by mail followed by a telephone reminder call, and two follow-up mailings. Several efforts were made to reduce non-response rates, such as the use of personalised cover letters, a free-phone enquiry number, and freepost reply envelopes.

The questionnaire included four sections covering the use of IT products, disposal, future service requirements, and background information. The availability of data on

quantities of redundant IT equipment disposed from previous studies (The Corporation of London 1996) and the pilot study appeared limited and of dubious quality. Therefore most questions were posed with simple "yes" or "no" (binomial), or three point (trinomial) responses e.g. "very important", "important", and "unimportant". Such approaches can provide accurate and useful quantitative information, and have been used very effectively in similar research on paper recycling within companies (Lee *et al* 1995).

Using binomial statistics (see Technical notes 1 and 2 below) minimum sample size was determined to be around 100 to give 95% confidence limits of ±10% i.e. to be 95% confident that the true population proportion lies within ±10% of any quoted sample proportion. Based on an expected response rate of 25% from the pilot survey, 500 companies employing more than 500 people in the UK were randomly selected from the Dunn and Bradstreet 1997 Key British Enterprises Directory[2]. This sample was estimated to be representative of 90% of the UK business-to-business or commercial market for Information Technology products (Key Note 1996)[3], excluding independent home office users.

Unless the number of responses to an individual question is below the minimum sample size of 100, or a sample proportion lies above 80% or below 20%, there is 95% confidence that the observed sample proportion will lie within ±6% to ±10% of the true population proportion (from binomial statistics). For results outside of these ranges, confidence limits have been provided for reference in Technical Note 3. In addition, chi-square tests have been used in the following section to determine the significance of differences in disposal behaviour and future service requirements by industry sector. The chi-square method is summarised in Technical Note 4.

Results

The survey was conducted between August 1997 and May 1998. In total 151 responses were received, comprising of around 4% of the business IT markets studied, and giving a response rate of 30%. As can be seen in Table 2, the industry sector profile of the sample closely matched that of the directory. This indicates that the sampling strategy used was sound, and the sample obtained was representative of industry and commerce in the UK as a whole. The companies that responded employed between 503 to 105,000 people, with a median of 1010 employees.

2 Excluding electronics manufacturers and distributors, waste management companies (by SIC code), who already play or have the potential to play important roles in managing redundant IT equipment, and primary industries who are not major users of IT equipment (see Footnote 3).

3 The remaining market being made up of smaller business users (3.9%), and users from primary industry sectors (6.3%) excluded from the study (Key Note 1997).

Table 2: Responses by industry type.

Sector	Sample	Key British Enterprises directory, 1997
Manufacturing	38%	45%
Transportation and communications	13%	10%
Wholesale and retail	18%	15%
Finance, insurance, and real estate	9%	10%
Services	23%	20%

n = 144

Management responsibility for redundant IT equipment

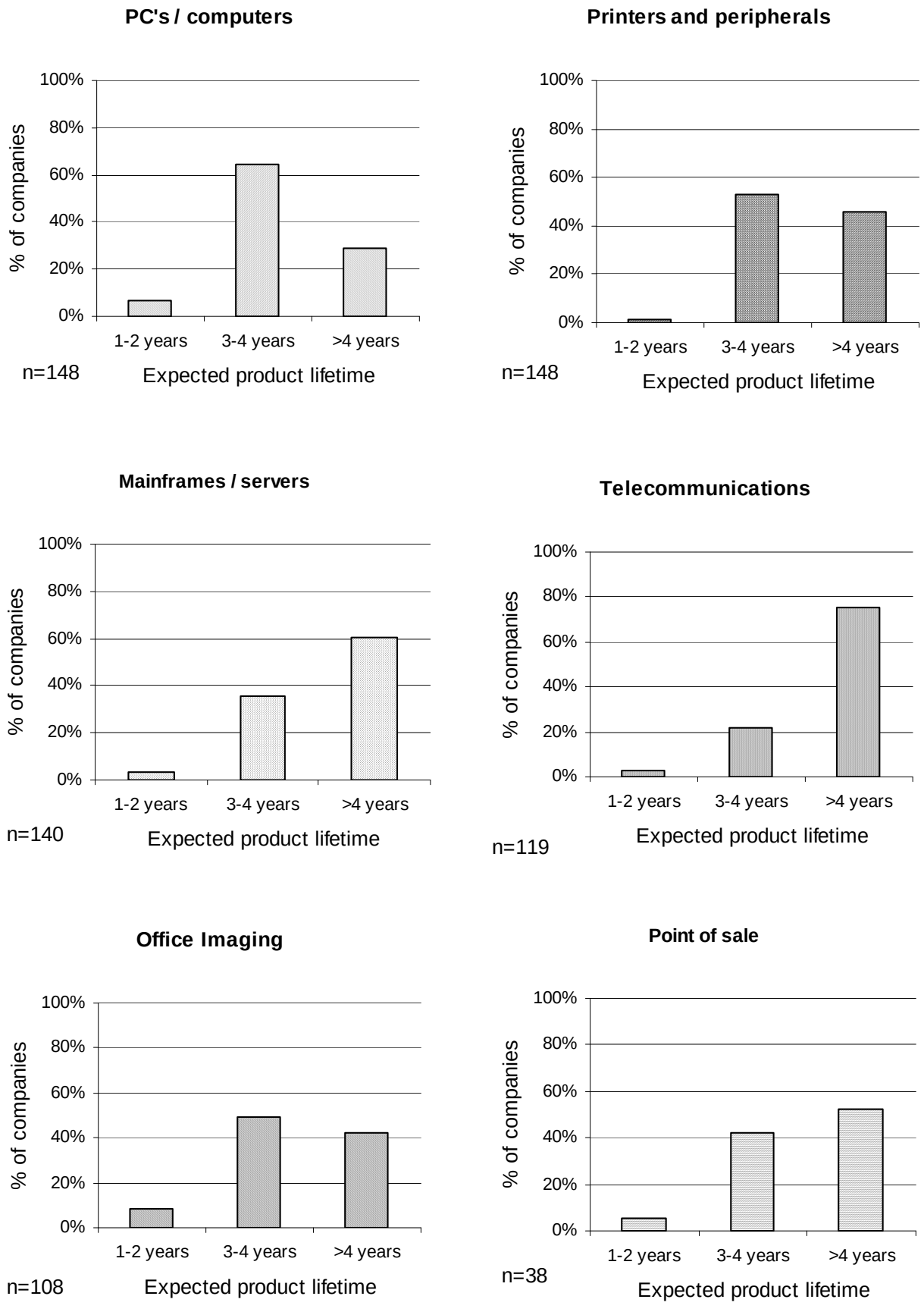
89% of respondents claimed to have responsibility for the management of redundant IT equipment within their companies. This not only qualified the legitimacy of their knowledge and responses, but provided evidence that redundant IT equipment presented UK companies with significantly large enough problems (or opportunities) to need "managing".

Table 3: Responsibility of redundant IT equipment by department.

Department with responsibility for redundant IT equipment	Percentage of companies
IT	77%
Other	9%
Finance & accounts	6%
Technical support	3%
Administration	2%
Facilities	1%
Purchasing	1%

As shown in Table 3, it was found that for 83% of companies sampled, redundant IT equipment was managed by departments also potentially involved in the purchase of new products including IT, finance and accounts, and purchasing. Therefore the provision of value-adding product disposal services by producers and distributors of IT equipment could help win new business and increase new product sales. This is an important finding of the research, discussed further in the discussion section.

Figure 1: Product life time of IT equipment in UK companies



Product use

Duration of use:

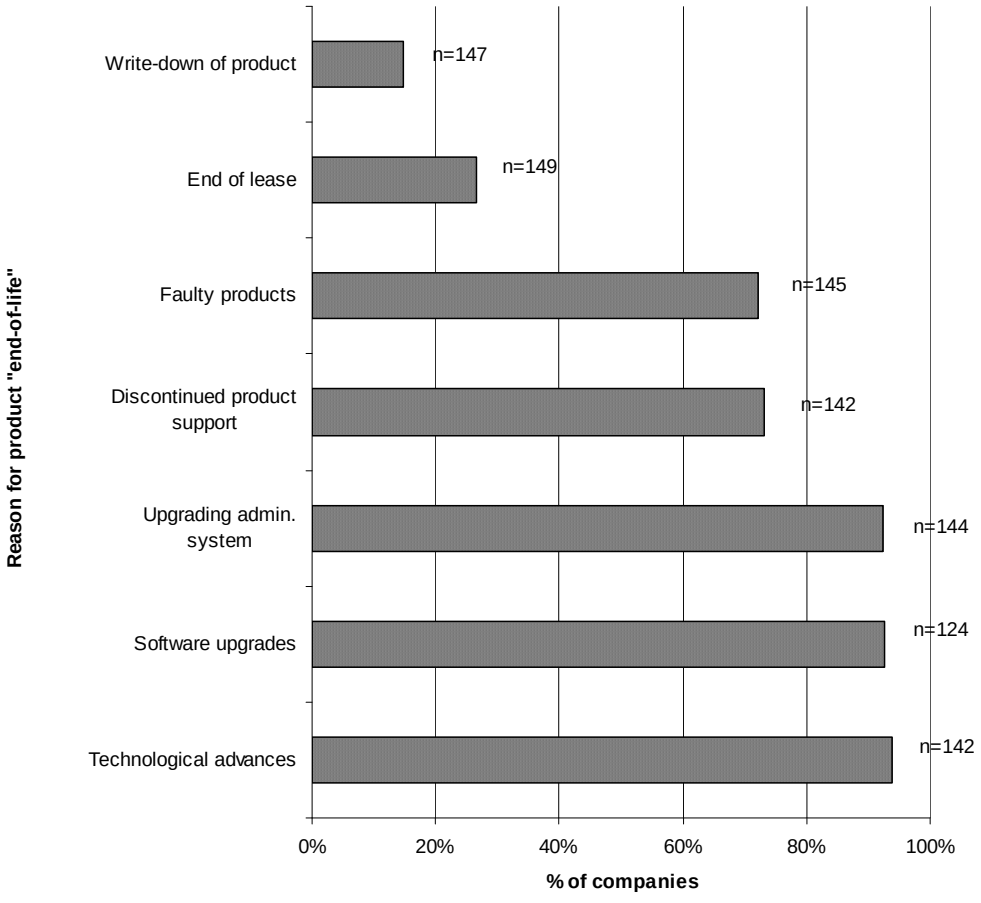
The majority of companies (an average of 95% taken across product categories) used IT products for longer than 2 years (see Fig. 1). A large proportion of companies used computer products within a 3 to 4 year time-span (64% of companies for computers, and 53% for printers and peripherals). The response rate for point-of-sale equipment was low at n = 38 as only companies in the service and wholesale and retail sectors used these products on a large scale (refer to technical note 3 for an indication of confidence limits for this data).

On average 51% of companies used IT products for more than 4 years (with a maximum of 76% for telecommunications equipment, and a minimum of 29% for PCs and computers). This makes some current industry estimates on the average usable lifetime of "IT products" sound highly improbable at 11 months (Hatley 1998).

Brand loyalty:

Different levels of brand loyalty were found for different product types. Only 57% of companies were loyal to only 1 to 2 brands of computer products (for both PCs and computers and printers and peripherals). Significantly more companies were found to be loyal to only 1 or 2 brands of networked products (mainframe and point of sale products at 79% and 77%[4] respectively).

Figure 2: Reasons for "end-of-life"

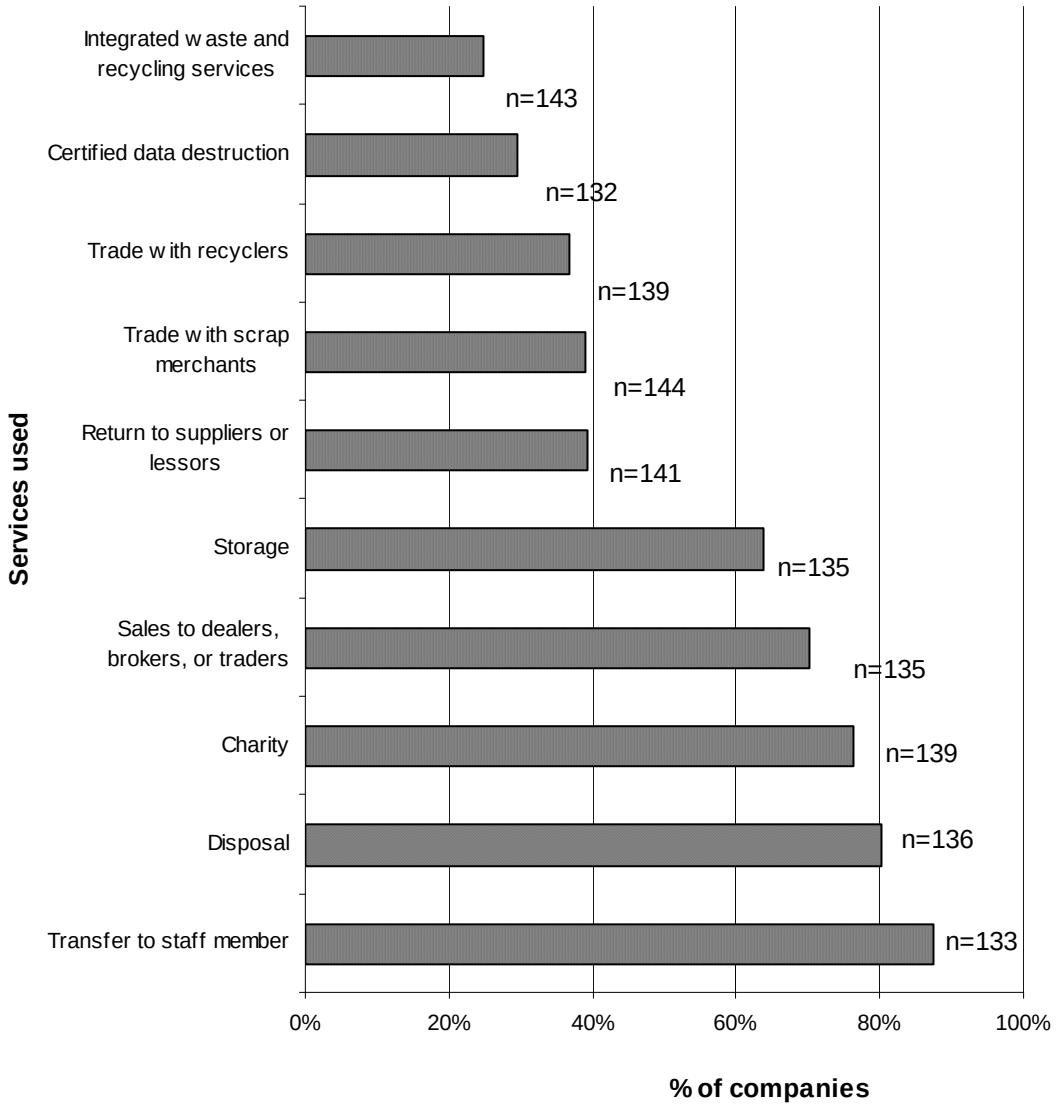


Product disposal

Causes of product obsolescence:

Technology related obsolescence was identified as a major cause of product end-of-life (see Fig. 2). Technological advances, software upgrades, and upgrading of internal administration systems were given as important antecedents for end-of-life by 94%, 93%, and 92% of respondents respectively. Discontinued product support and faulty products were also described as important by 73% and 72% of respondents. Only 27% of respondents believed that end-of-lease and only 15% of respondents believed that write down of product (accounting related issues) were important.

Figure 3: Services used for the disposal of redundant IT products



Disposal routes:

A total of 80% of companies disposed of redundant IT equipment as waste (see Fig. 3), with 37% describing this as a "frequent" activity. However, several other important product end-of-life "pathways" were found to be of similar and even greater significance, most resulting in the reuse of products in households and second-hand markets. These included transfer of equipment to employees for use in the home, donation to charity, and sale to brokers or dealers by 87%, 76%, and 70% of companies. Indeed, 23% of companies purchased second-hand equipment themselves, provided it had a reputable brand, was of "*high quality*", and had been refurbished responsibility. In addition 64% of companies stored some of their redundant equipment, 39% returned equipment to suppliers and lessors, 39% traded with scrap merchants, and 37% and traded with recyclers. Disposal categories were selected based on previous studies of the commercial sector (as shown in Table 1) and through investigation in the pilot study.

The cost / income of managing redundant IT equipment:

Although 56% of companies received income from the sale of their redundant equipment, only 15% of respondents described these products as assets. In comparison, only 20% of companies paid for product disposal, but as much as 43% of respondents described this equipment as waste. Clearly respondents saw little value in their redundant IT equipment, 11% even described it as "*neither an asset nor waste*" (as neutral).

Environmental management:

With respect to environmental management, 75% of companies were potentially breaching Duty of Care (Waste Management) legislation by failing to check vendors for waste management licenses and only 9% had environmental policies covering waste electronics. Only 28% of respondents were aware of the draft EU WEEE Directive.

Disposal rates:

Approximate IT product disposal rates were calculated in units per 100 employees for each product type. This was to investigate disposal patterns and trends, and evaluate possible predictors of disposal behaviour. Rates were calculated for each company from the range-medians[5] of products used and duration of product use and also from information on total employees from the KBE Directory (Dunn and Bradstreet, 1997).

It was found that disposal rates varied widely by up to 3 orders of magnitude between different industry sectors (as shown in Table 4). Generally and perhaps not surprisingly, the highest disposal rates were found for PCs and printers (used on an individual basis by employees) with median disposal rates of 15.4 and 5.5 units disposed of per 100 employees per year respectively. Other equipment surveyed (perhaps being larger and more expensive) appeared to be disposed of less frequently.

Financial institutions were found to dispose of a higher volume of PC's and computers than other sectors (with a median of 38.0 computers per 100 employees per year).

5 The median of a stated range. For example, the range-median of the range 2 to 3 years is 2.5.

Unsurprisingly, point-of-sale equipment was disposed of most frequently by the wholesale and retail, and service sectors (with medians of 4.6 and 8.2 products per 100 employees per year respectively).

Although there may be inaccuracies in this data due to errors in reporting of numbers of employees in the business listings, or in the estimation of products used and their expected lifetimes by respondents, this is unlikely to explain the great variation in this data. Although this data provides useful insight into rates of replenishment and disposal of IT equipment in companies, it must be treated and interpreted with caution due to its wide variability.

Table 4: Estimated products disposed of per 100 employees / year

Product type		PCs and computers	Printers and peripherals	Mainframes and servers	Telecommunications	Office imaging	Point of sale
Manufacturing	Median	15.32	4.89	0.66	0.80	0.69	0.29
	Range †	3.93-33.31	2.17-14.27	0.29-2.18	0.26-5.87	0.26-2.96	0-1.76
	n	57	57	56	50	50	13
Transport and communications	Median	16.06	4.62	0.56	1.78	1.72	1.21
	Range †	3.13-35.39	2.35-12.36	0.28-1.19	0.46-8.21	0.25-4.62	0-9.38
	n	19	19	18	15	18	8
Wholesale and retail	Median	13.64	4.24	0.61	0.61	0.49	4.57
	Range †	7.05-25.66	2.32-10.27	0.18-0.82	0.21-2.47	0.18-1.2	1.38-23.44
	n	26	26	25	22	24	21
Finance, insurance, and real estate	Median	38.02	4.94	1.79	1.82	1.62	0.11
	Range †	6.89-106.76	2.67-26.69	0.11-5	0.11-48.02	0-19.23	0-1.03
	n	13	13	13	9	10	5
Service	Median	11.33	7.07	0.83	2.01	0.77	8.21
	Range †	2.13-28.06	4.22-28.06	0.38-5.06	0.54-7.07	0.4-2.96	0-223.16
	N	21	21	19	21	20	10
Overall	Median	15.41	5.51	0.67	0.92	0.80	1.76
	Range †	4.59-41.97	2.49-15.73	0.28-2.74	0.39-5.86	0.26-2.96	0-9.38
	N	148	148	143	126	133	57

† Where n>10, inter-quartile range is shown, where n<11, full range (minimum and maximum values) is shown
Where length of use of product given as >6 years, 7 years used
Where number of products used is given as > 5000, 5001 products used

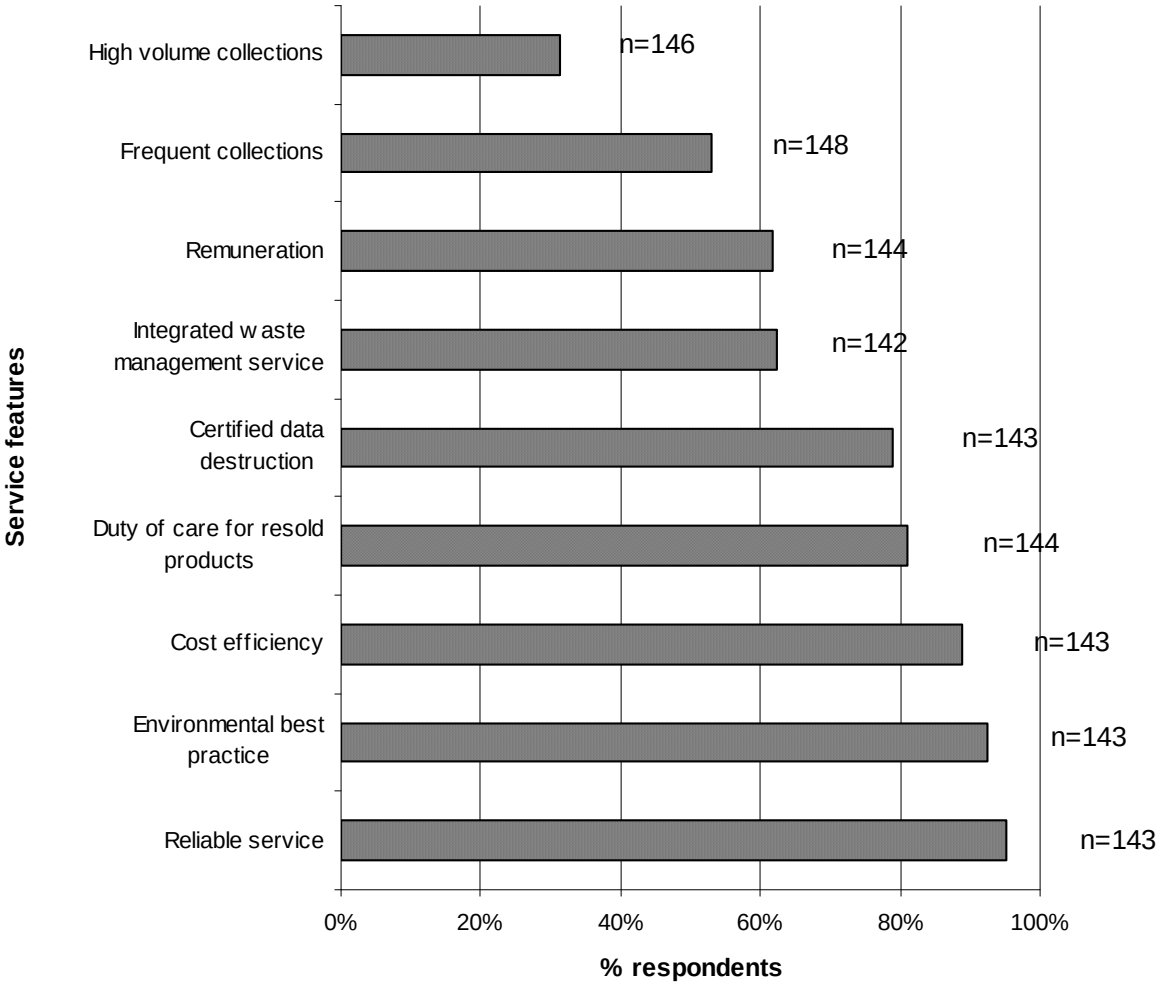
The market for redundant IT equipment management services

Service requirements:

Notably, 76% of respondents indicated that they *"had a need for better-developed services to manage their redundant IT equipment"*. The important features of such services were investigated in more detail (see Fig. 4): 95% of respondents indicated reliability was an important element of service success, 93% environmental best practice, 89% cost efficiency, 81% duty of care for resold products, and 79% certified data destruction (51% describing this as very important). There was a significantly greater need for frequent

rather than high volume collections (with 53% of respondents describing the former as important compared to 31% for the latter).

Figure 4: Perceived important features of a recycling / reuse service



Service coverage:

In terms of the provision of services to manage redundant IT equipment, it was found that:

- 77% of companies required national coverage.
- 42% of companies required site-by-site collections, with 1 to 16 sites per company. These companies were relatively large, with a median of 4941 employees (and an inter-quartile range of 3499 to 6111 employees).
- 58% of companies consolidated their redundant equipment to only 1 to 4 sites for collection purposes and possibly for storage. Each of these sites was found to consolidate their equipment from a further 5 to 140 sites (with a median of 23). These companies were relatively small, with a median of 1062 employees (and an inter-quartile range of 706 to 2392 employees).

From these results it is clear that companies with just a few large sites (with more employees) were most likely to need site by site collection services for their redundant IT equipment. Companies with many small sites (with fewer employees, and consequently less of a critical mass of equipment for disposal) were most likely to consolidate their equipment to a few centralised points.

Market segmentation:

Information on current disposal behaviours and service requirements was broken down by industry sector and company size (by number of employees) to identify market needs in greater detail. Using the chi-square method (explained in Technical Note 4), significant differences were found both in current disposal patterns (as shown in Tables 5 and 6) and in future service requirements (as shown in Table 7 and 8) between these groupings.

Significant differences were found in service requirements concerning collection between industry sectors, and financial arrangements between companies of different sizes. Perhaps not unsurprisingly, the number respondents from financial institutions describing high volume and frequent collections as important service needs was twice that expected. In comparison, respondents from larger companies (with >1500 employees) indicated that both remuneration and cost efficiency were important service requirements (with 25% and 15% more respondents describing these as important than expected).

Return to suppliers and lessors was the only disposal method which differed significantly between industry sectors. Around one third more manufacturing companies disposed of their redundant IT equipment through suppliers and lessors than was expected, compared to around two thirds less transport and communications and wholesale and retail companies (as shown in Table 5). Certified data destruction services were used 20% more than expected by both larger and smaller companies (those with greater than 1500 or less than 750 employees, as shown in Table 6). In comparison, companies with 750-1500 employees used certified data destruction services only half as much as expected.

Table 5: Disposal of redundant IT equipment by industry sector

		Manu-facturing	Transport-ation and commun-ications	Whole-sale and retail	Finance, insurance, and real estate	Services	Total	Results
n		**57**	**20**	**27**	**13**	**21**	**138**	
Certified data destruction	Observed	16.00	3.00	5.00	4.00	7.00	35.00	
	Expected	14.46	5.07	6.85	3.30	5.33		$p>0.05$ NS
	(Oj-Ej)2/Ej	0.22	1.13	0.67	0.20	0.70		$\chi^2 = 2.93$
Storage	Observed	30.00	14.00	17.00	7.00	14.00	82.00	
	Expected	33.87	11.88	16.04	7.72	12.48		$p>0.05$ NS
	(Oj-Ej)2/Ej	1.09	0.93	0.14	0.17	0.46		$\chi^2 = 2.78$
Transfer to staff member	Observed	52.00	13.00	22.00	11.00	17.00	115.00	
	Expected	47.50	16.67	22.50	10.83	17.50		$p>0.05$ NS
	(Oj-Ej)2/Ej	2.56	4.84	0.07	0.02	0.09		$\chi^2 = 7.57$
Charity	Observed	43.00	14.00	19.00	9.00	13.00	98.00	
	Expected	40.48	14.20	19.17	9.23	14.91		$p>0.05$ NS
	(Oj-Ej)2/Ej	0.54	0.01	0.01	0.02	0.85		$\chi^2 = 1.42$
Return to suppliers or lessors	Observed	29.00	3.00	3.00	5.00	9.00	49.00	
	Expected	20.24	7.10	9.59	4.62	7.46		$p<0.01$ **
	(Oj-Ej)2/Ej	5.88	3.67	7.02	0.05	0.50		$\chi^2 = 17.12$
Sales to dealers, brokers, or traders	Observed	41.00	14.00	18.00	10.00	11.00	94.00	
	Expected	38.83	13.62	18.39	8.86	14.30		$p>0.05$ NS
	(Oj-Ej)2/Ej	0.38	0.03	0.03	0.46	2.39		$\chi^2 = 3.30$
Trade with scrap merchants	Observed	22.00	8.00	8.00	6.00	7.00	51.00	
	Expected	21.07	7.39	9.98	4.80	7.76		$p>0.05$ NS
	(Oj-Ej)2/Ej	0.07	0.08	0.62	0.47	0.12		$\chi^2 = 1.36$
Trade with recyclers	Observed	22.00	10.00	6.00	4.00	6.00	48.00	
	Expected	19.83	6.96	9.39	4.52	7.30		$p>0.05$ NS
	(Oj-Ej)2/Ej	0.37	2.04	1.88	0.09	0.36		$\chi^2 = 4.73$
Integrated waste management	Observed	15.00	6.00	4.00	2.00	5.00	32.00	
	Expected	13.22	4.64	6.26	3.01	4.87		$p>0.05$ NS
	(Oj-Ej)2/Ej	0.31	0.52	1.06	0.44	0.00		$\chi^2 = 2.35$
Disposal	Observed	43.00	12.00	17.00	8.00	17.00	97.00	
	Expected	40.07	14.06	18.98	9.14	14.76		$p>0.05$ NS
	(Oj-Ej)2/Ej	0.72	1.01	0.69	0.48	1.14		$\chi^2 = 4.05$

v = 4

Table 6: Disposal of redundant IT equipment by company size

		500-749 emp-loyees	750-1500 emp-loyees	>1500 emp-loyees	Total	Results
n		**42**	**54**	**42**	**138**	
Certified data destruction	Observed	15.00	6.00	14.00	35.00	
	Expected	10.65	13.70	10.65		$p<0.01$ **
	(Oj-Ej)2/Ej	2.38	5.79	1.41		$\chi^2 = 9.58$
Storage	Observed	22.00	29.00	31.00	82.00	
	Expected	24.96	32.09	24.96		$p>0.05$ NS
	(Oj-Ej)2/Ej	0.86	0.73	3.61		$\chi^2 = 5.20$
Transfer to staff member	Observed	37.00	44.00	34.00	115.00	
	Expected	35.00	45.00	35.00		$p>0.05$ NS
	(Oj-Ej)2/Ej	0.69	0.13	0.17		$\chi^2 = 0.99$
Charity	Observed	25.00	40.00	33.00	98.00	
	Expected	29.83	38.35	29.83		$p>0.05$ NS
	(Oj-Ej)2/Ej	2.69	0.25	1.17		$\chi^2 = 4.10$
Return to suppliers or lessors	Observed	14.00	19.00	16.00	49.00	
	Expected	14.91	19.17	14.91		$p>0.05$ NS
	(Oj-Ej)2/Ej	0.09	0.00	0.12		$\chi^2 = 0.21$
Sales to dealers, brokers, or traders	Observed	26.00	35.00	33.00	94.00	
	Expected	28.61	36.78	28.61		$p>0.05$ NS
	(Oj-Ej)2/Ej	0.75	0.27	2.11		$\chi^2 = 3.13$
Trade with scrap merchants	Observed	17.00	17.00	17.00	51.00	
	Expected	15.52	19.96	15.52		$p>0.05$ NS
	(Oj-Ej)2/Ej	0.22	0.69	0.22		$\chi^2 = 1.14$
Trade with recyclers	Observed	18.00	16.00	14.00	48.00	
	Expected	14.61	18.78	14.61		$p>0.05$ NS
	(Oj-Ej)2/Ej	1.21	0.63	0.04		$\chi^2 = 1.88$
Integrated waste management	Observed	12.00	11.00	9.00	32.00	
	Expected	9.74	12.52	9.74		$p>0.05$ NS
	(Oj-Ej)2/Ej	0.68	0.24	0.07		$\chi^2 = 1.00$
Disposal	Observed	30.00	39.00	28.00	97.00	
	Expected	29.52	37.96	29.52		$p>0.05$ NS
	(Oj-Ej)2/Ej	0.03	0.10	0.26		$\chi^2 = 0.39$

v = 2

Table 7: Future disposal service requirement by industry sector

		Manufacturing	Transportation and communications	Wholesale and retail	Finance, insurance, and real estate	Services	Total	Results
n		**63**	**20**	**27**	**13**	**21**	**144**	
Certified data destruction	Observed	43.00	16.00	16.00	10.00	17.00	102.00	
	Expected	44.63	14.17	19.13	9.21	14.88		$p>0.05$ NS
	(Oj-Ej)2/Ej	0.20	0.81	1.75	0.23	1.04		$\chi^2 = 4.04$
Reliable service	Observed	53.00	19.00	23.00	13.00	18.00	126.00	
	Expected	55.13	17.50	23.63	11.38	18.38		$p>0.05$ NS
	(Oj-Ej)2/Ej	0.66	1.03	0.13	1.86	0.06		$\chi^2 = 3.73$
High volume collections	Observed	15.00	7.00	6.00	8.00	4.00	40.00	
	Expected	17.50	5.56	7.50	3.61	5.83		$0.025<p<0.05$ *
	(Oj-Ej)2/Ej	0.49	0.52	0.42	7.39	0.80		$\chi^2 = 9.61$
Frequent collections	Observed	26.00	10.00	12.00	12.00	10.00	70.00	
	Expected	30.63	9.72	13.13	6.32	10.21		$0.025<p<0.05$ *
	(Oj-Ej)2/Ej	1.36	0.02	0.19	9.94	0.01		$\chi^2 = 11.51$
Remuneration	Observed	31.00	12.00	16.00	12.00	12.00	83.00	
	Expected	36.31	11.53	15.56	7.49	12.10		$p>0.05$ NS
	(Oj-Ej)2/Ej	1.83	0.05	0.03	6.40	0.00		$\chi^2 = 8.31$
Cost efficiency	Observed	49.00	17.00	22.00	12.00	16.00	116.00	
	Expected	50.75	16.11	21.75	10.47	16.92		$p>0.05$ NS
	(Oj-Ej)2/Ej	0.31	0.25	0.01	1.15	0.26		$\chi^2 = 1.98$
Integated waste management services	Observed	35.00	13.00	13.00	6.00	14.00	81.00	
	Expected	35.44	11.25	15.19	7.31	11.81		$p>0.05$ NS
	(Oj-Ej)2/Ej	0.01	0.62	0.72	0.54	0.93		$\chi^2 = 2.82$
Environmental best practice	Observed	52.00	20.00	23.00	12.00	18.00	125.00	
	Expected	54.69	17.36	23.44	11.28	18.23		$p>0.05$ NS
	(Oj-Ej)2/Ej	1.00	3.04	0.06	0.34	0.02		$\chi^2 = 4.47$
Duty of care for resold products	Observed	45.00	17.00	21.00	9.00	16.00	108.00	
	Expected	47.25	15.00	20.25	9.75	15.75		$p<0.05$ NS
	(Oj-Ej)2/Ej	0.43	1.07	0.11	0.23	0.02		$\chi^2 = 1.85$

v = 4

Table 8: Future disposal service requirements by company size

		500-749 employees	750-1499 employees	>1500 employees	Total	Results
n		**47**	**54**	**43**	**144**	
Certified data destruction	Observed	31.00	38.00	33.00	102.00	
	Expected	33.29	38.25	30.46		$p>0.05$ NS
	(Oj-Ej)2/Oj	0.54	0.01	0.73		$\chi^2 = 1.27$
Reliable service	Observed	38.00	47.00	41.00	126.00	
	Expected	41.13	47.25	37.63		$p>0.05$ NS
	(Oj-Ej)2/Oj	1.90	0.01	2.42		$\chi^2 = 4.33$
High volume collections	Observed	12.00	12.00	16.00	40.00	
	Expected	13.06	15.00	11.94		$p>0.05$ NS
	(Oj-Ej)2/Oj	0.12	0.83	1.91		$\chi^2 = 2.86$
Frequent collections	Observed	19.00	28.00	23.00	70.00	
	Expected	22.85	26.25	20.90		$p>0.05$ NS
	(Oj-Ej)2/Oj	1.26	0.23	0.41		$\chi^2 = 1.90$
Remuneration	Observed	20.00	32.00	31.00	83.00	
	Expected	27.09	31.13	24.78		$0.025<p<0.05$ *
	(Oj-Ej)2/Oj	4.38	0.06	3.68		$\chi^2 = 8.12$
Cost efficiency	Observed	36.00	40.00	40.00	116.00	
	Expected	37.86	43.50	34.64		$0.025<p<0.05$ *
	(Oj-Ej)2/Oj	0.47	1.45	4.27		$\chi^2 = 6.19$
Integated waste management services	Observed	26.00	29.00	26.00	81.00	
	Expected	26.44	30.38	24.19		$p>0.05$ NS
	(Oj-Ej)2/Oj	0.02	0.14	0.31		$\chi^2 = 0.47$
Environmental best practice	Observed	39.00	48.00	38.00	125.00	
	Expected	40.80	46.88	37.33		$p>0.05$ NS
	(Oj-Ej)2/Oj	0.60	0.20	0.09		$\chi^2 = 0.90$
Duty of care for resold products	Observed	31.00	41.00	36.00	108.00	
	Expected	35.25	40.50	32.25		$p>0.05$ NS
	(Oj-Ej)2/Oj	2.05	0.02	1.74		$\chi^2 = 3.82$

v = 2

Greater differences may have been found between industry sectors and companies of different sizes if statistically representative samples of each sector had been obtained (with over 100 respondents in each). Thus further research is required to investigate the specific needs of these different market sectors in greater detail.

Discussion

Product use, obsolescence, and disposal

Examination of product use provided interesting insights. Very few companies appeared to purchase products at the rate that new technologies are created. For example, if product technology development cycles last around 6 to 9 months, then the majority of companies (using their products for more than 2 years) will only purchase new products after at least 3 to 4 generations of new technology have passed. It appeared that companies were more likely to replace their products to keep pace with these technological advances, rather than because of functional obsolescence (products breaking-down irreparably).

At present, the IT industry is continually cutting prices to encourage first time buyers in the consumer market, and existing commercial markets are becoming saturated (Gross 1998). This point is perhaps illustrated by the 33% of respondents' not expecting future increases in the number of products used. It appears for now that IT producers looking to technology development to gain market share will focus on an increasingly smaller number of high specification users. Meanwhile, extensive second-hand markets appear to have developed independently of producers. For example where only 39% of companies returned their redundant equipment to suppliers or lessors, 70% sold equipment privately to second-hand dealers and brokers. Indeed, 23% of companies were found to purchase second-hand equipment themselves.

A large variation in the rate of disposal of redundant IT equipment was found between companies making interpretation difficult. However, it was found that finance companies disposed of PCs and computers, and retail and service companies disposed of point-of-sale equipment at a much higher rate than companies in other sectors. Based on the volume and specific composition of redundant products disposed of each year, it is likely that these sectors had very different requirements from an equipment disposal service.

The definition of waste

Under the proposed EU directive, producers will be forced to address the waste that supposedly results from the rapid turnover of technology. The current definition of waste is *"...any substance or object… which the holder discards or intends to discard or is requires to discard"* (75/442/EEC), which does not accommodate for the complexity of existing patterns of product use and disposal. As shown earlier, most companies already manage their redundant IT equipment to a certain extent which results in a variety of different "*disposal*" pathways at end-of-life.

A large proportion of companies passed equipment on for reuse in businesses, households, public institutions, charities, and international markets via brokers and

dealers, charities, and employees. It would be difficult to distinguish when these products reach *"end-of-life"* and become waste, as they may endure many years of use by several users with different perspectives on when a product has reached end-of-life. Ultimately these products will reach an end-of-life either in landfill, or perhaps in various recovery processes. However, the sources, availability, and opportunities for reuse and recycling of this equipment will be critically dependent upon a company's individual disposal behaviours.

For redundant IT products disposed by the commercial sector, product end-of-life would be best considered as an extended process in which equipment is used by more than one user, and during which it will devalue, degrade, and disperse through society.

New market opportunities

There clearly is a market demand for improved services to help large companies manage their redundant IT equipment. These services should be reliable and allow customers to dispose of their redundant IT equipment in a cost effective and responsible manner. Services that could be developed competitively as market differentiators include:

Certified data destruction (used only by 27% of companies at present, but perceived as an important by 75% of respondents). Such services may be particularly useful for medium sized companies with between 750 and 1500 employees, which were found to use them significantly less than other companies.
Brand name support for second hand sale of products
Acceptance of all brands of returned products (as many companies were not loyal to any particular brand)
Provision of nation-wide collection services.
However, different industry sectors or companies of different sizes may be more effectively serviced as separate market segments. For example, the finance and insurance sector appeared to produce higher volumes of redundant IT equipment than companies of other sectors. Consistent with this finding, they also had a significantly greater need for frequent and high-volume collections for disposal.

Although 93% of respondents claimed that "environmental best practice" was an important service need, this result should be regarded with caution due to the apparent lack of environmental policy commitment and awareness within each company (previously discussed):

Only 9% of companies had environmental policies covering the disposal redundant IT products
Only 28% of companies were aware of the EU draft Directive on WEEE
Up to 75% of companies may have been in breach of waste management regulation in the disposal of their redundant IT equipment

Current market developments

Many IT producers already provide redundant equipment management services to their commercial customers, even though not yet legally mandated to do so. Examples include:

Extended product leasing as provided by Xerox for office imaging products (where the leasing company retains title of the equipment, and therefore manages its disposal)
Take-back services as offered by the Digital Equipment Corporation (now owned by Compaq) and Dell across Europe
The resale of refurbished second-hand products supported by leading product brands. For example, ICL sell various brands of refurbished second-hand computers under a recently launched service brand called "Star" or "Second Time ARound", which are sold through up to 300 dealers nationally (Price, 1998). Similarly, Compaq have recently launched and marketed a new range of refurbished computers supported by full manufacturer's warrantees, known as "Digital Classic".

Strategic "channel partnerships" between IT producers and companies responsible for the refurbishment and resale of 2nd hand equipment are therefore likely to be of increasing importance in the development of IT markets.

Implications for IT producers

The increased levels of reuse and recycling resulting from the development of redundant IT equipment management services for the commercial sector could help producers to meet their future obligations under Producer Responsibility legislation. In addition, producers could profit financially from second-hand sale of products while exerting greater control over the quality and competitiveness of these markets.

At present 39% of companies were already found to return their redundant equipment to suppliers. This was especially notable for manufacturing companies (with 50% returning equipment via this route), whereas transport and communications and wholesale and retail companies used this route far less frequently than other sectors (at 15% and 11% of companies respectively). For future growth and expansion of these producer and supplier "take-back" services under producer-responsibility, the individual needs of these different end-of-life market and industry segments must be addressed.

Through the development and provision of such product "end-of-life management" services, producers could gain increased access and additional influence over new and existing customers. In the overwhelming majority of companies (85%), departments given responsibility for managing redundant IT equipment were also involved in the purchase of new products. *This clearly is an important marketing opportunity.*

In summary, the extension of customer support services by the IT industry to cover the management of redundant IT equipment from the commercial sector could help tackle two related environmental and economic concerns. These are: the environmental effects of resource consumption and materials disposal from the production of IT products, and the development of more enduring customer relationships through the provision of full product life-cycle services.

Future research

As larger IT producers supply markets on a global basis, future research on the use and disposal of redundant IT products by commerce in different countries may be useful.

This would help producers to determine the level at which such services should be provided (nationally or globally). In addition, the development and continued provision of product end-of-life services will require a more detailed knowledge of (in order of priority):

- Market segmentation
- The most effective "service channels" or methods of service delivery
- Service pricing

Given the broader remit of the EU Directive on Waste Electrical and Electronic Equipment, research must also be undertaken on the use and disposal of electrical and electronic products more broadly in the consumer and public sectors. The principal author, with the support and sponsorship of various other academic, non-governmental, and commercial partners is currently undertaking such research, focussing on the use and disposal of household appliances in the UK domestic sector.

Conclusions

Patterns of the use and disposal of redundant IT equipment in the commercial sector have been investigated through a survey of 151 companies employing 500 or more people in the UK. This was to investigate why IT products reach end-of-life, how these products are currently managed, and the scope for the development of future services in respect of European Union Producer Responsibility legislation.

Results indicated that only around 5% of companies (averaged across product categories) used IT products for less than 2 years. Therefore it is argued that producers focussing on rapid turnover of product technologies could find it increasingly difficult to gain increased market share, especially considering current market limitations.
Most companies had employees with specific responsibility for the management of redundant IT equipment. Although 80% of companies disposed of some of their equipment as waste, several other pathways were found to be of similar importance. These included transfer of equipment to company employees, donation to charity, and sales to dealers or brokers through which equipment may be resold and reused. In this context it is argued that existing conceptions of product consumption, and legal definitions of "waste" do not sufficiently reflect the complexity of pathways by which this equipment may progress *through* end-of-life. It is suggested that it is inappropriate to define end-of-life as a *point of disposal* (or even purchase as a *point of consumption*) for IT equipment sold into and passed out of the commercial sector. This equipment retains significant utility and may be passed onto subsequent users, thus entering a *process of extended use*. There are some signs that the European Commission now at least in part recognise this. The term "end-of-life" has been removed and replaced with the term "waste" in the most recent draft of the WEEE Directive (WEEE – July 1999).

Finally, it is argued that there are market opportunities for producers wishing to provide redundant IT equipment management services to larger business customers (77% of respondents identified a need for improved services). It is concluded that, provided there is sufficient consideration of the needs of different market segments, the provision of

such services could help producers meet their future requirements under Producer Responsibility legislation. It may also add-value to an IT producer's existing post-sales services, beyond the immediate production and consumption of new product technologies, and potentially contribute to the establishment of longer lasting relationships with commercial customers. To support the continued development of services in this area, it is argued that future research would need to focus more specifically on market segmentation, service pricing, and the effectiveness of different service delivery channels.

Technical notes.

1. Calculation of minimum sample size

Where:

$$n_{\min} = \frac{z^2 \pi (1-\pi)}{H^2}$$

$n_{\min}$	Minimum sample size required
z	Z-score (level of confidence, at 95% z = 1.96)
H	Difference required to be detected as significant (0.1)
π	Population proportion (0.5 is the proportion at which the standard deviation is the greatest, as explained in Technical note 2 below)

Source: Churchill 1996: 532-559, Parasuraman 1991: 494-503:

2. Worked example for survey

Table T1: The curve of binomial variation

π	0.001	0.005	0.01	0.05	0.10	0.20	0.30	0.50	0.70	0.80	0.90
σ_p^2	0.001	0.005	0.010	0.048	0.090	0.160	0.210	0.250	0.210	0.160	0.090

Source: Kish 1965: 260

When π = 0.5, sample variation is greatest (as shown in Table T1 above). Therefore this is the value used in calculating minimum sample size at "worst case".

$$n_{\min} = \frac{1.96^2 \cdot 0.5(1-0.5)}{0.1^2}$$

$$n_{\min} = 96.04$$

3. Confidence limits

Upper and lower limits are provided at the 95% confidence level (by sample size and observed population frequency) in Table T2 below. These figures have been validated against binomial values provided in Fisher and Yates (1963: 65). Trinomial data (which provides useful qualitative information) has been converted to binomial data within the report by combining categories. For example, disposal behaviours classified as "frequent" and "infrequent" were combined to give information of the number of companies disposing of redundant IT equipment by any particular method.

Table T2: Upper and lower bounds of confidence at the 95% level with sample size and observed population frequency

p	n = 50		n = 100		n = 150	
	Lower limit	Upper limit	Lower limit	Upper limit	Lower limit	Upper limit
0.01	0.00	0.10	0.00	0.05	0.00	0.05
0.05	0.01	0.15	0.02	0.11	0.02	0.10
0.10	0.03	0.22	0.05	0.18	0.06	0.16
0.25	0.13	0.40	0.17	0.35	0.18	0.33
0.50	0.35	0.64	0.40	0.60	0.42	0.58
0.75	0.60	0.87	0.65	0.83	0.67	0.82
0.90	0.78	0.97	0.82	0.95	0.84	0.94
0.95	0.83	0.99	0.89	0.98	0.90	0.98
0.99	0.90	1.00	0.94	1.00	0.95	1.00

4. The chi-square method

Chi-square tests can be used to test for statistically significant differences between an observed population distribution and the distribution that was expected. The value of chi-square has been described as:

"A measure of the discrepancy existing between observed and expected frequencies is supplied by the statistic χ^2 (read chi-square)" – Spiegel 1972, 201

The Chi-square value is given by:

$$\chi^2 = \sum_j \frac{(o_j - e_j)^2}{e_j}$$

Where:

χ^2	Chi-square value
o_j	Observed frequencies
e_j	Expected frequencies

Source: Spiegel 1972: 201-203

For example, a Chi-square test can be used to investigate whether there are statistically significant differences between the number of computers owned by different age groups in a population from that expected by chance alone. Degrees of freedom must also be calculated to determine the statistical significance of a chi-square result using the appropriate statistical tables (White *et al* 1974: 17-18):

For chi-square tests, the degree of freedom is given by:

$$v = k - 1$$

Where:

v	Degree of freedom
k	Number of columns (factors)

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The development of end-of-life management systems for electronic products

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THE DEVELOPMENT OF END-OF-LIFE MANAGEMENT SYSTEMS FOR ELECTRONIC PRODUCTS

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ABSTRACT

With the development of 'Producer Responsibility' policies and legislation by governments in countries throughout the developed world, the cost burdens of waste management are shifting away from society to producers, and through cost internalisation, ultimately to the individual consumer. Under this approach, producers are required to provide for the collection, treatment, and recycling of their products at "end-of-life". This major change will require producers not only to acquire new competencies, but also to excel and perform beyond the current state-of-the-art in the waste management and recycling industries.

In this presentation, the authors own research on a novel "End-of-Life Management" system for Waste Electrical and Electronic Equipment (WEEE), and also a related reverse logistics software tool presently under development as part of the European Union project, RELOOP, will be discussed. In conclusion, the effectiveness and key findings of these related projects will be summarised in relation to the implementation of the proposed WEEE Directive.

FURTHER INFORMATION

- Detailed academic paper on the proposed End-of-Life Management system methodology to follow.
- Brochure outlining key aspects of the RELOOP project available on request.

THE DEVELOPMENT OF A SYSTEM FOR IMPROVING THE ENVIRONMENTAL PERFORMANCE AND COMMERCIAL VIABILITY OF END-OF-LIFE MANAGEMENT PROCESSES FOR ELECTRONIC PRODUCTS

C.K. Mayers and C. France

Abstract

With the development of 'Producer Responsibility' policies and legislation by governments in countries throughout the developed world, the cost burdens of waste management are shifting away from society to producers, and through cost internalisation, ultimately to the individual consumer. Under this approach, producers are required to provide for the collection, treatment, and recycling of their products at "end-of-life". This major change will require producers not only to acquire new competencies, but also to excel and perform beyond the current state-of-the-art in the waste management and recycling industries.

This article presents an "End-of-Life Management" system for Waste Electrical and Electronic Equipment (WEEE), a category of durable goods currently under discussion for Producer Responsibility legislation across Europe. Using a combination of life-cycle assessment, logistics management, and continuous improvement approaches, progress on the development and novel application of this methodology is described using an example of a printer trade-in between a major producer and high-street retailer in the UK. It is concluded that the proposed system can be effective in improving the environmental performance and commercial viability of product End-of-Life Management processes. Finally, it is argued that such approaches will become more practicable following improvements in the availability of environmental information and of specialist software applications for environmental and financial assessment in this area.

Key words: Reverse Logistics, Producer Responsibility, End-of-Life, Waste from Electrical and Electronic Equipment, Life Cycle Assessment, Quality Management, Logistics Management, Mission Costing

1. Introduction

At present, the European Commission is in the third stage of drafting a new Directive that will require Producers of Electrical and Electronic Equipment to provide for the collection, treatment, and recycling of their products at "end-of-life" (WEEE-27/7/98). The European Union has already adopted "*Producer Responsibility*" Directives for packaging (94/62 EC) and batteries (91/157 EEC), and many countries throughout the developed world have implemented similar regulations and policies (Mayers and France 1999).

Producer Responsibility is intended to be a market-based instrument of government policy, providing economic incentives for Producers to reduce the environmental impacts of their waste products (at their so-called "*end-of-life*") by redesign and / or by establishing product collection, treatment, and recycling processes. These economic incentives are likely to be significant. In 1991, it was estimated that Producer Responsibility for WEEE would cost the industry £100 million in the UK alone, which

was around 0.4% of its revenue at that time (Roy 1991). In Norway, the introduction of Producer Responsibility legislation will result in price increases on new products from around £1.60 to as much as £23.80 (ENDS Daily 1999).

The introduction of Producer Responsibility demands much higher standards for waste management and recycling than are currently achieved within the waste-management industry. This includes standards for recycling and collection, and specific treatment standards, for example, governing the disposal of cathode ray tubes. In contrast with conventional logistics processes used to distribute products to market, it has been argued that "*reverse*" logistics processes used in materials recycling are poorly understood and underdeveloped in general (Pohlen and Farris 1992). There are claims that even seemingly simple reverse logistics processes, such as the collection of used chemical drums from customers for reuse by suppliers, requires *"vastly expanded infrastructure and new management systems"* (Guitini 1997: 81).

The transfer of waste management responsibilities to Producers will require them to either develop or employ considerable expertise in the fields of waste management and reverse logistics, areas not traditionally part of their core competencies. Using a novel application of environmental assessment and logistics management approaches, this paper discusses the development of a system to continuously improve the environmental performance and commercial viability of end-of-life management processes for electronic products. Firstly, a theoretical definition of the structure of reverse logistics processes for end-of-life electronic products (developed by the author and used to underpin of the proposed system) is discussed below.

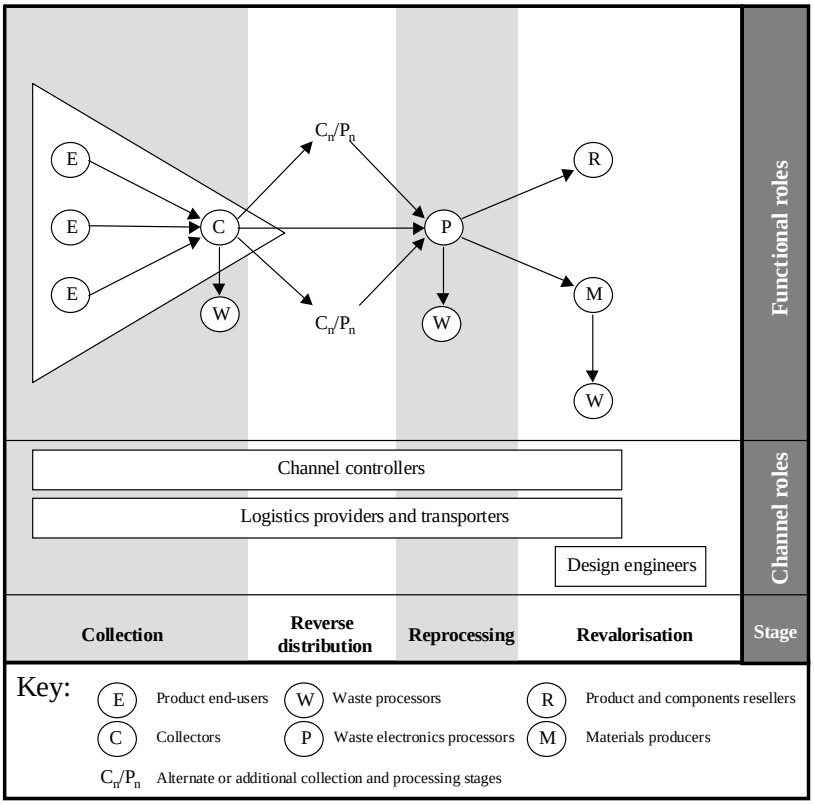
2. The logistics of product end-of-life management

In order to understand waste management and recycling processes, it has been argued that they are best considered as logistical "*channels*" of reverse distribution (Zikmund and Stanton 1971). The concept of channel structure is important because it defines the sequence of stages and players in a logistical chain of distribution (or reverse distribution). Based on 10 case studies of major End-of-Life Management processors in Europe (Bettac, Mayers, and Buellens 1998), the author has proposed a theoretical process definition or "*channel model*" for these products (see Fig. 1 below). Within this channel model, the roles and activities of various different types of organisations (or "*actors*") have been identified at different stages of the process chain. This is intended to provide a basis of comparison between End-of-Life Management processes.

3. System overview

In order to improve the environmental performance and commercial viability of product end-of-life management channels, a system has been proposed that uniquely combines environmental *lifecycle assessment* and *mission costing* (a logistics management and accounting approach) methodologies within a framework of *continuous improvement*. It is important to include continuous improvement techniques, as they are an essential feature within existing environmental management systems such as ISO 140001 and EMAS.

Figure 1: End-of-Life Management channel model for electronic products



Product end-users: Organisations & individuals disposing of end-of-life products.

Collectors: Collecting from end-users directly or through drop-off points e.g. retailers.

Waste electronics processors: Electronics recyclers & subsequent specialist materials recyclers e.g. cathode ray tube recyclers.

Product and component resellers: Traders or brokers re-marketing and reselling refurbished products or components.

Material producers: Producers of finished materials using materials reclaimed from waste for use in new products e.g. copper smelters.

Waste processors: Waste management companies providing waste treatment and disposal services.

Logistics providers and transporters: Logistics providers & transporters providing transport links between all stages in the end-of-life management chain e.g. hauliers.

Channel controllers: Performing high-level integrated management functions e.g. waste management companies and producer consortia.

Design engineers: Designing products to reduce end-of-life environmental and economic burdens.

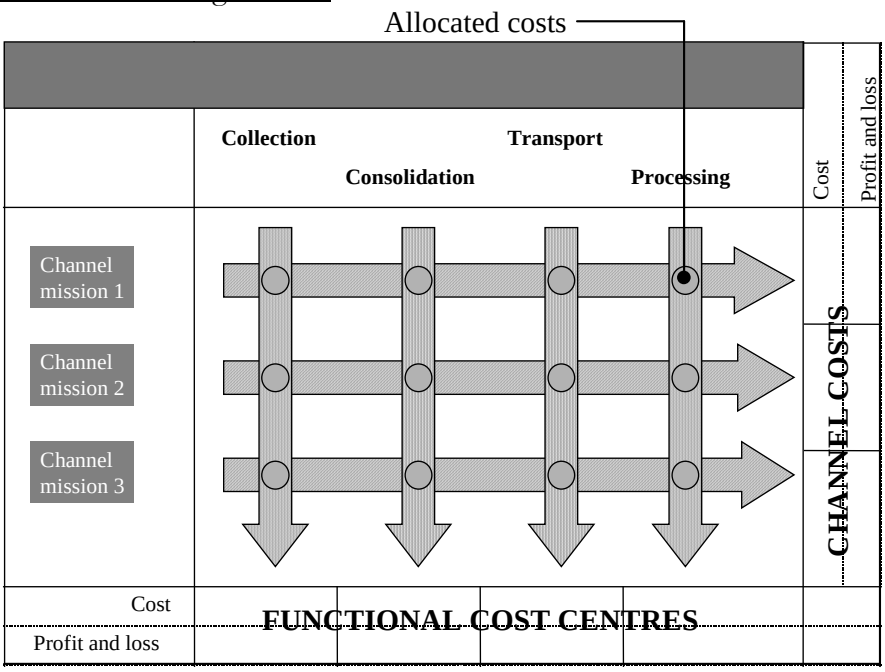
Source: Bettac, Mayers, and Buellens, 1998

Environmental life-cycle assessment is a method by which the total environmental impacts of providing and delivering a particular product or service can be determined and assessed holistically from cradle-to-grave, and compared to other products or services (ISO 1994, OECD 1995).

Logistics mission costing is a similar method by which the total costs of providing and delivering a particular product or service can be determined and assessed holistically from a "supply-chain" or logistics perspective, and compared to other products and services (Christopher, 1992; Barret, 1982). Rather than focusing on the "functional" costs of individual stages (cost centres) in a distribution channel, as with traditional management accounting, mission costing is used to identify the overall profitability of supplying individual customer groups with agreed levels of service (defined by a series of "*channel missions*", as described in Section 4) through an *integrated* channel of distribution (as shown for end-of-life management in Fig.2).

> *"Each group of customers is deemed to constitute a unique physical distribution mission. If it is possible to establish the cost of supplying the various levels of service to the various market segments, i.e. to cost the physical distribution missions, the potential exists to establish the level of service which yields the highest net benefit (profit) to the company, since both the revenue and the cost implications of changes in level of service may be quantifiable." – Barret 1982: 10*

Fig. 2. The mission costing method



Source: adapted from Christopher 1992.

Table 1: The combined end-of-life management system methodology

End-of-Life Management stage	***Methodology***	***Equivalent stages***	***Description***
1. Policy development and planning (PLAN) *Channel strategy & channel management.*	Life-cycle assessment	Goal definition & scoping	*Definition of functional unit & setting of system boundaries*
	Mission costing	Mission identification	*Identification of service missions, & development & identification of channel processes*
2. Implementation and operation (DO) *Operational stage & data collection.*	Life-cycle assessment	Inventory analysis	*Data collection*
	Mission costing	Mission costing	*Data collection*
3. Information collection and reporting (CHECK) *Data inventory & data quality assessment.*	Life-cycle assessment	Inventory analysis	*Calculation of direct environmental impacts*
	Mission costing	Mission costing	*Calculation of channel costs*
4. Improvement assessment (ACT) *Environmental and cost assessment compared to strategic and tactical objectives.*	Life-cycle assessment	Valuation and improvement assessment	*Prioritisation of environmental impacts and recommendations for environmental policy*
	Mission costing	Assessment of channel costs	*Channel cost assessment and policy recommendations*

For example, the mission costing method could be used to evaluate the profitability of different service delivery channels in a fast-food restaurant (such as take-away, eat-in, or home delivery), including the differential costs of ingredients and preparation in each case.

Life-cycle assessment and missing costing methodologies are based on relatively similar procedures, whereby environmental impacts or costs are evaluated throughout a defined product supply-chain (or life cycle) and allocated to a specified product or service, and so can be used in parallel (as summarised in Table 1 above).

As an example, a printer "trade-in" conducted between a major international producer of IT products and printers and a major group of UK based high-street retailers is at present being used to evaluate the proposed system methodology. In this trade-in, various discounts were offered on the price of selected new printer products on exchange for an older model. During the month of April 1999 (the period of the trade-in), over 3,250 printers, weighing over 20 tonnes in total, were returned through retail outlets to a third party recycling organisation in the UK.

Although this trade-in was undertaken principally as a marketing promotion, to increase consumer awareness of new printing technologies and thus stimulate new product sales, it also offered useful opportunities for end-of-life management research. In terms of logistics requirements it was very similar to the take-back of products under the future proposed WEEE Directive, which is likely to require products to be returned on the sale of new through retail outlets. The proposed end-of-life management system can be divided into four key stages, which are discussed below using specific examples of the ongoing trade-in.

4. Policy development and planning (Stage 1)

Initially, strategic end-of-life management objectives must be set at an organisational level, and more specific tactical objectives decided for each individual end-of-life management channel. At this level, consideration should be given to the market for end-of-life management services, applicable legislation, industry best practice, levels of innovation, and the level process integration desired. Decisions should also be based on an initial review of the potential costs and environmental impacts of product collection, recycling, and treatment services to be used, such as through the use of 3rd party vendor assessments. The minimum decision criteria at this stage should be to ensure compliance with environmental legislation as valid basis for continuous improvement.

Objective setting

Although it may be relatively simple to set commercial and environmental objectives that *appear* tangible and achievable, it is difficult to judge the most legitimate course of action (especially regarding the environment), as all costs and impacts must be considered, some of which are likely to be in conflict:

- Conflict between environmental factors: *for example, increased rates of recycling may only be achievable with an increase in energy consumption*

- Conflict between cost factors: *for example, a reduction in the costs of reverse distribution by reducing the number of collection points in a channel may increase the direct cost of collection from end-users.*
- Conflict between cost and environmental factors: *for example, in current markets, increased plastics recycling may only be achieved at increased cost.*

An example of an environmental objective might be *"to ensure that the energy burden of individual end-of-life management channels is not above that of the equivalent alternative disposition route (unless otherwise environmentally justified)"*. Three principle objectives regarding commercial viability have been identified:

- *…to return competitive levels of net profit to internal or external customers*
- *…to operate competitively on a cost neutral basis*
- *…to be competitively priced and funded by internal or external customers*

Mission identification

At a tactical level, unique service related objectives for each end-of-life management channel must be defined by a series of individual *service missions*, in keeping with strategic end-of-life management objectives set previously. Although essentially this step is required as part of mission costing, service missions are also used to define the unit of functionality similarly required in life-cycle assessment. Service missions may be defined as a combination of statements on product (end-of-life product composition), market, service level, and cost / revenue objectives, for example *"to serve the Dutch market with product X with 95% delivery within 14 days at lowest possible cost"* (Barret 1982; 5). The identification and definition of service missions should ideally be based on detailed market investigations of (end-of-life management) service levels to be provided and the potential for revenue generation. This should be followed by market segmentation to classify separate groups of customers (end-users) on the basis of the mix of service factors to be offered.

Service-level factors or variables are critical in the identification and definition of each service mission. Factors used to describe service levels in conventional distribution, such as order fulfillment rate and order time cycle, do not necessarily have the same degree of relevance or importance to the relatively less advanced field of reverse logistics and end-of-life management. To redress this gap in knowledge, parallel research has been conducted by the author on the need for product end-of-life management services in both commercial (Mayers *et al* 1998) and domestic sectors. The results of these will be evaluated with respect to this methodology in a future paper (as described in Section 7).

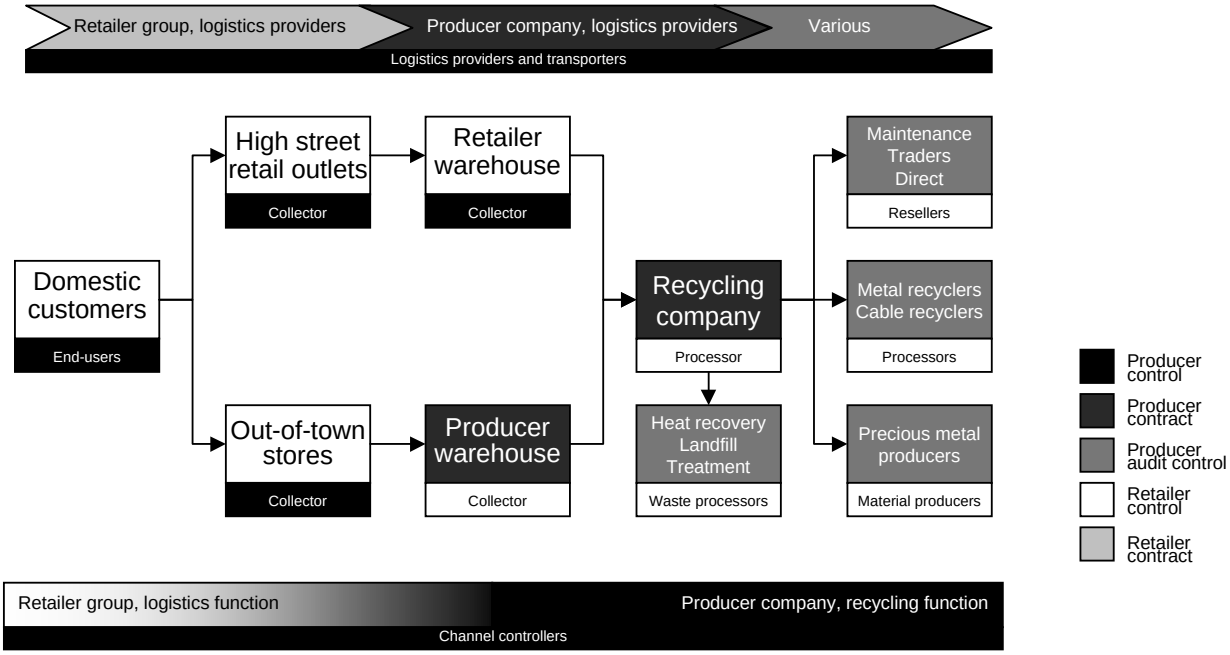
In the evaluation of the printer trade-in, the service mission was relatively simple to define given that it was a specific service offering, provided to specific customers (internal company marketing, and ultimately, the consumer): *"To provide a collection and disposal route for the resale of selected printer types, ensuring maximum material recycling and energy recovery, and controlled treatment and disposal of non-resellable printers traded-in at UK retail outlets participating in the trade-in promotion."*

Finally, dedicated end-of-life management channels must be developed as delivery mechanisms to support of each individual service mission. The "foreground" system boundary required in life-cycle assessment is determined by the equivalent structure of the end-of-life management channel under study. The end-of-life management channel set up to manage the printer trade-in is given in Fig. 3, using the process definition and terminology defined in Fig. 1.

5. Implementation and operation (Stage 2)

In the second stage of this management system, plans agreed in stage 1 are implemented and end-of-life management channels established. This requires that an appropriate network of suppliers and processes are linked together and organised to deliver agreed levels of service. Each process, or channel, must then be continually managed to ensure its integrity is maintained, its boundaries remain intact, and it is reported on separately. Good operational management is absolutely critical at this stage.

Figure 3: The printer trade-in example



6. Information collection and reporting (Stage 3)

During stage 3 (which runs parallel to stage 2), inventories of environmental impacts and costs are produced for each End-of-Life Management channel under study. The data collected at this stage must be sufficient to evaluate the environmental and financial objectives set during stage 1, and must include an identification and full reporting of all the functional "sub-systems" in the end-of-life management channel under study (Barret 1982). Records should also be made of the accuracy of data for use in data quality assessment, for example of the accuracy of weight measurements and the relevance and quality of the environmental measures used. At present, the results of the printer trade-in are awaited to begin stage 3.

To complete the mission costing of each end-of-life management channel, all costs (including divisible fixed costs that would usually be excluded from activity-based costing methods) must be attributed to relevant process variables (as shown in Table 2 for the printer trade-in) and allocated to each end-of-life management system under study. This approach is known as "attributable costing" (Shillinglaw 1963).

Towards the completion of this third stage, the environmental life-cycle assessment is undertaken incorporating additional external impact data (such as energy used in production of raw materials from virgin resources compared to resources recovered from waste) from process records, literature, and commercially available life-cycle databases. Although this assessment is principally focused on tracking the achievement of environmental objectives, the net environmental impacts of the end-of-life management channels under study should also be reviewed in order to assess the overall legitimacy of improvements made. From the literature, it appears the environmental impacts of greatest concern in the collection, treatment, recycling, and disposal of electronic products for consideration in this assessment include (Mayers and France 1999):

- Creation and dispersion of carcinogenic and bioaccumalative poly-chlorinated biphenols, dioxins, and polybrominated dibenzo-dioxins and furans
- Dispersion of metals at levels toxic to humans or eco-systems
- Energy consumption (fuel or electricity) and related environmental effects
- Carbon dioxide emissions and global warming
- Release of chloro-flouro carbons and other ozone depleting substances (from refrigerators and freezers)
- Quantity of waste disposed to landfill and related environmental effects
- Quantity virgin materials conserved and related environmental benefits

Again, specific consideration must be given in respect of the relevance of measures used and the quality of data collated if the results of the study are to be meaningful.

Table 2: The attribution of end-of-life management functional costs to process variables

	Attributable financial factors:	***Quantitative attribution factors:***
Service-level factors:	Transport	– Number of collections / pallets collected
	Sorting	– Weight / number of products received
	Storage	– Area of pallet space used
	Management and administration	– Management time
	Materials processing and dismantling	– Weight and type of materials processed
	Product refurbishment	– Number and type of products refurbished
	Treatment and disposal	– Weight / units of waste disposed
	Sales commission and profit share	– Percentage revenue / profit
Revenue factors:	Product resale	– Number and type of product resold
	Materials recycling	– Weight and type of materials recycled

Both the mission costing and life-cycle assessment exercise should include an assessment of alternative "base-line" disposal routes, for use as a basis of relative comparisons for continuous improvement. This could be a theoretical assessment of the costs and

environmental impacts of disposal in landfill, and / or an actual past assessment of the previous period of operation.

7. Improvement assessment (Stage 4)

During the fourth and final stage of the end-of-life management system, data collected on the environmental impacts and costs of each individual end-of-life management channel are reviewed with respect to the original tactical service missions and overall End-of-Life Management strategic objectives and targets. Once completed, the proposed system will provide a method by which companies will be able to:

- Identify product end-users and their demands for end-of-life management services.
- Develop end-of-life management channels focused on delivering services to defined groups of end-users.
- Assess the environmental impact and cost of each end-of-life management channel.
- Identify key environmental impact and cost drivers and areas of conflict between different environmental and cost objectives.

The limitations of the proposed methodology have also been considered:

- The "mission identification" stage of mission costing, and the "scoping" stage of Life-Cycle Assessment (incorporated into stage 1 of the proposed system) involves a degree of subjectivity, which may result in errors.
- It does not indicate *how* environmental impacts and costs may be optimised.
- Different environmental impacts may not be directly comparable.
- It is limited by the quality and availability of data.
- It is limited by the time frames in which data must be collected.

As an example, based on some initial results of the printer trade-in to date, key cost drivers have been identified. The mission costing approach revealed that the cost of managing the printer trade-in (the channel control or management cost) was around 11% of total channel costs (based on an attribution of management cost by share of management time involved). The traditional management accounting approach (allocating total management cost on the basis of total weight processed for all end-of-life management channels) indicated somewhat spuriously that this management overhead constituted 60% of total costs. In addition, the latter approach does not provide the complete cost of the printer trade-in channel (it only includes the total direct "functional" processing costs of the trade-in to the producer). If in the next period of operation, a 10% cost reduction were targeted, the latter method would erroneously indicate that channel management would be a good target for cost reduction.

Finally, stage four must include a decision framework that will allow objective and defensible recommendations and decisions to be made on the objectives and targets of the next planning period, thus completing the loop back to stage 1, policy development and planning. This will be included along with an analysis of the detailed results of this study in a future paper, and is not discussed further here. Given the data gathered so far

it is not possible to draw any conclusions for the improvement of the overall environmental performance and commercial viability of the printer trade-in.

8. Conclusions

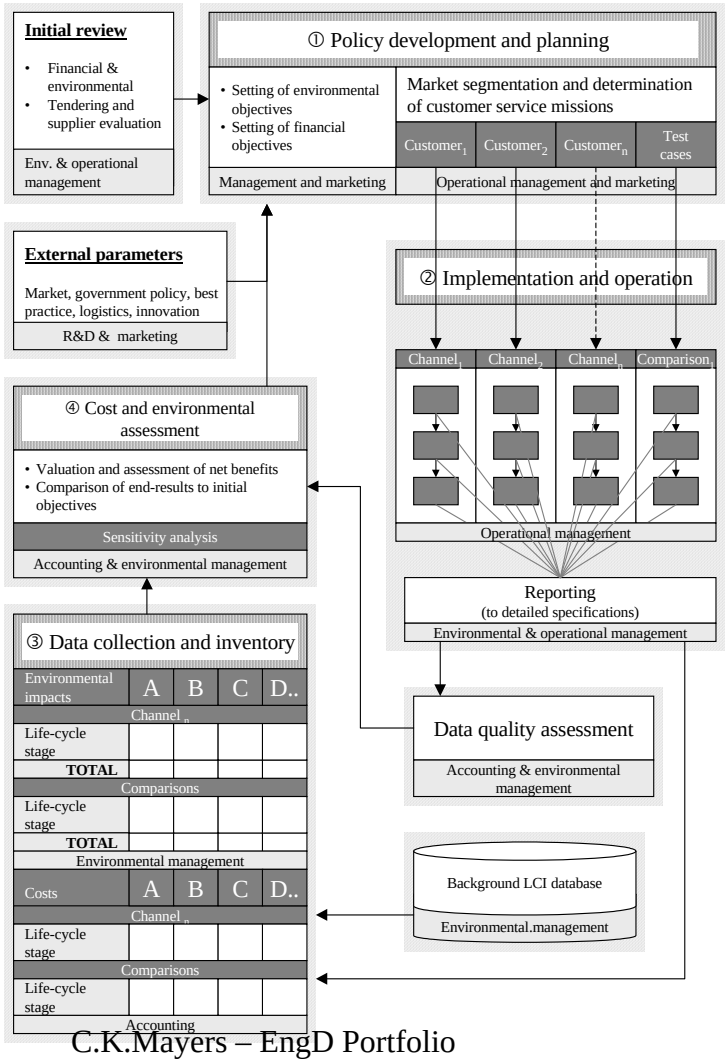
It is intended that this methodology will provide Producers of electronics equipment, and other organisations concerned with the organisation and control of end-of-life management processes for electronic products, with the means to develop competencies in waste and environmental management to meet the future needs of Producer Responsibility legislation. A complete overview of the proposed end-of-life management system has been provided in Fig. 4.

At the time of writing the methodology was still under development and testing. Areas for subsequent evaluation, development, and methodological expansion include:

- Completion of the inventory stage of the printer trade-in and subsequent analysis of mission costs and life cycle environmental impacts.

- An assessment of the additional cost overhead of operational and environmental management and reporting required in implementing this methodology.

Figure 4: The proposed end-of-life management system



- An assessment of the effectiveness of supply-chain management and life-cycle assessment software tools in reducing administrative cost overheads of the proposed methodology.

- The development of a decision framework by which decisions based on the assessment of environmental impacts and costs may be qualified using defensible and objective management criteria.

Once completed, the full results if this study will be included in a subsequent paper.

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