Dealing with Electrical and Electronic Equipment Waste in Colombia: The Case of TV Sets

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INTRODUCTION

Worldwide, the level of consumption of electrical and electronic equipment (EEE) continues to rise. Many countries have developed or have considered systems dealing with environmental impacts known as waste of electrical and electronic equipment (WEEE). Such systems consist of: (a) technical processes for processing, reuse, and recycling waste as well as disposal of remaining fractions; and (b) the social infrastructure which is necessary for managing the collection of waste and returning usable products and/or materials to society. While technological solutions implemented for the formal system in developed countries may seem similar, in developing countries since there is lack of a formal system or just incipient, such systems cannot be transplanted from one country to another. The reason is that the social infrastructure needs to be adapted to local consumption patterns and waste production as well as local policies.

The specific context of WEEE in Colombia was analysed, focusing on TV sets. In Colombia, consumption of electrical and electronic products is increasing, but consumption patterns differ from developed countries due to socioeconomic and cultural conditions. Those conditions make the reuse as well as storage of products a predominant practice.

This article seeks to answer the question: how socioeconomic conditions influence the shaping of a system dealing with WEEE. Existing literature is used to uncover possible conditions, and then present the results of an empirical study focusing on consumer behaviour, including a survey conducted in Bogotá, Colombia's capital city. This study focuses on TV sets, the EEE with the highest penetration in Colombian households, and evaluates consumer behaviour in the different socioeconomic strata. Currently, there exists approximately 19 million TV sets and this amount is expected to increase at an annual rate of 20 per cent. If a WEEE system is introduced in 2011, it will be expected to collect 0.2 kg/person/year and would rise up to 0.35 kg/person/year in 2019. Based on the analysis of Colombian consumer behaviour, estimation of recycling rates can be approached in a more precise way, and from the physical flow it is possible to determine the appropriate operational conditions of a WEEE system for

the region. It can be concluded with the conditions for the Colombian WEEE system.

Waste from EEE is a rapidly developing global problem.[1] The enlarged production and consumption of electronic products leads to an increased volume of waste, and the toxicity of waste components poses additional problems. Also, the use of scarce material such as gold and platinum in electronic products is increasing, further adding to the ecological footprint of this category of products. As a consequence, societies have begun to address the issue of electronic waste. From an environmental perspective, there are clear priorities in terms of ways to deal with such waste.[2] Prevention of waste through product and process redesign is preferable over product and material recycling, which, in turn, is preferable to energy recovery through waste incineration and landfilling. An effective system that deals with these categories of waste implies at least the following: (a) eco-design to prevent waste from materializing; (b) an embedded logical connection between the use and reuse/recycling phase which combines physical and social infrastructure; and (c) a well-monitored network of post-consumer waste handling, looking to balance the options of reuse, storage, recycling, and disposal.

In the literature on handling EEE, specific factors pertainng to many countries are mentioned, including the availability of preventative and curative technology, precise flows of different types of waste, and existing infrastructure for waste management. In order to be able to estimate future waste flows and develop a waste system that suits the existing social infrastructure, knowledge of the behavioural patterns of consumers is vital.[3] For this reason, the research question is: how do socioeconomic conditions influence the shaping of a system for dealing with WEEE in Colombia?

This article presents a report on a survey conducted in Bogotá which uncovers consumption patterns related to TV sets and related issues on electronic waste management. TV sets are chosen because they have a penetration rate in Colombian homes of 88.5 per cent.[4] The survey thus provides insight into urban consumption patterns of a representative category of Colombian inhabitants, as 75 per cent of its population lives in urban areas. Based on this survey, future flows of waste from TV sets are estimated, and ways to develop a network of waste handling were suggested that are suited to the consumption patterns.

The next section presents insights from the literature on the way in which consumption patterns affect electronic waste streams and their management, focusing on developing countries, and provides the background to the study. The authors then present the methodology, followed by results dealing with consumption patterns. Based on these data, the authors provide estimated future flows of TV waste. The article concludes with conditions for the WEEE system to be developed in Colombia.

OVERVIEW OF THE LITERATURE

Generic Differences between Developed and Developing Countries

There have been several studies on EEE waste. Due to European Union (EU) legislation, research on its Member States is well developed.[5] There are also studies on the US,[6] Canada,[7] and Japan. In addition, there is an increasing amount of research on developing countries, principally India, China, Viet Nam, and Nigeria.[8]

Worldwide, increased consumption of EEE is affected by the reduction of the useful life of products through factors such as technological shifts,[9] low introduction cost al-

lowing more frequent acquisition or replacement, and planned obsolescence determined by manufacturers.[10] In developed countries, new devices are obtained through household purchasing power and the desire of maximizing household welfare through devices which include the latest technological changes. In developing countries, socioeconomic and cultural conditions combine to make consumption and substitution less accelerated, and show a trend to extend the useful life of a product. Therefore, the amount of waste in the same period is smaller.

In developing countries, the life span is enlarged by the reuse of products (second hand and storage). The useful life span, including reuse, is different in various studies, depending on the socioeconomic condition of their populations, but its undeniable effect is a delay in the generation of waste.[11]

Disposal of WEEE in developed countries typically takes place through formally established companies. In developing countries such as China, the user faces different disposal channels such as selling to peddlers, selling for second use, selling or giving to a recycling firm, returning to retailers or manufacturers, direct discarding, donating, and storing at home.[12] Such activities make the system different from the system of developed countries, as the majority of the waste is handled by the informal sector. Typically, this guarantees a high recollection rate and a large number of hand labour employment, but its primitive nature often causes enormous health and safety risks to workers and has negative impacts on the local environment.[13]

Another distinctive characteristic of developing countries is the inflow of used products or waste for recovery and disposal through import. China, India, and some African countries receive great quantities of WEEE which is illegally shipped from developed countries.[14] It is estimated that the US alone exports 80 per cent of its WEEE to China, India, and Pakistan.[15] In the disposal phase, it is common that people in developing countries send WEEE to the general landfill. This practice occurs because the informal or formal system for dealing with WEEE is not available or is weak.

Finally, for governmental bodies of developing countries WEEE is considered a low priority issue, resulting in a lack of legislation regarding WEEE. Although the majority of countries have adopted the Basel Convention, the way in which it is implemented is unclear. On the other hand, many countries have no registered data of EEE imported, produced, and exported from and to their countries, making it difficult to estimate the flow of WEEE.

Colombia: A Special Case?

The Colombian context differs from other developing countries. A relatively large part of its population lives in urban areas. Urban growth in developing countries represented 95 per cent of the world's growth in 2004, in contrast with many developed countries where urbanization rates are much lower.[16] The Colombian formal recycling sector is still in the planning phase with few organized enterprises and some successful pilot projects.[17] The informal sector is not dealing with electronic waste, although it is responsible for the recovery of 80 per cent of the total recycled urban solid waste in Bogotá and the formal sector recovers only 0.5 per cent of it.[18] In contrast, developed nations deployed recycling systems more than fifteen years ago, and during the last eight years many electronic waste systems have been implemented, with different outcomes. Meanwhile, in many developing countries scavenging and informal recycling (often with severe health and environmental consequences) play an important role since there is no

policy or regulatory action taken by their governments. Finally, Colombia differs in the sense that there is no reported import of electronic waste. As the formal electronic waste recycling sector is under study and the informal sector is almost nonexistent, according to a recent United Nations Environment Programme (UNEP) assessment it is part of group C, which means it belongs to a group of countries that are developing, or have already established, a formal recycling sector and where informal activities in the collectors, dismantlers, and refining sectors occur on a small scale, having the potential to adapt process technology to their own needs.[19]

METHODOLOGY

The field study consists of a survey which maps the practices of purchase, use, and consumer practices regarding the end of life of a TV set. A questionnaire was applied in Bogotá, the capital of Colombia with 7,317,800 inhabitants,[20] reflecting the behaviour of Colombians in urban areas, which represent 77.6 per cent of the country's population.[21]

The authors complement the data obtained through the survey with data from other studies. The questionnaire was applied through personal interviews which were held at different places such as homes, schools, universities, and bus stops. As shown in table 1, the sample was validated comparing the income level by stratum between the survey answers and the statistics data of the National Bureau of Statistics (DANE, acronym in Spanish).[22] Bogotá's population is divided into six strata.[23] Traditionally, the stratum segmentation is associated to the income level of household. These strata are traditionally used by municipal governments to arrange the people for charging differential rates and assigning subsidies for residential public utilities, as well as planning public investment and social programmes. The strata ranges from 1 (greater needs) to 6 (fewer needs).[24] It has been observed that differences in lifestyles between the successive stratum are not as clear as proposed. For this reason, combined strata is used (1-2, 3-4, and 5-6) in the analysis.

TABLE 1. COMPOSITION OF POPULATION AND SURVEY SAMPLE PER STRATUM

Stratum	Bogota's Population (total 7,317,800)	Percentage of Bogota's Population	Survey Sample (total 178)	Percentage of Sample
1	585,424	8	14	8
2	2,634,408	36	64	36
3	2,927,120	40	71	40
4	731,780	10	18	10
5	365,890	5	9	5
6	73,178	1	2	1

The projection of TV sets, which will be discarded at the end of their useful life, is carried out using the market supply method,[25] taking into account purchase trends and time of use. Also, a projection trend is carried out considering different scenarios, which takes into account buying trends, time of use, speed of technological changes, and introduction of a WEEE management system. To perform this projection, data from govern-

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ment sources, business associations, and companies are used in addition to results obtained from the survey. The market supply method was chosen because it requires less information compared with other methods. Reuse and storage time are included in the useful time of the equipment, aligning it with the market dynamics that reveal consumer behaviour and technological shifts. Other methods such as the Time Step Method require household saturation levels, industrial stock levels, and amount of WEEE collected and transformed, and these data are currently not available for Colombia. The Carnegie Mellon Method requires assumptions regarding the pathways or "material flow" during reuse, storage, recycling, and landfilling, and no pattern is yet available on which to base such assumptions.

Determining the current situation in Colombia allows the authors to establish the best initial conditions for the WEEE management system in Colombia. This analysis may be extended to other countries in the region based on similarity of socioeconomic and cultural conditions.[26]

RESULTS

Socioeconomic and Cultural Conditions

The survey included questions that enable the authors to identify the relationships between purchase behaviour and socioeconomic conditions. The income of the survey population is segmented in ranges between 0 and 2 statutory national minimum wage (NMW), 2 and 4 NMW, 4 and 8 NMW, and above. According to the survey, 75 per cent of those interviewed have an income between 0 and 2 NMW, as shown in table 2. It is therefore reasonable to expect that the majority of people will keep their existing TV set.

TABLE 2. INCOME LEVEL

| | | Stratum | | | Total |
		Low	Medium	High	
	Total	44	50	6	100
Income Level	**0-2 NMW**	39	34	2	75
	2-4 NMW	3	9	2	14
	4-8 NMW	1	5	2	8
	More than 8 NMW	0	2	0	2

(in per cent)

A typical Colombian with low income shows an attachment to his/her TV set, especially if it was bought on credit. If it still functions properly, he/she does not perceive the need to change it. This is different for respondents with higher incomes. For example, a 21-inch Cathode ray tube (CRT) colour TV set costs col$389,000 (about US$190)[27] corresponding to 78 per cent of NMW (about US$243), while for those having higher income, it represents 10 per cent or less of salary. For technologies such as plasma or liquid crystal display (LCD), even the latter group must rely on credit.

Household credit thus plays a significant role in TV purchases. Opportunities have changed since 2001 when an electric utility company decided to provide credit to its clients, including the credit payments in the monthly electricity bill. Between 2001 and 2006, the company provided credit to more than 444,000 persons for a total value of

US$250,000,000. Around 66 per cent of the clients were not bank clients. The distribution by socioeconomic strata was: 11 per cent strata 1; 51 per cent strata 2; 33 per cent strata 3; and the remaining went to a higher strata. The clients used these credits to buy: 23 per cent TV sets (CRT); 19 per cent entertainment; 17 per cent washing machines; 12 per cent computers; 8 per cent refrigerators; 2 per cent flat panel TVs; 6 per cent other household appliances; 6 per cent technology; and 6 per cent others.[28]

The educational level is 10 per cent primary; 59 per cent secondary; 13 per cent professional; and 6 per cent graduate (as shown in table 3). It may therefore be expected that the population has the ability to access information, understand it, and be critical towards it, once it is available. The last condition is not always fulfilled.

TABLE 3. EDUCATIONAL LEVEL PER STRATUM

			Stratum		Total
		Low	Medium	High	
	Total	44	50	6	100
Level of Education	Primary	9	1	0	10
	Bachelor	28	29	3	59
	Technical	4	4	0	8
	Technology	1	2	0	3
	Professional	2	10	1	13
	Graduate	0	4	2	6
	Other	0	0	0	0

(in per cent)

Household size, defined as the number of people, is another factor important for consumption practices of TV sets. In the sample, households are made up of four people with 33 per cent, between one and three persons with 41 per cent, and more than five people with 36 per cent, as shown figure 1. In relation to the survey of DANE 2005, there is an overrepresentation of three to four persons per households in the sample, as show in figure 1.

Figure 1. No. of Persons per Household

No. of Persons

■ DANE 2005   ▨ Study 2009
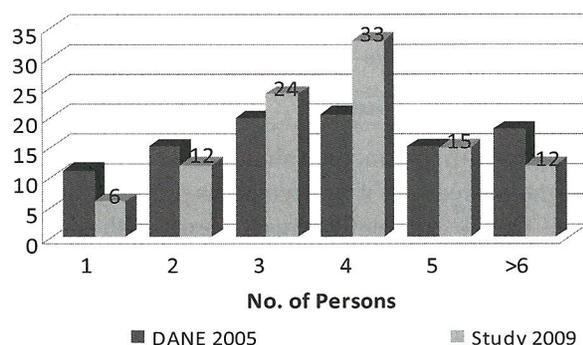
Conditions of TV Set Use

Further questions in the survey were designed to find out how consumer practices have an impact on the flow of WEEE, expected amount of recovery, and hazardous materials.

Additionally, the authors wanted to collect data in order to estimate the collection fee, identify the most suitable collection channel, and determine the level of social awareness of the different actors towards the consequences of EEE waste.

The number of TV sets in each household varies from one to more than five. Seventy-seven per cent of households have between one and three televisions, as shown in figure 2. The remaining 23 per cent has more than four televisions per household. This figure includes information from an independent study "The Great Survey of TV Sets in Colombia,"[29] which finds that the predominant number of TV sets per household is one TV set with a share of 54 per cent. The number of TV sets per household is higher in the authors' sample because the study is limited to the urban population.

Figure 2. No. of TV Sets per Household

No. of TV Sets

■ Survey 2008   ▨ Study 2009
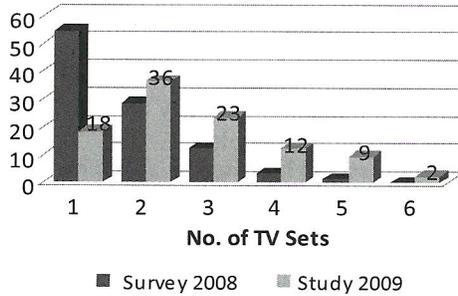
Having more than one TV set is mostly due to the habit of keeping a TV even when a new one is purchased. The old one is then moved to another room, allowing more household members to fulfill individual entertainment preferences.

The brands that dominate the market are: Sony, LG, Samsung, and Panasonic which together are responsible for 82 per cent of the survey. There are seven other brands with a share of 11 per cent such as: Toshiba, Challenger, Phillips, Sharp, JVC, Kalley, and Hitachi, which are mostly foreign brands. The remaining 7 per cent did not list the brand. The researchers found no brand preference by stratum.

In relation to the acquisition of TV sets, the Ipsos survey[30] shows that 69 per cent of consumers purchased one within a period of 0 to 5 years. In the field study, this figure is 62 per cent. This tendency may be based on the flexible credit conditions provided by the financial system.[31] For a period of 6 to 10 years, Ipsos gives a figure of 22 per cent which corresponds exactly to the field study, while a purchasing period of more than ten years has a 9 per cent share in the Ipsos data and the study has 10 per cent, as shown in figure 3. The middle stratum tends to have older TV sets.

The most frequent place of purchase is large department store with 57 per cent of the survey, since recently these stores offer monthly credit payment. Second on the list is the "San Andresito" market with a share of 18 per cent, where in the past appliances were sold at a lower price through the black market. Currently, this price difference has been reduced, and chain stores generate greater consumer confidence because they offer warranty on the product purchased in addition to the aforementioned credit. In third place are technology stores where 10 per cent of TV sets were purchased. Other ways of obtaining a TV set include "I bought it used" and "It was a gift," with a percentage of 3 per cent. Some people (14 per cent) did not remember where they bought their TV set, either because their devices were really old, because they were bought by another fam-

Figure 3. Acquisition Time of TV Set

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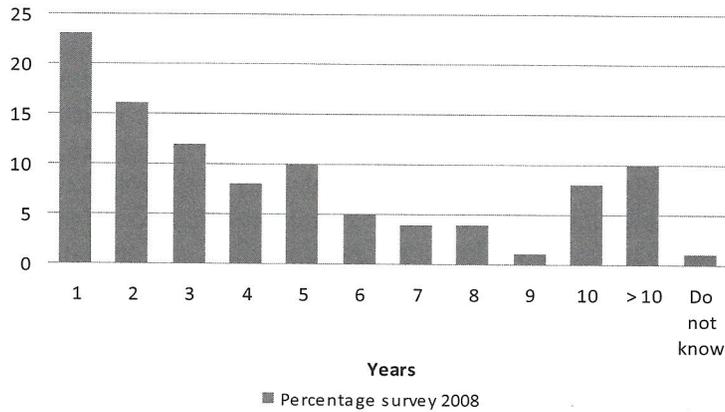
ily member, or because the stores did not generate a memory in the mind of the consum-ers.[32] There is a trend for the lower stratum to buy more often (66 per cent) on the black market or "San Andresito," as shown in table 4.

TABLE 4. TV TECHNOLOGY AND PLACE OF PURCHASE BY STRATUM

			Stratum			Total	Total Percentage
			Low	Medium	High		
Which technology?	TV set 1	B&W CRT TV	2	3	0	5	1
		Colour CRT TV	137	181	20	338	86
		Plasma	6	9	1	16	4
		LCD	10	18	6	34	9
Where did you buy it?	TV set 1	Department Store	77	131	15	223	57
		"San Andresito"	48	21	3	72	18
		Technology Store	8	16	2	26	7
		Abroad	1	2	0	3	1
		Do not know	10	39	6	55	14
		Other	9	2	0	11	3

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Concerning the issue of changing the TV set, the ranking is "updating" with 38 per cent, "switching to flat screen" with 15 per cent, and "introduction of digital television broadcast" with 13 per cent, showing that the greatest motivation to buy a new TV set is associated with new technology with 66 per cent. Another important reason is "be-cause it is broken" with 33 per cent. Among the reasons why respondents would not buy a new TV set, "cost" scores highest with 36 per cent, "awaiting the introduction of digital broadcast television" scores 11 per cent, and "just bought a new one" 8 per cent. The introduction of digital broadcast television is a reason that affects 24 per cent. Its effect is dual: it encourages some respondents to buy a TV soon, but discourages others who prefer to wait until this technology has matured.

The action respondents take with their previous TV set(s) shows that there is a lively "culture of reuse," since 38 per cent give it away, 16 per cent keep it for use at home, and 11 per cent keep it without use. Only 6 per cent of respondents sold it while 8 per cent abandoned it. Only 14 per cent did not own another TV set, as shown in table 5. The strata analysis shows a difference in the handling of the previous TV set because