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Consumer attitudes and perceptions on electronic waste: An assessment

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ABSTRACT: The electronics industry is one of fastest growing manufacturing industries in India. However, the increase in the sales of electronic goods and their rapid obsolescence has resulted in the large-scale generation of electronic waste, popularly known as e-waste. E-waste has become a matter of concern due to the presence of toxic and hazardous substances present in electronic goods which, if not properly managed, can have adverse effects on the environment and human health. In India, the e-waste market remains largely unorganized, with companies being neither registered nor authorized and typically operating on an informal basis. In many instances, e-waste is treated as municipal waste, because India does not have dedicated legislation for the management of e-waste. It is therefore necessary to review the public health risks and strategies in a bid to addressthis growing hazard. There is the strong need for adopting sustainability practices in order to tackle the growing threat of e-waste. In the present work, we attempt to identify the various sources and reasons for e-waste generation, in addition to understanding the perception of the public towards e-waste management. This study aims to induce an awareness of sustainability practices and sustainability issues in the management of E-waste, especially waste related to personal computers (PCs) and mobile phones. From the results of the study, we concluded that the majority (90%) of the public is ignorant about e-waste and its issues; hence, there is a strong requirement for spreading awareness about the growing hazard of E-waste.

Key words: Developing countries, Electronic waste, Hazardous substances, Personal computer (PC), Upgrading

INTRODUCTION

Electronics is the world's largest and fastest growing manufacturing industry. Development in this area has significantly assisted the human race; however, its mismanagement has led to new problems of contamination and pollution. The technical prowess society has acquired during the pastcentury has creatednew challenges in terms ofwastemanagement. The Environmental Protection Agency (EPA) refers to electronic waste as "electronic products that are discarded by consumers". This definition covers almost all types of electrical and electronic equipment (EEE) that has or could enter the waste stream. The improper disposal of these items affects human and environmental health, as many of these products contain toxic substances. E-waste that includes iron, aluminium, gold and other metals make up over 60% of these products, while plastics account for about 30% and hazardous pollutants comprise 2.70% (Kurian Joseph, 2007).

The growing quantity of e-waste from the electronic industry is starting to reach disastrous proportions. According to the Organization for Economic Cooperation

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and Development (OECD), any appliance fitted with an electric power supply that has reached its end-of-life is included in theWaste Electrical and Electronic Equipment Directive (WEEE) (EU, 2002; Sushant et al., 2010). The primary materials found in electric and electronic waste are ferrous material (38%), non-ferrous material (28%), plastic (19%), glass (4%) and others, including wood, rubber, ceramics, etc. (11%) (Sushant et al., 2011).

The management of electronic waste (or E-waste) is one of the most rapidly growing areas for curbing pollution problems worldwide. New technologies are fast superseding millions of analogue appliances, leading to their disposal in prescribed landfills despite their potentially adverse impacts on the environment. The consistent advent of new designs and ‘‘smart’’ functions and technology during the past 20 years has led to the rapid obsolescence of many electronic items. The lifespan of many electronic goods has been substantially shortened (less than two years for computers and cell phones) due to advancements in electronics, attractive consumer designs and marketing and compatibility issues (Peeranart et al., 2013; Denga, 2006; Macauley, 2003).

Consequently, the volume of WEEE grows rapidly every year and is also believed to be one of the most critical waste disposal issues of the 21st century. To be precise, the United Nation University estimates that 20 to 50 tons of e-waste is being generated per year worldwide (UNEP, 2005) and suggests the urgent need for developing an estimation technique (UNEP, 2009). Compared to conventional municipal waste, certain components of electronic products contain toxic substances that can generate threats to the environment as well as to human health (Woodell, 2008). For example, television and computer monitors generally contain hazardous materials such as lead, mercury and cadmium, while nickel, beryllium, and zinc can often be found in circuit boards. Due to the presence of these substances, recycling and the disposal of e-waste has developed into an important issue.

The physical composition of e-waste is diverse and contains over 1000 different substances that can be categorized as belonging to either organic or inorganic fractions. Heavy metals form a significant part of inorganic fraction, accounting for 20% to 50%. E-waste consists of hazardous metallic elements like lead, cadmium, chromium, mercury, arsenic, selenium and precious metals like silver, gold, copper and platinum. An overview indicates that manufacturing of mobile phones and personal computers consumes 3% of gold and silver mined worldwide each year, as well as 13% of palladium and 15% of cobalt. Both hazardous and precious heavy metals are non-renewable and are therefore finite resources that will eventually become extremely valuable. Moreover, managing e-waste is a difficult task due to the various challenges it presents including technical, financial, strategic, information failures, etc. As such, there is an urgent need for managing e-waste in a formal, systematic and eco-friendly manner by way of recycling precious metals from waste streams.

In emerging economies like that of India, current e-waste management practices are followed in a disorganized manner, which may cause deleterious impacts on human health and ecology. It is thought that if an efficient system for removal/recovery could be proposed and developed, precious metals could be conserved, which in the authors' opinions would be a novel approach toward resource recovery (Viraja et al., 2012).

Generally, exposure to the hazardous components of e-waste is most likely to arise through inhalation, ingestion and dermal contact. In addition to direct occupational (formal or informal) exposure, people can come into contact with e-waste materials and associated pollutants through contact with contaminated soil, dust, air, water and through food sources, including meat (Robinson, 2009; ATSDR, 1995; 1998; 1999; 2000; 2002;2004; 2005; 2007; 2012). Children, foetuses, pregnant women, elderly people, people with disabilities, workers in the informal e-waste recycling sector and other vulnerable populations face additional exposure risks. Children are a particularly sensitive group, due to the presence of additional routes of exposure (e.g., breastfeeding and placental exposure), high-risk behaviours (e.g., hand-to-mouth activities in early years and high risk-taking behaviours in adolescence) and their changing physiology (e.g., high intakes of air, water and food, and low rates of toxin elimination) (Pronczuk de Garbino, 2004). The children of e-waste recycling workers also face take-home contamination from their parents' clothes and skin, and direct high-level exposure if recycling is taking place in their homes (Kristen et al., 2013).

Most people are unaware of the potential negative impact of the rapidly increasing use of computers, monitors and televisions. When these products are placed in landfills or incinerated, they pose health risks due to the hazardous materials they contain. The improper disposal of electronic products leads to the possibility of damaging the environment. As more e-waste is placed in landfills, exposure to environmental toxins is likely to increase, resulting in elevated risks of cancer and developmental and neurological disorders (Khurrum, 2011).

MATERIALS & METHODS

Study area

Visakhapatnam is the second fastest 'emerging city' in India (Fig. 1). The city is plagued by a large variety of pollution types. There is air pollution, the groundwater is polluted and plastic abuse is rampant; more recently, e-waste has seen a significant increase, too. With over 70 software companies and numerous schools and corporate offices in the city, e-waste has the potential to be the next big form of pollution within the city in the coming years.

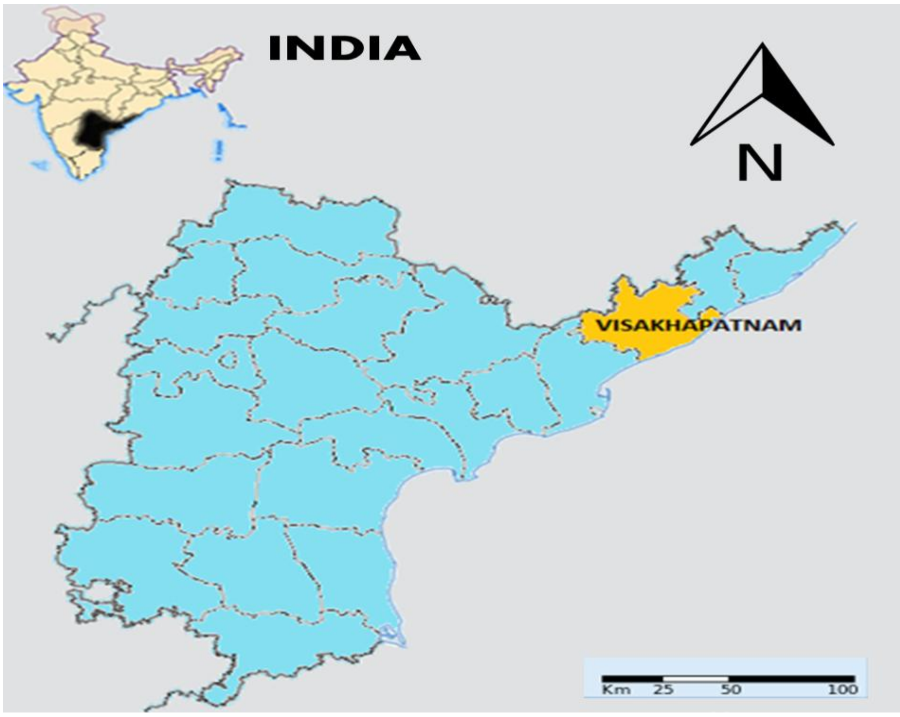

Fig. 1. Study area (Source: http://www.veethi.com)

Study design

The study aimed to obtain information about the knowledge, awareness and disposal methods of e-waste as practiced by the urban population of Visakhapatnam. Each subject participated in a face-to-face interview. The questionnaire was designed to obtain information with respect to the above-mentioned parameters.

The structured interview and questionnaire

During the face-to-face interview, questions consisted of five parts:

I) Demographic profile: information included age, gender, marital status, occupation, income and education.

II) Information regarding the use of electronic devices: to understand the various types of devices used, period of use, methods of storage, etc.

III) Awareness regarding e-waste: to better understand the awareness of e-waste among the public.

IV) E-waste disposal practices: included to evaluate individual perceptions and methods of e-waste disposal.

V) Consumer behaviour: to comprehend the readiness of the consumer concerning various disposal options provided by the manufacturer.

Face-to-face interviews were thought to be more reliable for obtaining accurate information from respondents, as they hailed from a wide range of backgrounds and had different educational levels. This also helped to ensure that all questions were answered and that the answers were recorded in a consistent manner. Most of the questions utilized the checklist approach in order to reduce ambiguity and to facilitate quantitative analysis.

RESULTS & DISCUSSION

Figure 2 illustrates the demographic profile of the respondents. The larger percentage of respondents was male (77.6%). The majority of respondents belonged to the age group of 26 to 35 (48.8%). The majority of respondents in the age group 26 to 45 were married (67.2%).

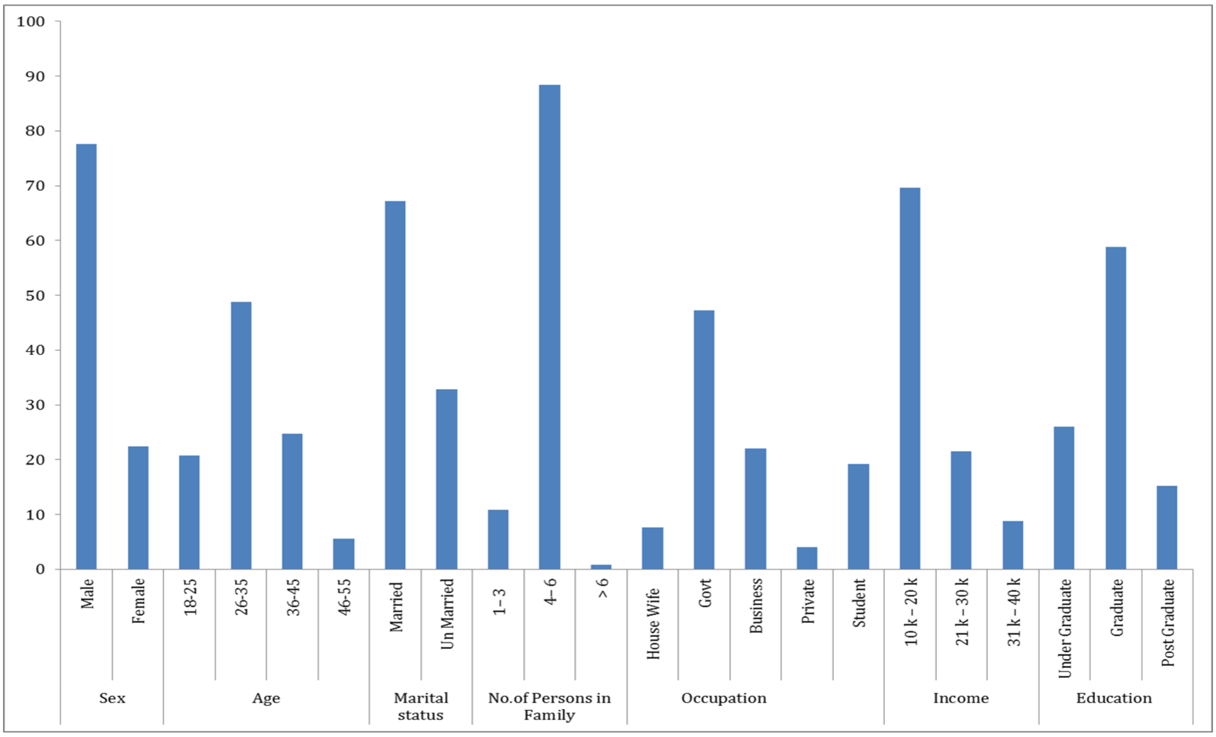

Fig. 2. Demographic profile of respondents

Among the respondents, 88.4% had 4 to 6 persons per family only. The occupational trends of the respondents was observed as follow: 47.2% served in the government sector, while respondents in business made up 22%; 19.2% were students and 7.6% and 4% were housewives and private employees, respectively. The majority of respondents earned 10000 to 20000 per month; 58.8% of them were graduates and only 15.2% were postgraduates.

Figure 3 depicts information regarding the ownership of various devices among the respondents. Among them, 90% to 100% used common electrical goods like fans or televisions. Surprisingly, cell phones and earphones also were included in this list. Among the respondents, 80% to 90% had VCD/DVD/CD players, washing machines, fluorescent light bulbs and Mp3/Mp4 players; 40% to 80% registered ownership of air conditioners, refrigerators, computer /laptops, cameras and telephones. Only 10% to 30% of respondents used advanced electrical goods like printers, microwaves, etc.

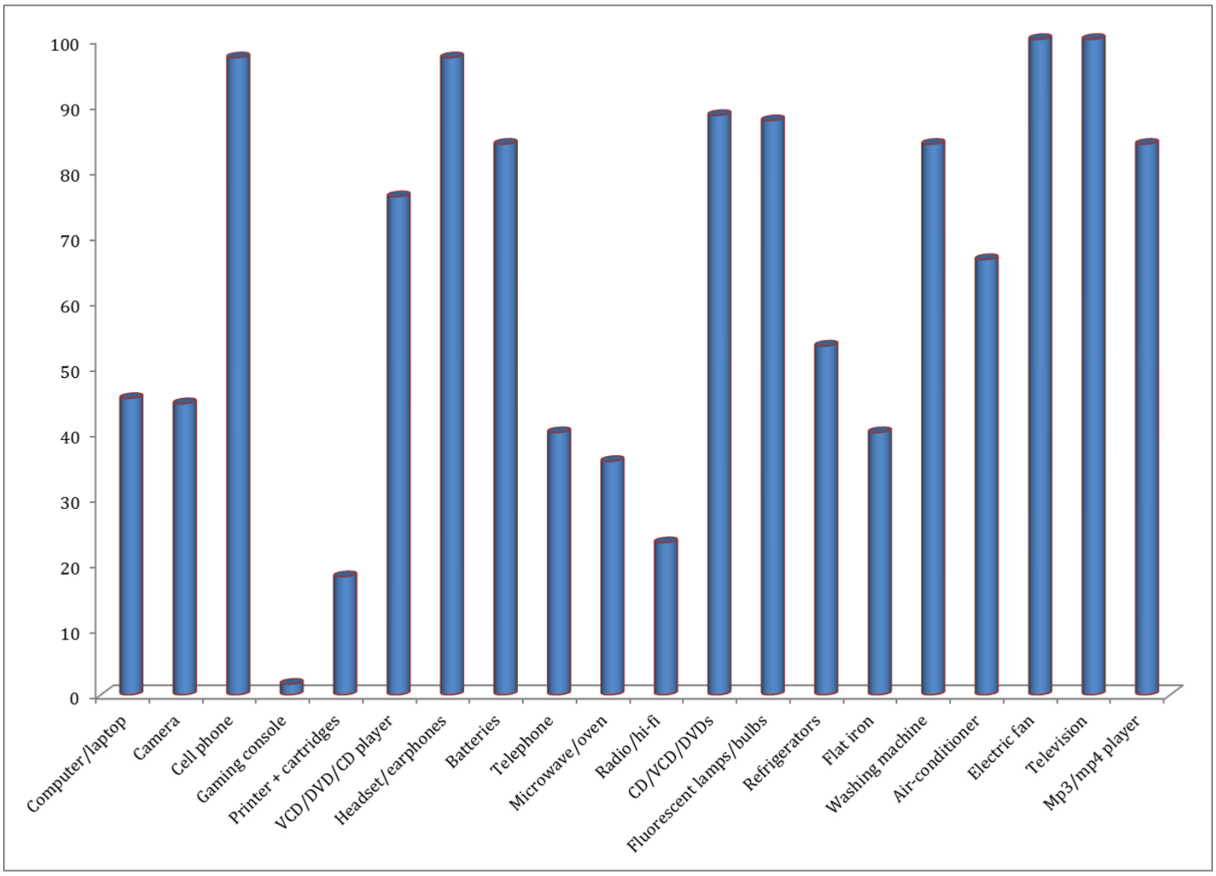

Fig. 3. Devices currently in use

Figure 4 represents the usage patterns of the above-mentioned devices. The hierarchy of the most frequently used devices was television, cell phone, washing machine, VCD player, air conditioner and computer.

Among the respondents, 81.6% of them articulated that the primary reason for replacing devices was to keep up with the latest technology, technology became obsolete or to upgrade features, whereas 14.8% of respondents replaced devices due to technical failures. Only 4% replaced devices for eco-friendly reasons (Fig. 5).

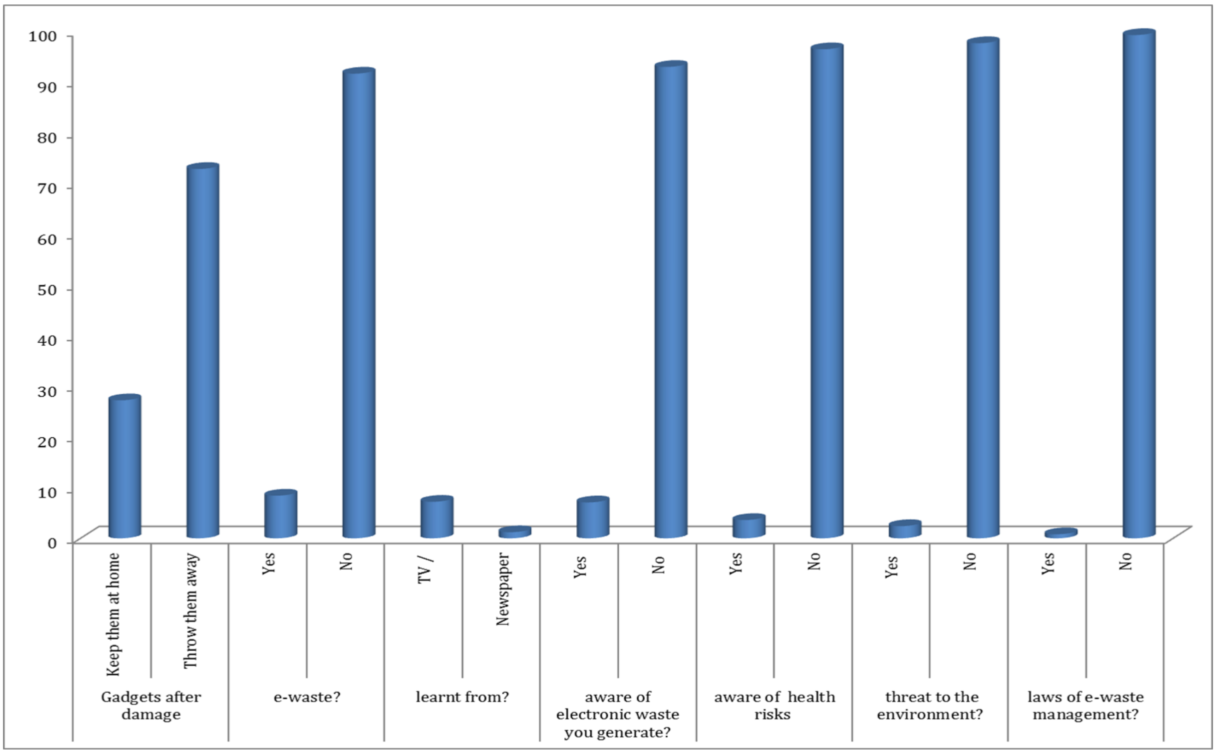

Fig. 4. Respondents' awareness about waste (usage patterns)

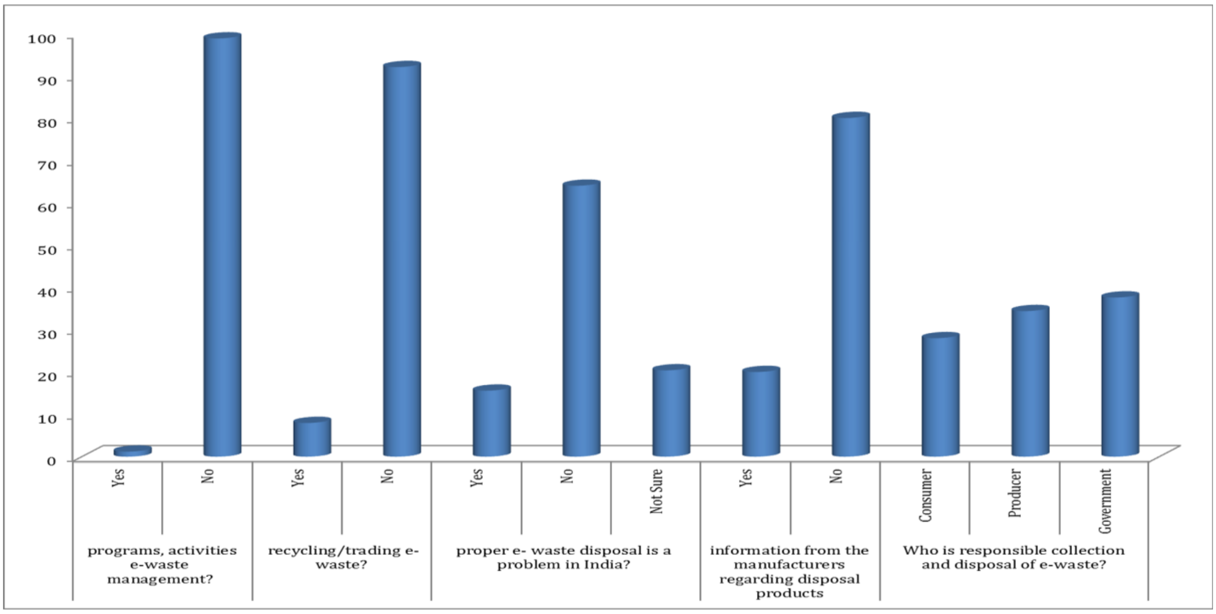

Fig. 5. Respondents' awareness about waste (attitudes)

Of the respondents, 55.6% replaced their gadgets within one to two years, 35.2% after three to four years and 0.8% within five to six years; 84% of respondents stored broken, unused devices for one to three years, while 16% stored them for four to six years. Furthermore, 50.4% of respondents sold these devices as scrap once they stopped using them, 41.2% exchanged them, 7.2% of respondents kept them at home and only 1.2% gave devices away or donated them (Fig. 6).

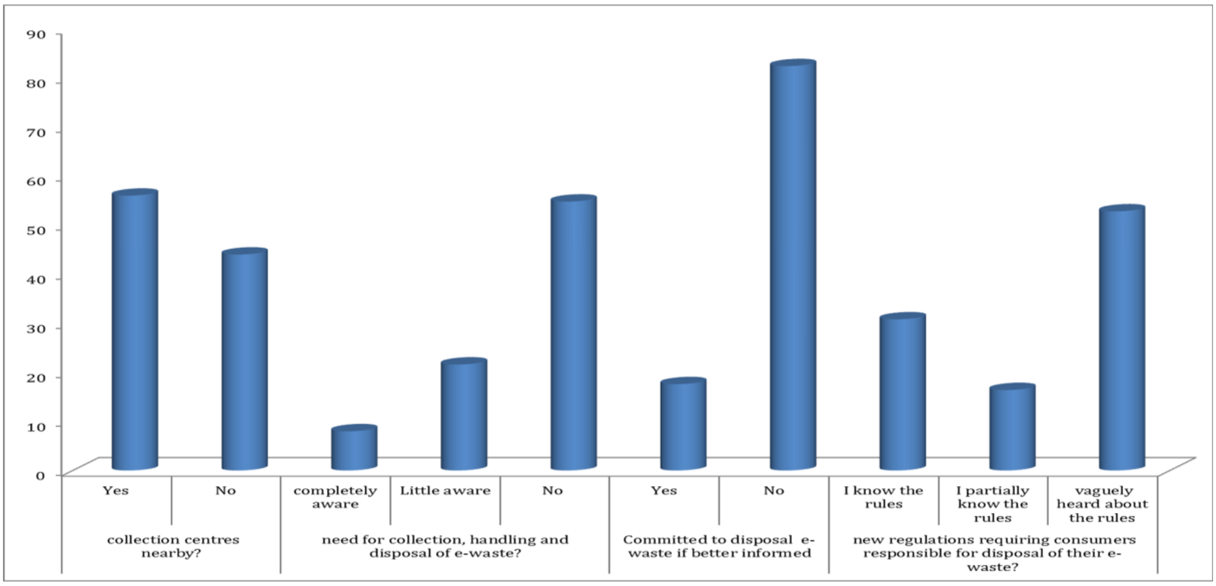

Fig. 6. Respondents' awareness about waste (details)

Figure 7 expresses the current e-waste disposal patterns adopted by respondents. Among them, 53.2% of respondents recycled with an electronics recycler (specifically, commercial outlets), 16.8% sent devices away for reuse, while 6.8% disposed of these devices. Furthermore, 70.8% replaced desktop computers every one to two years and 22.8% did so whenever required, irrespective of the age of the device; 53.2% replaced depending on attributes such as cost, ease of donation, limited choices for responsible recyclers, data security and convenience. Among participants, 40.4% attributed a lack of convenience as one of the hurdles for recycling, while 23.6% admitted a lack of awareness about e-waste recycling, 22% highlighted the cost of doing so and 14% stated that they did not find it secure to recycle e-waste.

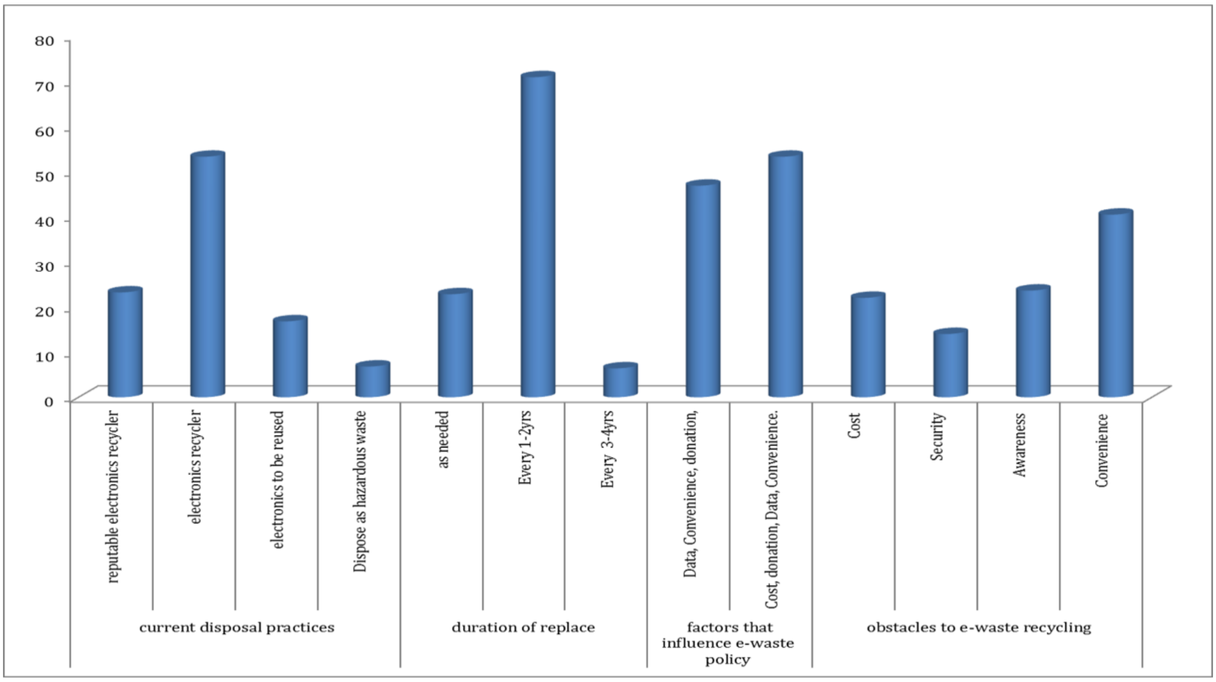

Fig. 7. E-waste disposal practices

Among the respondents, 88% took into consideration the end of life requirements when purchasing a new device. Flat screen monitors, large office printers, DVD players, CPU's, computer mice and other accessories, netbooks, tablet PCs, keyboards and television sets were noted as the major devices regularly being disposed of or recycled;60% of respondents owned two cell phones. Furthermore, 36% preferred to take their e-waste to a recycling centre, 22.4% to donate it to a local charity and 18.4% offered it to a retailer for sale, with only 13.6% getting rid of it on events such as eDay, etc.

Figure 8 represents the consumer behaviour of the respondents. Among them, 41.2% would consider disposing of old products in an eco-friendly manner, while 94% agreed to return it to the manufacturer for free if the latter claimed to recycle products in an eco-friendly manner. Furthermore, 78.8% approved of paying extra as included in the price of a product as part of the product purchase price for recycling. Among the respondents, 41.6% were willing to pay 5% to 10% of the product cost, 24% would pay 1% to 5% of the cost and 18.4% would pay more than 10% of the product cost.

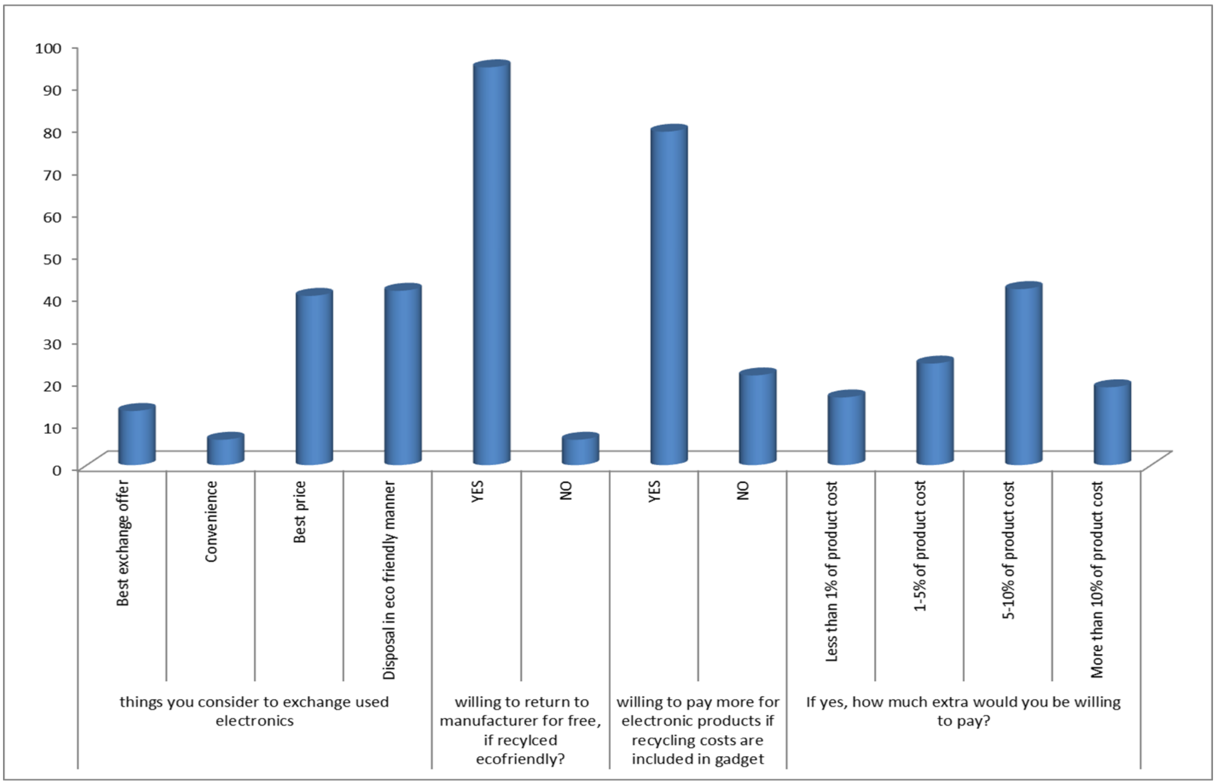

Fig. 8. Consumer behaviour

Electronic and electrical equipment cannot be avoided in today's world. The same therefore holds true for electronic and electrical waste equipment. As long as we use electronic devices, minimizing its adverse impacts on environment has to be managed. Through innovative changes in product design under EPR (Extended Producer Responsibility), the use of environmentally friendly substitutes for hazardous substances can help mitigate these impacts.

The demographic profile of the respondents revealed most of them hailed from social classes less fortunate than middle class, yet they nonetheless owned a number of devices, particularly mobile phones. As stated by Vinod Kumar et al.

(2011), computers and mobile phones have different estimated life spans. The average life span of a computer is three to five years and in case of mobile phones, this is only two to three years. Due to innovative products and offers, the life cycles of products are getting shorter. Attractive market offers push customers into buying new products rather than upgrading their existing devices.

Consumers who like to replace their computer or mobile phone when they see a new product with improved and innovative features (known as early adopters of technology) contribute to more e-waste generation (Mundada et al., 2004; Cairns, 2005; Williams et al., 2008). Indian people generally use pirated operating systems and software. A new computer is purchased, sometimes not because of improper functioning but for upgrading systems and software (Williams et al., 2008). Customers today tend not to upgrade a computer; instead, they prefer to simply replace it; very few customers like to send products away for repair and service. From the study, it is evident that the above factors tend to concern younger and middle-aged generations who like have their technology constantly upgraded.

The ownership of devices has increased tremendously in the past two decades. The most frequently used gadgets were reported to be televisions, cell phones, computers, VCD/DVD players and washing machines. Reasons for this can be found in Sushant et al. (2010), who state that the problems associated with e-waste in India began surfacing after the country's first phase of economic liberalization, after 1990. Due to strong competition in the market concerning brand, quality, price and services offered between various Indian and foreign companies, the electronic and consumables industry in India grew significantly.

The use of electronics has indicated the remarkable trend of replacing existing devices with newer and more advanced alternatives within a very short span of three to four years for various reasons such as the upgrading of features and following the latest trends. The average lifespan of electric and electronic equipment is getting shorter, while the amount of related waste is increasing (Saroj Gupta, 2004). E-waste has become pervasive due to rapidly updated technology and changes in fashion, style and status.

It was also noted by participants that they had reserves of stored broken, unused equipment at home. In India, most waste e-items are stored at households, as people do not know how to discard them. It is estimated that 75% of electronic items are stored due to the uncertainty of how to manage them correctly. This electronic junk lies unattended in houses, offices and warehouses, usually mixed in with other household waste, and eventually disposed of at landfills. These actions have necessitated the need for implementable e-waste management measures. Within industries, e-waste management should start at the point of generation. This can be done by implementing waste minimization techniques and through sustainable product design (Freeman, 1989).

The majority of respondents articulated that they would exchange their old devices for newer ones every time they wanted to upgrade. This was especially true in the case of mobile phones. The components of mobile phones and computers are costly, so much so that customers prefer to simply buy new products; for example, the cost of a battery for mobile phones and laptops, and the cost of print cartridges in case of printers. Thus, customers do not consider buying a component,but simply to replace it with a new product (Cairns, 2005; Vinod Kumar et al., 2011).

Using the understanding that respondents were only concerned about updating their technology, we wanted to discern the knowledge and awareness of the respondents. The reason for 91.6% of respondents' ignorance regarding e-waste was that it was a relatively new type of waste, albeit increasing in an incremental fashion. For this reason, 72.8% of respondents simply threw their e-waste away and 92.2% of them were unaware that they generated e-waste. Problems related to e-waste are therefore likely to become serious in India in the near future. Whenever a customer replaces a computer or mobile phone, the product may go away from the customer, but it never goes away from the environment. Regular improvements in this area should therefore be implemented through the research and development of products to enhance their reuse and recycling properties. Moreover, there is the need for a framework that can assist in the management of e-waste (Vinod Kumar et al., 2011).

Among the respondents, 97.6% were ignorant about the hazardous nature of the e-waste. Furthermore, 96.4% of respondents were ignorant about the health effects of e-waste. Nickel (Ni), which is present in e-waste and enters the environment through the air, causes skin damage, asthma and lung damage, and is also a carcinogen. Antimony (Sb) causes skin irritation, hair loss, lung and heart damage and fertility problems. This element is better absorbed in soil containing steel, magnesium or aluminium. Polybrominateddiphenyl ethers (PBDE) cause anaemia, damages the skin, liver, stomach and thyroid and contaminate water and the food production chains of some foods. Tetrabromobisphenol A (TBBPA) can cause some mutation and carcinogenic effects, and can damage the endocrine system. Polybrominated biphenyls (PBB) can be passed along the food chain and can damage the kidneys, the liver and the thyroid. Chlorofluorocarbon (CFC) damages the ozone layer. Polyvinyl chloride (PVC) damages animal kidneys and is soluble in water, while arsenic is a carcinogenic that can cause skin and lung cancer. Barium causes gastrointestinal disorders and muscle weakness, changes heart rate, causes paralysis and accumulates in the aquatic system. Beryllium inhalation causes pneumonia, respiratory inflammation and lung cancer. Cadmium and mercury are carcinogenic and can causelung damage. It is clear therefore that treatment technologies need to be developed for cleaning upe-waste from the environment (Sharma et al., 2012).

Among the respondents, 34.6% and 34.4% claimed that the responsibility of e-waste should be taken up by government and manufacturers, respectively. In many countries, there is no dedicated legislation for dealing with e-waste. At best, the problem of e-waste management is confused by disparate laws pertaining to the environment, water, air, health and safety, municipal waste and hazardous waste. The government is ultimately responsible for enforcement through mandatory regulations that serve the purpose of controlling and monitoring, setting goals and establishing enforcement rules (itunews.itu.int).

As quoted by a majority of the respondents, many devices can be recycled, as most of the components can be recovered and reused. Components like CD's, DVD's, toasters, refrigerators and televisions are rated best for recycling. A study conducted by Guillermo and Zhang (2012) determined compact disk drives (CDD) to be the most efficient components from an economic and environmental perspective. The methodology used indicates that the CDD clearly outranks the other four PC components in all three criteria. HDD and FDD also presented good general performance, but the preference functions used determined that they are not as good as for CDD. The study presents the conflict of incomparability between these two components (FDD and HDD) in that the criteria weight and the actual performance scores showed that no clear preference difference could be elicited for either component according to the overall evaluation.

More than 95% of the respondents lacked the personal perception or awareness of e-waste and its related issues. Even the compulsory labelling of such products as hazardous was hardly ever observed. The consequence of this is that a large amount of toxic materials enter the waste stream with no special precautions taken to avoid their known adverse effects on the environment and human health (Alake and Ighalo, 2012).

India is currently in a very interesting position. The immediate need is an urgent approach to e-waste hazards through technical and policy-level interventions, implementation and capacity building, as well as increasing public awareness to convert this challenge into an opportunity for show the world that India is ready to deal with future problems, and can set global credible standards concerning environmental and occupational health (Violet, 2008).

Among the respondents, 80% were ready to accept additional charges on products if the producer claims responsibility for recycling the product. In an effort to make users aware of the recycling of e-waste, many electronic companies such as Apple, Dell and HP have started various recycling schemes (Raymond, 2007). Nokia India has also announced its "recycling campaign" for the Indian region. The programme encourages mobile phone users to dispose of their used handsets and accessories, irrespective of brand, at any of 1300 green recycling bins at priority dealers and care centres. Nokia also plans to launch an electronic waste management programme (Sushant, 2011).

Public awareness of the e-waste problem is only the beginning; the public has to be willing to support companies that help to properly dispose of e-waste, even if the cost of their products become slightly higher as a result. Consumers hold the power, but need to be educated about the facts and the fact is that recycling starts with the individual. With a little effort and an Internet connection, the average individual can learn where to recycle their electronic products (Saroj Gupta, 2004).

CONCLUSION

Problems due to e-waste are likely to become serious in India in the near future. Whenever a customer replaces a computer or mobile phone, the replaced product may leave the customer, but it remains within the environment. There should therefore be regular improvements through research and development to enhance the reuse and recycling of products.

India is undoubtedly at present being dominated by the informal sector concerning the management of e-waste. However, the country has also started thinking about the sustainable management of e-waste. There exists an urgent need for the detailed assessment of the current and future scenarios, including quantification, characteristics, existing disposal practices and environmental impacts.

Moreover, there is a need for a framework that can help in the management of e-waste. A draft has been prepared for e-waste handling and the rules related there to, which is available on the website of the Ministry of Environment and Forests of India. The responsibilities of collection centres, producers, recyclers, dismantlers and consumers have been included in the draft.

The present study showed that e-waste is going to become a significant challenge for environmentalists and technologists, as its rate of growth is much higher than the rate at which it is being disposed of, recycled or reused. There is an urgent need for the improvement of all aspects of e-waste management, as well as the rules and policies for those who work in e-waste disposal. Above all, education regarding this activity as it concerns the environment and public health should be explained properly.

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