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Measuring the Willingness to Pay for Hazard-Free E-Waste Management in Dhaka City, Bangladesh

Sarwar Uddin Ahmed, PhD

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D.Net received the Gender & ICT Award at 2005 for its innovation to linking new ICT tools for improving access to livelihood information by the poor people, particularly women and the handicapped, through the introduction of the "mobile lady". D.Net also received Manthan Award at 2008 and 2009 for its contribution on e-Content development and e-Education sector.

About the Series

The objective of the Working paper series is to bring important issues to the readers on various topics of public domain, based on the findings, observations and insights revealed from D.Net's in house research activities and action programmes.

Electronic waste is becoming a serious threat for our surrounding environment. We need integrated initiatives to fight this growing concern in Bangladesh. On this background, this paper is the second in the series, aimed at calculating the willingness to pay for hazard-free e-waste management system in Dhaka city, the capital of Bangladesh. Contingent Valuation Method (CVM) was used with direct face-to-face interview technique and double bounded dichotomous-choice (DC) format for eliciting willingness-to-pay (WTP). From the results of the study we had found that, the aggregate value of the WTP of the respondents in Dhaka was BDT 1.1 billion (USD 16.16 million). The results of the study provided us a guideline regarding the concern of the residents on e-waste and will help us to formulate e-waste management policy.

D.Net believes that this publication will meet the demand of policy makers, researchers, academics and activists for analysis on the mentioned topic. Readers are most welcome to send their queries, comments, criticism and suggestions for further improvement of D.Net's publications.

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List of Abbreviations:

PC	–	Personal Computer
WTP	–	Willingness to pay
E-waste	–	Electronic Waste
LCD	–	Liquid Crystal Displays
PBDE	–	Polybrominated Diphenyl Ethers
BDT	–	Bangladesh Taka

Abstract

This paper aims to estimate the willingness to pay for hazard-free e-waste management system in Dhaka city, the capital of Bagladesh by using the Contingent Valuation Method (CVM). Direct face-to-face interview technique and double bounded dichotomous-choice (DC) format have been used for eliciting willingness-to-pay (WTP). From the results of the study we have found that, the aggregate value of the WTP of the respondents in Dhaka was BDT 1.1 billion (USD 16.16 million).

Key words: e-waste, contingent valuation method (CVM), dichotomous-choice (DC), willingness-to-pay (WTP).

Measuring the Willingness to Pay for Hazard-Free E-Waste Management in Dhaka City, Bangladesh

Sarwar Uddin Ahmed*

I. Introduction

The revolution in the field of telecommunication and information technology is leading towards the development of new electronic appliances. These new electronic gadgets include computers, cell phones, televisions, refrigerators, photocopiers, washing machines, air conditioners, DVD players and other consumer durables. With the development of new technology electronic products are becoming cheaper, fancier, faster, and easier to use. However, they also get obsolete very fast. Consumers in some cases find it comparatively cheaper and convenient to buy new devices than repairing the older ones. Electronic wastes (e-waste) are the junk generated form these discarded electronic components and contain more than 1,000 different toxic materials. For example, chemicals such as lead, mercury, copper found in computer screens and TVs and beryllium in motherboards are poisonous and can lead to fatal diseases like cancer, kidney failures, thyroid hormone disruption and damage the environment through soil and water pollution [1].

Commensurate to the global trend, in Bangladesh also the market for electronic goods is having exponential growth due to the rising disposable income and increasing demand for the latest electronic gadgets. A large proportion of waste generation in our country comprises e-waste. According to BEMMA, Bangladesh consumes around 3.2 million tonnnes of electronic products each year. Of this amount, only 20 to 30 per cent is recycled and the rest is released in to landfills, rivers, ponds, drains, lakes, channels and open spaces, which are very hazardous for the health and environment of the country. Presently, there is no specific law or ordinance for e-waste management and recycling in Bangladesh. However, by considering the deadly impact of e-waste our neighboring country India has established several plants for hazard-free e-waste recycle and also formulated the Draft Rules for E-waste Management and Handling (2010) which is now in the process of government approval.

In Bangladesh, generally e-waste includes PCs, televisions, telephones, cell phones, air conditioners, electronic toys, washing machines, etc. According to an estimate, more than 500 thousand computers were in use in 2004 and this number has been growing at 11.4 per cent annually [2]. Even if the figure of 500 thousand were taken as the baseline, that many PCs would contain approximately 15,323 tonnes of waste (@ 27.2 kg/PC for 5 year obsolescence) in 2010 containing deadly plastics, lead, mercury etc.

On this background, this study below aims to quantify the willingness to pay for hazard-free e-waste management in Dhaka city, the capital of Bangladesh. In order to do so, we plan to use contingent valuation method (CVM), to quantify the potential benefits to be generated from this system. Widely known as contingent valuation, the technique uses economic theory and the methods of survey research to elicit directly from the consumers the values they place on public goods [3].

Despite of these criticisms CVM has been widely used by researchers both in developed and least developed countries.

II. Environmental Evaluations and Contingent Valuation Method (CVM)

For making life convenient accepting technological advancement sometimes become inevitable.

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However, restoring to this technological advancement often brings environmental degradation. In such a case a choice has to be made. Should we accept technological advancement without considering environmental damages? Or we just reject all technological advancement having negative impact on environment? The decision is not straightforward and nor we can reject technology neither environment. One of the possible ways to resolve such dilemma would be to compare the benefits of defending environmental resources compared with the opportunity costs or benefits forgone for alternative uses, i.e., conducting cost-benefit analysis. Accordingly, Contingent Valuation (CV) evolved as a method to quantify the benefits of non-marketed environmental goods attributes so that they could be entered directly into cost-benefit calculations. The CV was seen both as an alternative method of valuation to travel-cost (TC) and hedonic pricing (HP) models and as being able to quantify some types of benefits, such as non-use or passive-use benefits, which lie outside the scope of TC and HP studies [4].

In simple terms, contingent valuation is a method of estimating the value that people places on a particular good. Because the estimated WTP values are contingent upon the particular hypothetical market described to the respondent, this approach is known as the contingent valuation method [5] At different times and in various places the contingent valuation method has been called the survey method, the interview method, the direct interview method, the direct questioning method, the hypothetical demand curve estimation method, the difference mapping method, and the preference elicitation method [3].

The CVM is not also beyond any criticism. It has the shortcomings that survey studies usually have. The way the WTP questions are made may biases value estimates. Much controversy surrounds the use of CVM when most of the value of the good derives from passive use, as has been typical in litigation over the damages to natural resources and amenities caused by releases of pollutants [6].

Despite of these criticisms CVM has been widely used by researchers both in developed and least developed countries.

III. Approximating the quantity of E-waste Generated in Dhaka City

The quantity of e-waste (PC and Cell phone) to be generated has been estimated by following two methods suggested in [1]. The first method, Market Supply Method A, (MA) assumes that the average lifetime of an electronic product is approximately five years and after that these are discarded and come to the waste stream. The second method, Market Supply Method B (MB) assumes that all the products are not disposed at the same time, rather they are disposed in varying quantities over successive years. Here weighted average method is used to show the product disposal trend. For PCs the growth rate is considered to be 11.4 per cent [2] and for cell phones a 100% growth rate is considered annually [8]. The quantity of e-waste to be generated from these two types of electronic products is shown in Table 1.

IV. Methodology of the study

Contingent Valuation Method (CVM) is used to estimate the willingness to pay (WTP) value, which depends on survey techniques to value a particular commodity. In order to choose from the various survey techniques and elicitation methods, particularly suitable for our study of measuring the willingness to pay for hazard-free e-waste management, we have conducted pre-testing of questionnaires. And this led us to opt for direct interview survey technique and dichotomous choice (DC) elicitation method. Both parametric and non-parametric estimate analysis have been conducted.

In this study double bounded dichotomous-choice (DC) elicitation method has been used for deriving the WTP figures. In pre-testing study of the questionnaire, we have found DC method as more widely used and balanced compared to other elicitation methods. Again under DC method both parametric and non-parametric estimate analyses have been conducted to estimate WTP. We consider the non-parametric estimation of the distribution function F of a real-valued random variable X, when the sample data are incomplete due to restricted observation brought about by grouping, censoring and/or truncation [9]. Among

non-parametric estimation Turnbull method is followed, which uses equation (1) to calculate the WTP.

$$LL = \sum_{i \in yy} \ln S(T_{hi}) + \sum_{i \in nn} \ln\left[1 - S(T_{li})\right] + \sum_{i \in ynony} \ln\left[S(T_{li}) - S(T_{hi})\right] \quad (1)$$

Where, LL is the maximum likelihood estimate. S(T) denotes the probability to accept bid value T, Thi is highest bid value and Tli the lowest bid value to the ith individual. On the other hand, yy shows the set of respondents who answered yes for both the bid values. Accordingly nn, yn, and ny represents the set of respondents who responded both time no, first time yes and then no and first time no and then yes, respectively.

Whereas, under Weibull method of parametric estimation, the value of μ and σ are fixed to give shape to the cumulative distribution function and determines S(T) by the following equation:

$$S(T) = \exp\left[-\exp\left(\frac{\ln T - \mu}{\sigma}\right)\right] \quad (2)$$

Where, exp is the exponential operator. After determining the S(T), then we go for the estimation of LL.

Both of these two methods have their relative advantages and disadvantages. Hence we are going to conduct our calculation by using them together and compare the results.

Table 1: Estimation of Pc and cell phone waste in Dhaka City

Year	Personal Computers Weight (in tons)			Cell Phone Weight (in tons)		
	M A	M B	Average	M A	M B	Average
2010	16,701	13,945	15,323	2,567	2,824	2,696
2011	18,251	16,701	17,476	5,135	5,135	5,135
2012	19,802	16,116	17,959	7,702	7,702	7,702

Note: 1. weight of PCs is derived 27.2 kg/PC. 2. Weight of cell phones derived 0.079kg/cCell phone Source: [7]

V. Research design and data collection

A. Survey Description

Direct face-to-face interview method is followed as this is considered to be the best method for contingent valuation studies [10], [11].

Officially Dhaka city is divided into 10 zones and each zone is again divided into wards (see Fig.1 for the location of Dhaka city). A total of 90 wards were listed during the time of the survey [12],[13]. The survey covered 200 households randomly chosen from 90 wards of Dhaka city of which 185 questionnaire were found complete and useable for the purpose of the analysis.

B. Survey Instrument

A structured questionnaire was used in the survey adapted and reconstructed from [11]. Fig. 2 shows the contents of the questionnaire. The questions contained in the questionnaire of the study can be categorized into three broad headings. Before getting into the first part, a description is given regarding the problem in hand: the electronic products, their recycling methods and hazards, and

Fig 1. Location of Dhaka City

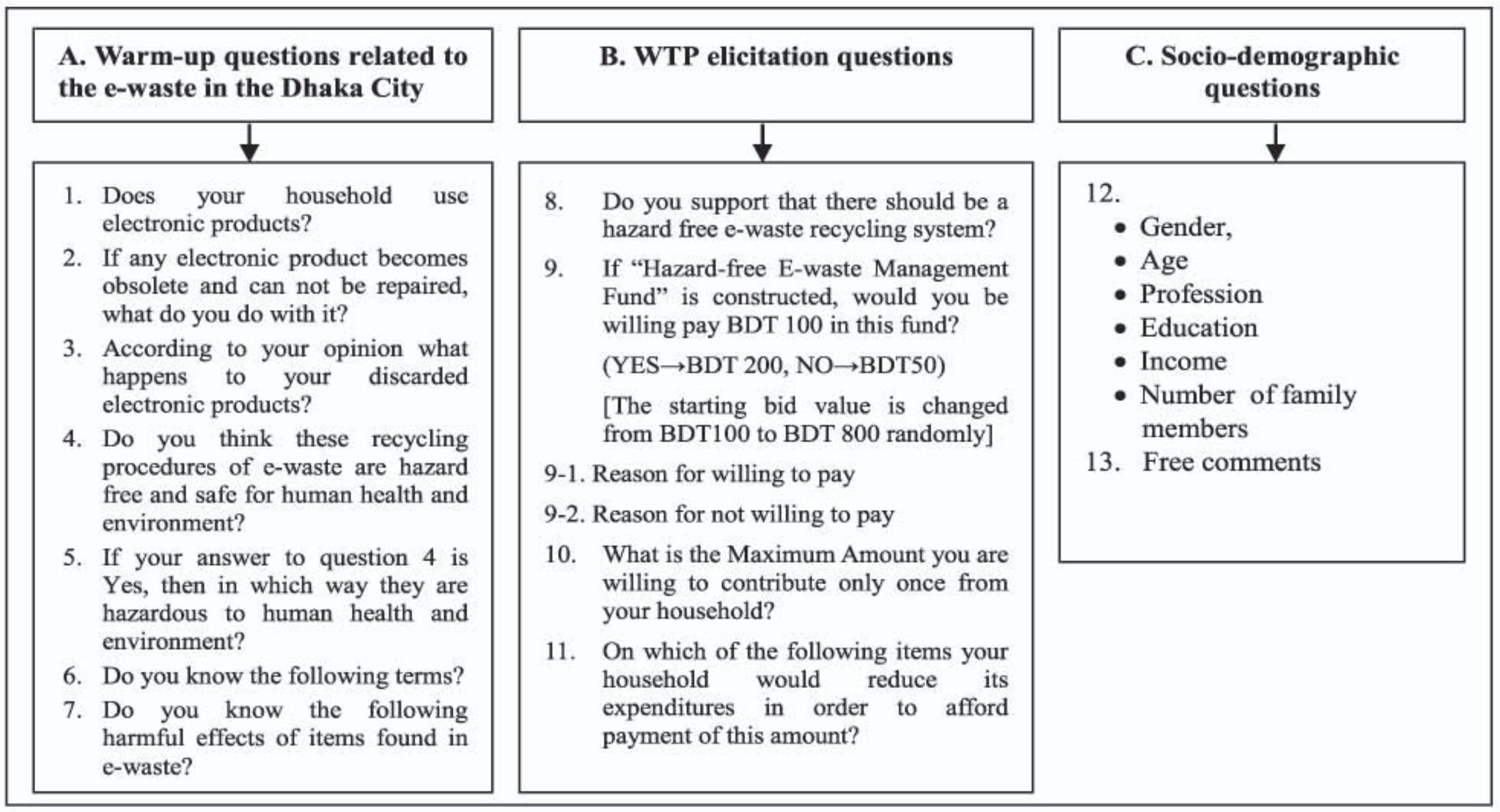

Fig 2. Contents of the questionnaire used in the survey

its effect on the surrounding environment aided by some photographs on current e-waste recycling procedures practiced in Dolai khal, the largest e-wate recycling center in Dhaka city. Regarding the picture behind the payment, we have stated that the proposed fund would be used to introduce hazard-free e-waste management system. Accordingly, the question asked to elicit the respondent's willingness to pay (WTP) is: Suppose we are going to create a fund named "Hazard-free E-waste Management Fund" to ensure safe management of e-waste in Dhaka city. Would you be willing to contribute BDT 100 (1USD is approximately 70 Bangladesh Taka) to this fund only once, to protect the environment? The amount of the first bid was assigned randomly ranging from BDT100 to BDT 800. This was followed by a follow-up question where the amount is increased or decreased, depending on whether the respondent's initial answer was positive or negative, respectively. The questionnaires were divided into four versions or groups with different amounts of starting bid value under double-bounded dichotomous-choice elicitation method and were interviewed on January 2010 [7].

C. Versions of the Questionnaire

As shown in Table 2, the questionnaires were divided into four versions or groups with different amounts of starting bid value under double-bounded dichotomous-choice elicitation method. The number of versions of the questionnaire was increased to four versions as our pre-testing results revealed that relatively higher number of different versions of questionnaire with different bid values reduces error of the estimation [7], [14].

D. Pre-testing Results

Pre-testing study was conducted on June 2009 on hundred randomly selected households located in 90 wards of Dhaka city. Only one edition of questionnaire was used in the first trial, with a combination of dichotomous-choice elicitation method and open ended method. Accordingly we have found the mean WTP was BDT 2,990 under open ended method. This gave us a guess about the final mean WTP of the study. Based on the experience of the pre-testing study, the final survey questionnaire was modified to some extent and the numbers of bid values were increased to four.

Table 2 : Bid values used under double-bounded Dichotomous-choice Elicitation Method

Versions	Starting Bid Value (BDT)	Second Bid Value	
		YES (BDT)	NO (BDT)
First	100	200	50
Second	200	400	100
Third	400	800	200
Fourth	800	1600	400

VI. Results and discussion

The findings of the survey and empirical study are summarized as follows:

A. Knowledge and Attitude of the Respondents Regarding E-waste Management

Regarding the level knowledge on hazardous items found on e-waste more than 50 percent of the respondents commented that they had low level of knowledge on these items (lead, mercury, copper etc.) (see Fig. 3). Thus, it can be commented that still residents of Dhaka city are not aware of the harmful effects of toxic material discharged from unsafe e-waste disposal.

When respondents were asked whether they support to have a hazard free e-waste management system for Dhaka city, approximately 98% of the respondents commented that they support it (see Fig.4). Also 95 percent of the respondents commented that the e-waste disposal practice of Dhaka city was unsafe (see Fig.5). It indicates that people are becoming aware of the perils of indiscriminant disposal of electronic goods.

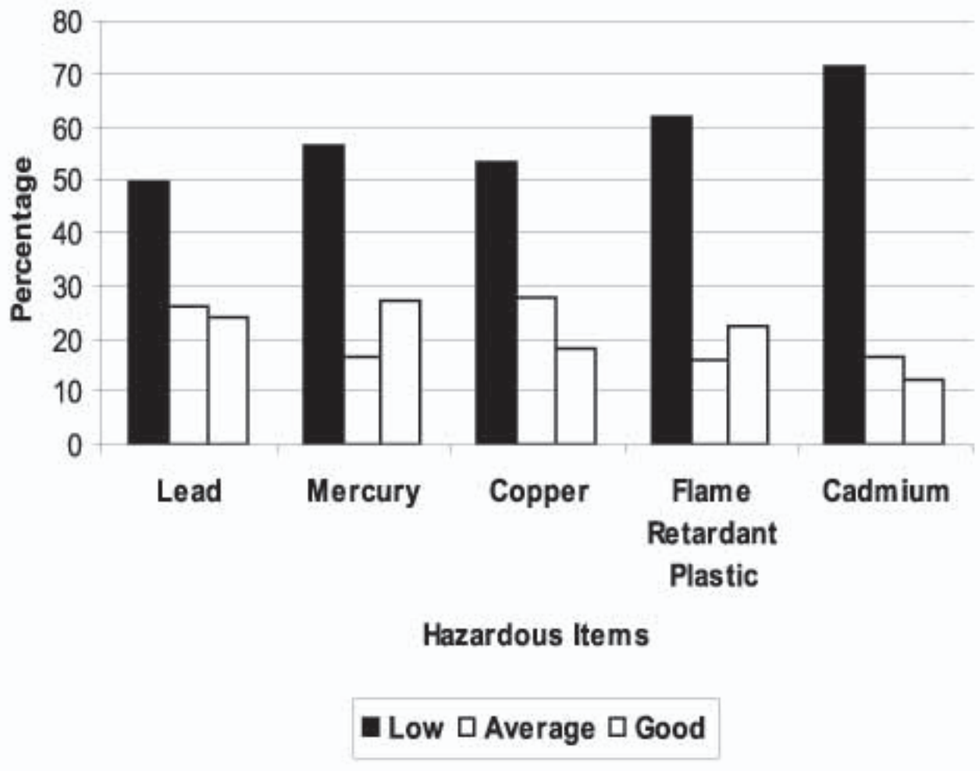

Fig. 3 Knowledge level of respondents on hazardous items found in e-waste

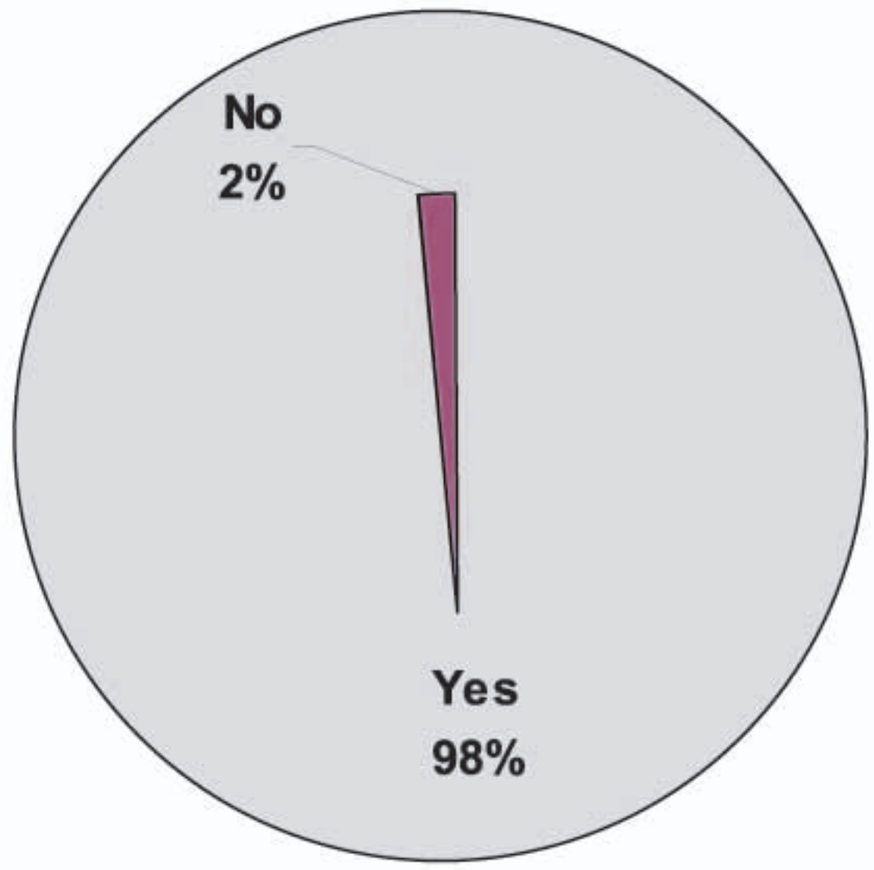

Fig. 4 Support for e-waste management system

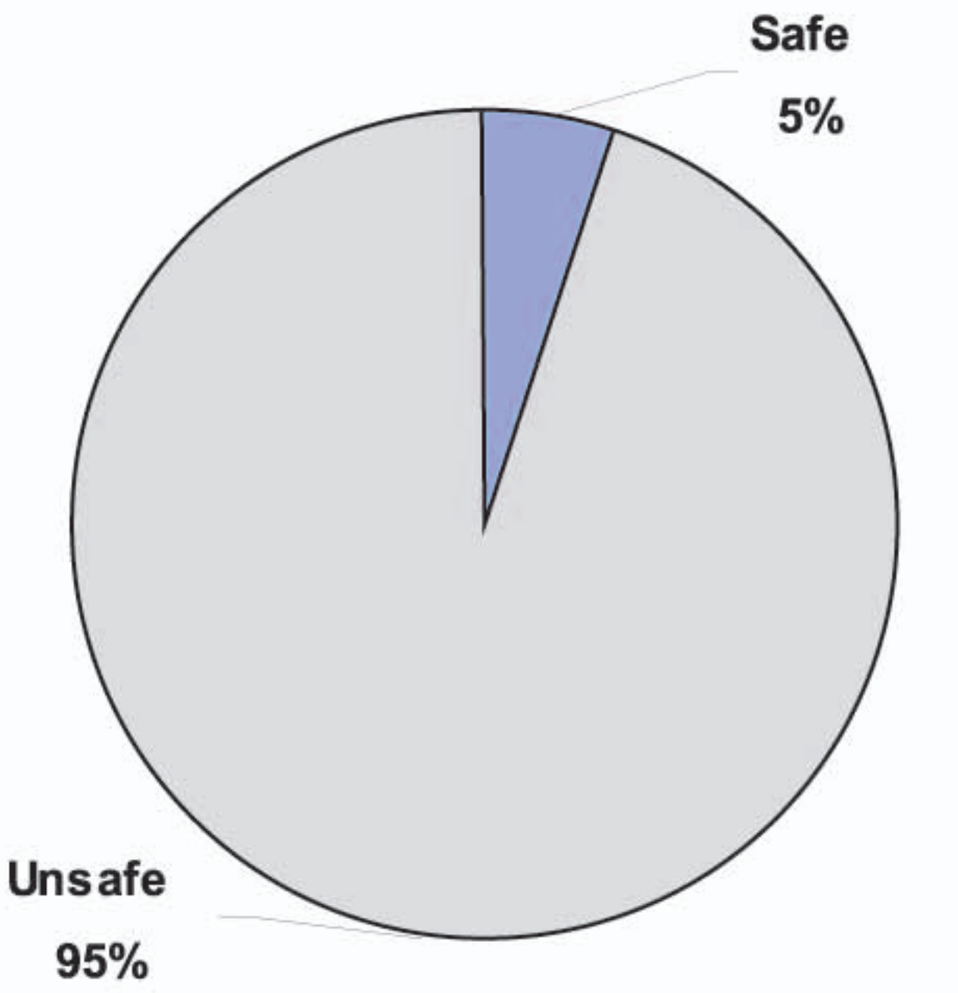

Fig. 5 Safety of current e-waste disposal system

Table 3 : Willingness to pay

	Turnbull Method	Weibull Method
Sample Size (complete)	185	185
Mean WTP (/household)	1,017	1,644
Median WTP (/household)	1200	1102
SD of the Mean	76.38	
Range of 95% confidence interval (\)	± 150	

B. Willingness to Pay (WTP)

The analysis of data has been conducted by applying both Turnbull and Weibull method. The respondents who had resisted to pay in all of the two bids are considered to have zero WTP, but their opinion regarding refusal to pay are summarized to dug out the reasons for not willing to pay. According to the Turnbull method, the mean WTP was BDT 1,017 (USD 14.53) (see Table 3 and Fig.6). Whereas, under Weibull method, the mean WTP was BDT 1,644 (USD 23.49).This implies the extent of importance of the hazard-free e-waste management system to the residents of Dhaka city. From the economic point of view, it can be said that the utility function of the residents of the Dhaka city would increase by this amount of total WTP, if hazard-free e-waste management system is implemented.

The total number of household in DCC (Dhaka City Corporation) was 1,112,000 (BSS, 2008). If we multiply the mean WTP by the number of households, the aggregate value of the WTP of the respondents in Dhaka would be (BDT1,017 X 1,112,000) BDT 1.13 billion (USD 16.16 million). We have taken the mean WTP found by Turnbull method to take the most conservative estimate.

C. Reasons for Willing to Pay

Fig. 7 presents the reasons why the respondents are willing to pay. From the figure we can see that, protecting human health and the environment is the more common reason cited by the respondents, as the reason for payment (59 percent and 56 percent). On the other hand, only 18 percent of the respondents mentioned protecting the soil fertility as the reason for willing to pay. Thus the respondents are more concerned about the immediate health and environmental hazards generated by unsafe disposal of e-waste.

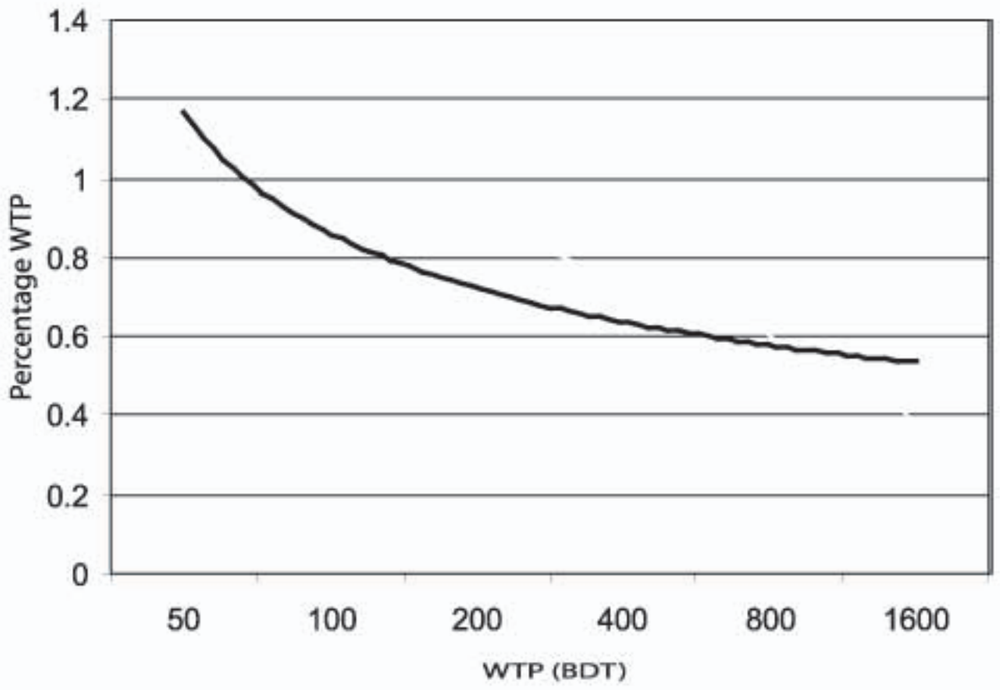

Fig. 6 Percentage of respondents WTP

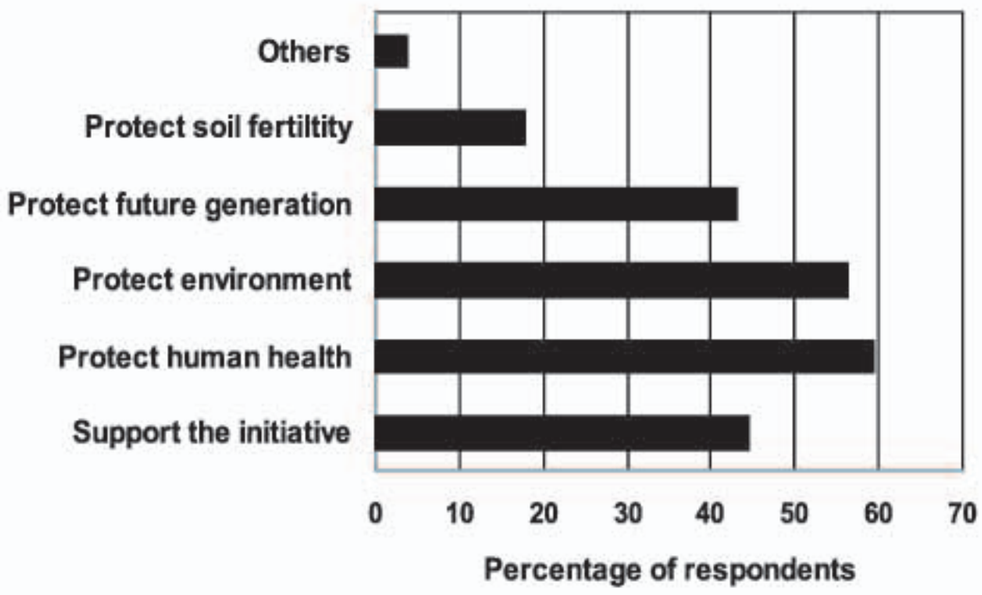

Fig. 7 Reasons for willing to pay

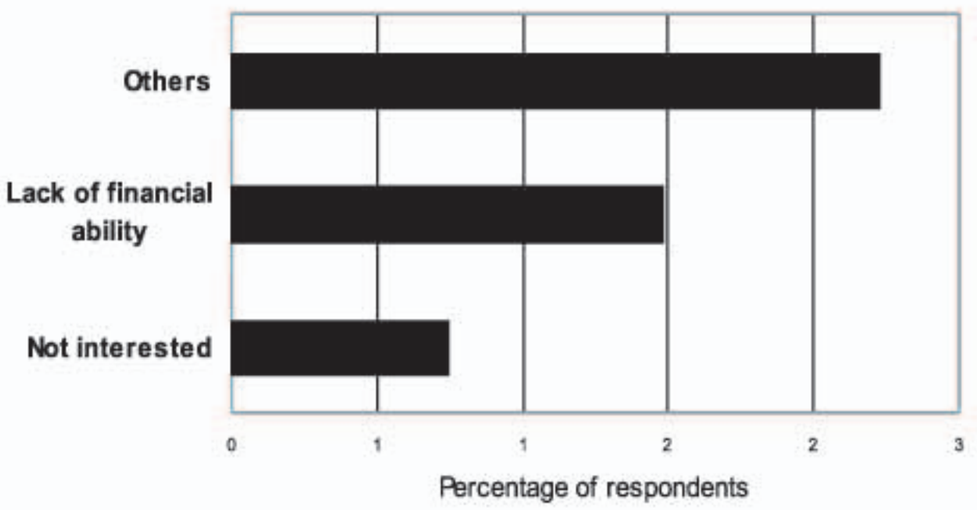

Fig. 8 Reasons for not willing to pay

D. Reasons for not willing to pay

Interestingly majority of the respondents were willing to pay. Accordingly, only 1 percent of the respondents mentioned lack of financial ability and interest as the reason for not willing to pay (see Fig. 8).

E. Robustness of the Results

Diagnostic tests were run on the analysis to rule out extreme values and ensure the reliability of the results. However, as CVM studies are based on survey data, this study also contains the limitations that survey based studies usually have.

VII. **Conclusion and policy implication**

We have conducted a comprehensive study for estimating the willingness to pay for hazard-free e-waste management system in Dhaka city by applying contingent valuation method. The results lead to the following observations and policy implications:

a. The respondents though reported low level of knowledge on hazardous items found in e-waste, they showed a very positive attitude towards (98 percent support) development of hazard free e-waste management system. (See Figs. 4-5).

b. The aggregate value of the WTP of the respondents was BDT 1.13 billion (USD 16.16 million). Although this figure is high comparing to other study [12] measuring willingness to pay for solid waste management in Dhaka city, but is reasonable if we see that the payment vehicle offered was once in a life time and also there is a big difference in hazard involved in solid waste and e-waste. There is a sizeable gap between median WTP and mean WTP, a difference that has large implication on policy makers as this quantifies the importance of hazard-free e-waste management in the most conservative manner.

c. A key policy implication drawn from the findings of the study is that the concerned authorities should seriously think about establishing hazard-free recycling and disposal centers for e-waste. Obviously the setting and running of such centers will involve cost. However, the extent of concern and willingness to pay shown by the respondents of the study indicate that they would even be willing to bear this cost in a reasonable structure.

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