Analysis of Santa Clara Residents' Electronic Waste Recycling Behavior

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Abstract Prior study showed that the most of Santa Clara residents are not aware of nearby e-waste recycling facilities. The existence of this annual clean-up campaign may give residents an opportunity to dispose of e-waste and limits their motivation to take e-waste to the recycling facilities. This study investigates the history of residents' electric waste disposal habits and the city's role in educating residents about recycling e-waste. Randomly selected residents in front of four popular electronic stores near Santa Clara are surveyed about their knowledge and behavior regarding e-waste recycling programs in Santa Clara City. The results show that residents who are uninformed about e-waste recycling programs in Santa Clara are more likely to dispose of e-waste during the city's annual clean-up campaign. Although the city mails brochures and advertises on the city web site to motivate residents to participate in recycling program, I conclude that the city has not effectively educated residents. If the city is capable of putting more effort on educating residents and making it more convenient for residents to recycle e-waste, the city's landfill space can be conserved and less toxic may be flowing into ecosystem around the city.

Introduction

Increasing demand for more advanced electronic equipment and the trend of replacing rather than upgrading old electronic equipment (Toxic Link 2004) rapidly generate huge amounts of electric waste. Electric waste can be defined as computers, VCRs, DVDs, copiers, fax machines, printers, televisions, cellular phones that are not used. These obsolete electronics are stored in warehouse or are sent to landfill or incinerator facilities (Wood 2001). Studies show that approximately seventy-five percent of out-dated electronics are stored in warehouses, and according to the EPA more than 3.2 million tons of e-waste ended up in landfills in the U.S in 1997. (Computer Recyclers of America 2003). Another estimation of e-waste was at the end of 1999 twenty four million computers in the U.S. became obsolete, but only about fourteen percent were recycled or donated (Sloan 2000). More than twenty million computers in the U.S. are "dumped, incinerated, shipped as waste exports or put into temporary storage in attics, basements, etc" (Wood 2001). In California alone approximately two to three million tons of e-wastes are generated per year, according to the City of Los Angeles Environmental Affairs Department (LAEA Dep. 2003). Currently, electric waste represents about two to five percent of the national municipal waste stream, and it is expected to increase by three to five percent per year (Arensman 2000).

The short life span of electronic products is considered to be the main cause of increasing e-waste. According to the U.S. National Safety Council, the estimated average life span for PCs is 3.1 years, cathode ray tube is 4-7 years, printers are 3-5 years, and scanners is 3-5 years. According to NSC's report, the life span of a PC is expected to decrease and level off to two years by 2005 (NSC 1999), which means, "one computer will become obsolete for each one put on the market" (True Cycle 2003).

The rapid rate of increasing electric waste has become a threat to the environment and human health. The consequence of the e-waste dumped in landfills or burned in incinerators is the release of heavy metals and the dioxins, which pollute the air (BA Network 2002). About 70% of heavy metals found in landfills (including mercury and cadmium) come from electronic discards and heavy metals and other hazardous substances found in electronics can contaminate groundwater (CRA 2003). Moreover, electronic equipment often contain other toxic elements such as batteries, mercury switches, sensors, and relays (Engler 2001), and these are considered to be toxic and hazardous elements to the environment and human health (Shelly 2001).

Despite the fact that e-waste contains harmful elements, most households and small businesses send obsolete electronic equipment to landfills or incinerators rather than take them to the recycling systems (CRA 2003). The San Francisco Toxics Coalition states that "three quarters of all computers ever bought in the U.S. are sitting in people's attics and basements because they don't know what to do with them" (Wood 2001). These computers, which may be effectively reused in the future, are losing their potential value, and many people may find it more convenient and economical to simply throw away e-waste than to recycle it.

Philip J. Chen, a former ES 196 student, carried out a simple survey to find out residents' awareness of a computer-recycling center in Santa Clara City. His survey concluded that a large percentage of residents were unaware of a computer recycling facility and had thrown away computer components before. (Chen 2001)

However, as a five year resident of Santa Clara, I believe that residents' ignorance is not merely due to the apathy, but rather the city is not adequately informing citizens about recycling programs or facilities in their area. I have never received any brochures from city explaining about electric waste recycling facilities. Moreover, the city of Santa Clara holds the curb-side pick up campaign annually, and the main purpose of this campaign is to dispose of bulky wastes that are not routinely collected by weekly garbage collection services. Because of this campaign, Santa Clara residents use it as an easy way to dispose of old electric waste. According to the Street Dept Corporation Yard of Santa Clara city, the city collects and recycles televisions and computer monitors that contain cathode ray tubes separately, but other e-wastes are taken directly to the landfills.

One objective of my study is to investigate why Santa Clara residents' have low awareness of recycling facilities. I hypothesize that the disposal system of Santa Clara City limits residents' motivation to recycle e-wastes. In particular, I believe that by providing an annual clean up campaign, the city of Santa Clara gives residents an opportunity to throw away obsolete electric equipment. I believe that Santa Clara residents have low awareness of recycling facilities because of low exposure to information about electric waste recycling combined with easy excess to disposing of electric wastes. Thus, I hypothesis that the Santa Clara residents, who are informed by the city about e-waste recycling programs, have less tendency of disposing electric waste during past annual campaign than those residents who are not provided with the city information.

Methods

My study evaluates the Santa Clara residents' habits and their level of exposure to the city provided information. I also look at how the city of Santa Clara educates and informs residents about recycling electric waste. I investigate my hypothesis by conducting a simple survey of the Santa Clara residents. My survey questions ask how frequently residents receiving information from the city, their past experiences of disposing e-waste during campaign, and motivation for disposing of e-waste during the campaign. Also, I measure their willingness to participate in recycling program if the city provides more information.

Participants in my survey were consisted of Santa Clara residents. I conducted surveys in front of four different popular electronic stores within 3 miles of Santa Clara City boundary: CompUSA located at 3561 El Camino Real in Santa Clara, Circuit City located at 4080 Stevens Creak Blvd in west San Jose, Fry's Electronics located at 1077 East Arques Avenue in Sunnyvale, and the Good Guys located at 1506 Stevens Creek Blvd in Santa Clara. These sites are chosen because residents who are visiting electronic stores to purchase new electronic equipment have a higher chance of thinking about disposing of old electronic equipment. These stores are the most popular electronic stores in the neighborhood and the chance of interviewing Santa Clara residents was high.

The survey was conducted in person. Participants were approached in the parking lot and asked to identify the area that they live. If the participant was from other than the city of Santa Clara, the participants were not asked to take survey. Also, participants whose ages were under 18 were excluded from survey, and the survey was limited to only English speaking participants. I had 104 participants.

I sought to test the null hypothesis that the frequency of disposing e-waste during annual campaign and the frequency of receiving information about e-waste recycling from the city is independent. In order to test this hypothesis, I used a survey with four multiple-choice questions. The questions referred to residents' awareness of town and recycling program, past experience of disposing electric waste, reasons for disposing e-waste during the past annual clean-up campaign, and willingness of participation in recycling program if more information were provided. The multiple-choice answers were compiled to identify ratios of the population who answered in a particular way. I then ran statistical analyses to analyze the relationship among questions; namely, I tested whether residents who are previously exposed to the city

provided information dispose of electric waste less frequently than those who are not exposed to this information.

Respondents were divided into two groups — group 1 consisted of those who receive information provided by the city regarding e-waste disposal while group 2 consisted of residents who said they do not receive information regarding e-waste disposal. Respondents were then asked about their past experiences of disposing electric waste during the annual clean up campaign. These responses were analyzed to see whether the group 2 has more tendency of disposing electric waste during past annual campaign than group 1.

I also examined whether respondents indicated that they would change their behavior with access to more information. I performed a chi-square test to analyze the relationship between the subjects' answers in the first and second question and in their change of mind in questions 2 and 4.

Question 3 of the survey asked the resident to indicate what is the most prominent factor that contributes to residents' choice of disposing e-waste during the clean up campaign.

Results

Of the 104 surveys collected, I found 15 residents, (14.4 % of population) received about e-waste recycling information and 89 residents, (85.6% of population) did not receive information from the city. The distribution of the frequency of receiving information about e-waste recycling from the city is illustrated in (Fig.1).

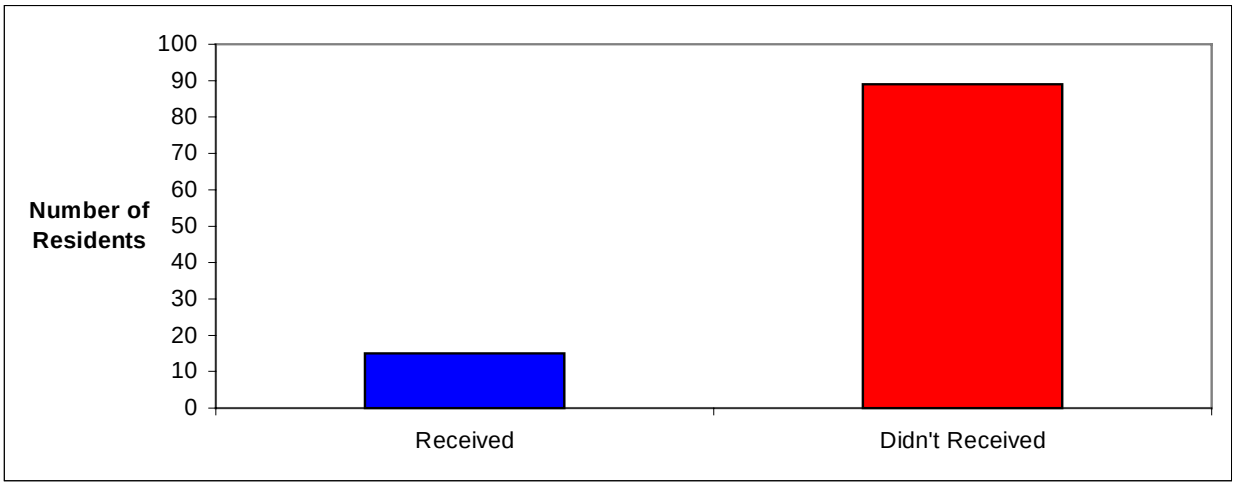

Figure 1: The frequency of receiving e-waste recycling information from city

Question 2 of the survey asked the residents to indicate whether residents have disposed of e-waste during the past annual clean up campaign. I found 83 residents (79.8% of the population) have disposed of e-waste during the past annual clean up campaign and 21 residents, (20.2% of the population) did not dispose of e-waste during the past annual clean up campaign. The proportion of the frequency of disposing e-waste during the campaign is illustrated in (Fig. 2). As it shows, the number of residents disposing of e-waste during the past annual clean up campaign exceeded the number of resident who did not dispose of e-waste in the past.

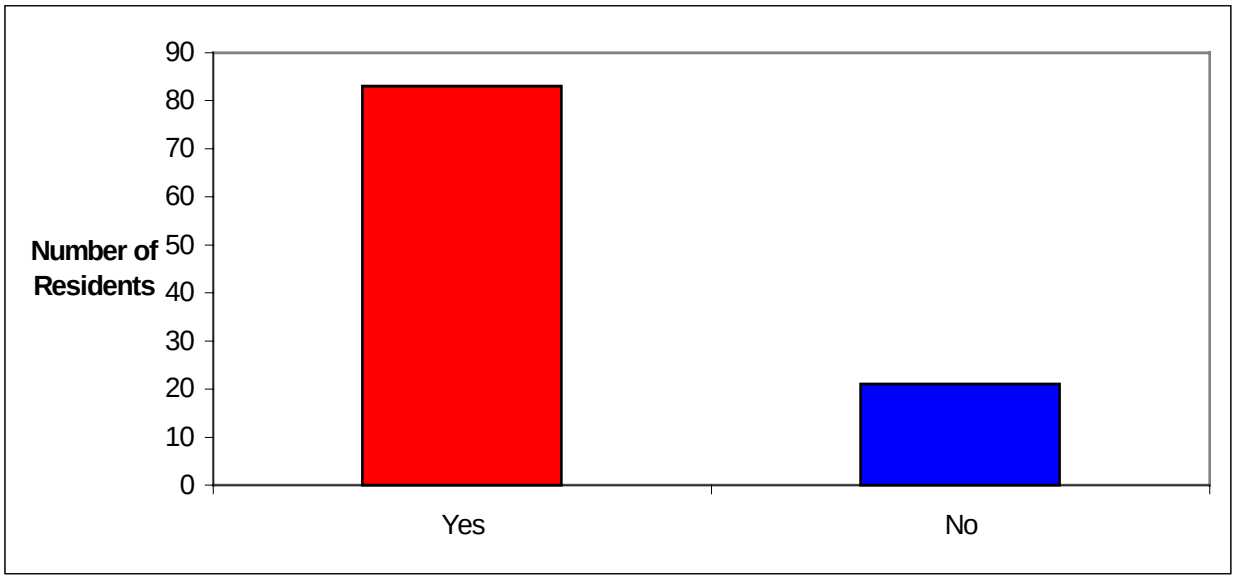

Figure 2: The frequency of disposing e-waste during the past annual clean up campaign.

In comparing with the frequency of receiving information about e-waste recycling from the city with the frequency of disposing e-waste during the past annual clean up campaign, my chi-square analysis detected significant dependency between the results from two questions with χ^2=39.03 and p-value of 4.16 x 10^-10. (Fig.3)

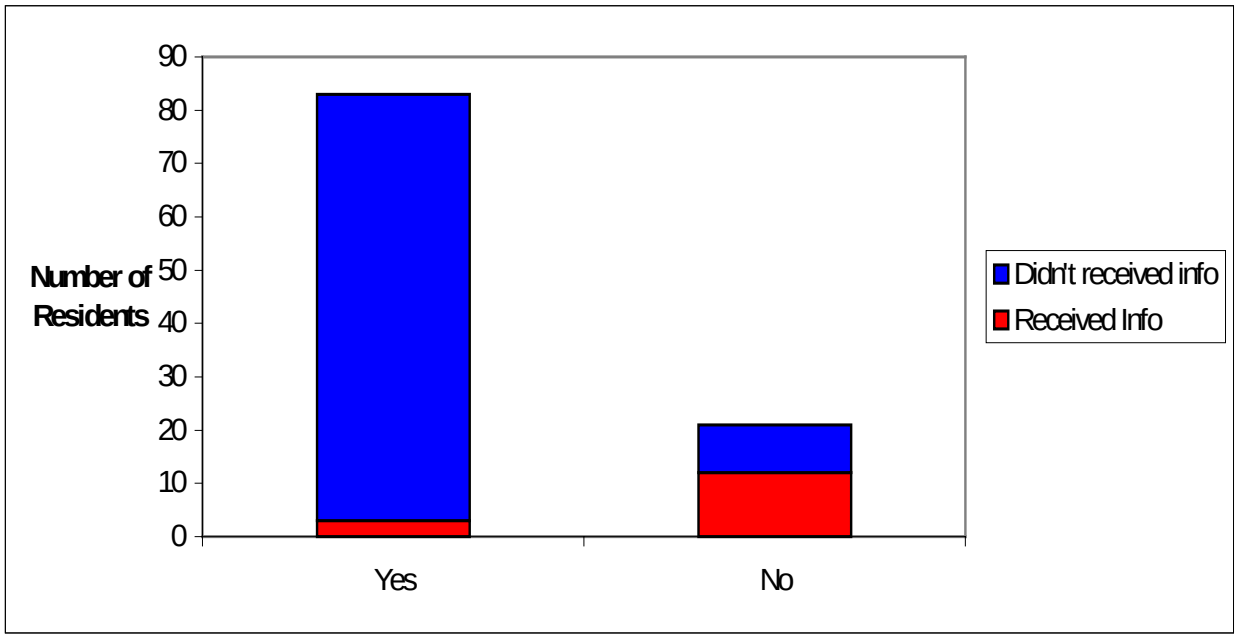

Figure 3: Proportion of disposing e-waste with and without receiving info. from the city

Question 4 of the survey asked whether residents would participate in e-waste recycling programs if residents were provided with more information. The distribution of the frequency of respondents' willingness to participating in recycling program if more information were to be provided is illustrated in (Fig.4).

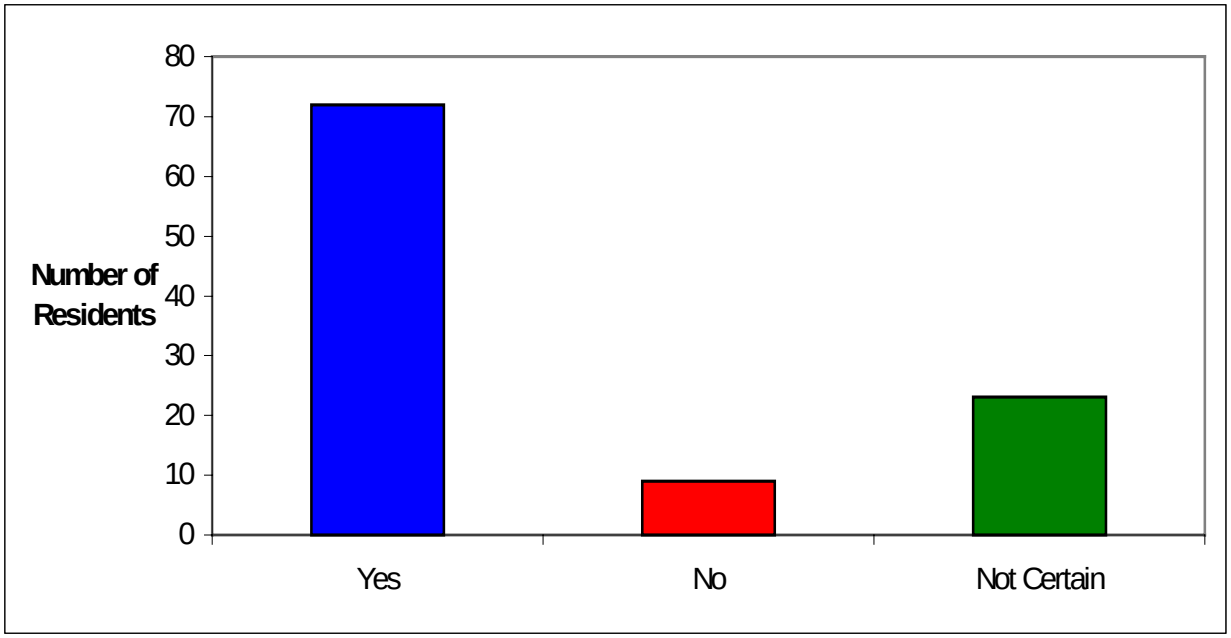

Figure 4: The frequency of respondents' willingness to participating in e-waste recycling programs if more information were to provide.

In comparing with the frequency of disposing e-waste during the past annual clean up campaign (Question 2) with the willingness of participating in e-waste recycling programs if more information were provided to residents (Question 4), I found that 69 residents, among 83 residents who have disposed their e-waste during the annual campaign, answered that they would participate in e-waste recycling program if more information were to be provided. My chi-square analysis revealed statistically significant dependency between the two groups with χ^2=59.85 and p-value of 8.26 x 10^-14. (Fig.5)

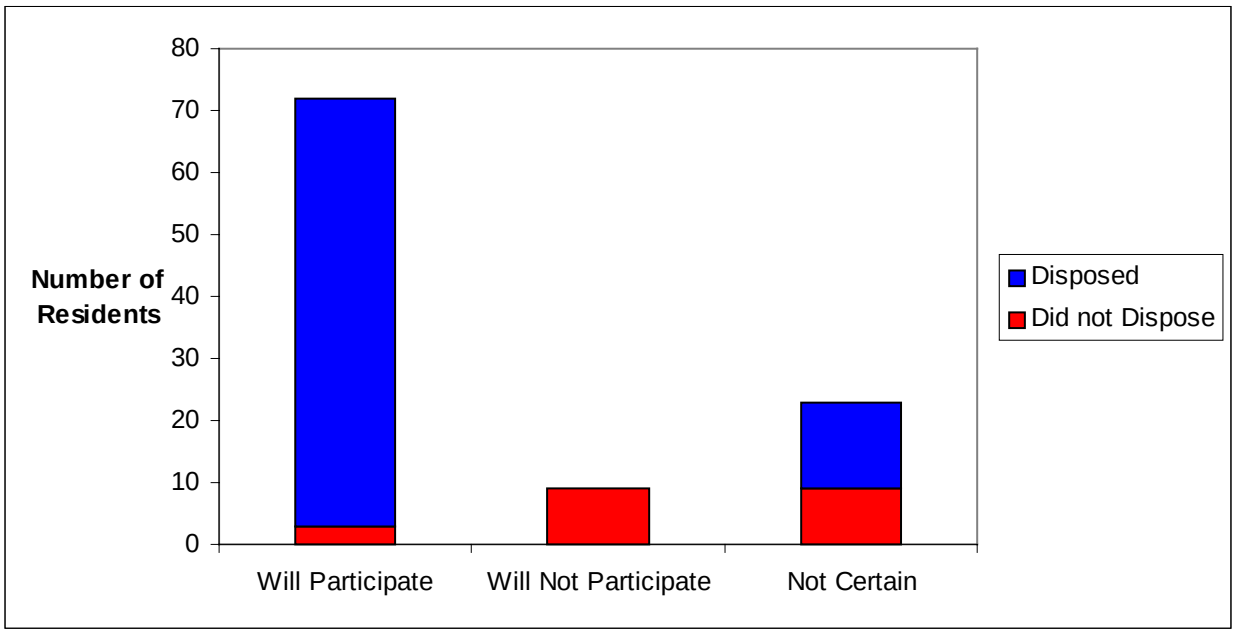

Figure 5: Proportion of participating in e-waste recycling program w/ or wo/ information from the city

Question 3 of the survey asked residents to indicate what is the most prominent factor that contributes to residents' choice of disposing e-waste during the clean up campaign. Among 83 residents who have disposed of e-waste, 38 residents (45.78% of the population) blamed unconsciously following others, 33 residents (39.75% of the population) blamed convenience, 5 residents (6.02% of the population) blamed high cost of recycling, 5 residents, (6.02% of the population) did not indicate anything, and 2 residents, (2.4% of the population) said couldn't finding alternative ways of disposing e-waste. The proportion of the frequency of major factors, which contributed to residents dispose of e-waste during the annual clean up campaign, is illustrated in (Fig. 6).

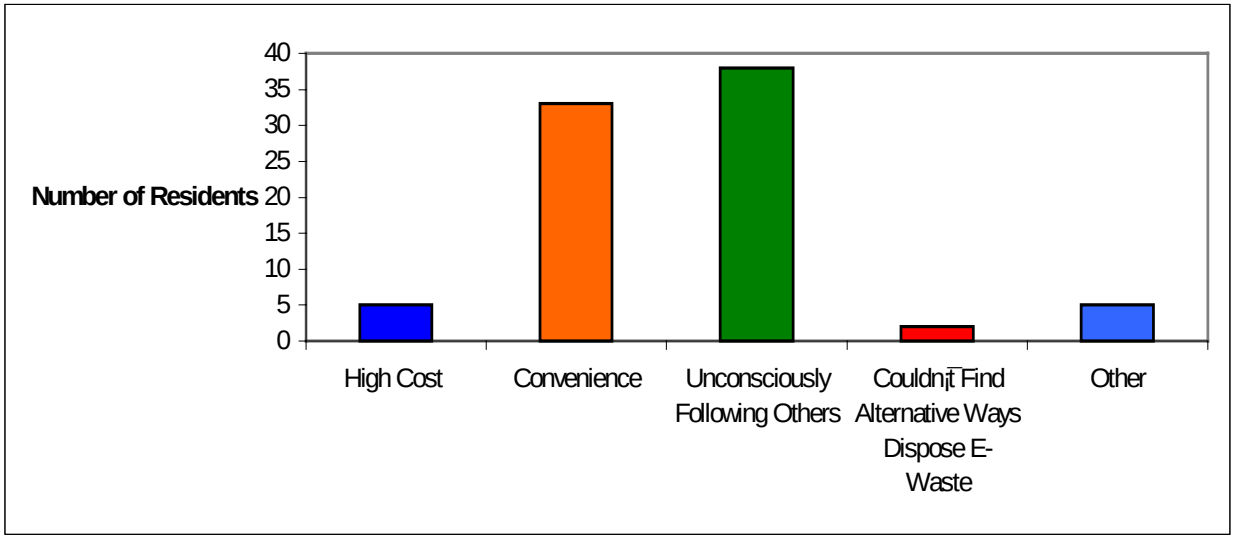

Figure 6: the frequency of the major factors, which contribute residents to dispose of e-waste during the annual clean up campaign

Discussion

From the survey data, only 14.4% of the Santa Clara residents have received information and were educated about e-waste recycling programs while 85.6% of residents did not. The result reveals the significant difference between two groups, and it shows that not many residents were exposed to the city provided information about e-waste recycling program.

As (Fig. 2) shows, 83 residents (79.8% of the poll) have disposed of e-waste in the past annual clean up campaign and 21 residents (20.2% of the poll) did not dispose of e-waste in the past. These numbers clearly inform me that the annual clean up campaign is an easy alternative for uninformed residents.

By combining the results from two questions and analyze with chi-square test, a strong conclusion is made. My statistical analysis indicates that the frequency of disposing e-waste during annual campaign and the frequency of receiving information about e-waste recycling from the city is dependent. My result shows that residents who are uninformed about e-waste recycling programs are more likely to dispose of e-waste during the city's annual clean up campaign.

Also, I conclude from question 4 that residents are willing to participate in recycling program if more information are provided by the city. By combining the results from question 2 and question 4 and testing with chi-square, my statistical analysis also indicates that the frequency of

disposing e-waste during the annual clean up campaign and the willingness of participating in e-waste recycling program if more information are provided by the city is dependent.

However, the result from question 3 leads me into the thoughts of whether residents really would participate in the recycling program if more information about recycling program were provided by the city. Among 83 residents, who answered that they have disposed of e-waste during the past annual clean up campaign, 33 residents (39.75% of the population) showed that disposing of e-waste during the annual clean up campaign is more convenient than taking e-waste to the facility, and 5 residents (6.02% of the population) found that recycling is expensive. The result shows that the Santa Clara residents might have low potential of participate in recycling program even after the city provides with more information. Because these residents found more convenient and less expensive ways to get rid of obsolete electronic products, I suspect that these residents might not participate in e-waste recycling program although more information is provided. However, 38 residents (45.78% of the population) and 2 residents (2.4% of the population) blamed on unconsciousness and not finding alternative ways of disposing e-waste, and I suspect that these residents may have potential of participating in recycling program if they can self-recognize that disposing of e-waste during the annual clean up campaign may harm the ecosystem around them. Because these residents either are not aware of recycling facilities or are not consciously thinking what they are doing, they can be directed towards recycling facilities if the city provides more information about e-waste recycling programs around the Santa Clara City.

Bias in my data could have arisen from residents' lack of participation. When the Santa Clara residents walked out from the stores with merchants on their hands, they ignored my presence. As I mentioned early in method section, I assumed that residents who purchase new electronic equipment may have greater potential of disposing old equipment, and I was hoping to receive responses from residents who were purchasing new electronic equipment. Despite my intention, residents who were not buying new electronic equipment mostly answered my survey questions.

My research result is an important outcome for the Santa Clara City. Apparently, low percentages of the Santa Clara residents are receiving information about the city's e-waste recycling programs, but my result indicates that there is high potential of having residents participate in the e-waste recycling programs. If more residents participate in recycling programs, the city's landfill space can be conserved and less toxic waste will be flowing into the

ecosystem around the Santa Clara City. By surveying the Santa Clara residents, I was hoping that I might have brought residents' attention to the importance of recycling e-waste.

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Appendix A

Your participation in this research is voluntary. You are free to refuse to take part. You may refuse to answer any questions and may stop taking part in the study at any time. Whether or not you participate in this research will have no bearing on your standing in your class/school/job.

1) How do you find ways to recycling programs or facilities?
_____ a) Yellow Pages
_____ b) City Recycling Guide Brochure
_____ c) Internet
_____ d) City provided Media Advertisements
_____ e) City Office
_____ f) Other

2) Have you ever disposed electric waste during past annual clean up campaign? (Ex. TV. Computer, Monitors, VCR, DVD player etc.)
Yes
No

3) If your answer is yes, please answer following questions. If your answer is no, skip to next question.

Which of the following is the most prominent factor that contributes to your choice of disposing electrical wastes during the Annual Clean-up Campaign?

_____ a) because it is less expensive to dispose electrical wastes during the campaign
_____ b) because it is more convenient to do so
_____ c) unconsciously follow what many others around them do
_____ d) Could not find alternative ways of disposing electrical wastes
_____ e) Other

4) If you were to receive more information about electric waste recycling programs and facilities, would you participate more often?
Yes
No
Not certain

5) Other comments about e-waste disposal system or recycling programs?