Towards a model for effective e-waste management: a study of the software industry in India

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Abstract: In last few years tremendous growth in information technology results a new kind of waste known as e-waste. This growing volume of e-waste is harmful for human health and environment and lead to resource depletion. So, it's important to manage this e-waste effectively. In this study the variables responsible for the growing volume of e-waste identified and to arrive at a research model for effective e-waste management. A total of 200 software developers participated in the survey. A multiple regression analysis was employed and the, 'collection and recycling' appeared as the best predictor, followed by 'awareness' and 'regulations'. Which shows that through proper collection and recycling of e-waste and awareness about the hazardous nature and proper implementation of regulations related to e-waste management need to be done effectively. The policy implication is that policy makers of software industry can use so developed model for developing policies related to e-waste management.

Keywords: recycling; e-waste; reuse; collection; software industry; waste electrical and electronic equipment; WEEE; India.

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1 Introduction

The management of e-waste in developing countries is a big challenge due to lack of proper collection and recycling, less awareness among citizens about the hazardous nature of e-waste and poor legislation in comparison to developed countries. The current system of e-waste management in developing countries is not sustainable because the process for collection, recycling, reduce, reuse are still need to be developed. So, there is need for sustainable design, recycle and handling electronic devices (Morrissey and Browne, 2004). In developing countries, the process to dismantle and recycle CRT TV, as well as other information and communications technology (ICT) devices, is commonly performed by the informal sector; such is the case in Peru, Mexico or Bangladesh (Kahhat and Williams, 2009; Lepawsky and Billah, 2011; Estrada-Ayub and Kahhat, 2014).

Handling of WEEE in developing countries encompasses repair, reuse and substandard processing within a largely informal recycling sector (Ongondo et al., 2011). Landfilling of e-waste is also one of the common disposal methods in developing as well as developed countries (Cucchiella et al., 2015). It has been found that WEEE sites are 100 times more contaminated than residential areas (Ghosh et al., 2015).

Another line of argument suggests that the intense competitive pressure on developed-country firms to reduce costs has forced some firms to seek to export e-waste to low-cost locations where they can recycle more cheaply (Slade, 2006; Nnorom and Osibanjo, 2008).

Empirical studies have shown that because discarded electronics contain precious materials such as copper, gold and silver – many informal recycling yards have sprung up in developing countries (Sthiannopkao and Wong, 2013).

Exporting to under-developed countries where workers uses sub-standard equipment can increase this particular risk (Garlapati, 2016; Orlins and Guan, 2015).

Lack of informal data and poorly documented data of informal sector are also major issues in developing countries (Wang et al., 2013). Despite of many preventive legislation still e-waste is transferred from developed to developing countries through legal or unregistered routes (Cucchiella et al., 2015). Due to a lack of policies to manage and control the recycling of e-waste in developing countries, much of this waste is processed in small-scale, unregulated family workshops where labourers manually disassemble electronics (Li et al., 2009; Liu et al., 2006).

The comparison of developed country and developing countries indicates that there is a huge gap between their e-waste management status and process. During literature

review related to developed and developing countries of e-waste management practices, various factors have been identified in different context like country, culture, economic parameters etc. It imperatively says that building blocks of effective e-waste management is known in developed countries but how many of those are applicable in India are not known. So it is important to know what will be the building blocks of e-waste management practices in India. This paper attempts to create a model of e-waste management in India, which is empirically tested in Indian software industry.

Various studies by authors on e-waste management practices in developed and developing countries contribute steps, mechanism and factors of effective e-waste management relevant to ever increasing volume of e-waste. Factors like 'collection and recycling', 'awareness', 'rules and regulations', 'government support', 'initiatives', and 'responsibility' could be the building block of effective e-waste management in India (Srivastava et al., 2014). In this study we provide building block of effective e-waste management.

2 Literature review

During literature review it has been found that various authors have tried to define e-waste in their terms. Various authors define e-waste like it is an electronic device 'which reached its end of life', 'device no longer privately valued by its owner', 'past their useful lives', 'devices are disposed or sent for recycling'. Such products include IT and telecommunications equipment such as computers, televisions, cell phones, and PDAs, as well as large and small home appliances including refrigerators, air conditioners, washing machines, and toasters.

There is direct correlation between e-waste generation and gross domestic product (Huisman, 2003), and because of which in developing countries per capita generation increased (Gu et al., 2015). A report also revealed that India and China will double their e-waste in the coming few years (Ruan and Xu, 2016). It has also been predicted that in developing countries obsolete computers quantity will reach 400–700 million by 2030 (Sthiannopkao and Wong, 2013).

There are various reasons for the growing volume of e-waste in India like the life span of electronic devises are dropping day by day, rise in the consumption of electronic devices, import of e-waste in the name of second hand electronic devises, lack of recycling facilities (Brigden et al., 2005; Puckett and Smith, 2002; Cobbing, 2008; Deutsche Umwelthilfe, 2007). According to Widmer et al. (2005), though waste generation is estimated to be less than 1 kg e-waste per capita, due to the high population of the country, the absolute quantities of e-waste generated is very huge in India and China. In India, more than 60% of its e-waste is generated from 65 cities. The top 10 cities that generate e-waste are Mumbai, Delhi, Bangalore, Chennai, Kolkata, Ahmedabad, Hyderabad, Pune, Surat and Nagpur (Chatterjee, 2007).

As per existing literature e-waste contains valuable resources which can be easily recycled, as well as hazardous substances which need to be treated in an environmentally sound manner (Widmer et al., 2005). As per existing literature 'availability of low and high value of hazardous materials in e-waste', 'crude techniques for e-waste recycling used by informal sector', 'using landfill and incineration for disposal of e-waste',

'primitive recycling of e-waste' are the main reasons which are big concern of e-waste (Halluite et al., 2005; Realff, 2004; Liu et al., 2006).

As per existing literature e-waste is processed by either landfill or incineration. Landfill causes negative effects such as groundwater pollution, while incineration causes air pollution. Hence e-waste is a critical issue that requires close attention.

Most types of e-waste contain a combination of low and high value of hazardous materials like Pb, Hg and plastics (Realff, 2004). For example Pb is considered a major element in the glass of CRTs, which is a part of monitors (Macauley et al., 2003). Another component in many e-wastes is printed wire boards which contain lead (Pb) and brominated flame retardants (Niu and Li, 2007). These hazardous materials in the obsolete electronics can be released to the environment during disposal which can cause an adverse impact to human and environment.

Table 1 Status of e-waste management in developed countries

Country	*Takeback*	*Responsibility*
Denmark	• Responsibility of local government • Retailers will receive WEEE	• Producers are responsible for managing e-waste and bearing cost
Estonia	• Producers responsibility to finance the collect of e-waste	• Producers are responsible for managing e-waste and bearing cost
Finland	• 1:1 take-back by retailers • Producers responsibility to organise and funding collection of e-waste	• Producers are responsible for managing e-waste and bearing cost
Norway	• Producers responsibility to collect e-waste from retailers and municipalities	• Producers are responsible for managing e-waste and bearing cost for new as well as old
Switzerland	• Responsibility of manufacturer, distributors and retailers to take back e-waste free of cost.	• Consumers are ready to fund the collection and recycling.
UK	• Responsibility of distributors and retailers to take back e-waste free of cost.	• Producer's responsibility to manage.
USA	• Ongoing drop off at non-profit institutions	• Not clearly defined.
Japan	• Collection points are located at retailers, collection centres or post offices	Exist

Source: Sthiannopkao (2012), Cucchiella et al. (2015), Link Toxic (2013), Wen et al. (2006), Rolf et al. (2005), Slade (2006), Nnorom and Osibanjo (2008), Kahhat and Williams (2009), Lepawsky and Billah (2011), Kahhat and Williams (2009) and Estrada-Ayub and Kahhat (2014)

E-waste constitutes more than 1,000 different substances. The significant fractions are plastics, metals, glass, ceramics, and paper etc. Upon contact with these toxic elements humans can have health problems such as breathing difficulties, respiratory irritation, coughing, choking, pneumonitis, tremors, neuropsychiatric problems, convulsions, comas and even death (Halluite et al., 2005). Presence of toxic substances in the e-waste is also

global environment problem in developing countries (Kiddee et al., 2013). Landfilling of e-waste and its shipping to developing countries has significant hazard to the environment (Tsydenova and Bengtsson, 2011).

Developed countries like Europe and Japan are the front runner to formulate policies or regulations of e-waste management. These countries not only developed these policies but also implemented successfully. As per existing literature in most of the developed countries it has been decided that its producers responsibility to manage e-waste effectively and sustainable manner. Second important points are that in most of the developed countries the entire process of e-waste management from collection to disposal manages by formal sector. The status of e-waste management practices in developed countries is shown in Table 1.

Table 2 E-waste management practices in developing countries

Country	*Legal framework*	*Separate collection*	*Recycling technology*
Argentina	Plan to develop legal framework	No separate collection	Only recyclable e-waste recycle
Cambodia	No legal framework	Only recyclable e-waste collected, no legal framework	No facility
China	Legal framework enforced	Only recyclable e-waste collected, no legal framework	Available but not fully operational
India	Legal framework prepared and issued	Only recyclable e-waste collected	Available but not fully operational
Indonesia	Plan to develop legal framework	No separate collection	Only recyclable e-waste recycle
Malaysia	Legal framework enforced	Only recyclable e-waste collected, no legal framework	Plan to set up
Philippines	No legal framework	No separate collection	Only recyclable e-waste recycle
Sri Lanka	Legal framework prepared and plan to issue	Only recyclable e-waste collected, no legal framework	Only recyclable e-waste recycle
South Africa	Plan to develop legal framework	E-waste proper collection mechanism	Plan to set up
Thailand	Legal framework enforced	Only recyclable e-waste collected, no legal framework	Available but not fully operational

Source: Sthiannopkao (2012), Cucchiella et al. (2015), Li et al. (2009), Brigden et al. (2005), Puckett and Smith (2002), Cobbing (2008) and Deutsche Umwelthilfe (2007)

In developing countries either there is no framework for e-waste management or if exist not properly implemented. As per existing literature in most of the developing countries there is no separate collection of e-waste it normally collects with other wastages and there is collection of only recyclable e-waste. In most of the developing countries either there is lack of recyclable facilities or not fully operational. Second important point is that in most of the developing countries the entire process of e-waste management from collection to disposal manages by informal sector. The status of e-waste management in Developing countries is given in Table 2.

The key comparison points for developed and developing countries shown in Table 3.

Table 3 Comparisons of e-waste management practices

E-waste management in developed country	*E-waste management in developing country*
• Some have national inventory and technical directives to deal with e-waste. • Existence of legal framework which provide an implementation and management model for the e-waste handling and minimisation, disposal, setting up goals and standards, allocation of responsibilities and identify penalties. • Take-back policy is implemented by assigning responsibilities to producer, consumer through take back network and separate committee for monitoring the fund. • Existence of national standards to regulate EEE entering in their countries • Existence of infrastructure for the disposal of the hazardous e-waste • Disposal method: Incinerators	• Developing counties usually lack the proper storage spaces and disposal areas for e-waste. • The importation of used EEE is allowed in many developing countries. • The e-waste collection is usually done by the informal sector due to lack of legislation and take back policies. • Besides simple repairing, some broken/non-functional EEE is sent to overseas for repair according to the negotiation between the shop owner and customer. • Due to lack of public awareness the residues are disposed off close to the dismantling shops or dumped in illegal site. • Consumers are not willing to handover their WEEE free of cost to recycling centres. • Disposal method: Storage or landfilling

Source: Summarised from Tables 1 and 2

On the basis of literature related to e-waste management practices in developed and developing countries summarised in Tables 1 and 2 it was found that in developed countries' e-waste collection is usually done by the formal sector. While in developing countries e-waste collection is usually done by the informal sector. Comparison of disposal method and infrastructure related to disposal of e-waste shows that developed countries have sufficient infrastructure for the disposal of the hazardous e-waste, while developing countries have lack of proper storage spaces and disposal areas for e-waste. However, on comparison of disposal method it was found that developed countries use incineration method while developing countries use storage or land filling method for disposal of e-waste.

In developed countries there is existence of national standards to regulate electrical and electronics (EEE) entering while in developing countries importation of used EEE is still allowed in different forms. In comparison of practice related to responsibilities it was found that in developed countries there is a proper assignment of responsibilities for producer, consumer through take back network. While developing countries there is no clear demarcation of responsibilities.

In comparison in terms of consumer and enterprises willingness to pay for WEEE recycling, it was found that in developed countries consumer and enterprises are ready to pay for WEEE recycling, while in developing countries consumers and enterprises shows their unwillingness to hand out their obsolete EEE or pay for WEEE recycling.

Comparison of e-waste management monitoring in terms of practices and fund shows that developed countries have separate committees for monitoring the fund and practices, while developing countries there is no method of formal monitoring in terms of fund and practices.

Comparing developed and developing countries for awareness about hazardous nature of e-waste, it was found that people in developed countries are aware about the hazardous nature of e-waste, while in developing countries due to lack of public awareness the residues are disposed off close to the dismantling shops or dumped on an illegal site.

Comparison of developed and developing countries in terms of rules and regulations shows that in developed countries there is proper implementation of take-back policy, while in developing countries there is a lack of legislation and take back policies.

The comparison of developed countries and developing countries as shown in Table 3 indicates that there is a huge gap between developed and developing countries e-waste management status and process. On the basis of the above findings, practices followed in developed countries are considered benchmarks for effective e-waste management shown in Table 4.

Table 4 Benchmark of e-waste management practices

Practices	*Developed country (based on literature)*
Collection	The e-waste collection is usually done by the formal sector and separate collection of e-waste.
Infrastructure	Existence of infrastructure for disposal of the hazardous e-waste.
Transboundary movement	The existence of national standards to regulate EEE entry.
Responsibility	Proper assignment of responsibilities to producer and consumer.
Disposal method	Incinerators
Consumer willingness	Consumers and enterprises are ready to pay for WEEE recycling.
Monitoring	A separate committee for monitoring the fund and practices.
Awareness	People are aware about the hazardous nature of e-waste.
Rules and regulation	The take-back policy is implemented properly.

Source: Summarised from Table 3

While comparing bench marked e-waste management practices with e-waste management practices of India as per the existing literature following things have been identified:

1 Collection: the existing e-waste recycling systems are purely business driven that have come about without any government intervention. Any development in these e-waste sectors will have to be built on the existing set-up as the waste collection and pre-processing can be handled efficiently by the informal sector.

2 Infrastructure: the lack of a safe e-waste recycling infrastructure in the formal sector and thus reliance on the capacities of the informal sector pose severe risks to the environmental and human health.

3 Transboundary movement: besides being e-waste generated in the country, e-waste from developed countries lands in India as second hand goods and mixed metal scrap for recycling (Link Toxic, 2013). The main reasons for imports to India are its cheap labour cost and less stringent environmental laws (Ragupathy, 2006). Imports have

been regarded as one of the major sources of PC scrap in India (IRGSSA, 2004). Though India is a signatory to Basel Convention on the control of transboundary movements of hazardous wastes and their disposal under which e-waste is also a component, it fails to stop the illegal imports to India.

4 Disposal: there is no proper disposal system in India that has led to enormous amount of electronic waste. There is a need to find a proper recycling and disposal technique, so that reduce the environmental pollution and health hazards (envis.maharashtra.gov.in).

5 Consumer willingness: the majority of Indian people would prefer to store their old home appliances at home or office rather than dispose them. When given a considerable price, people are willing to sell their e-waste (Ongondo et al., 2011).

6 Awareness: the collection and recycling of electronic wastes is being done by the informal sector in the country at present, the government has taken the following action /steps to enhance awareness about environmentally sound management of electronic waste (CII, 2006): several workshops of electronic waste management was organised by the central pollution control board (CPCB) in collaboration with toxic link.

7 Rules and regulation: comparative analysis of policy statement of 1990s and 2006 shows that initial major focus on pollution control has gradually shifted to recycling, recovery and reduction (MOEF Report, 2006–2007). Social and human health problems have been recognised in some developing countries and it is worth noting that China, India, and some other Asian countries have recently amended their laws to address the management and disposal of e-waste imports (Widmer et al., 2005)

Table 5 Literature review of e-waste in Indian perspective

Study	*Contribution*
Jain et al. (2006)	Analysis of the existing policy and regulations and emergence of future trends has been carried out for e-waste management in India
Jain et al. (2006)	A combination of 'market supply method' followed by tracer tracking is used to arrive at e-waste inventory in a geographical area. The efficacy of this approach and methodology has been tested and demonstrated in three cities of Delhi, Mumbai and Pune in India.
Gupta et al. (2012)	It is suggested that recycling facilities to manage e-waste should be supported by the government.
Widmer et al. (2005)	This paper provides insight into the legislation and initiatives intended to help manage these growing quantities of e-waste.
Streicher-Porte et al. (2007)	The management and recycling of waste electrical and electronic equipment WEEE was assessed in the city of Delhi, India.
Rode (2012)	Mumbai Municipal Corporation is generating high e-waste in Mumbai Metropolitan Region. E-waste generation is depending on population, health and education institutions, shops and malls, industrial units, etc.

India is also generating a huge amount of e-waste and this e-waste is mainly handled by informal sector. Informal sector interested to recycle only valuable equipment's from the e-waste. Papers contributed by various authors in Indian perspective are shown in Table 5.

3 Recognition of variables

The following superset of variables, as shown in Table 5, was established from the literature survey that formed the building blocks of e-waste management roadmap adopted by developed countries. In this way six hypotheses were made to validate the research model. One hypothesis for each independent variable is made. The explanation of the variables and the related hypotheses are mentioned below:

1 *Collection and recycling:* collecting back used electronic devises or e-waste from collection centres, retailers or distributors of electronic devices and sending them to authorised recycling centres for dismantling, refurbishing and finally for safe disposal is known as collection and recycling of e-waste. The major problems in collection of e-waste are delay in collection process of e-waste, less number and easy availability of collection points and cost involved in collection of e-waste (Ali and Chan, 2008; Shih, 2001; Shanshan and Kejing, 2008. While the major problems in recycling of e-waste are low recycling rate, high cost, non-availability of sufficient e-waste, competition with informal sector (Marie-Claude et al., 2008; Gullett et al., 1992; Jinglei et al., 2009; Yoon and Jang, 2006). In this background it is hypothesised that:

   H1 Collection and recycling is positively related to effective e-waste management.

2 *Rules and regulations:* rules and regulations means the law/policies/regulations required for the effective and sustainable management of e-waste. Trans-boundary movements of huge amount of e-waste from developed countries to developing countries (Wen et al., 2006), lack of legislation around e-waste (Roa, 2007), dumping e-waste into landfills, terrible working conditions for workers (Hanks et al., 2008), rigorous controls to prevent the illegal import and export of e-waste (Rolf et al., 2005) and lack of relevant laws to adjust or control the selling behaviours of waste electric and electronic equipment (Wen et al., 2006) are some important drivers for effective e-waste management. In this background it is hypothesised that:

   H2 Rules and Regulations are positively related to effective e-waste management.

3 *Government support:* government supports refer to the support required from government at various levels for effective e-waste management. Inadequate technical infrastructure for handling and managing the waste and movement of e-waste dismantling from the formal to the informal sectors (Jain and Sareen, 2006) are important drivers in effective e-waste management. The system creates incentives for collectors and recyclers to over-report the amount of collecting e-waste in order to gain extra subsidies from the fund (Kojima et al., 2006). In this background it is hypothesised that:

   H3 Government support is positively related to effective e-waste management.

4 *Awareness:* to make end consumer, retailer and distributor aware about the authorised collection centres hazardous nature of e-waste is known as awareness. To aware end consumer about the environmental issues of e-waste and facts about recycling services (Huang and Truong, 2008; Rolf et al., 2005) are some important drivers for effective e-waste management. In this background it is hypothesised that:

   H4 Awareness is positively related to effective e-waste management.

5 *Initiatives:* initiatives means promoting activities like collection, recycling, and safe disposal of e-waste for effective e-waste management. Efforts like taking initiatives like collecting e-waste with the help of manufacturer of e-waste or government, collecting e-waste from residential and business sector, individual consumer and enterprises give their e-waste to formal sector, promotional activities for reduce and reuse of e-waste (Jinglei et al., 2009; Kahhat et al., 2008; Liu et al., 2006; Hanks et al., 2008) are some important drivers for effective e-waste management. In this background it is hypothesised that:

   H5 Initiatives are positively related to effective e-waste management.

6 *Responsibility:* responsibility refer to the understanding their role by the all stake holders to manage e-waste in effective manner. Defining clear cut roles and responsibilities of all stakeholders, reducing the use of toxic materials in manufacturing of electronic devices, acceptance of e-waste by retailers and distributors (Rolf et al., 2005; Thiel and Neeli, 2006; Kojima et al., 2006) are some important drivers of effective e-waste management. In this background it is hypothesised that:

   H6 Responsibilities are positively related to effective e-waste management.

In this way six hypotheses were made to validate the research model. One hypothesis for each independent variable is made. In these hypotheses each independent variable is a predictor of the effective e-waste management. The summary of these research hypotheses is given in Table 6.

Table 6 Summary of research hypotheses

Hypotheses	*Supporting studies*
H1 Collection and recycling → effective e-waste management	Gullett et al. (1992), Shih (2001), Yoon and Jang (2006), Shanshan and Kejing (2008), Marie-Claude et al. (2008), Suzuki et al. (2008), Ali and Chan (2008) and Jinglei et al. (2009)
H2 Rules and regulations → effective e-waste management	Rolf et al. (2005), Wen et al. (2006), Roa (2007), Hanks et al. (2008) and Susan et al. (2008)
H3 Government support → effective e-waste management	Jain and Sareen (2006) and Kojima et al. (2006)
H4 Awareness → effective e-waste management	Rolf et al. (2005) and Huang and Truong (2008)
H5 Initiatives → effective e-waste management	Rolf et al. (2005), Hao et al. (2007), Hanks et al. (2008), Kahhat et al. (2008), Liu et al. (2006) and Jinglei et al. (2009)
H6 Responsibility → effective e-waste management	Rolf et al. (2005), Thiel and Neeli (2006), Kojima et al. (2006), Susan et al. (2008) and Jinglei et al. (2009)

Note: → represents 'is a predictor of'.

4 Research gap and research problem

Existing literature shows that the building blocks of effective e-waste management are known in different countries but how many of these are applicable in India are not known. Also, no model is available to empirically test the impact of these building blocks

on the effective e-waste management in India. This paper attempts to bridge this research gap.

Based on following above discussion, it is important to conduct study of the various factors responsible for the effective e-waste management in the software industry.

Based on the review of literature related to e-waste management, the literature review can be classified into six themes: collection and recycling, rules and regulations, government support, awareness, initiatives and responsibility. The description and detailed literature of these six themes are described in next section.

5 Objectives of the study

To develop a model from the building blocks of effective e-waste management identified from literature and empirically test that model for India.

5.1 Research question

What are the factors contributing to the effective e-waste management in India?

5.2 Research model

Based on the nature of the study and audience of the study quantitative model was used. The data is collected from the respondent by using questionnaire as an instrument, the collected data is analysed using statistical tools, to know the relationship among the variables and to measure the impact of independent variables on the dependent variable. Finally a quantitative model is used in this study.

6 Research methodology

This research work involved the study of identified variables, framing the model of the research, testing the hypotheses, and reliability of the instrument by using various statistical tools to reach the conclusion, for research design quantitative approach and methods was concluded as the suitable methodology to implement this research.

6.1 Sampling

Personal search was made at various websites related to the service sector. Information was provided about the use of electronic equipments and it was found that software industries used large amounts of electronic equipments in their organisation as compare to other service sectors. So software industries constitute the population of the study. Sampling frame is the software companies located in Mumbai, NCR, Chennai, Bangalore, and other part of India. Random sampling is used to get response from the Top managers, and Software developers of software industry selected. Respondents were selected randomly to get response from the respondent in 2016 and 2017.

6.2 Data collection

An effort was made to get the responses from the target respondents. For this purpose randomly structured questionnaire was mailed and personal visits as well as telephonic request were also made to get the questionnaire filled up.

Total 200 responses collected from the respondent among which few of them fount incomplete. Incomplete questionnaires were not considered for analysis. Total 167 responses were found complete and considered for analysis. Cronbach's alpha test was used to test the reliability of the questionnaire. Items having α value found greater than 0.7 (Hair et al., 2011).

Table 7 Multiple regression analysis results

Model summary			
Model	*R*	*R square*	*Adjusted R square*	*Std. error of the estimate*
1	.892[a]	.795	.787	.50099

Note: [a]Predictors – (constant), Resp, Init, Awrn, Coll, Regl, Govt.

Model		*Sum of squares*	*Df*	*Mean square*	*F*	*Sig.*
1	Regression	155.905	6	25.984	103.526	.000[a]
	Residual	40.159	160	.251		
	Total	196.064	166			

Notes: [a]Predictors – (Constant), Resp, Init, Awrn, Coll, Regl, Govt.
[b]Dependent variable: Ewas.

Coefficients[a]						
Model		*Unstandardised coefficients*		*Standardised coefficients*	*t*	*Sig.*
		B	*Std. error*	*Beta*		
1	(Constant)	.434	.226		1.923	.056
	Coll	.502	.071	.517	7.045	.000
	Regl	.115	.095	.114	1.218	.225
	Govt	.043	.105	.047	–.403	.687
	Awrn	.396	.067	.418	5.882	.000
	Init	.024	.049	.025	.498	.619
	Resp	.108	.051	.125	–2.118	.036

Note: [a]Dependent variable: Ewas.

6.3 Model for data analysis

The analysis of the collected data using multiple regression analysis, the regression model shown in Table 7 found significant (F = 103.526, p =.000) at 5% level. The value of R^2 found .795 which explain 79.5% variance in the dependent variable (effective e-waste management) explained by independent variables. The analysis result found by using multiple regression analysis are summarised in Table 7.

7 Findings of the study

The hypothesised research model was validated through multiple regression analysis. The analysis enabled to predict the variability in the dependent variable based on its covariance with all independent variables. Regression coefficients (beta value) showed the degree of association between dependent variable and independent variable. There were six hypotheses of effective e-waste management, three of them were accepted. Thus 'collection and recycling', 'responsibility', and 'awareness' supported as the predictor of the effective e-waste management.

The findings of the quantitative study have revealed that 'collection and recycling' has major contribution in the overall model as the value of the path coefficient came out to be .502 which means that for effective e-waste management in software industry 50.2% contribution is of this variable. Variable 'awareness' also have a major contribution in the overall model as the value of the path coefficient came out to be .396 which means that for effective e-waste management in software industry 39.6% contribution is of this variable. Similarly other variable 'responsibility' also has 10.8% contribution. Variable 'government support', 'rules and regulations' and 'initiatives' have little contribution in the overall model.

8 Discussion

Existing literature shows that the building blocks of effective e-waste management are known in different countries but how many of these are applicable in India are not known. Also, no model is available to empirically test the impact of these building blocks on the effective e-waste management in India. This paper attempts to bridge this research gap. So, to bridge that gap a model was developed from the building blocks of effective e-waste management identified from literature and empirically tests that model for India. Keeping in view the objective of the study six factors were identified from the existing literature that are contributing to the effective e-waste management in India. Six factors identified from the existing literature are 'collection and recycling', 'government support', 'awareness', 'initiatives', 'responsibility' and 'rules and regulations'. The findings of the quantitative study have revealed that 'collection and recycling' has major contribution in the overall model (path coefficient came out to be .502), 'awareness' also have a major contribution in the overall model (path coefficient .396). 'responsibility' also has 10.8% contribution. Factors like 'government support', 'rules and regulations' and 'initiatives' have little contribution in the overall model.

As per the existing literature the first factor 'collection and recycling' is considered to be the one of the important factor for effective e-waste management. Findings of the study also concluded that this factor has major contribution in the overall model (path coefficient came out to be .502). Similarly as per existing literature 'awareness' and 'responsibility' are also considered to the important factor for effective e-waste management and findings of the study also supports that.

However three factors identified from the literature 'government support', 'rules and regulations' and 'initiatives' considered to be important factor of effective e-waste management were not much supported in the finding of the study. So as per the finding of

the study these three factors have not much contribution in managing the e-waste in the effective manner.

So the major implication of the study says, by collecting back used electronics devices for the purpose of recycling, reuse and safe disposal of e-waste is one of the important factor for effective e-waste management. Study emphasises that by reducing time delay in the collection and recycling of e-waste, increasing number of collection points and reducing cost of collection are the main drivers for collection of e-waste. From recycling point of view by reducing recycling cost, improving recycling process rate recycling process of e-waste can be improve.

Secondly study says that by making end consumer of electronics devices aware about various activities and services related to e-waste management it can be made effective. It emphasises that by providing relevant information about collection points and recycling services, making consumer aware regarding environmental issues and by running more awareness programs that will enable consumers to reduce, reuse and recycle greater volume of this e-waste can be manage effectively .

Study also says that all stakeholders of e-waste understand and play their role in a responsible manner to managed e-waste effectively. It emphasises that consumers need to bring their e-waste to designated drop-off collection points, manufacturer to reduce toxicity in material used for making electronics equipment's, retailers and repair shops to accept discarded appliances and hand them over to formal recyclers and finally clear demarcation of responsibility for e-waste collection, recycling, disposal among consumers, retailers, and manufacturers are also important to manage e-waste effectively.

Limitations of the research were inevitable in any research process. Limited literatures were found related to effective e-waste management in Indian context. Due to paucity of time and funds the study was carried out for software industries only. Scope for future work in this area is abundant, because e-waste has significant contribution in the growth of the Indian economy and it is a new sector defined by the Government of India. The model for effective management of e-waste in software industry developed here can be further validated for other sectors like telecommunication and higher education.

So as per the result obtained from the analysis the policy maker can help in many terms to help environment and human health. Some recycled products may require special treatments for hazardous materials produced during the recycling processes. Different products consume different levels of recycling processes, resources, and equipment's. So, by making policy for effective e-waste management in which recycling process should be product specific rather than common to different types of product can help to save environment and health. Secondly by dismantling and providing reuse possibilities, intact natural resources are conserved and air and water pollution caused by hazardous disposal is avoided. Additionally recycling reduces the amount of greenhouse gas emissions caused by the manufacturing of new products. It simply makes good sense and is efficient to recycle and to do our part to keep the environment green.

Recycling of e-waste is very essential as it saves energy, expenses, reduce environmental pollution and less chances of health hazards. So such types of initiatives need to be incorporated in policies related to effective e-waste management.

Policy should also focus to restrict the use of certain hazardous substances in electrical and electronic equipment (RoHS) which aims at minimising the risks and environmental impact during the treatment and disposal of electrical and electronic wastes. Its stated aim is to reduce the use of hazardous substances.

9 Concluding remarks

India generating huge amount of e-waste in house as well as in the form of import in the name of second hand electrical and electronic devices. This increasing amount of e-waste need to be managed effectively otherwise it is very harmful for the environment and human health. The factors that impact the effective management of e-waste in India broadly cover 'collection and recycling', 'awareness' and 'responsibility' (factors emerge from the analysis). However, two among the three factors: 'collection and recycling' and 'awareness' have much higher impact on the effective e-waste management in India and hence need to be area of focus.

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