Inventorization of E-waste in Bangalore city

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ABSTRACT

The main objective of this paper focused on field exploratory survey of e-waste generation in Bangalore city. Field data were collected through questionnaire-based survey followed up with interviews where the target respondent groups and e-waste categories were predetermined to determine the e-waste flow purchasing pattern, recycling and disposal practices, and to understand the existing measures for e-waste management in Bangalore. There are three main target respondents included in the survey. The three main categories are Households, Offices (business entities and institutions) and Recyclers (Including importers and exporters, manufacturers, collectors, second-hand shops, repair shops, dismantlers, and processors of recyclable materials from used WEEE). A total of eleven major area of Bangalore city were selected. The basis for the selection of the survey location is based on the population density and also the socioeconomic status of the areas. The average weight of EEE was taken as per E-Waste Volume I, Inventory Assessment Manual, UNEPBased on the survey, it was estimated that the total e-waste generation in bulk quantity from software industry of all scales is 250162.8 kg/annum. Total e-waste generation due to repairs of EEE is 32443 Kg per annum. Total e-waste generated from seven EEE items due to households is 12190.09 Kg per annum. Total e-waste generated due to consumers/users in bulk quantities in hotels and institutes is 9447.12 Kg per annum. Total e-waste generated is 121 Kg from users/ consumers of mobile phones in bulk quantity n organizations. Total e-waste generated from users/consumers in bulk quantity from manufacturing industry of all scales is 20420.7. 8 Kg/annum.

Introduction

The largest and fastest growing manufacturing industry is the "electronic industry". There is a tremendous growth in the field of information technology all over the world. The Indian information technology industry has a prominent global presence today largely due to the software sector. More recently, policy changes have led to a tremendous influx of leading multinational companies into India to set up manufacturing facilities, R&D centres and software development facilities. The domestic market is getting revitalized due to buoyant economic growth and changing consumption patterns. This growth has significant economic and social impacts. The increase of electronic products, consumption rates and higher obsolescence rate leads to higher generation of electronic waste. All electronic and electrical items such as computers, televisions, mobile phones etc. on completion of their useful life, are being discarded rapidly and contribute to the huge quantum of Waste Electrical and Electronic Equipment (WEEE)/e-waste. The generation of this waste (e-waste) has grown manifold in the last two decades and would continue to accelerate at a fast pace [1,3,4]. The increasing obsolescence rates of electronic products added to the huge import of junk electronics from abroad create complex scenario for solid waste management in India. At the consumer end disposal of e-waste or used product is a big issue. In India computers and peripherals are recycled / reused much more than they are in developed countries. Till the last decade affordability of computers was limited to only a socio-economically advantaged section of the population. Resale and reuse of computers continues to be high as dependency on assembled machines. No reliable figures are available as yet to quantify the e-waste generation. Increasingly as computers are becoming more affordable and there is greater access to technology, the turnover of machines could definitely be higher. Apart from the consumer end, another source of more obsolete computers in the market is from the large software industry where use of cutting edge technology, greater computing speed and efficiency necessarily increase the rate of obsolescence. In the same way as the standard of living is growing high / dealers are providing monthly payment/ instalment facilities / banks are providing loans in a comparatively easy way, affordability of televisions, mobile phones and other house hold appliances are enormously increasing. As the consumption pattern increases, e-waste generation also increases [5,6,7].

Bangalore which is referred as silicon valley in India in the State of Karnataka has more than 1300 numbers of software industries and about 40 hardware industries established in and around the city and in addition Business Process Outsourcing (BPO's) companies with more than sixty thousand employees are actively functioning in the city. Bangalore has emerged as an important destination/hub for recycling of e-waste generated in Karnataka. Currently, e-waste recycling in Bangalore is completely undertaken by the unorganized sector. The processes involved in e-waste recycling by the informal sector are highly polluting and are not only hazardous for the environment, but also to the health of workers. The problem is further complicated by higher consumption and disposal rates among

the users leading to increase in volume of e-waste. Due to growing quantities and health and environment hazards involved in e-waste recycling, immediate action from all concerned is required to curb risk and improve the situation. This paper focused on field exploratory survey of e-waste generation in Bangalore city.

Field Studies and Data Collection

Field data were collected through questionnaire-based survey followed up with interviews where the target respondent groups and e-waste categories were predetermined to determine the e-waste flow purchasing pattern, recycling and disposal practices, and to understand the existing measures for e-waste management in Bangalore. There are three main target respondents included in the survey. The three main categories are Households, Offices (business entities and institutions) and Recyclers (Including importers and exporters, manufacturers, collectors, second-hand shops, repair shops, dismantlers, and processors of recyclable materials from used WEEE).

There are seven types of electrical and electronic equipment (EEE) targeted in this survey to determine the e-waste disposal patterns which are: Television sets (TVs); Computer sets with CRT monitors or LCD Monitors and Notebook; Washing Machines; Mobile Phones; Refrigerators; Air Conditioners; Rechargeable batteries (mobile phones).The respondents were required to be geographically diverse and to cover the socio-economic spectrum to reflect as closely as possible the potential e-waste generation trend in Bangalore. A total of eleven major area of Bangalore city were selected. The basis for the selection of the survey location is based on the population density and also the socioeconomic status of the areas. Table 1 shows the selected zones and areas covered for questionnaire-based survey in the Bangalore city

The distribution of the e-waste survey questionnaires was started on the 30th of January 2011 and ended on the 30th of July 2011. A total of 2469 sets of questionnaires were sent out to all target subjects through e-mails and site visit interviews. Of these, 860 questionnaires were sent out to household respondents, 1337 to business entities and institutions respondents and 272 to Recyclers. In most cases, the employees in the business and institutions respondents were also given the household questionnaire to answer as an individual.

Household Questionnaires

For the household category, 750 responses are required in this survey. The target for this category was met with a total of 740 answered and completed questionnaires returned. The questionnaires were received either by e-mails or directly by the interviewer during the personal interviews. The number of response from 3 locations met or exceeded the target while the responses from the remaining locations were 80% – 98% of the target needed. The number of returned questionnaires is considered to be representative of the socioeconomic status and geographical distribution which influence the e-waste generation from households.

Business Entities and Institution Questionnaire

There are 390 completed responses required for the business entities and institutions category. A total of 780 sets of questionnaires were distributed. The number of returned questionnaires from three locations met or exceeded the target while the returns from the remaining locations were between 90-95% of the target needed. The total returned questionnaire and the target number of questionnaire for each area is shown in Fig. 2.

Recyclers Questionnaire

There are three sub-categories in the recyclers group which are the scrap metal collectors, the second-hand/repair shops, and the Karnataka State Pollution Control Board (KSPCB), Bangalore licensed e-waste contractors (collectors, dismantlers, processors). Most of the returned questionnaires are obtained through site visits and only a few questionnaires were returned by e-mail. The overall number of questionnaires sent to the target locations are 272 sets. A total of 105 (38.6%) sets of questionnaire were answered and returned in the recyclers category and mainly are from the second-hand shops and repair shops with the total of 75 sets (71.4%), 11 sets from collectors (6 sets from KSPCB, Bangalore licensed e-waste contractors and five from non-KSPCB licensed facilities) (10.5%), 11 sets from the KSPCB -licensed processors (9 sets from KSPCB licensed e-waste contractors and 2 sets from non KSPCB licensed facilities) (10.5%) and 8 sets are from the dismantlers (3 sets from scrap collectors and 5 sets from KSPCB licensed e-waste contractors) (7.6%). The total returned questionnaire and the target number of questionnaire for each area for recyclers is shown in Fig. 3.

Results and Discussions

To collect information on current generation of e-waste due to computers, printers, mobile phones, televisions, washing machines and Refrigerator, a total of 1585 units were approached out of which 1085 responded and 500 have not responded. Survey on dealers and assemblers of Computers and Printers showed that a total of 36816 computers are assembled by twenty seven surveyed companies. They informed and also observed during field visit that no e-waste is generated while assembling the computers. It is interesting to note that most of the assemblers are dealers of various companies. The dealers are responsible for the sale of computers and printers. Twenty nine dealers were approached and 19 have responded. To obtain information on sales of branded (Samsung, HCL, Lenova, Sony, IBM) and unbranded companies and on e-waste generation, approached various dealers. It was observed that no e-waste is generated during this activity (dealing / sales). On an average per year 7788 computers and 1908 printers are sold. Survey on dealers of television showed that a total of 4560 televisions are assembled and sold by twenty seven surveyed companies.
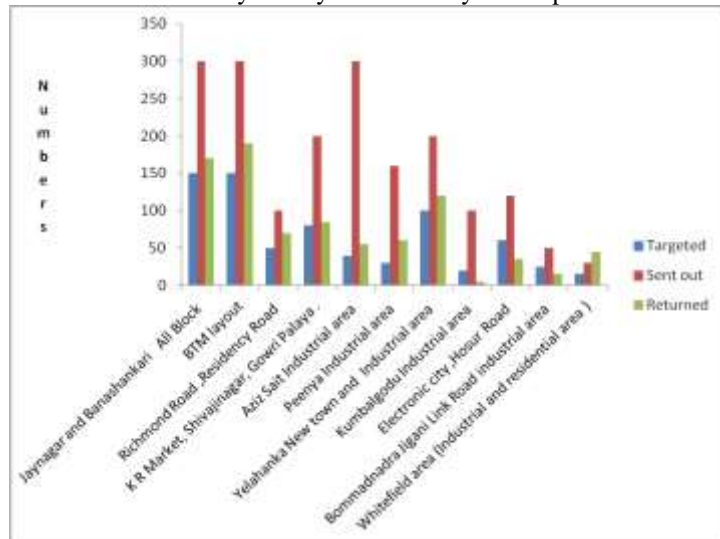

Fig. 1(a)

Table 1: Localities covered in e-waste survey n Bangalore city

No	Locality Name	Zone
1	Jaynagar and Banashankari All Block	Bangalore South Zone
2	BTM layout	Bangalore South Zone
3	Richmond Road, Residency Road	Bangalore Central Zone
3	K R Market, Shivajinagar, Gowri Palaya.	Bangalore Central Zone
4	Aziz Sait Industrial area	Bangalore Central Zone
5	Peenya Industrial area	Bangalore North Zone
6	Yelhanka New town and Industrial area	Bangalore North Zone
7	Kumbalgodu Industrial area	Bangalore West Zone
9	Electronic city, Hosur Road	Bangalore South Zone
10	Bommadnadra Jigani Link Road industrial area	Bangalore South Zone
11	Whitefield area (Industrial and residential area)	Bangalore East Zone.

Table 2: Summary of survey from Software industry and quantity of e-waste generation

E-waste components	E-waste Survey from Software sector (Survey Sample: 60)								
	Large Scale (Population Equivalent : 78525.9)			Medium Scale (Population Equivalent: 2593)			Small Scale (Population Equivalent: 870)		
	Used	Discarded/ Repaired/yr	E-waste	Used	Discarded/ Repaired/yr	E-waste	Used	Discarded/ Repaired/yr	E-waste
Computer	71388	7737	228995.2	2358	184	5438.0	725	86	2538.0
Printers	1483	258	1290	153	38	185	103	26	130
TVs	206	48	1738	115	23	900	60	9	324
Air Conditioners	247	49	1960	238	50	2000	186	37	1480
Refrigerators	98	23	1104	45	9	432	32	7	336
Mobile Phones	226	36	3.6	75	14	1.4	110	26	2.6
Washing Machine	63	16	720	43	9	405	17	4	180
Total E waste, Kg/yr	235810.8			9361.6			4990.6		

Table 3: Summary of survey from House hold sector and quantity of e-waste generation

| E-waste components	E-waste Survey from House hold sector (Survey Sample: 750)								
	Large Scale (Population Equivalent :1184)			Medium Scale (Population Equivalent: 1274)			Small Scale (Population Equivalent: 1147)		
	Used	Discarded/ Repaired/yr	E-waste	Used	Discarded/ Repaired/yr	E-waste	Used	Discarded/ Repaired/yr	E-waste
Computer	412	138	3732.04	150	25	4	17	29	90.3
Printers	46	12	45.3	71	70	135.9	3	2	0.2
TVs	777	146	4818.9	430	81	11.4	249	181	297.7
Air Conditioners	478	58	1204.8	834	86	43.05	5	2	0.2
Refrigerators	274	40	1156.5	318	31	35.3	19	18	1.8
Mobile Phones	963	255	25.5	227	44	51.2	836	247	17.7
Washing Machine	270	29	499.7	245	73	16.1	80	25	2.5
Total E waste, Kg/yr	11482.7			297.0			410.4		
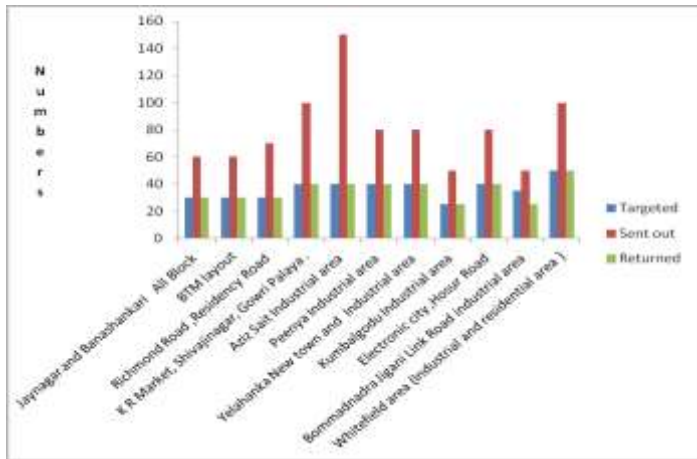
Fig.1(b)
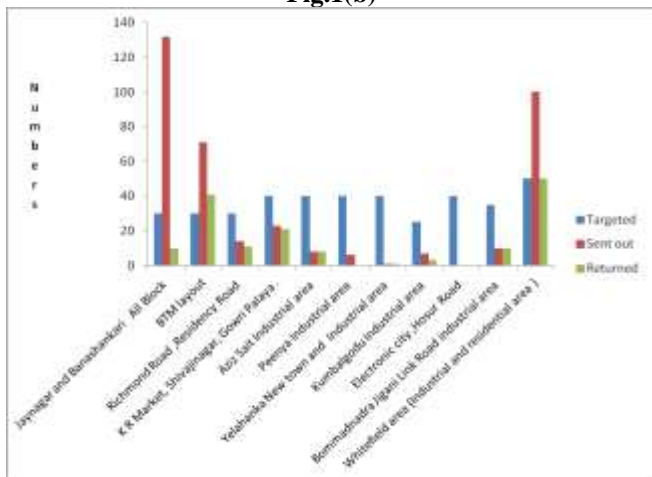
Fig. 1(c)

Fig.1 The total returned questionnaire and the target number of questionnaire for each area of Bangalore city for (a) House hold Sector (b) Business Entities and Institution (c) Recyclers

They informed and also observed during field visit that no e-waste is generated while assembling the television. Similarly, the survey on dealers of mobile phones showed that the dealers are responsible for the sale of mobile phones. Out of nineteen dealers approached only nine responded. To obtain information on sales of branded (Samsung, Sony Ericsson, Spice, Nokia and LG) and unbranded companies and also on e-waste generation, approached various dealers. It was observed that no e-waste is generated during this activity. It is observed from the survey that 7302 mobile phones were sold by nine sampled survey.

E-Waste Generation in Bulk Quantity from Software industry of all scales (Large, Medium and Small)

The users/consumers of seven types of electrical and electronic equipment (EEE) targeted such as Computers, Printers, TVs, Washing machines, Refrigerators, Mobile Phones and Air Conditioner are surveyed from Software industry of all scales. Out of 60 organizations surveyed a total of 60 have responded. Table 2 shows the Summary of survey from Software industry and quantity of e-waste generation. These 60 organizations are using 74471 computers 520 printers, 481 TVs, 671 ACs, 175 Refrigerator, 411 Mobile Phones and 123 washing machines. They have discarded 9007 computers 312 printers, 80 TVs, 136 ACs, 39 Refrigerator, 76 Mobile Phones and 29 washing machines. Total e-waste generated from these items is 250162.8 Kg/annum (236971 Kg/annum from computers, 1605 Kg/annum from printers, 2962 kg/annum from TVs, 5440

Kg/annum ACs, 1872 Kg/annum from Refrigerator, 7.6 Kg/annum from Mobile Phones and 1305 Kg/annum from washing machines). (Assuming an average weight of EEE as per E-Waste Volume I, Inventory Assessment Manual, UNEP).

E-Waste Generation Due to Repairs

Approached 200 repairers of Computers, Printers, TVs, washing machines, Refrigerators, Mobile Phones and Air Conditioner and only 147 repairers responded. As regards to computers, 4413 were repaired and 362 discarded as a whole, 918 Printer were repaired and 173 Discarded as Whole, TVs 4130 were repaired and 179 discarded as a whole, Air conditioners 1191 were repaired and 51 discarded as a whole, Refrigerators 3264 were repaired and 125 discarded as a whole, Mobile Phones 33927 were repaired and 1433 discarded as a whole and washing machines 2287 were repaired and 79 discarded as a whole. E-waste generation from repair of Computers, Printers, TVs, and washing machines, Refrigerators, Mobile Phones and Air Conditioner and discarded of whole Computers, Printers, TVs, washing machines, Refrigerators, Mobile Phones and Air Conditioner is 32443 Kg per annum. (Assuming an average weight of EEE as per E-Waste Volume I, Inventory Assessment Manual, UNEP).

E- Waste Generations Due to Households

A total of 750 houses were surveyed to know the trend of usage of computers, printers and e-waste generation. Table 3 shows the Summary of survey from House hold sector and quantity of e-waste generation. A total of 579 Computers, 75 Printers, 1456 TVs, 146 Air Conditioner, 99 Refrigerators, 2026 Mobile Phones and 595 washing machines. Total e-waste generated from these seven items is 12190.09 Kg per annum. In most of the houses the EEE are in good condition, however if any trouble arises, they get it repaired either from service centers or a person from service centers visits and rectify the items. In few cases the EEE which needs repair are either repaired and stored in houses or donated to other family members or are being replaced by a new one.

E- Waste Generation Due to Consumers/users of in Bulk Quantities in Hotels and Institutes

Hotels, multistoried institute buildings and travel companies use EEE in bulk quantities. Out of fifty five surveyed a total of twenty two have responded. These 22 organizations are using 791 Computers, 15 Printers, 817 TVs, 10 washing machines, 10 Refrigerators, 117 Mobile Phones and 7 Air Conditioner. Total e-waste generated is 9447.12 Kg per annum. (Assuming an average weight of EEE as per E-Waste Volume I, Inventory Assessment Manual, UNEP).

E -Waste Generation Due to Users/ Consumers of Mobile Phones in Bulk quantity

Out of 24 surveyed a total of Twenty Two firms have responded. These eight organizations uses 12,661 mobile phones and yearly discarded / repaired is 1106. Total e-waste generated from these mobile phones is 121 Kg. (Assuming an average weight of mobile phone is 0.100 Kg as per E-Waste Volume I, Inventory Assessment Manual, UNEP).

E-Waste Generation Due to Users/Consumers in Bulk Quantity from Manufacturing industry of all scales (Large, Medium and Small)

Out of Two Hundred organizations surveyed a total of Hundred and six have responded. Table 3 shows the summary of survey from manufacturing industry and quantity of e-waste generation.

These organizations are using 1445 computers 578 printers, 132 TVs, 537 ACs, 41 Refrigerator, 635 Mobile Phones and 33 washing machines. They are have discarded 447 computers 169 printers, 20 TVs, 123 ACs, 6 Refrigerator, 175 Mobile Phones and 7 washing machines. Total e-waste generated from these items is 20420.7. 8 Kg/annum (13231.8 kgs/annum from computers, 845 kgs/annum from printers, 723 kgs/annum from TVs, 5000 kgs/annum ACs,288 kgs/annum from Refrigerator, 17.9 kgs /annum from Mobile Phones and 315 kg/annum from washing machines) (Assuming an average weight of EEE as per E-Waste Volume I, Inventory Assessment Manual UNEP).

Conclusions

It was observed during field visit that no e-waste is generated while assembling the computers, television and mobile set. It is interesting to note that most of the assemblers are dealers of various companies. Assuming an average weight of EEE as per E-Waste Volume I, Inventory Assessment Manual, UNEP [2], total e-waste generation from seven types of EEE from different categories of users/consumers surveyed are as given below.

i. Total e-waste generation in bulk quantity from software industry of all scales (large, medium and small) is 250162.8 kg/annum

ii. Total e-waste generation due to repairs of EEE is 32443 Kg per annum

iii. Total e-waste generated from seven EEE items due to households is 12190.09 Kg per annum

iv. Total e-waste generated due to consumers/users in bulk quantities in hotels and institutes is 9447.12 Kg per annum

v. Total e-waste generated is 121 Kg from users/ consumers of mobile phones in bulk quantity n organizations

vi. Total e-waste generated from users/consumers in bulk quantity from manufacturing industry of all scales (large, medium and small) is 20420.7. 8 Kg/annum.

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