Public Awareness of Plastic Recycling in Berkeley and Oakland

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Abstract With the unique characteristics of being light weighted and long durability, plastics become convenient products to the society. Unfortunately, plastics production uses nonrenewable resources, which may not be economically viable in the long run. One of the current alternatives is recycling. Domestic plastic recycling is difficult to accomplish because of the differences in individual awareness, habits and lifestyles. Once understand these differences, improvements of the current recycling program can be made. This study focuses on comparing cities of Berkeley and Oakland on how much the public knows about plastic recycling in their cities and the level of plastic recycling participation. Approximately 200 surveys are being collected in front of two separate supermarkets for each city on two consecutive weekends. Analyzed surveys do not support the first hypothesis, which proposed city of Oakland has the better knowledge of plastic recycling code than Berkeley. By using Chi-Square analysis, the result shows no significant difference between Berkeley and Oakland. ($p = 0.7905$). Another Chi-Square analysis tests the second hypothesis, which states that city of Berkeley has a higher level of plastic recycling participation. Result also shows no significant difference ($p = 0.7418$) base on the sample population. These findings are important to show that cities locate next to each other behave similarly even though they do not recycle exactly the same materials. Therefore, by influencing the adjacent cities to recycle more plastics, the nation-wide plastic recycling rate may increase and the dependency on nonrenewable resources to produce virgin plastics may decrease.

Introduction

Recycling has become one of the solutions to conserve natural resources by collecting used materials and manufacture secondary usable products. Materials made up of papers and glasses are being recycled constantly due to the reason that it is economically viable. Plastics, however, are not being recycled as frequently. In fact, plastic composes the majority of solid waste in the US and only 2% of the plastic wastes are recycled (Stone *et al.* 1992). With technology improvements and higher awareness of using recyclable plastics, recycling rate in the US has increased along with a decrease in landfill disposal (Subramanian 2000).

As indicated by General Mill Supply Company (2003), a paper and plastic recycling company, the general plastic recycling process includes collection, identification, categorization, separation, and reclamation of the recyclable plastic into production of new plastic products. The new plastic products have two types, according to Fletcher and Mackay (1996), which may or may not replace the virgin plastic products. If the virgin plastic can be replaced with recycled plastic, then such process is "true" recycling (Fletcher and Mackay 1996). Otherwise, the "new market" recycling only creates another market for recycled plastic, which does not reduce the usage of virgin plastics (Fletcher and Mackay 1996). This idea is important to understand because the ultimate goal of plastic recycling is to reduce the extraction of nonrenewable resources that are used to produce virgin plastics. If the recycled plastic products cannot fulfill this goal, then plastic recycling cannot be considered as "true" recycling. There are products indicating that "true" recycling had been done (Ambrose *et al* 2002) such as plastic lumber for piers (Vincent *et al.* 1998). Therefore, with government recycling policies being adapted to everyone and high public participation, "true" plastic recycling can be done more commonly (Stone *et al* 1992, McDonald and Ball 1998).

This research compares and contrasts the public awareness of plastic recycling in cities of Berkeley and Oakland. According to Alameda County Waste Management Authority, city of Berkeley only recycles plastic types #1 and 2, which consist of most of beverage bottles while city of Oakland recycles all plastic types #1 to 7 including most plastics on the market where public has access to (Alameda County Source Reduction and Recycling Board). It is interesting to recognize how much the public from these two cities knows about recyclable plastic types and the level of recycling participation. Geographically speaking, Berkeley and Oakland situated right next to each other, but they may or may not have the same recycling trend. Research like

this has never been performed before because previous researches focused mainly on the different plastic recycling methods and case studies of management. However, it is necessary to determine the current public awareness of plastic recycling in order to improve the existing recycling programs, which could potentially result in higher participation over time as technology advances with higher plastic recycling efficiency. Eventually, a significant portion virgin plastic market could be replaced by the "true" recycled plastic.

The objective of this research is to compare resource conservations in the city of Berkeley and Oakland in terms of the public knowledge toward recyclable plastic in their city and public's participation level specifically regards to plastic recycling. Since Oakland recycles plastic types #1 to 7, residents should be more aware of plastic recycling from such a straight forward message. Berkeley, on the other hand, has the highest per-capita membership in environmental organizations of any city in the US (City of Berkeley). For that reason, Berkeley residents should care more about protecting the environment and thus participate in recycling more with ease. Therefore, the proposed hypotheses are: Oakland residents should have higher public knowledge toward recyclable plastic codes and Berkeley residents should have a higher level of plastic recycling participation.

Methods

The study is based on conducting surveys at two stations in each city. Survey stations locate at different parts of the city in order to involve as many different neighborhoods as possible. To maintain a proper sampling process, all survey stations have the following characteristics: First, they are close to the residential area to avoid sampling from out-of-city individuals attracted by commercial areas such as those close to high-traffic public transportation stations or well-developed shopping centers. Second, they locate near an infrastructure that the majority of the nearby residents go to such as supermarkets or neighborhood parks. Therefore, two Andronico's Markets in Berkeley and two Albertsons in Oakland were chosen as the survey stations.

Survey was conducted on both Saturday and Sunday afternoons from 2 to 4 for two consecutive weeks. It is assumed that the majorities of the residents do not work on Saturday and Sunday afternoon and perform their grocery shopping at these hours. The two consecutive weekends do not overlap with any holidays to eliminate factors that may affect public's grocery shopping habits.

Sample population had approximately 200 individuals for each city and about 100 people from each survey station in order to give enough power for the representative results. For purposes of consistency, all surveyors were located at the entrance(s) of the supermarkets and surveys were conducted before people entered the supermarkets. The selection of sample population was determined by the closest person to the surveyor before entering the supermarket in cases of two or more people entering at the same time.

The survey consists of three parts: awareness of plastic recycling, knowledge of plastic types that are being collected locally, and level of participation in plastic recycling (Appendix 1).

All collected surveys had been double counted with results shown in Appendix 2. To test the two hypotheses, chi-square analysis was used to determine the differences in the knowledge of recyclable plastic code as well as the level of plastic recycling participation between cities of Berkeley and Oakland.

In addition, comparison of plastic recycling level between people with and without the knowledge of the plastic recycling code for each city determines whether knowledge of these plastic recycling codes is a factor that affect public's plastic recycling pattern. Chi-square analysis was used and the result could be used as a reference to determine the improvements of existing plastic recycling program(s).

The finalized results from data analyses determine the city with higher knowledge of recyclable plastic codes and the city with higher plastic recycling participation between Berkeley and Oakland residents.

Results

Given that city of Oakland recycles all plastics and Berkeley does not, it is hypothesized that Oakland residents would have a higher knowledge about recyclable plastics than Berkeley. Question #3 in the survey (Appendix 1) can be used to test this hypothesis. The answers for question #3 are categorized into three groups: Correct, Incorrect and Unanswered (including answer choice "I Do not Know" in question #4.). Figure 1 indicates the answer distribution of the two cities for question #3. In order to determine the possible existence of significant difference between Berkeley and Oakland, chi-square analysis is the best appropriate

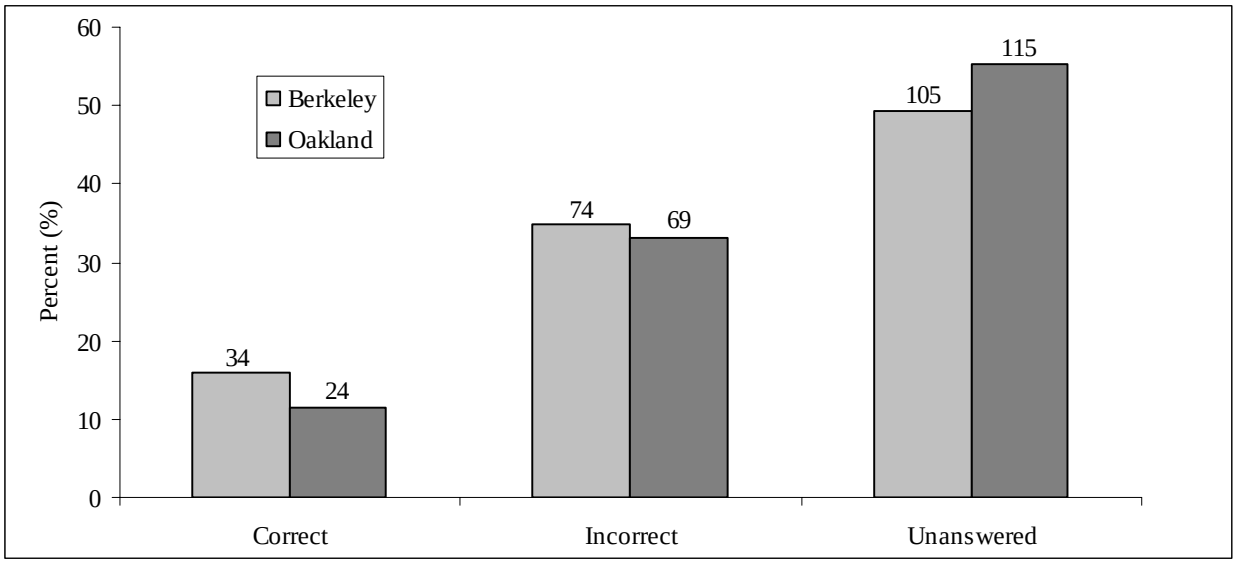

Figure 1. Knowledge of Recyclable Plastic Code. Answer percentage distribution between cities of Berkeley and Oakland. Numbers at the top of each bar represent the actual number of respondents.

statistical analysis when comparing two or more groups with the categorical outcomes. With a p-value greater than 0.05 (p=0.7905), the chi-square analysis indicates that there is no significant difference regarding to recyclable plastic knowledge between cities of Berkeley and Oakland residents.

%	Berkeley	Oakland
Yes	86 (183)	84 (175)
No	14 (30)	16 (33)

Table 1. Awareness of Plastic Recycling. Numbers in the prentices represent the actual number of respondent.

Even though Berkeley residents do not have significantly higher knowledge toward recyclable plastics, the second hypothesis predicts that they have higher plastic recycling participation than Oakland residents. Question #1 in the survey (Appendix 1) asks for the awareness of plastic recycling (Table 1) and Question #5 asks for the frequency of plastic recycling (Figure 2), which together can be interpreted as participation. As seen in Table 1, Berkeley and Oakland residents have similar trend of plastic recycling awareness. They both have mid-80 percent of sample population aware of plastic recycling in their cities. A chi-square analysis has also been used sufficiently to determine that there is no significant difference (p=0.7418) between Berkeley and Oakland regarding to levels of plastic recycling participation.

Figure 2 shows the results of plastic recycling participation between Berkeley and Oakland residents.

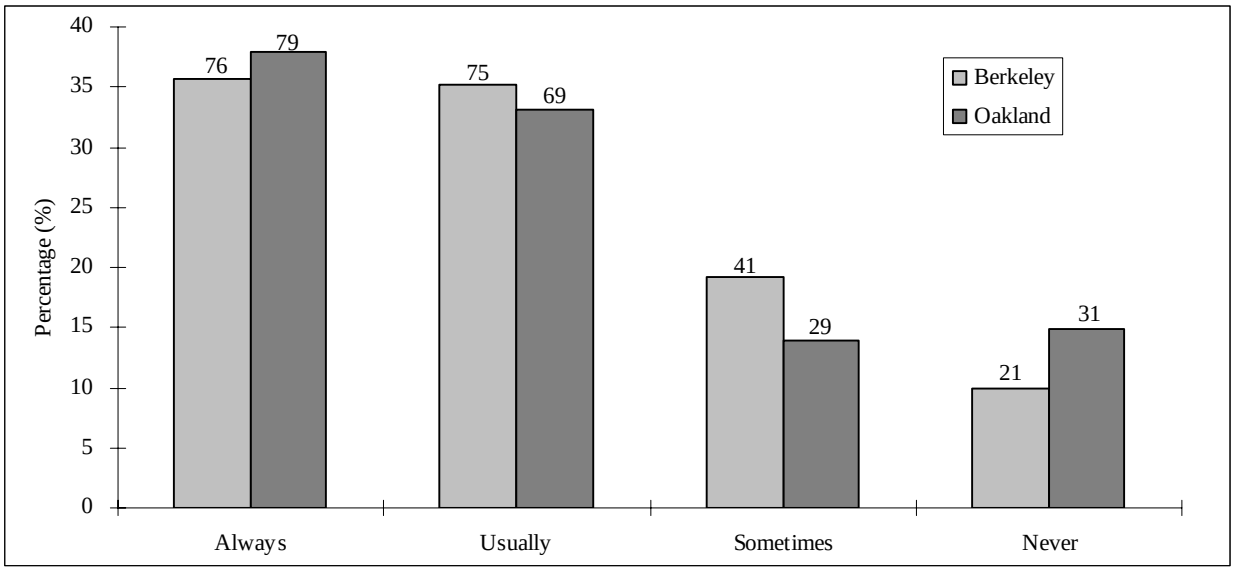

Figure 2. Plastic Recycling Frequency in percentage of the sample population. Numbers at the top of each bar represent the actual number of respondent.

Berkeley and Oakland residents also show similar trends of plastic recycling method (Figure 3) that majority of plastics are being recycled through curbside collection programs. Only about 17% of Berkeley residents and 9% of Oakland residents take plastics to recycling centers. Other methods include: recycling bins in apartments and dorms, other family members take care of the recycling and bring back to stores.

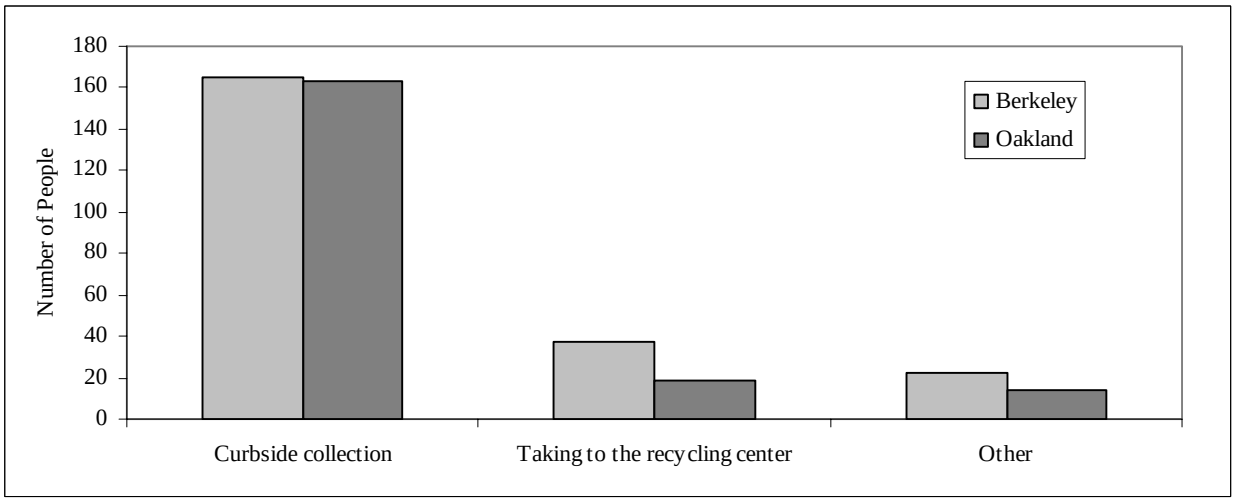

Figure 3. Method of Plastic Recycling. "Other" includes recycling bins in apartments and dorms, other family members take care of the recycling and bring back to stores.

Once again, cities of Berkeley and Oakland have similar answer distribution for prefer/not prefer recycling code on products (Figure 4).

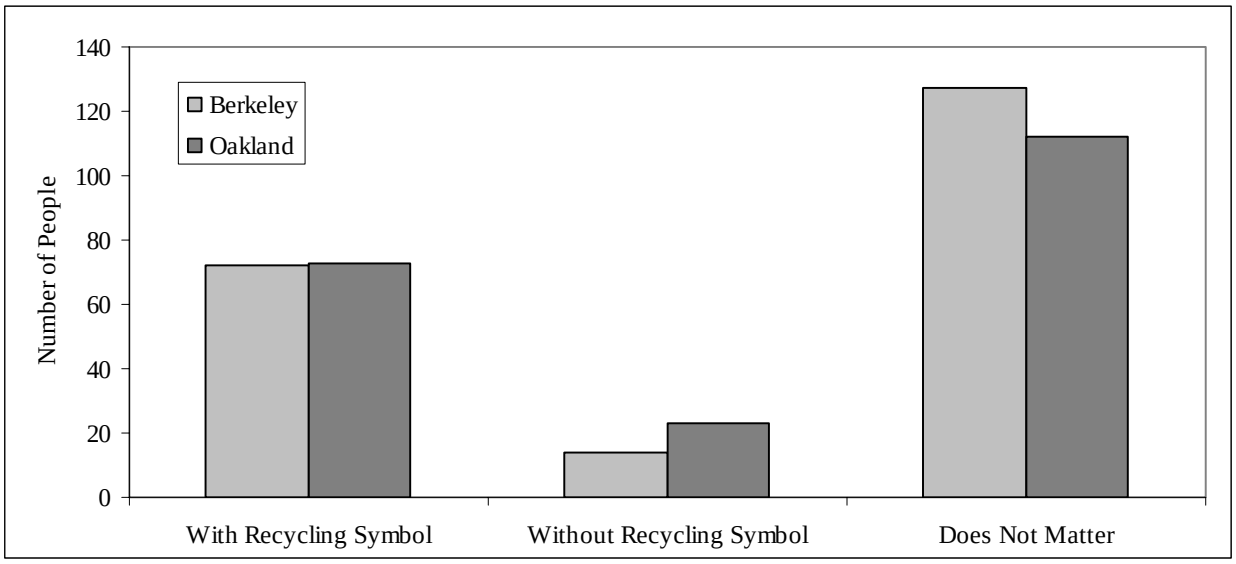

Figure 4. Prefer or Not prefer the recycling symbol on the products.

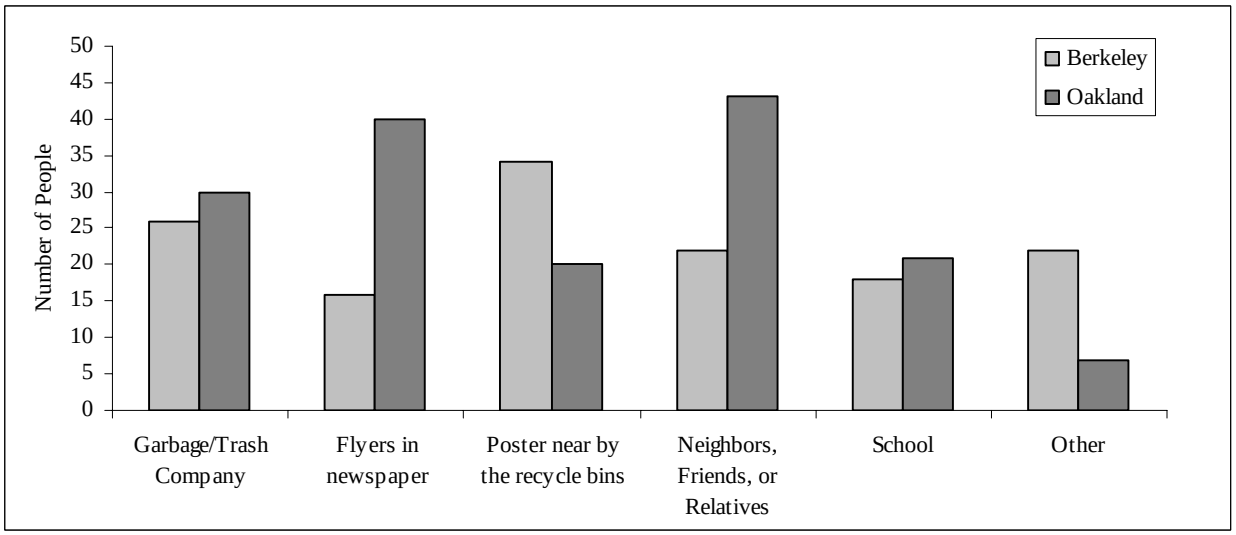

Figure 5. Sources of Information in Terms of Recyclable Plastic Codes.

In terms of differences, Berkeley and Oakland residents have different sources to recognize the recyclable plastic codes (Figure 5). For Berkeley residents, the total number of individuals for each answer choice is very close together with "posters near by the recycling bin" the highest. Many respondents also choose "other" with diverse replies such as city info in mail (3), ecology center (3), reading (1), internet(1) and recycling centers(3). Oakland residents, however, have three major sources stand out from the others: garbage/trash company, flyers in newspaper and

neighbors, friends, or relatives. One individual also indicates the source of information comes from the internet.

The last question on the survey asks for suggestions to encourage plastic recycling. Some of the responds including sending e-mails, hiring homeless people to collect recyclable plastics, increasing recycling collection bin in the neighborhood, advertising recycling programs through school, newspaper quiz, TV shows, make the code larger and easier to see and many more.

One interesting finding is that half of the sample population responds "I Do Not Know Anything about Question #3" for both cities of Berkeley and Oakland, which brings up a concern that knowledge of recyclable plastic codes may influence individuals' plastic recycling pattern. To solve the puzzle, one chi-square analysis was used with two categories within each city: individuals who have some knowledge of recyclable plastics and individuals who do not know anything about recyclable plastics. Data distributions are shown in Figure 6a (Berkeley) and Figure 6b (Oakland). For city of Berkeley, people who know about the recyclable plastic codes have more individuals who "always" and "usually" recycle. Another group of people who do not know anything about recyclable plastic codes have the highest number of individuals who "never" recycle. The chi-square analysis shows a statistically significant difference with $p=0.0154$.

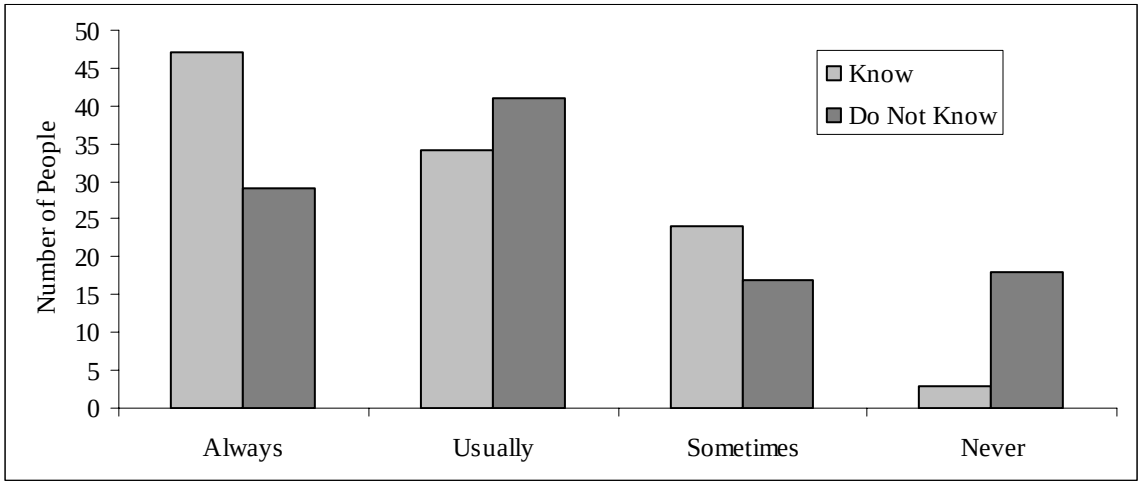

Figure 6a. Berkeley Respondents' Recycling Pattern regarding to individuals who know about plastic recyclable codes and individuals who do not.

City of Oakland has a more complex pattern. Similar to Berkeley, a large portion of people who know about the recyclable plastic codes have also "always" and "usually" recycle. However, many people who do not know about recyclable plastic codes have also "always" or

"never" recycle plastics. The chi-square analysis determines an extremely statistically significant difference where p is less than 0.0001.

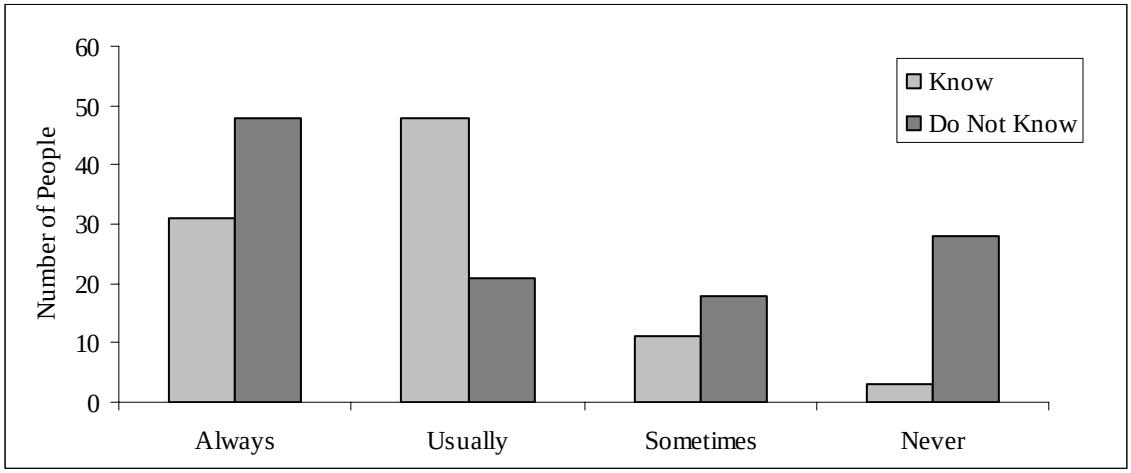

Figure 6b. Oakland Respondents' Recycling Pattern regarding to individuals who know about plastic recyclable codes and individuals who do not.

Discussion

Results from the chi-square analyses show no significant differences between Berkeley and Oakland residents regarding to knowledge of recyclable plastic codes (p=0.7905) and the levels of plastic recycling participation in each city (p=0.7418).

Level of plastic recycling has a general correlation for both cities: higher number of individuals is correlated with higher frequency of plastic recycling. The chi-square analysis does not show any statistical significant difference with p=0.7418. From the results, majority of the sample population "always" or "usually" recycle plastic. The awareness of plastic being recycled for both cities is also very similar that 86% of the sample population in Berkeley and 84% in Oakland are aware of plastic recycling.

For question #3, answer categories "correct" and "unanswered" directly correspond to individuals who answer the question 100% correctly and who did not answer. "Incorrect" category includes answers with any mistake regardless the scale of the mistake is large or small. Even thought some answers may be more correct than others, they are all classified into the "incorrect" data due to such results are simpler and easier to understand. Both cities have about half of the sample population who do not know anything about plastic recyclable codes, which is extremely higher than expected. By assuming people who answer the question (both correctly and incorrectly) have some knowledge of plastic recycling, the sample population from each city

can be divided into two halves: people who know something about plastic recycling and people who do not know anything about plastic recycling. Chi-square analysis is used to determine if there is any significant difference between these two groups. For Berkeley residents, both groups illustrate the same pattern such that the majority of people “always” or “usually” recycle plastic. However, chi-square analysis determines a statistically significant difference with p=0.0154. For city of Oakland, the group of people who know something about the recyclable plastic code follows the same pattern as before. However, the group of people who do not know about the recyclable plastic code have the majority of the population choosing “always” and “never” recycle, which does not follow the same pattern as for all other plastic recycling levels. The chi-square analysis determines an extremely statistical significant difference of p value less than 0.0001. These two chi-square analyses determine that there is a significant difference in terms of levels of recycling participation between people who know about the recyclable plastic codes and people who do not. However, the factors are not clear with chi-square analyses, which may be multiple factors that are not included in this research.

The most participated recycling method, as expected, is curbside collection. About 77% to 78% of residents from both cities take part of this program. Possible reason may be the recycling process occurs at individual’s home. All recyclable may be collected in a bin and take out along with the household trash for pick ups. It is much easier and convenient than taking the recyclable to a specific recycling center because it may involve longer traveling distance.

Recycling symbols on the products do not matter for most people as they shop for grocery, which can be predicted with the general lack of knowledge in recyclable plastic codes. Since around half of the sample population does not know anything about these codes, it is naturally that these people do not pay attention to the symbols on the plastic products. Also, when individuals are able to answer the recyclable codes correctly, those people may care about plastic recycling to a certain extend that such information is worth to remember. Therefore, whether preferred or not preferred of the recyclable codes, such notion is somewhat correlated to the knowledge of recyclable codes.

The variability of the recyclable codes sources between the two cities may be caused by different available programs from separated governments or focuses of the local environmental organizations. In city of Berkeley, results for all listed options are close to each other. In Oakland, however, the answers are being grouped into two groups. One group has much higher

number of people than the other group. Garbage/trash company, flyers in the newspaper and neighbors, friends and relatives has been the major source of plastic recyclable codes for residents in Oakland. These results may indicate that Berkeley's overall recycling educational programs have been received by some residents with an average turnout because there is still half of the sample population indicating no knowledge of recyclable plastic codes. Also, city of Oakland may be focusing on these three major areas more than the others, which cause higher number of residents receives the recyclable plastic code knowledge from these places.

There are two potential biases in this research. The first potential bias in this study is the sample populations not representative for the entire city because survey stations, date and time are selected base on assumption that most people shop for grocery in these hours at these places. Moreover, selection of individuals in the sample populations may vary between different surveyors even thought guidelines of selection was presented to all surveyors.

The second potential bias regards to the socio-economic status between Andronico's Market and Albertsons. Products in Andronico's Market have a tendency to be more expensive than Albertsons'. However, the similar trend of results between cities of Berkeley and Oakland indicate that such bias may be small. Moreover, Andronico's Market had been voted the "Best Grocery Store" in the San Francisco Chronicle Reader's Choice Awards (Andronico's Market), which may gives the idea that price is not be the main factor for people to choose to shop for their groceries.

The sample population does not show significant differences between cities of Berkeley and Oakland regarding to knowledge of recyclable plastic codes and levels of plastic recycling participation. Due to possible reason that cities are able to influence each other, trends of plastic recycling awareness, knowledge of recyclable plastics, levels of plastic recycling participation, plastic recycling methods and preferred/not preferred recycling code on plastic products between cities of Berkeley and Oakland are all very similar except major sources of recyclable plastic codes information varies. Therefore, future studies can focus on the effectiveness of current recycling programs and methods with the results that are able to improve to have better programs and increase the plastic recycling frequency.

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Appendix 1 -- Survey Questions

1. Which city do you live in?
   - ☐ Berkeley
   - ☐ Oakland
   - ☐ Other (specify): _____

2. Are you aware that your city recycles plastic?
   - ☐ Yes, I am aware
   - ☐ No, I am not aware

3. Most plastic containers now have a number code on them, which indicates the type of plastic they were made from. To your knowledge, what type(s) of the following plastics does your city recycles? (circle all that apply)

4. How do you know the above information? (check all that apply)
   - ☐ I do not know anything about question #3
   - ☐ Garbage / Trash company
   - ☐ Flyers in newspaper
   - ☐ Poster near by the recycle bins
   - ☐ Neighbors, Friends, or Relatives
   - ☐ School
   - ☐ Other (please specify): _____

5. How often do you recycle plastics?
   - ☐ Always
   - ☐ Usually
   - ☐ Sometimes
   - ☐ Never --- skip question #6

6. How do you recycle plastics? (check all that apply)
   - ☐ Curbside collection
   - ☐ Taking to the recycling center
   - ☐ Other (specify): _____

7. When you are shopping, would you choose plastic container with or without the recycling code (as seen in #3)?
   - ☐ Plastic container **with** the recycling code
   - ☐ Plastic container **without** the recycling code
   - ☐ Does not matter

8. If you have any suggestion that you think will encourage public to recycle, please write them here:

Appendix 2 – Raw Data

#	Answer Choices	Berkeley	Oakland
1	Sample Population	213	208
2	Yes	183	175
	No	30	33
3	Correct	34	24
	Incorrect	74	69
	Unanswered	105	115
4	Garbage/Trash Company	26	30
	Flyers in newspaper	16	40
	Poster near by the recycle bins	34	20
	Neighbors, Friends, or Relatives	22	43
	School	18	21
	Other	22	7
5	Always	76	79
	Usually	75	69
	Sometimes	41	29
	Never	21	31
6	Curbside collection	165	163
	Taking to the recycling center	37	19
	Other	22	14
7	With Recycling Symbol	72	73
	Without Recycling Symbol	14	23
	Does Not Matter	127	112