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Research Article

Behaviour of Individuals Towards E-Waste Management in India

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Abstract

Technology is changing very quickly at very cheap prices. Along with this, it becomes easier to buy any electronic product right now as compared to previous years. There are many channels (Online & Offline) available in the market to buy your desired products. Nowadays it becomes a trend: to buy new electronic products to use the latest available technology. People prefer to buy new product instead of upgrading the old product. Mobiles and laptops are the most common products which are bought frequently instead of to upgrade. Expanding usage of the mobiles, computers/laptops, and LCD/LED in all the sectors inflicting dramatically increase in generation of e-waste. E-waste referred to all kind of electric and electronic appliances that is thrown by their end user. The electronics equipments are very complex assembly structure. It contains toxic gases, toxic metals plastics, circuits, some precious metals like gold in very small quantity. The toxic substances have very adverse effect on the health of human being. These are also very dangerous for our environment also. . The objective of the study is to find how the individual consumers behave towards the e-waste. Awareness level of the individual consumers also checked. Northern Indian states are selected to conduct a study to check the awareness level of individual consumers. In this paper consumer recycling behavior was analyzed with the help of questionnaire.

Keywords: E-waste; Awareness; Northern Indian States; Consumers; Hazardous Effects; End of Life

1. Introduction

Nowadays electronic products such as laptops, mobile phones and TV etc. become our basic necessity. We feel very uncomfortable without these products. Today, almost every person in India has a mobile phone and TV. Conjointly the life span of the mobile phones is terribly short. Peoples in India have become accustomed to change their mobile phones very frequently. They change their mobile phones very frequently to get the latest technology and also to increase their social esteem. This is the reason why e-waste is generating on menacing stage in India. E-waste is the one in all the quickest growing steam within the world. There are another factors conjointly that support the e-waste generation like "high obsolescence rate", "rapid change in technology", "social esteem" etc. now the question arises that why do we need to think about e-waste management? A very simple answer to this is that all electronic products contains some toxic and potentially hazardous substance like barium, cadmium, cobalt, lead, mercury etc which have very adverse effect on our health. These content cause damage to lever and heart, affects the kidney, human brain, lungs etc.

The figure shows that in all the factors, the value of mean lies between 1 and 2. It shows that most of the consumers either have no idea of hazardous materials in e-waste, concept of e-waste management and electronic waste management policies implemented in India or they have very little knowledge.

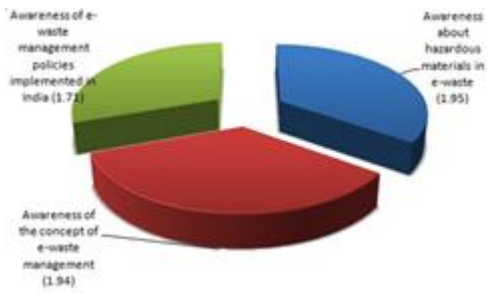

Fig. 1. Graphical Abstract

On the other side electronics items also have precious metals also like silver and gold which also needs to be quarantined from the electronic waste before being disposed off. Along with it the problem become more dangerous that the developed countries dump their discarded electrical and electronics equipments in the developing countries like India, China etc.

This paper is simply to visualize the awareness level of the Indian stakeholders regarding e-waste. The survey was conducted in Northern Indian States i.e. Punjab, Haryana, Himachal Pradesh, New Delhi and Uttar Pradesh and Chandigarh. Such respondent have been selected whose educational qualification is graduate.

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Table 1
Source of E-Waste and Constituent

Source of E-waste	**Constituent**
Electron Tubes, filler for plastics and rubber, front panel of CRTs	Barium
Casing, circuit boards, cables and PVC cables	Brominated flames retardants (BFR)
Solder, alloys, circuit boards, computer batteries, monitor CRT, chip resistors	Cadmium
Dyes/pigments and switches	Cobalt
Conducted in cables, copper ribbons, coils circuitry	Copper
Lead rechargeable batteries, transistors, lasers, LEDs, circuit boards, glass panels and gaskets in computer monitors	Lead
Switches, LCDs, printed circuit boards	Mercury
Relays, semiconductor pigments	Nickle
Transformers, capacitors, plastic	Polychlorinated biphenyls Selenium(PCB)
Capacitors, switches, batteries, resistors	Silver
Steel, brass, alloys, luminous substances	Zinc
Motherboard	Beryllium

(Source: Alexander Janz and Bernd Bilitewski, 2008)

Table 2
Constituent in e-waste and danger (Source – Down to Earth, 2010)

Acid	Acids are used in pickling – removal of rust and corrosion from the metals, as electrolyte in the Pb-Acid batteries and in mineral processing. Acids fumes causes respiratory problems and are corrosive to eye & skins.
Plastics	Excessive use of plastic is adversely affecting Earth's environment, humans & wildlife. Plastic pollutants may be micro-, meso-, macro- debris in size. Humans are excessively using plastic due to their economy and durability. Extensive use of plastics leads to cancer, various skin diseases, liver malfunction, hormonal changes etc.
Chromium (Cr)	Chromium is used as coating on metal parts, in order to protect them from corrosion, which produces Chromium dust & fumes. A small inhalation of hexavalent chromium compounds may increase the risk of cancers (Sinus, nasal & lungs).
Mercury (Hg)	Mercury fumes inhalation is harmful to humans' nervous system, lungs, kidneys and affects immune & digestive system. Mercury can easily enter to food chain through water bodies. Mercury is naturally produces from volcanic eruptions & oceans, while anthropogenic sources include burning of fossil fuels & industrial processes.
Lead (Pb)	Lead is an highly toxic metal which is found in human vicinity in forms of fumes & minute dust particles by burning of fossil fuels, mining, & also produces in large amount during recycling of e-wastes. Humans in regular contact with high levels of load is very dangerous which causes changes in humans fertile cycle, and also causes severe damages to lungs, kidneys and permanent damage to brain.
Cadmium (Cd)	Rich sources of Cadmium includes green/leafy vegetables such as potatoes, peanuts, spinach, sunflower seeds, soyabeans, tobacco leaves which accumulate high level of cadmium from the soil. Inhalation of high levels of Cd over a short period of time results in flu like symptoms like fever and muscle pain; while chronic exposure to Cd kidnies mul-function, damage to lungs & livers, softens the bones tissues.

Table 3
E-waste generation in 2014 (Source Dr. Brijesh Sivathanu, 2016)

Items	**Obsolescence Rate**	**E-Waste in Tons/year**
Cell Phone	2	44.50
Personal Computers	5	1183.90
Refrigerator	15	1949.48
Televisions	15	1395.55
Total		**4573.43**

Fig. 2. E-waste storage and handling in India

1.1 Role of individual consumers

As we know that there are two pillars which are accountable for the generation of the e-waste. First one is the Individual consumers and another one is organizational consumers. As individual consumers have mobile phones, TV/LED, Refrigerator and different electronic appliances in their possession. Therefore we can say that individual end users play a significant role in the e-waste generation. Even after the end of life, the individual consumer keeps electronic products at their homes. They do this because they are not aware of the hazardous effects of e-waste on human health and environment. The government should make awareness programs to make people aware of ill effects of e-waste.

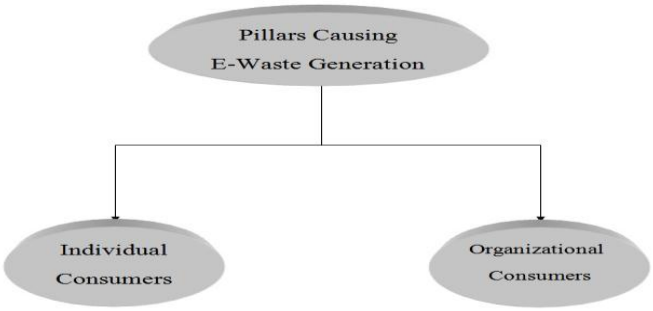

Fig. 3. Pillars Causing E-waste Generation

1.2 Aim of the Study

Northern states of India like Himachal Pradesh, Punjab, Haryana, New Delhi and Uttar Pradesh and Chandigarh have been selected for the survey. This survey has been done to check the awareness of the individual consumers about the negative impact of e-waste.

2. Literature

In India number of brands are indulge in electronic equipment manufacturing. Due to lack of strong policies towards e-waste management in India, major companies – Apple, Sony, Sharp, Sony-Ericsson, Sharp, Panasonic, and Toshiba etc have no take-back policy. But others brands either do not have any take back facility or non-user friendly policies. Only Samsung is claiming a take-back facility in major cities of India & e-waste drop centers in approximately all d cities of India. Even some other brands claims to have take-back facility but they don't provide any data/information on their websites which makes it tough for the Indian customers to avail the facility. Brands are not interested in investing towards education and awareness of customers on e-waste management and recycling. Even executive level officers of top brands are not aware of e-waste management.

Today, India is becoming a pit ground for dumping of in-house e-waste or imported illegally. Developed countries are exporting their e-waste to developing countries like India. The most common method of disposing e-waste is to dispose-off them in landfills being the least expensive and least environment friendly.

According to a report by Rajya Sabha Secretariat, 2011 which studied the scope and present condition of e-waste management and recycling in India in February 2009 submitted by Ministry of Science & Technology, India – which conclude an crucial status relationship between formal and informal sectors producing e-wastes. It is observed the necessity of informal sector role in collecting, segregating & dismantle of e-waste must be nurtured to fulfill the supply chain partners as formal recyclers. They must disregard upper technology involved in recycling of e-wastes. The informal sector is collecting, segregating & dismantling the e-wastes into refurbished items which are being sold to second users as recycling of e-waste is non-hazardous and recycling processes are

expeditiously adopted by them. Additionally, Indians are generating speedily increasing amounts of e-wastes domestically. On the opposite hand, consumers may play a vital role by using the electronic equipments to their extended life by minute repairs & AMCs and hand down the equipments to family and friends, fellow employees & needy peoples and in the last disposed them in proper manner. In an exceedingly positive note such practices are abundantly evident in India. Lack of awareness about e-waste hazards makes Indians to reluctant to dispose – off e-wastes instantly. Faulty electronic items remain in houses without proper care and attention in all the places like houses, work places and other storage houses for years and ordinarily mixed with other ordinary domestic wastes which are meant to be disposed off finally in landfills. It has been studied that maximum electronic items in India are on-hold because of uncertainty of finding the way to manage it.

E-wastes contains both hazardous and significant materials that need exceptional treatment and reusing practices to maintain a strategic distance from unfavorable natural and destructive effect on human wellbeing. Rettrieving the valuable and base metal is attainable by frecycling e-waste. Through reusing, 95% of a PC's valuable materials and 45% of CRT materials will be reused.

David, V., 2008 deineated that an unnatural weather change, greenhouse emanations and e-waste are generally serious issues around the world. Reception apparatuses are at present a typical component in a large portion of the customer's electronic gadgets furthermore to remote detecting component systems and radio recurrence frameworks utilized item the executives and creature farming. In moving to RoHS and WEEE consistent frameworks, radio wire designers should consider new style techniques and materials in reception apparatus mass assembling.

Human, A. et al., 2002 show the startegic and natural issues associated with the usage of maker obligation regarding bussiness to bussiness tasks with in an IT frameworks and administration organization. They conjointly legitimize the duties of the maker and ecological edges of e-waste the executives.

Susan, D. et al., 2002 focus on the existence cycle ecological effect of consistently developing and unendingly powerful universe of EEE. This market proceeds fundamentally with progress in innovation. They additionaly concern chimney wellbeing perspectives for EEEfor the security of life, insurance of condition. Fire retardants are utilized to decrease the fire dangers.

Matsumoto, M. et at., 2007 referenced the ecological contaminations brought about by uncontrolled e-waste reusing might be a squeezing isue with in the space. The objective of this investigation is to examine the since quite a while ago run future projections for e-waste reusing framework. To start with, they present essential information that is gainful for the circumstance assesments. The data is particularly for the Japanese case. The data incorporates e-waste amount, e-waste stream, material substance in e-waste, LCA of material science item and use costs. Second, they characterize the more drawn out term consequences for e-waste use framework. Third, as a circumstance for the more drawn out term e-waste reusing, they will in general propose the tele-opposite creating model.

Bullock, J., 1995 tells that the electronic business faces a test, might be trouble along the reclaim system. Moreover he thinks about that PCs don't wear out; they become old as client need mechanical propelled item with lower cost. PCs have a short life expectancy. He conjointly legitimize the climate of chain of command that are immediate reuse of complete computers, direct reuse of working components, recuperation and reuse of gadgets components, recovery of the crude materials and transfer.

Chancerel, P. furthermore, Rotter, V., 2009 focus on the assessing the administration of minimal waste EEE through Substances Flow Analysis. They focus on the measuring the progression of gold related with little EEE in Germany and USA. The extent of the significant metal in EEE is incredibly less in amount, anyway these metals have a high affordable connectedness.

Jinglei, T. et al., 2010 referenced the reusing of WEEE in China. Dominant part of the e-waste is overseen by casual areas in china. China assumes a critical job with in the reusing of the WEEE. China is the world biggest shipper of e-waste. They conjointly choose the limitations and difficulties of e-waste reusing business and approaches to beat them.

Kahhat, R. and Kavazanjian, E. Jr., 2015 advised the strategy to manage the e-waste is that the use of the mono-disposal land filling. it's a short lived storage for the longer term mining. They show this answer as sustainable solution to e waste management.

Mead, C.D. et al., 1999 take into account the Nortel Networks that is work system for knowledge exchange and products environmental information management throughout the product life cycle and methodology to boost the performance of product environment. They conjointly concentrate on the drivers to e-waste management which are customer information requirement and legislation. They take into account four solutions to the merchandise knowledge capture: Database- A- element life cycle inventory, Database- B element environmental specification knowledge, Database- C Nortel Network Specific, Database- D business collaboration.

Manufacturer have following alternative of reverse channel structure-firstly the manufacturer collect from the merchandise directly, second the distributor collects the used product for manufacturer and at last the manufacturer subcontracts the used product assortment to a 3rd party. (Hung, C. C., 2014).

Dwivedy, M., 2013 summarized the 3-R principle, which might be termed as reduce, reuse and Recycle. He also considers the two scenarios for the estimation of the present and future outflows of e-

waste in India. First situation represents the optimistic assumptions whereby majority of the obsolete things are reused and few are hold on. Second situation represents the pessimistic situation, where wide quantity of stock remains in storage.

Waste product are recycled, disassembled, tested and replaced or build new product. Remanufacturing is absolutely coordinate the two supply system of components that are new components provide syste m and re-manufactured provide system. (Wen-hui, X. et al., 2011).

Jian, L. And Shanshan, Z., 2010 study the e-waste management system based on Extended Producer Responsibility (EPR), to cut back electronic pollutants. They conducted their study in China. They recommend how the govt will carry out EPR system.

2.1 Problem Formulation

With the evolution of the technology, e-waste generation is additionally increasing swiftly. E-waste contains materials like lead, cadmium, mercury, chromium etc. that cause harmful pollutants if not properly disposed off. Therefore it becomes vital to possess an effective e-waste management system. This can conjointly necessary for human health as well as surroundings. It is clear from the literature that Indians are not aware at all about e-waste. They don't even know about the term "e-waste". In this paper, we have learned about consumer's awareness level.

Due to the lack of awareness about the hazardous effects of the e-waste on human health and surroundings, we choose land filling, open burning strategies for our discarded electronic products. These methods have a very adverse effect on our health and environment. Hazardous substances can contaminate the ground water due to land filling of discarded electronic products. Along with this, due to lack of strict laws and regulations, availability of labor at cheaper rate in India, developed countries are also dumping their electronic waste in India.

2.2 Objectives of the Study

The objectives of the study are:

1. To check public awareness about the hazardous impact of e-waste in northern Indian states.
2. To search out the level of awareness of e-waste management concept.
3. To find out the knowledge of people about the present e-waste management policies enforced in India

2.3 Research Methodology

This is an exploratory research study to understand the consumers' awareness towards e-waste. This study is based on the northern Indian states i.e Punjab, Haryana, Himachal Pradesh, Uttar Pradesh, New Delhi and Chandigarh. A survey was conducted in these states to check the awareness level of the negative effects of e-waste among the individual consumers. A questionnaire has been set up to conduct the survey. The survey was conducted among those who have at least graduation educational qualification. Total 280 consumers surveyed from various northern Indian states to conduct the exploratory study. First, descriptive statistics has been performed to find out the mean and standard deviation from the responses. After this technique, we find out the correlation between the different objectives. Full liberty to the respondent to choose more than one option. A demographic profile of the respondents was prepared by applying frequency distribution.

2.4 Analysis and Interpretation

The demographic details are as below:

Table 4
Demographic Details of Consumers

Items	Counts	Percentage (%)
Gender		
Male	165	59%
Female	115	41%
Age		
20-29	112	40%
30-39	93	33.20%
40-49	57	20.40%
50 or above	18	6.40%
Marital Status		
Married	214	76.43%
Unmarried	66	23.57%
Educational Qualification		
UG	149	53.20%
PG	54	19.30%
Professional	77	27.50%
Income		
Below 1 Lakh	12	4.30%
2 Lakhs to 3 Lakhs	96	34.30%
4 Lakhs to 5 Lakhs	158	56.40%
10 lakhs or above	14	5%

Table 5
Education level and Awareness of E-waste

Sr. No.	Response	Count of the Respondents	Percentage %
1	**Aware**	**148**	**52.86%**
	UG	89	31.80%
	PG	15	5.35%
	Professional	44	15.71%
2	**Unaware**	**132**	**47.14%**
	UG	72	25.71%
	PG	34	12.14%
	Professional	26	9.30%

3. Result & Discussion

This chapter includes the outcome of the study. First we applied descriptive statistics technique to find out the mean and standard deviation using SPSS software.

Table 6
Descriptive Statistics to find out mean and standard deviation

	Mean	Std. Deviation	N
Are you aware about the hazardous materials in e-waste?	1.95	1.242	280
How aware are you of the concept of e-waste management?	1.94	1.313	280
Are you aware of any electronic waste management policies currently implemented in India?	1.71	1.223	280

As it is clear, the value of standard deviation is less than the value of mean in all cases. The mean of first objective is 1.95 and standard deviation is 1.242. The mean of second objective is 1.94 and standard deviation is 1.313. Similarly mean of third objective is 1.71 and standard deviation is 1.223. Thus nearly all of our normal distribution would stretch out over a line segment. Not all the data is normally distributed and bell curve shape. But most data is well behaved enough that is more than, 1.2 standard deviation away from the mean captures nearly all the data.

This data shows that in all the factors, the value of mean is between 1 and 2. This reflects consumers' awareness of electronic waste. It shows that most of the consumers either have no idea of hazardous materials in e-waste, concept of e-waste management and electronic waste management policies implemented in India or they have very little knowledge.

Next we find out the correlation between the objectives of the study using SPSS software.

Table 7
Correlations table between three objectives

		Are you aware about the hazardous materials in e-waste?	How aware are you of the concept of e-waste management?	Are you aware of any electronic waste management policies currently implemented in India?
Are you aware about the hazardous materials in e-waste?	Pearson Correlation	1	.948**	.887**
	Sig. (2-tailed)		.000	.000
	N	280	280	280
How aware are you of the concept of e-waste management?	Pearson Correlation	.948**	1	.931**
	Sig. (2-tailed)	.000		.000
	N	280	280	280
Are you aware of any electronic waste management policies currently implemented in India?	Pearson Correlation	.887**	.931**	1
	Sig. (2-tailed)	.000	.000	
	N	280	280	280

		Are you aware about the hazardous materials in e-waste?	How aware are you of the concept of e-waste management?	Are you aware of any electronic waste management policies currently implemented in India?
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How aware are you of the concept of e-waste management?	Pearson Correlation	.948**	1	.931**
	Sig. (2-tailed)	.000		.000
	N	280	280	280
Are you aware of any electronic waste management policies currently implemented in India?	Pearson Correlation	.887**	.931**	1
	Sig. (2-tailed)	.000	.000	
	N	280	280	280

**. Correlation is significant at the 0.01 level (2-tailed).

From the above Pearson correlation table it has been observed that there was a highly significant positive correlation among the 'Are aware about the hazardous materials in e-waste?' with the 'How aware are you of the concept of e-waste management?' and 'Are you aware of any electronic waste management policies currently implemented in India? It shows that as the awareness of concept e-waste management increases, awareness about the hazardous materials also increases. On the other side the increase in the awareness about the hazardous materials in e-waste responsible for increase in the awareness about e-waste management policies in India and vice a versa.

Similarly there was a highly significant positive correlation among the 'How aware are you of the concept of e-waste management?' with the 'Are you aware about the hazardous materials in e-waste?' and with 'Are you aware of any electronic waste management policies currently implemented in India?' was observed.

Like these two, it has been observed that there was a highly significant positive correlation among the 'Are you aware of any electronic waste management policies currently implemented in India?' with the 'Are you aware about the hazardous materials in e-waste?' and with 'How aware are you of the concept of e-waste management?'

Now we show the response graphically. In response to the first question, 47 % of people have not any idea of the hazardous materials of the e-waste. 31 % of the consumers have very little awareness of the hazardous materials in electronic scrap. This shows that the majority of people either do not have any idea: or they are little aware of the hazardous materials in e-waste.

We can say that these three factors are directly proportional to each others.

From the figure below, Awareness level of approx 19 % of the stakeholders is found to be average. Awareness level of only 4 %of the crowd was found to be high and only 2 % of consumers have updated level of information about the hazardous materials in e-waste.

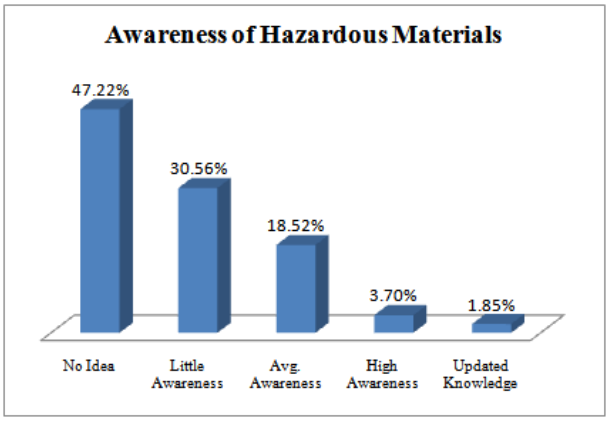

Fig. 4. Level of awareness of hazardous materials in E-waste

Next we would like to ascertain the awareness regarding the term "e-waste management". Majority of the population i.e. 51 % have no idea about the concept of e-waste management. Proportion of the stakeholders with

little awareness is only 28 %. On the opposite hand, solely 15 % of the peoples have average awareness of the term e-waste management. 5 % of the end users are extremely attentive of the idea and solely 4 % find their knowledge up to the updated level.

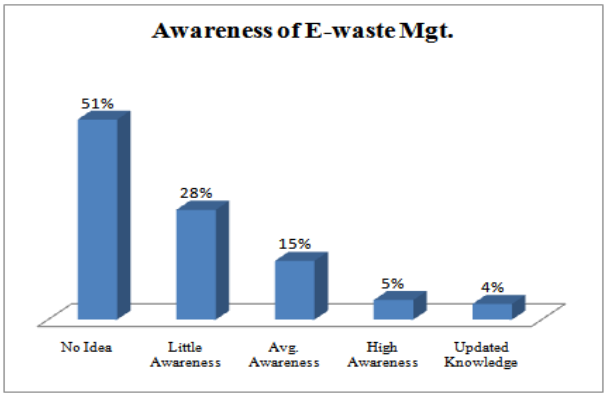

Fig.5. Awareness of the concept "E-waste management"

In response to the next question, 36 % of the people said that they do nothing with their discarded electronic equipments before end of life (EOL). They ignore such products or keep them anywhere in the house. 13 % of Indians deal with their electronic waste along with their household waste. 39 % of the crowd sells their e-scrap to an informal collector like scrap dealer etc. Majority (44 %) of peoples donate their discarded electronic equipments to their family members/friends etc. No consumer burns their discarded electronic scrap in the open environment before EOL.

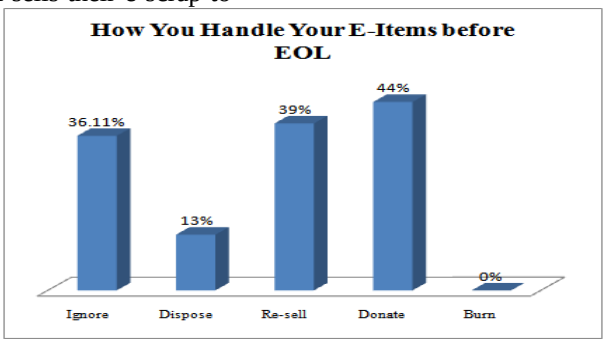

Fig. 6. How consumers handle e-waste before EOL

The difference between the previous question and this question is just that in the earlier question we handled the discarded electronic products before the end of life (EOL) while in this question we have considered the handling of discarded electronic products after end of life (EOL). 36 % of the buyers store their electronic items in their home even after the completion of their useful life. Majority (55 %) of people sell their e-items to others after EOL. 20 % of people sell their e-scrap to informal channel such as scrap dealer etc. Only 7 % of the crowd is those who dispose off their e-waste through formal channel. Along with this, it is also doing a show of how much the formal channel is supplied in India and how much awareness about formal channels in India. Approx 8 % of the consumers trash their discarded electronic products with their household waste.

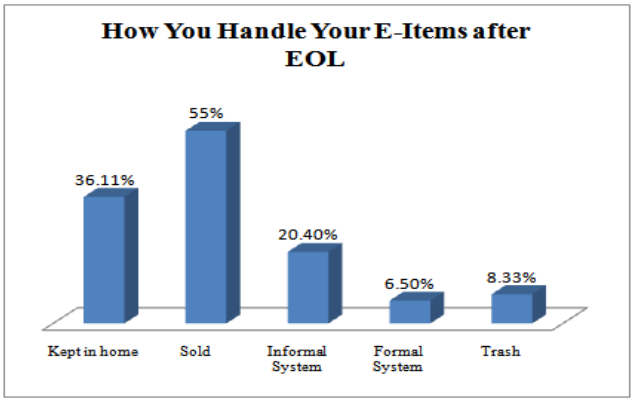

Fig. 7. How consumers handle e-waste after EOL

54 % of peoples have no idea about the e-waste management policies in Republic of India. They are completely unaware of the Indian e-waste management policies. 32 % of the stakeholders have little knowledge of the Indian policies of e-waste management. It shows that the majority of people are not aware of the policies either, and those who have it, they have very little information. Only 9 % of consumers think that their information is of average level. 5 % of the population has been found to have high level of knowledge and the same population has been found to have highly updated knowledge of e-waste management policies implemented in India

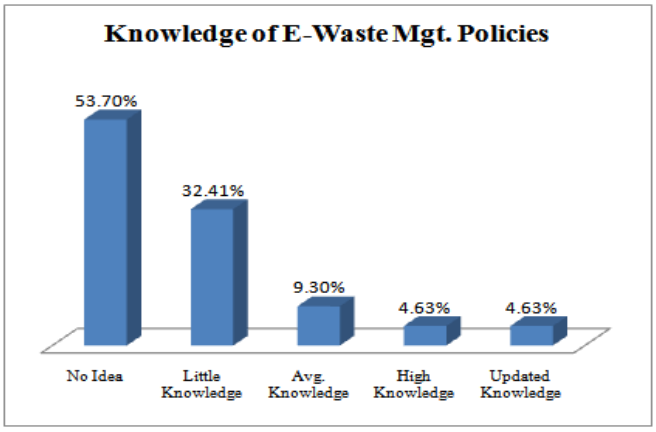

Fig. 8. Knowledge of consumers about Indian e-waste mgt. policies

Now we want to find out the main obstacle which is an impediment in formal e-waste management. Based on this study, we came to the conclusion that there are two obstacles in the way of formal e-waste management system. One of them is the lack of legislations whose share is 29 %. The second one is the lack of awareness about the dangerous effects of e-waste on human health and environment. Its contribution is 71 %. According to 4 % peoples, lack of promotional schemes is the main obstacle towards the formal e-waste management. Only 10 % of the entire crowd feels that lack of financial incentives is the main reason for the failure of the system. Only 7 % of the people feel that lack of collection centers is the main reason

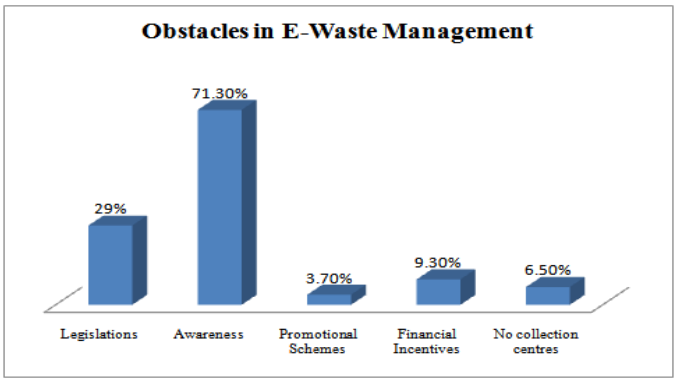

Fig. 9. Main obstacles in proper e-waste management

4. Conclusion

The value of standard deviation is less than the value of mean in all cases. But most data is well behaved enough that is more than, 1.2 standard deviation away from the mean captures nearly all the data. From the Pearson correlation table it has been observed that there was a highly significant positive correlation among the all the three objectives. Approx half of the crowd has no idea of hazardous materials in the e-waste. It becomes essential to aware the Indian citizens for the e-waste hazards. Over half of the entire population is completely unaware of e-waste management thought/concept. 80 % of the peoples opt for either re-sell their electronic things to informal collector before EOL or present to different family members/friends/charity. Over half of the peoples sold their e-items to their personal contact after EOL. 54 % of the whole population has no idea of e-waste management policies presently enforced in India. About 71 % of the people contemplate into account lack of awareness about hazardous effect of e-waste is that the main obstacle in proper e-waste management. Government ought to run awareness programs to urge the end user aware of the unsafe effects of e-waste on health of the individual and also the environment.

References

Alexander, J., & Bernd, B. (2008). *E-waste: Implications, regulations and management in India and current global best practices*, TERI, New Delhi.

Borthakur, A., & Sinha, K. (2013). Electronic Waste Management in India: A Stakeholder's Perspective. *Electronic Green Journal*, 1(36), 1-21.

Chancerel, P., & Vera S. R. (2009). Assessing the management of small Waste Electrical and Electronic Equipment through Substance Flow Analysis - The example of gold in Germany and the USA. IEEE, 1-6.

David, V. (2008). Sustainable Electronics: Wireless Systems with Minimal Environmental Impact. IEEE, 1298-1301.

Dey, S., & Jana, T. (2014). E – waste Recycling Technology Patents filed in India - An Analysis. *Journal of Intellectual Property Rights*, 315–324.

Down to Earth, IT's underbelly'(2010). 19 (1).

Gaidajis, G., Angelakoglou, K., & Aktsoglou, D. (2010). E-waste: Environmental problems and current management. Journal of Engineering Science and Technology, 3(1), 193-199.

Greenpeace Report (2005). *The e-waste problem*.

Hume, A., Grimes, S., Jackson, T., & Boyce, J. (2002). Implementing Producer Responbility: Managing End-of-Life Consumables in an IT-Service Industry IEEE, 144- 149

Hung, C. C., Charles, X., Wang, & Zhao, Y. (2014). Closed Supply Chain Models for a High-tech product under alternative reverse channel and collection cost structures. An international Journal of Production Economics, 156,108-123.

Jian, L., & Shanshan, Z. (2010). Study e-waste management based on EPR system. International Conference on E-Business and E-Government, 820-823.

Jinglei, Yu., Meiting, Ju., & Williams, E. (2009). Waste Electrical and Electronic Equipment Recycling in China: Practices and Strategies. Conference on Sustainable Systems and Technology.

John, C. B. (1995). Environmentally Sound Management of Electronic Scrap and the Basel Convention on Control of Transboundary Movements of Hazardous Waste and Their Disposal IEEE, 192-197.

Kahhat, R., Kim, J., & Xu, M.. (2015). E-marketing for E-waste. IEEE.

Maheshwar, D. (2013) Modeling and Assessment of e-waste Management Issues in India: Generation, Flows and Extended Producer Responsibility.

Matsumoto, M., Mishima, N, Masui, K, Kondoh, S. (2008). Proposal and feasibility assessment of tele-inverse manufacturing IEEE.

Mead, C.D, Donaldson, J.D., Snowdon, K.G. & Francis, D.P. (1999). Supplying DFE in Telecommunications Industry. Proceedings of the 1999 IEEE International Symposium on Electronics and the Environment, 331-336.

Rahman, S., and Subramanian, N. (2011). Factors for implementing end-of-life computer recycling operations in reverse supply chains. An international Journal of Production Economics,140, 239-248.

Rajya Sabha Secretariat Report, (2011). *E-Waste in India*.

Ramachandra, T., & Varghese, S. (2004). Environmentally Sound Options for E-Wastes Management. *Envis Journal of Human Settlement*. 1-10.

Sinha, S. (2008). Dark shadows of digitalization on Indian horizon, in Johri, R. (Ed.): E-Waste Implications, Regulations and Management in India and Current Global Best Practices, Teri Press, New Delhi, India

Skinner, A., Dinter, Y., Lloyd, A.,& Strothmann, P. (2010). The Challenges of E-Waste Management in India: Can India draw lessons from the EU and the USA?. The German Journal of Contemporary Asia (ASIEN). 7–26.

Susan, D. (2002). .Life-Cycle Environmental Impact of Flame Retarded Electrical and Electronic Equipment. IEEE Interntional Symposium on Electronic and the Environment,1,163-168.

Townsend, T.G. (2011). Environmental Issues and Management Strategies for Waste Electronic and Electrical Equipment. *Journal of the Air and Waste Management Association*. 61 (6). 586–586.

XIA Wen-hui, Dian-yan, J., & Yu-ying, H. (2011).The remanufacturing reverse logistics Management based on Closed-loop supply chain management processes. Procedia Environmental Sciences, 11, 351-354.

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