

User's Perspective: Knowledge and Attitude towards E-Waste

Dr. Brijesh Sivathanu

*Associate Professor, Symbiosis Center for Information Technology,
Symbiosis International University, Hinjewadi, Phase-I,
Pune-411057, Maharashtra. India.*

Abstract

The world's largest and fastest growing manufacturing industry today is the electronics industry. The rapid growth in this sector combined with rapid product obsolescence due to the advent of latest technologies and discarded electronics is now the fastest growing concern in the entire industrialized world. The growing quantity of waste from the electronics industry that is "E-waste" is beginning to reach disastrous proportions not only globally but also in most of the cities in India.

In this paper, the author discusses the consumers' awareness and preference towards the disposal of e-waste. A primary survey was conducted using a structured questionnaire among 600 consumers in Pune city. The exploratory factor analysis technique was deployed to identify the awareness factors contributing to the consumer's preference towards the proper disposal and management of e-waste.

The findings show that five important factors contribute to the consumer's preference during the disposal of e-waste. These antecedents are Awareness of toxic effects on human health, Awareness of Environmental Hazards, Awareness of proper disposal of E-waste, Awareness of E-waste Management by various stakeholders and Awareness of Convenience of Recycling.

This paper suggests the various pathways to create awareness so that the attitude of the consumers towards disposal of e-waste can be changed which would be helpful to the society to handle E-waste properly and focus towards efficient and effective E-waste management.

Keywords: Awareness, preference, e-waste disposal, antecedents and E-waste management.

Introduction

The manufacturing and service industries are the key drivers of global economic growth, and within this, Information and communication technology (ICT) along with the electrical and electronics sectors play a major role. The recent advancements in science and technology translate to the fact that day-to-day life today is incomplete without an electronic or electrical device. India is one of the largest growing consumer electronics markets globally and will be the fifth largest consumer electronics market by 2025, from its current 12th position. Though electrical and electronic equipment have enhanced the quality of our lives, their usage has also led to the generation of electronic waste (e-waste) that causes health and environmental issues. E-waste has a direct relationship with the country's economic growth and overall consumer spending (Frost and Sullivan Report 2015).

The consumption of electrical and electronic equipment (EEE) has increased tremendously from the institutional users to the households too. This growing rate of consumption among the consumers along with the shortened product life cycle due to rapid progression of technology has resulted in the rapid growth of electronic waste (e-waste). The e-waste comprises of discarded television, computers, mother boards, mobile phones, pen drives, cathode ray tubes, printed circuit boards, air conditioners, refrigerators, compact discs and plasma television. The data published by Central Pollution Control Board (CPCB) in the year 2014 mentions that 75 % of the e-waste is television and electrical equipment, 20% computers, 2% mobile phones and 3% others which include toys, leisure and sports equipment.

E-waste is more hazardous than any other municipal waste and it contains many hazardous chemicals like polyvinyl chloride (PVC plastics), Nonylphenol, Polybrominated diphenyl ethers, polychlorinated biphenyls copper, Triphenyl phosphate, Chromium VI, Barium, Beryllium, Phosphor and additives lead, mercury, arsenic (in older models), cadmium, manganese, cobalt, gold, and iron. These chemicals create water pollution, land pollution and air pollution and hazardous to human health.

With reference to the above hazards, the proper management of e-waste is an alarming issue for government agencies. There are various stake holders involved in the e-waste management comprising of regulatory bodies like Ministry of environment and forest (MoEF), Central Pollution Control Board (CPCB) and Maharashtra Pollution Control Board (MPCB). The National Association of Software and Services Companies (NASSCOM), Manufacturers' Association for Information Technology (MAIT), NGOs, Consumer, Individual households, manufactures and retailers, business sector companies, Traders / Scrap Dealers / Disassemblers, Recyclers along with informal sectors like Hawkers are involved in the collection of E-waste.

Among the states in the country, Maharashtra is leading in the e-waste generation as the cities like Mumbai and Navi Mumbai has generated 61,500 MT and Pune has 12,300 MT in 2014 (Frost and Sullivan Report, 2015).

As the electronic waste (e-Waste) generated in Pune city is not segregated, collected or processed by government institutions, the Pune City's solid waste management system has to bear an additional 30 per cent burden. While the e-waste rules were

implemented in 2011, even after four years the problem of domestic e-waste disposal and recycling still remains in Pune city.

The e-waste generated in the city is the waste coming from the IT belts of Hadapsar, Kharadi and Magarpatta areas. This waste usually has computers, copper and lead wires, laptops and other electrical equipments used in offices.

As per the Pune Municipal Corporation (PMC) report in 2014, around 500 MT to 1000 MT e-waste generated in the city is of domestic nature of which maximum 300 MT is being collected. The PMC is conducting awareness programs and campaigns for citizens to encourage them to segregate their e-waste.

The IT/ITeS sector was found to be the highest contributor to the quantity of E-waste generated in Pune city. As found in this study, the main reason for this, is the frequent replacement and discarding of obsolete computers in this sector. With the introduction of new and modified versions of software every few months, the substitution and desertion rate of electrical and electronic equipments (EEE) is reasonably high in this sector. Most of the times, the older hardware is not compatible with the new software, and consequently, companies are forced to opt for newer hardware contributing significantly to the e-waste generation (Anwasha Borthakur, 2015).

The final inventory describing the quantity of E-waste from the four electronic items in Pune considering a combination of obsolescence rates confirmed through this technique is given below (K.R.Takale et.al, 2015). The analysis of the data shows that the E-waste generation exceeds 4573.43 tons/year in Pune. The E-waste generation analysis has been described in Table 1.

Table 1: E-Waste Generation in 2014

Items	Obsolescence Rate	E-Waste in Tons/year
Cell Phone	2	44.50
Personnel Computer	5	1183.90
Refrigerator	15	1949.48
Television	15	1395.55
Total		4573.43

Consumer awareness and consumer behavior towards the e-waste really plays an important role in e-waste management. Though regulatory framework precisely defines each stakeholder's role in e-waste management still it is facing challenges to create awareness regarding e-waste in individual consumers. Lack of consumer awareness and sale of e-waste to hawkers is a vital obstacle in e-waste management.

As per the research conducted in Pune city (Viraja Bhat and Yogesh Patila, 2014) the general consumer awareness about e-waste is good but consumers are not aware of e-waste collection centers, rules and various proper disposal practices of e-waste. It also mentions that awareness of the consumer is most important in the entire supply chain of e-waste management and which is crucial in framing the mindset of the consumer to reuse, recycle and repair that will be definitely helpful for proper e-waste

management to protect the environment, health, livelihood and sustainable development.

After the study of the existing literature, the link between socioeconomic, demographic characteristics of the consumers and recycling behavior was explored. The most commonly examined variables under consideration are education, age, gender and income.

The evidences examined during the literature review suggests that general attitudes towards the environment, environmental activism, convenience, as well as a broad array of socio-economic variables have to be considered while assessing the factors influencing the willingness of the consumers to recycle e-waste.

The importance of recycling and information about where and how to recycle needs to be conveyed to the general consumers to increase their participation in e-waste recycling (Guagnano et al., 1995)

The convenience in e-waste recycling can increase the household involvement as it requires consumer's time, effort, money and space (Domina and Koch , 2002)

The consumer's recycling behavior is largely driven by convenience. One of the important parameter in consumer recycling behavior is how frequently e-waste is collected by recyclers. (Hornik et al., 1995). It also mentions with reference to meta-analysis that one of the strong predictor of recycling behavior is the frequency of recyclable collection.

It is really necessary that the consumer be aware of the availability of recycling method and facilities provided by government and various agencies. Most of the studies (Oskamp, 1994; Hornik et al., 1995), state that knowledge about recycling is a strong predictor of the recycling behavior of the consumers.

As per (Nnorom, 2009) less awareness of the toxic hazards of e-waste and threat of not using correct techniques are considered prime barriers of e-waste recycling. This Research also confirms that the residents' willingness in e-waste recycling is directly associated with the awareness of environmental issues related to e-waste.

Many of the studies mention that the education level and income have a positive relationship with recycling of e-waste by residents (Hornik et al., 2005; Hansmann et al., 2006; Tonglet et al., 2004).

The research conducted (Zhaoua Wang et.al, 2011) in Beijing confirms that the convenience of recycling facilities and service, recycling habits, residential conditions and economic benefits are determinants of the consumers' willingness and behavior in e-waste recycling.

(Jenkins et al., 2003) in his research suggests that cost and convenience has a significant impact on the e-waste recycling behavior of the consumers.

The study conducted by Oskamp et al.,1998 and Guerin, Crete, and Mercier, 2001 show that significant statistical relationship exists between the environmental concerns of the consumer and their recycling behavior.

The research conducted by (Gamba & Oskamp, 1994; Oskamp, 1995) depict that a positive association exists between income and recycling behavior of consumers towards e-waste.

Objectives of the Study

1. To study consumers' awareness towards the E-waste in Pune city.
2. To identify the awareness factors contributing to the consumer's preference towards the proper disposal and management of e-waste in Pune city.

Research Methodology

This is an exploratory research study to understand the consumers' awareness towards e-waste in Pune city. For conducting this research, both primary and secondary data was collected. The primary survey was done using structured questionnaire with closed ended questions using five point Likert scale ranging from "Strongly Agree" to "Strongly Disagree".

The sample respondents were selected based on the convenience sampling method. A total of 600 consumers from Pune city were surveyed to conduct the exploratory study and to identify the awareness factors affecting the preference of consumers for proper disposal and management of e-waste. The collected data was coded and entered for statistical analysis using SPSS software. First a demographic profile of the respondents was prepared by applying frequency distribution. Later, the data obtained for the study were analyzed using Exploratory Factor analysis for identification of the awareness antecedents contributing to the consumer's preference towards the proper disposal and management of e-waste in Pune city. Factor analysis was conducted as a data reduction technique to minimize the number of variables whilst simultaneously maximizing the amount of information in the analysis.

Analysis and Interpretation

The demographic details are as below:

Table 2: Demographic Details of Consumers

Items	Counts	Percentage (%)
Gender		
Male	342	57 %
Female	258	43 %
Age Group		
18-28	102	17 %
29-39	438	73 %
40-60	60	10 %
Marital Status		
Married	516	86 %
Unmarried	84	14 %
Education		
Undergraduate	24	4%
Graduate	114	19%

Post Graduate	390	65%
Professional	72	12%
Income		
Below 1 Lakh	96	16
2 lakhs to 3 lakhs	132	22
4 lakhs to 5 lakhs	228	38
10 lakhs and above	144	24

Table 3: Income levels and Awareness of E-waste

Sr. No.	Response	Count of the Respondents	Percentage
1	Aware	351	58.5
	Below 1 Lakh	10	1.66
	2 lakhs to 3 lakhs	32	5.33
	4 lakhs to 5 lakhs	180	30
	10 lakhs and above	129	21.5
2	Not Aware	249	41.5
	Below 1 Lakh	86	14.3
	2lakhs to 3 lakhs	100	16.6
	4 lakhs to 5 lakhs	48	8
	10 lakhs and above	15	2.5
Total		600	100

As per the Table 3, 58.5 per cent of the consumers are aware of e-waste management and 88.03 per cent of them are in the high income group.

Table 4: Education level and Awareness of E-waste

Sr. No.	Response	Count of the Respondents	Percentage %
1	Aware	351	58.5
	Undergraduate	4	0.6
	Graduate	14	2.3
	Post Graduate	282	47
	Professionals	51	8.5
2	Not Aware	249	41.5
	Undergraduate	20	3.3
	Graduate	100	16.6
	Post Graduate	108	18
	Professionals	21	3.5
Total		600	100

As per the Table 4, 58.5 per cent of the consumers are aware of e-waste management and 94.87 per cent of them are post graduate and professionals.

Table 5. Preference for Proper Disposal of E-waste.

Sr. No.	Response	Count of the respondents	Percentage %
1	Preference for proper disposal of E-waste	321	91.45
2	Not sure for proper disposal of E-waste	15	4.27
3	Do not know about proper disposal of E-waste	15	4.27

The above table mentions that, out of the 351 aware consumers, 91.45 per cent of the shows preference for proper disposal of e-waste.

In accordance with the Churchill procedure, the researcher conducted the Principal Component Analysis with varimax rotation to identify the antecedents of awareness contributing to the consumers' preference towards proper disposal and management of e-waste. To determine the number of factors, the researcher considered the most usual rule of Kaiser criterion (selected the factors corresponding the to the Eigen values above 1.0). Only items with communality greater than 0.5 and the absolute value of their co-relation to an axis greater than 0.6 were retained. Then the Cronbach alpha was used to assess the reliability of the antecedents. The estimated coefficients can be described as acceptable as they are all above 0.70 (Peterson 1994).

From the below Table 6 The Kaiser-Meyer-Olkin (KMO) value of 0.586, which is greater than 0.5 indicates the measure of sample adequacy which proves that the given primary data is fit for data analysis using factor analysis. The Bartlette's test of sphericity indicates that the correlation matrix is not an identity matrix which indicates that the factor model is appropriate. Since the p-value is 0.000 i.e. the p-value is less than 0.05 which indicates that the correlation is significant.

It is clear from the factor analysis that five factors F1, F2, F3, F4 and F5 were extracted which cumulatively explains 76.684 per cent of the total variance.

The rotated component matrix shows that the factor loading of the items on the factors. The Factor F1 which has been named "Awareness of toxic effects on human health" consists of the items have factor loading: Kidney damage-.992, Damage of central nervous system-.952, Asthmatic Bronchitis-.956, skin diseases-.974, Damage to Heart-.972 and Effect on Brain Development-.906.

The extracted factor F2 which has been named "Awareness of Environmental Hazards" consists of the items having factor loading-Air Pollution-.976, Land Pollution-.986 and Water Pollution-.979.

The extracted factor F3 which has been named "Awareness of proper disposal of E-waste" consists of the items with factor loading: Recycle-.978, Reuse-.902, Return to producer-.903 and Refurbish-.901.

The extracted factor F4 which has been named "Awareness of E-waste Management by various stakeholders" consists of the items with factor loading: NGO working on E-waste-.779, Govt Initiatives-.929, Awareness of Campaigns on e-waste-.911, E-waste collecting Agencies-.799, Municipal Corporation Initiative-.895.

The extracted factor F5 which has been named as “Awareness of Convenience of Recycling” consists of items with the factor loading: Information of recycling centres-.852, Less time to drop e-waste at the centre-.789, E-waste collection by recyclers-.821, e-waste collection by manufactures-.799, Frequent pick up by recyclers-.897. The Scree plot indicates that only five factors F1, F2, F3, F4 and F5 emerged as important because their Eigen values were 5.311, 4.772, 3.851, 2.302 and 1.451 respectively. The remaining components with Eigen values under 1.0 were dropped as per the Kaiser rule.

Table 6: Factor Analysis

Factor Name	Statements	h^2 (Communality)	Reliability (α)	Factor Loading	Eigen Value	% Variance Explained	Cumulative %
F1 (Awareness of Toxic effects on human health)		-	.864	-	5.311	24.678	24.678
	S1-Kidney damage	.894		.922			
	S2-Damage of central nervous system	.889		.952			
	S3-Asthmatic Bronchitis	.995		.956			
	S4-Skin Diseases	.909		.974			
	S5-Damage to heart	.911		.972			
	S6-Effect on Brain development	.904		.989			
F2 (Awareness of Environmental Hazards)		-	.822	-	4.772	19.210	43.888
	S1-Air pollution	.835		.976			
	S2-Land pollution	.855		.986			
	S3-Water Pollution	.859		.979			
F3 (Awareness of proper disposal of E-waste)		-	.812	-	3.851	14.878	58.766
	S1-Recycle	.886		.978			
	S2-Reuse	.889		.902			
	S3-Return to producer	.895		.903			
	S5-Refurbish	.806		.901			
F 4 (Awareness of E-waste management by various stake holders)		-	.848	-	2.302	10.672	69.438
	S1-NGOs working on E-waste	.797		.779			
	S2-Govt. Initiatives	.825		.929			
	S3-Awareness campaigns on e-waste	.805		.911			
	S4-E-waste Collection Agencies	.816		.799			
	S5-Municipal Corporation Initiative	.795		.895			
F5 (Awareness of Convenience for recycling)		-	.864	-	1.451	7.246	76.684
	S1-Information of recycling centres	.889		.852			
	S2-less time to drop e-waste at the centre	.806		.789			
	S3-E-waste collection by recyclers	.803		.821			
	S4-E-waste collection by manufactures	.789		.799			
	S5-frequent pick up by recyclers	.805		.897			

Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy= 0.586

Overall Cronbach Alpha (α) = 0.842

Bartlett's Test of Sphericity = Approx. Chi-Square-3430.135 {(p=0.000)}

Source : Primary Data

Result and Discussion

Conclusion and Managerial Implications :

Consumer awareness plays a vital role in proper e-waste management. This study found that 58.5 per cent of the 600 consumers surveyed in Pune city were aware of e-waste. Out of the aware consumers, 88.03 per cent of them are of the high income group and 94.87 per cent of the consumers are post graduate and professionals. The results show that there is a significant relationship between the education and income levels of the consumers and their awareness of e-waste. This clearly shows that the findings of the current study align and confirm with the previous studies conducted as mentioned in the review of literature (Hornik et al., 2005; Hansmann et al., 2006; Tonglet et al., 2004). Also 91.45 per cent out of the aware consumers have preference for proper disposal and management of e-waste.

The present study makes both academic and practical contributions. From an academic point of view, it contributes to the existing literature in the area of consumer awareness and preference for proper disposal and management of e-waste. It can also be used by future researchers to study the role of various stakeholders including the formal and informal sectors and the techniques used in e-waste management. The results of this research confirm with many prior studies on e-waste management.

From a managerial point of view, the contributions of the proposed study are as follows:

One of the key determinants for the future success of E-waste management is the consumer's awareness and preference during the disposal of e-waste. These awareness antecedents are Awareness of toxic effects on human health, Awareness of Environmental Hazards, Awareness of proper disposal of E-waste, Awareness of E-waste Management by various stakeholders and Awareness of Convenience of Recycling. The key stakeholders can draw meaningful insights to understand the factors which influence consumers' preference towards management and disposal of e-waste.

Scope For Further Research :

This paper identifies the awareness antecedents contributing to the consumer's preference towards the proper disposal and management of e-waste. Future researchers may empirically examine the relationships among the consumers' awareness antecedents of e-waste management.

Further, demographic characteristics like age, income, gender and education play an important role in the consumers' awareness and preference of disposal and management e-waste. Future research may test the effects of these demographic characteristics on e-waste management.

This research was carried out only in the city of Pune. It would be important to test these measures in other cities and parts of India to improve the reliability and validity of the study.

References

- [1] Anwasha, Borthaku, (2015). Generation and Management of Electronic Waste in the City of Pune, India. *Bulletin of Science, Technology & Society* 2014, Vol. 34(1-2), 43-52.
- [2] Domina, T. & Koch, K. (2002). Convenience and frequency of recycling: implications for including textiles in curbside recycling programs. *Environment and Behavior*, 34, 216-238.
- [3] Frost and Sullivan Report (2015). *Electronic Waste Management Services in India-A perspective on growth opportunities*, 9835-15.
- [4] Gamba, R., & Oskamp, S. (1994). Factors influencing community residents' participation in commingled curbside recycling programs. *Environment and Behavior*, 26, 587-612.
- [5] Guagnano, G. A. Stern, P.C. and Dietz, T. (1995). Influences on attitude-behavior relationships: a natural experiment with curbside recycling. *Environment and Behavior*, 27(5), 699-718.
- [6] Guerin, D., Crete, J., & Mercier, J. (2001). A multilevel analysis of the determinants of recycling behavior in the European Countries. *Social Science Research*, 30, 195-218.
- [7] Hansmann, Ralf, Bernasconi, Petra, Smieszek, Timo, Loukopoulos, Peter, Scholz, Roland W.,(2006). Justifications and self-organization as determinants of recycling behavior: the case of used batteries. *Resources, Conservation and Recycling* (47), 133-159.
- [8] Hornik, Jacob, Cherian Joseph, Mandansky, Michelle, Narayana, Chem. (2005). Determinant of recycling behavior: a synthesis of research result. *The Journal of Socio-Economics* 24(1), 105-127.
- [9] Jenkins, R.R., Martinez, S.A., Palmer, K., & Podolsky, M.J. (2003). The determinants of household recycling: a material-specific analysis of recycling program features and unit pricing. *Journal of Environmental Economics & Management*, 45, 294-318.
- [10] Nnorom, I.C., (2009). Survey of willingness of residents to participate in electronic waste recycling in Nigeria. A case study of mobile phone recycling. *Journal of Cleaner Production*. (17) 1629-1637.
- [11] Oskamp, S., Harrington, M.J., Edwards, T.C., Sherwood, D.L., Okuda, S.M., and Swanson, D.C. (1991). Factors influencing household recycling behavior. *Environment and Behavior*, (23),494-519.
- [12] Oskamp, S., Burkhardt, R., Schultz, P.W., Hurin, S. & Zelezny, L. (1998). Predicting three dimensions of residential curbside recycling: An observational study. *Journal of Environmental Education*, 29(2), 37-42.

- [13] Oskamp, S. (1995). Resource conservation and recycling: Behavior and policy. *Journal of Social Issues*, 51(4), 157-173.
- [14] Scott, D. (1999). Equal opportunity, unequal results: Determinants of household recycling intensity. *Environment and Behavior*, 31(2), 267-290.
- [15] Takale, K., R., et.al. (2015). Electronic Waste & Its Present Scenario for Pune City. *International Journal of Innovative Research in Science, Engineering and Technology* 4(6), 4238-4244.
- [16] Tonglet, Michele, Phillips, Paul S., Read, Adam D.,(2004). Using the theory of planned behaviour to investigate the determinants of recycling behaviour: a case study from Brixworth. UK. *Resources, Conservation and Recycling* (41), 191-214.
- [17] Viraja, Bhat, & Yogesh, Patil (2014). E-waste Consciousness and Disposal Practices among Residents of Pune City. *Procedia-Social and Behavioral Science* (133), 491-498.
- [18] Zhaoua, Wang, et.al (2011). Willingness and behavior towards e-waste recycling for residents in Beijing city. China. *Journal of Cleaner Production* (19), 977-983.

