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QUANTITATIVE ANALYSIS OF E-WASTE IN DHAKA CITY, BANGLADESH

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ABSTRACT

The use of electrical and electronic equipment is increasing in Bangladesh as its transitioning from a least developed country to a developing country. With the increase of per capita income, the purchasing power of the people is also increasing. For this reason, the amount of electrical and electronic equipment is also increasing. And this is contributing to the very fast growth of e-waste generation. This paper deals with the amount of e-waste generation from households in the Dhaka city corporation area, both Dhaka North City Corporation and Dhaka South City Corporation. The main problem of e-waste estimation is the lack of reliable data in developing countries as they don't have the manpower to do so. In Bangladesh, there is a lack of reliable data regarding e-waste generation. So, a household survey was conducted and various types of data were collected to determine the e-waste generation in the Dhaka city corporation area. This study also helps to understand the awareness of the user and the willingness of the user regarding e-waste. For this study, the Consumption and Use Method was used to determine the e-waste generation in the Dhaka City Corporation area as it helps to give us results with a little amount of data. From this study in 2021, it was found that the per capita generation of e-waste was around 5.4 kg/person. And the total e-waste generation in the Dhaka City Corporation area was found to be 117,598 tons/year. Among the surveyed families, more than 85% knew about the hazardous fraction that is present in the e-waste needed special treatment before it can be disposed of. But only 38.87% were practicing recycling. Although, 95% of them are willing to recycle e-waste to protect the environment. 78% of the surveyed families would give out the e-waste to the waste collectors for free if they can be taken care of properly so that it does not harm the environment. And at present 37% of people store their old electronics in their house, 23% sell it to the recyclers, 13% discard the e-waste with the household waste, 13% sell it to individuals and only 8% donate their old equipment. And the amount of e-waste generated can be reduced by the government, corporational and personal initiatives.

Keywords: *E-waste, WEEE, Consumption and Use method, Bangladesh, Dhaka*

1. INTRODUCTION

In the last few decades, the lifestyle of people has changed a lot with the growing electrification around us. Due to this, demand for electrical appliances has also increased, mainly in households and industries. As these appliances are being used continuously the production has also increased for these electrical and electronic appliances. But after the mass use or consumption of these devices or products, they are reaching their end of life. In the end, discarded electrical or electronic equipment that is no longer useful becomes electronic waste. Electronic wastes are also known as waste electrical and electronic equipment (WEEE) (Miner et al., 2020). So, according to Nazrul Islam (2016), all secondary electronic goods, such as computers, entertainment device electronics, mobile phones, electronic medical and dental equipment, and other items such as air conditioners, television sets, VCRs, stereos, copiers, and fax machine refrigerators, that were sold, donated, or discarded by the

owner, are classified as electronic waste. In 2014, 12.8 million metric tons of small equipment, 11.8 million metric tons of large equipment, and 7 million metric tons of temperature exchange equipment (including cooling and freezing equipment) made up the majority of electronic waste globally (Sahu, 2019). Simultaneously, e-waste was predicted to reach about 50 million metric tons in total by 2018, with a year-to-year growth rate of 4 to 5%. Most of the e-waste generation contributor was Asia. From 2014 to 2016, it was expected that the electrical and electronics industry will expand the most, with 16 million metric tons of e-waste generated (Sahu, 2019). Now according to Statista, e-waste generation has been globally increasing since 2010. From the year 2010 to the year 2019, E-waste was generated 33.8 MMt to 53.6 MMt. There was an increase of 44.4 Mt in just five years. Only 17.4% was documented to be collected and properly recycled of this (Tiseo, 2021). In the year 2010, ESDO report states that roughly 2.8 million tons of e-waste is generated in Bangladesh, and in several studies, it is found that the e-waste stream is a source of different types of hazardous components (heavy metal and toxic components- mercury, lead, cadmium, zinc, chromium) which causes many of the health issues and environmental damages. These hazardous component-containing wastes are thrown into open landfills, farm fields, and water bodies due to the lack of awareness about the injurious impacts of e-waste. In Bangladesh, 15% of child laborers die as a result of e-waste recycling, and over 83 percent are exposed to harmful compounds and get sickened, forcing them to live with long-term diseases. Around 15% of the overall waste generated in Dhaka (mainly inorganic) and 475 tons of e-waste are recycled daily. Though it is a common practice in Bangladesh to reuse electronic devices, there is a lack of formal e-waste disposal facilities where the informal sector is more active (Hossain, 2010). Following the data of the global e-waste monitor 2020, it is seen that the e-waste generation of Bangladesh was 199 kt (Forti et al., 2020) which is an increasing amount. The continuous e-waste problem is becoming a new reality as the country continues to undergo fast technological improvement.

So, managing e-waste is a difficult task for both the public and private sectors. For a developing nation like Bangladesh with limited resources and technical competence, appropriate management systems are desperately needed.

The main objective of this study is to determine the approximate amount of e-waste generated from households, in various locations of Dhaka city using the ownership rate. This paper also has highlighted the consumer's awareness about hazardous components of e-waste, individual recycling attitudes, behavioral dispositions, and trash disposal behaviors of consumers to find out the effective waste management systems for Dhaka city.

2. METHODOLOGY

2.1 Study Area

Dhaka is the capital and is the largest city of Bangladesh. It is located in central Bangladesh at 23°42′ North and 90°22′ East, on the eastern bank of the Buriganga River.

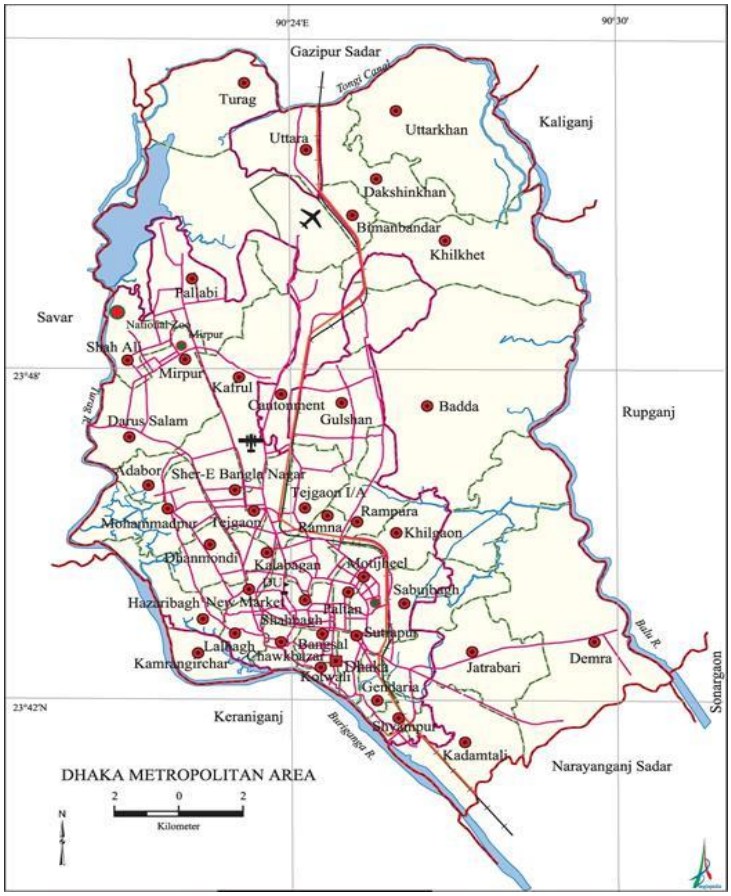

Figure 3.1: Dhaka Metropolitan Area Map; Source: (Banglapedia, 2021)

It is one of the most densely populated cities in the world (Banglapedia, 2021). The population of the Dhaka Metropolitan (DMA) area is 21,741,000 in 2021 (Macrotrends, 2021). Dhaka Metropolitan Area is divided into 2 city corporations, one is Dhaka North City Corporation (DNCC) and the other one is Dhaka South City Corporation (DSCC). And the total area of the two city corporations is around 306 km^2 (Dhaka North City Corporation, 2020; Dhaka South City Corporation, 2021).

2.2 Survey Procedure

The primary purpose of the survey was to collect information about household electrical and electronic equipment (EEE) and also determine the knowledge and awareness of the household user about e-waste in Dhaka city. The survey was conducted both in-person and online. Due to the covid-19 lockdown in Bangladesh, an in-person survey was not always possible, and that is why Google form was used to collect the necessary survey data. The main target of the survey was to collect information from households.

A total of 319 households were surveyed between June and September of 2021. The medium of the survey was English and Bangla for an in-person survey and only English for an online survey (Google Form).

2.3 Data

From the survey, the following data were collected,

1. Information about awareness and behavior regarding e-waste in the household
2. Information about the number of electrical and electronic equipment in the household

The E-waste Statistics Guidelines on Classification Reporting and Indicators – Second Edition (Forti et al., 2020) therefore divides EEE into 54 different product-centric categories.

These EEE types are grouped into six categories. Though minimum items from each of the six categories are not considered in this survey. For the quantitative analysis of e-waste generation, only 10 electrical and electronic equipment were considered and they are shown in following categories,

1. Temperature exchange equipment: Air Conditioning (AC), Fridge, Freezer
2. Screens and monitors: Television, Laptop
3. Lamps: Lamps were not considered for the e-waste estimation.
4. Large equipment: Washing machine, Microwave
5. Small equipment: Small equipment was not considered for the e-waste estimation.
6. Small IT and Telecommunication equipment: Feature phone, Smartphone, Desktop

All the collected data were stored in Microsoft Excel (version 2016) for further analysis. And all the calculations were done using the same software.

2.4 Method

According to Schluep et al., (2012); UNEP, (2007); Ikhlayel, (2016), available methods to determine the e-waste generation are:

a) Consumption and Use Method
b) Market Supply Method
c) Time Step Method
d) Carnegie Mellon Method
e) Approximation 2 Method

Now, data required for these methods (according to UNEP, 2007; Ikhlayel, 2016; Hamouda et al., 2017) are shown in the table below,

Table 2.1: Data requirements for e-waste assessment.

Methodology	Data Required								
			Sales Data		Stock Data				
	Number of Households	Lifetime	Single Year	Multiple Years	Single Year	Multiple Years	Saturation Level	Reuse Data	Recycle Data
Consumption and Use Method	√	√			√		√		
Market Supply Method		√		√					
Time Step Method	√			√		√	√		
Carnegie Mellon Method		√						√	√
Approximation 2 Method			√						

Here, “Single Year” means data is needed only for the year of the study. And “Multiple Years” mean that data of more than one year is required.

From the above table, it can be seen that to calculate the e-waste generated by the household, only "Consumption and Use Method" and "Time Step Method" can be used. Now, for the "Consumption and Use Method", the number of households, lifetime, stock data for that year, and saturation level is required. As Bangladesh is a developing country and there is a lack of reliable data, the Time Step Method cannot be used. Because there are no sale data for multiple years available and there are also no stock data available for multiple years. For this reason, this study used the Consumption and Use Method to calculate the e-waste generation in Dhaka city and the data required for this method was obtained from households very easily from the survey. The used model is given below,

Model: (Robinson, 2009, 184)

Total E-waste generation per year = mn/l (1)

Here, m = Weight of the electrical product

n = Number of electrical products in use

l = Average Lifetime of Electrical product

For this study, the aforementioned model was used as it only requires the weight of the electrical product, the number of electrical products in use, and the average lifetime of the electrical product. The data regarding weight and average lifetime were taken from the peer review and the number of electric and electrical equipment was collected from the survey data. From this method, the result of total e-waste generation will be in kg/year. And then it was converted into per capita generation (kg/person) and total "WEEE" or "E-waste" generation in Dhaka city (tons/year).

2.5 Assumptions

There were some hypotheses considered in this study to make the calculation easy and to resolve a few conflicts among the data. They are,

1. Data for lifetime and weight of EEE were taken from Alavi et al., (2015); UNEP, (2007); Robinson, (2009); Araújo et al., (2012); Cobbing, (2008). These data were not attained through the survey.
2. As most of the data were collected using Google Forms, the number of equipment 7+ is considered as 8.
3. As most of the data were collected using Google Forms, the number of family members in the household 8+ is considered as 9.
4. The mobile phone market and the laptop market were assumed to be saturated to ease the calculation of the total e-waste generation.

3. RESULTS AND DISCUSSION

3.1 Total E-waste Generation in 2021(Dhaka)

The total e-waste generation in the year 2021 in Dhaka city was estimated and found to be 117,598 tons and the per capita generation was found to be 5.409 kg/person, which is a higher amount. As Dhaka is the most developed city and the capital of Bangladesh, its population is too high and one of the densely populated cities in the world. Also, most of the private companies and tech companies are Dhaka-cantered. So, a high no of per capita e-waste generation is justified. According to World Population Review (2021), the population of Dhaka City in 2021 is 21,741,090.

Table 3.1: E-waste estimation

Equipment	Total Population of The Surveyed Households	Total Amount of Equipment in Households	Weight (kg)	Lifetime (years)	WEEE Generation (kg/year)	WEEE Generation (tons/year)	WEEE per capita (kg/person)	Total WEEE Generation in Dhaka City (tons/year)
Television	1441	426	30	8	1597.5	1.5975	1.109	24111
Air Conditioners	1441	345	55	12	1581.25	1.5813	1.097	23850
Fridge	1441	418	55	12	1915.8333	1.9158	1.33	28916
Freezer	1441	171	49	15	558.6	0.5586	0.388	8436
Washing Machine	1441	111	45	10	499.5	0.4995	0.347	7544
Microwaves	1441	246	15	7	527.1429	0.5271	0.366	7957
Desktop	1441	216	25	7	771.4286	0.7714	0.535	11631
Laptop	1441	416	5	7	297.1429	0.2971	0.206	4479
Feature phone	1441	436	0.113	4	12.317	0.0123	0.009	196
Smart Phone	1441	1124	0.113	4	31.753	0.0318	0.022	478
						Total:	5.409	117598

From table 3.1 it can be seen that; smartphones are the highest amount in the household but generated only 478 tons of e-waste in 2021. On the other hand, there are 418 fridges in the surveyed households. But they generated the maximum no of e-waste, which is 28,916 tons/year. This indicated that the weight of the equipment and the lifetime of the electrical device are the two most important factors for determining e-waste generation as they affect e-waste generation directly. Here the weight of the equipment is directly proportional to the generation of e-waste, and the lifetime is inversely proportional to the generation of the e-waste.

3.2 Analysis of responses on the basis of the waste collection system

According to this following figure 3.1, the local government bodies like Municipal Corporation are majorly responsible for collecting 72.41% of waste. However, 13.17% and 14.42% are responsible for collecting waste privately and informally respectably. Summing up according to response (13.17%+14.42%) = 27.59% <72.1%. So, it is quite evident that municipal corporations in the respective area should take the responsibility of collecting e-waste. But there is no Proper collection and disposal for E-waste separately.

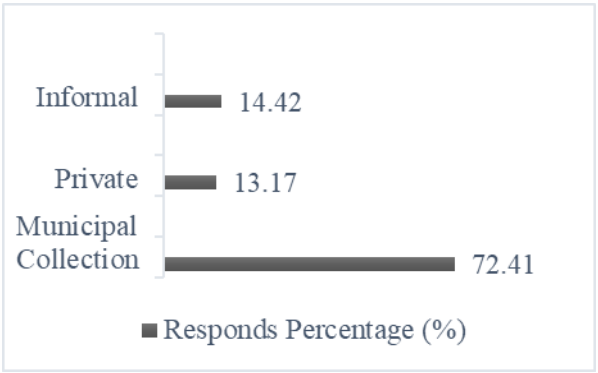

Figure 3.1: Responses on waste collection type

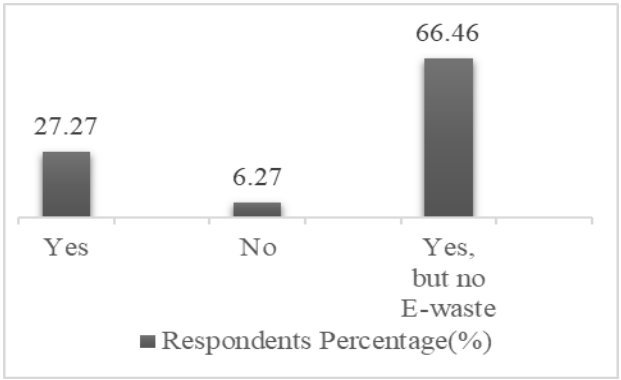

Figure 3.2: Responses on Collection of waste and e-waste at the door

From the following figure 3.2, it was noted that a maximum portion (66.46%) of respondents answered that waste collector come and pick up waste at your door, but they don't pick up e-waste.

However, 27.27% of respondents responded that waste collectors come and pick up waste at your door and pick up e-waste also. On the other hand, 6.27% of respondents said that waste collectors don't pick up any type of waste

3.3 Analysis of Responses on The Basis of Awareness

From this study, it was found that 85.89% of 319 respondents are aware that some hazardous fractions in e-waste need special treatment to be safely disposed of and 14.11% of 319 respondents are not aware of this. The difference in the percentage of responses (yes or no) in figure 3.3 indicates that the number of aware people is approximately 6.09 times higher than the number of unaware people. So, a good number of respondents are aware of this in Dhaka city. It is important to know how much people are aware of because it will be easier to educate about e-waste's other side-effects if people are aware of this. Following one of the literature of Jos, Plateau, Nigeria (Miner et al., 2020), reported that 50.9% (116 respondents) are aware and 49.1% (112 respondents) are unaware that e-waste requires special treatment before disposal.

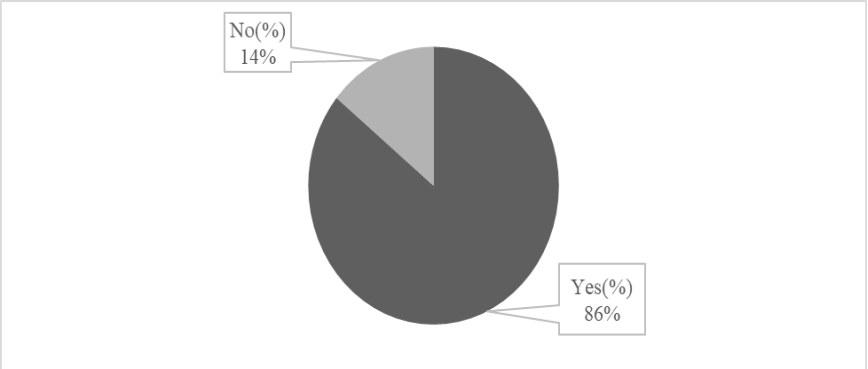

Figure 3.3: Responses on awareness questions

3.5 Analysis of Responses on The Basis of Behaviour

Though there are many reasons for changing electronic products, these reasons are categorized into 4 groups which are, due to damage, due to upgrade, due to theft, due to newer design of electronic products. The results based on these aspects are summarized in the following figure 3.4. The figure shows that 55.49% of the respondents strongly agreed that they would change or buy new electrical products to replace damaged products. Where 37.93% agreed, 4.08% disagreed and 2.51% strongly disagreed with this. Most of the respondents among 319 are agreed that they were changing products for product upgrades. The percentage of responses on agreed and strongly agreed are respectively 59.87% and 20.69%. On the contrary, 6.58% of the respondents are strongly disagreed with this. Most of the electronic device users have strongly agreed which percentage is 43.89% that they were changing their devices because of products were theft. 41.38% of total 319 respondents were changing their electronic products just for the new design. Where 25.71% and 13.48% are respectively disagreed and strongly disagreed.

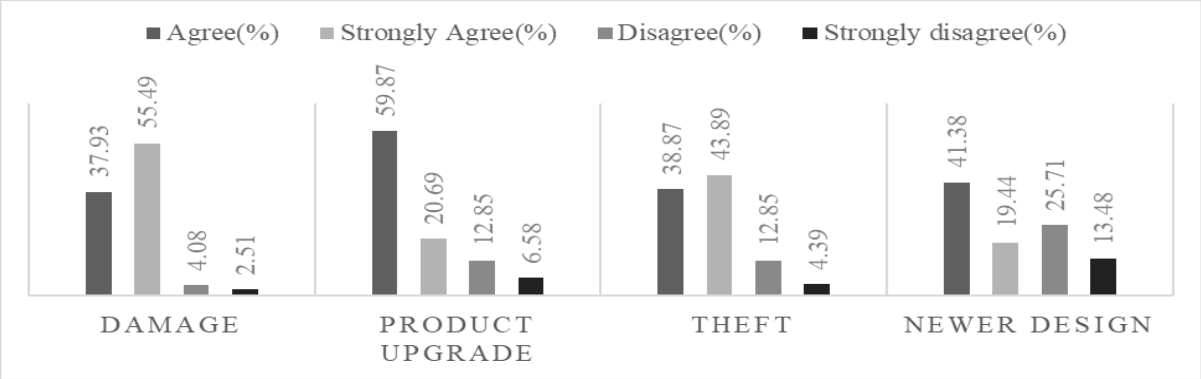

Figure 3.4: Reasons for changing electronic devices

There are different types of handling and discarding processes of e-waste in the study area. From the following figure 3.5, it can be illustrated that most of the respondents stored the electronic products at home after consumption which percentage is 36.99%. Larger percentage of storing e-waste homes is probably emphasized on the statement that a large number of people do not know what to do with e-waste after consumption as there is a lack of door-to-door e-waste collection programs and formal e-waste collection programs. A very little amount of people know proper disposal method of e-waste.

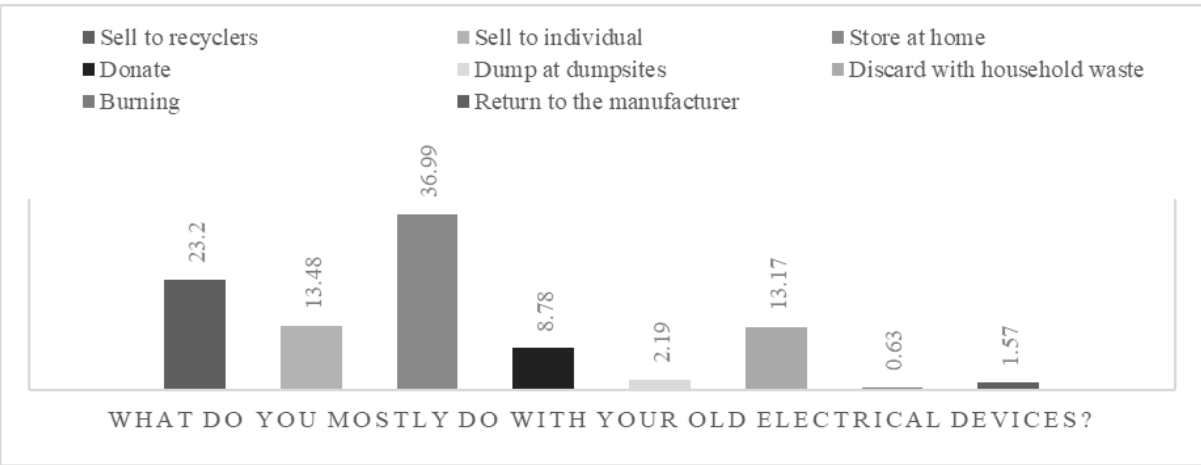

Figure 3.5: Handling and discarding process of electronic device

There may have been many reasons that respondents are not practicing recycling. Based on the responses of if they are practicing recycling, it was found from the figure 3.6 38.87% were practicing any kind of recycling and 61.13% of 319 respondents are not practicing recycling. So, the percentage of people who are not recycling anything is higher than the percentage of the persons who are practicing recycling. Lack of knowledge about further usage of waste or after consumption activity can be the reasons for not recycling. The amount of the higher percentage of not doing any kind of recycling may also depend on the fact that 61.13% of respondents do not know that unused electronics are not waste and can be reused. 38.87% may have thought that ELECTRONIC devices with end-of-life are not a complete waste. The components or raw materials of electronic devices can be reused by extracting them from unused devices or electronic waste which can be a productive mindset. The lifetime of the product may be increased by having this kind of mindset.

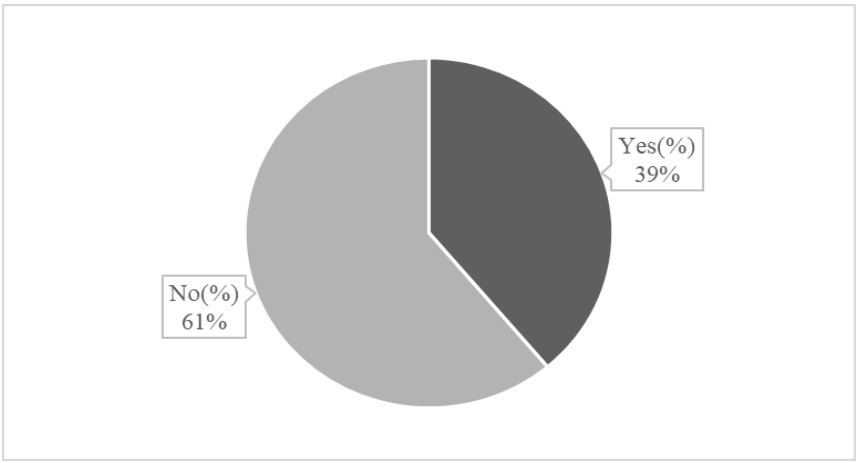

Figure 3.6: Responses on recycling practice question

3.6 Analysis of Responses on The Basis of Willingness

From the survey it was seen that 22% of respondents responds "NO" and 78% of respondents responds "YES" when they were asked if they are willing to give out e-waste of the surety of not polluting the environment (Figure 3.7). It is seen from the result of respondents that people who are willing, their percentage is higher than the percentage of the people who are unwilling to give out the e-waste even after being ensured that these e-wastes will not pollute the environment. If it is possible to aware people about the proper e-waste collection and disposal system, then the percentage of willing people may be increased. Trustworthy e-waste management agencies can arrange campaigns about how and where they are disposing of the e-waste without polluting the environment. These may increase the willingness rate on this topic.

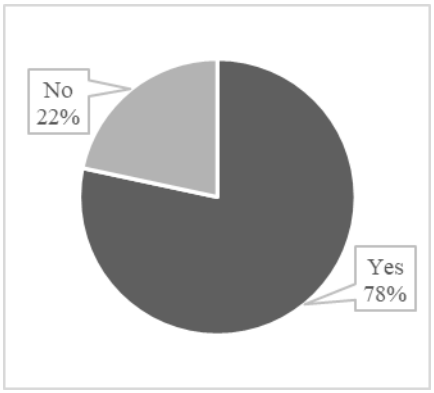

Figure 3.7: Responses on willingness to give away e-waste

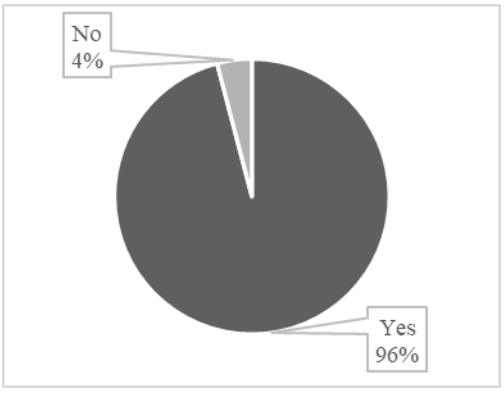

Figure 3.8: Responses on willingness to recycle e-waste

It was also seen from the survey that 96% of people want to recycle and the other 4% are not willing to recycle (Figure 3.8). The unwilling people may have a lack of knowledge about the toxic components and their hazardous effects. And they may be unaware of the fact that the environment is in danger because of this kind of waste which may affect human life and health later.

4. CONCLUSIONS

As Bangladesh is transitioning from a least developed country to a developing country, the use of electrical appliances is also increasing. And as a result, from this study, the total e-waste generation was 117598 tons/year with a per capita generation of 5.409 kg/person. But this is also creating new

problems for the country like e-waste. If they are not properly handled (sorted, reused, and safely disposed of), they can cause health problems and environmental pollution as they may contain hazardous material, chemicals, and rare metals. In Bangladesh, there is no formal e-waste collection system for the household, for which either they are stored in houses or discarded with solid waste. And this is harmful to the environment. It can also be seen from the study that people strongly agree to buy new equipment when their old devices are damaged. If they start to use high-quality electrical equipment, the chances of accidental damages may reduce. On the contrary, most of the people in Dhaka city are not practicing recycling, but are willing to recycle. So proper e-waste collection systems and recycling facilities are needed to be constructed so that people can recycle and save the environment. People also can rent electrical equipment instead of buying it upfront as it will also reduce the generation of e-waste. The government also need to take some step to reduce problems regarding e-waste. Like, establishing proper legislation for e-waste handling and maintenance, legislation of the right to repair, mandating extended producer responsibility for the equipment producer. By doing these, the amount of e-waste can be reduced in the long future.

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