Evaluation of Solid Waste Management In Cartago, Costa Rica

(Municipalidad Jiménez, 2010)

Evaluation of Solid Waste Management In Cartago, Costa Rica

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Abstract

This report, prepared for Commission of the Ordinance and Management of the basin of the Reventazón River (COMCURE), evaluates the recycling programs of three municipalities of Alvarado, Jiménez, and Oreamuno. In 2010, a law was approved in Costa Rica that dictated each municipality established an environmental management department, and along with this department a recycling program. Due to this law, municipalities, along with supporting organizations such as COMCURE, work together to develop recycling programs as well improve programs that are already established. Three objectives were chosen to evaluate each one of the municipalities; to evaluate the effectiveness of recycling education, current state, and major disadvantages and advantages of each program. To accomplish these objectives four different methods were used including site assessments, surveys, archival research, and interviews. Areas in need of improvement were identified for each recycling center, important aspects of each program's education strategy were reflected in survey results, and variations between each environmental management department were compared. After compiling data acquired through all of these methods, recommendations were made for improvement customized to each municipality. These recommendations were made in an effort to improve the effectiveness of each recycling program so it may fully comply with regulations. In addition to evaluations such as this, other municipalities that do not currently have a recycling program may obtain ideas as to how to begin.

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Executive Summary

In today's society, recycling has become a key factor in the lives of people everywhere. In Southern and Central American societies specifically, more people are starting to realize the importance of recycling. For example, Brazil has the highest recycling participation rate in South America and uses incentives to get residents to recycle more often (Soong, 2002).

The Commission of the Ordinance and Management of the basin of the Reventazón River (COMCURE), is an organization in Costa Rica that was established by law in 2000.The Reventazón River runs through many municipalities of Costa Rica and COMCURE's mission is to make sure that the river and the area surrounding the river are uncontaminated and preserved for people living in the surrounding communities. Efforts to improve the condition of the river are made both directly and indirectly, not only by COMCURE but also many other entities. In this project, the team collaborated with COMCURE, municipality leaders, and Sra. Paola Vidal, who is a faculty member in environmental engineering at the University of Costa Rica. The three municipalities of interest in this project are Alvarado, Oreamuno and Jiménez, all of which are located in the province of Cartago. All three have had recycling programs in place for different periods of time and each has characteristics that were designed to meet the needs of that specific municipality. COMCURE is working on expanding recycling programs to other districts that surround the Reventazón River. According to Guillermo Flores, one of our project liaisons, COMCURE commissioned this project after witnessing that a great amount of waste was being thrown into the river rather than recycled. This project evaluated the three recycling programs and recommended characteristics from each one that could possibly be used to implement new recycling programs in other regions of Costa Rica. These characteristics are specific to population, geographic size, and the degree of urbanization of each canton.

Our project consisted of three main objectives. The first was to determine the effectiveness of the recycling education programs that have been put in place by each municipality. This allowed us to determine the types of outreach methods that worked in the municipalities and whether they had a great effect on residents' tendency to recycle. The team's second objective was to evaluate the current status of each program in order to make recommendations to improve each municipality's plan, as well as to recommend feasible aspects of each one that could then be established in other municipalities in the future. The final

objective was to determine the advantages and disadvantages of each recycling program. The aspects of the program that were reviewed not only included monetary advantages and disadvantages, but personnel and other resources that are available for the municipality.

Through interviews, the team learned more about the recycling programs of each municipality, including how each began, what issues have arisen, the reasoning behind why programs are built the way they are, and what the hopes are for the future. Two of the interviews were with the environmental managers of the municipalities of Alvarado and Oreamuno. Since Jiménez does not have an environmental manager, we conducted an interview with the mayor, who is currently in charge of the program until an environmental manager is put in place. Site assessments served as first hand observations that allowed us to better understand the current states of the recycling centers and composting center. Follow up interviews were conducted when the site assessments were completed.

The team conducted surveys in each municipality to identify why citizens tend to recycle or not recycle and if their reasoning is directly correlated with the amount and types of education they received on the matter. The surveys were administered in Spanish, and were completed within a 3-week period in November 2012, by a total of 203 residents from the three municipalities. The survey comprised of twelve questions: eleven simple multiple-choice questions and one open-response question. In Alvarado and Jiménez, the team approached residents and administered the surveys by reading the questions to each resident then checking off the given answer to the questions on copies of the survey. Since Oreamuno has a distribution committee already established to administer surveys such as this, the team used this method. The end result that the surveys provided was an understanding of recycling habits in each municipality and how residents were influenced to recycle.

Correlations in the compiled data showed the variations in public participation and revealed insight into the underlying causes for these variations. For example, education proved to be of great importance from the perspectives of the program managers, since each of the municipality leaders highlighted this as a major duty for them; however the way that each municipality tackles this responsibility depends on the characteristics of each area. In Alvarado, television was the most successful mode of recycling education, whereas in Jiménez, brochures proved to be the most successful. Throughout all of the information received, various general

concepts were found to be common between all three municipalities, however details varied according to the demographics of each area.

All of the information received from the interviews and surveys allowed the team to make insightful recommendations for COMCURE. By creating charts and graphs that compared the residents' answers of each municipality, we were able to see what types of education influenced residents to recycle more and which types weren't as successful.

Chapter 1: Introduction

Sustainability and conservation of the environment have become major concerns in the world today. Recycling is one approach to sustaining natural resources, by transforming used materials into new products. It is one of the oldest and first ideas considered to increase sustainability. It lessens the burden on the earth caused by extraction and processing, consequently reducing the demand for raw materials (McDonough, 2002). The lifespan of landfills are also extended through recycling due to the fact that less waste is brought to them. Implementing recycling programs builds the groundwork for increasing a population's willingness to participate and to strive to be more sustainable (Canterbury, 2003). Subsequently, products that are made from recycled materials consume less energy in manufacturing than those of virgin materials. This reduces waste-disposal methods that may be damaging to the environment in favor of eco-friendly recycling options.

In many countries, recycling has become a routine practice. Other countries, however, face difficulties initiating recycling programs due to factors such as insufficient recycling infrastructure and a lack of public support. Although local governments may have the resources available to establish recycling programs, the success of these programs is highly dependent on the cooperation of the citizens of these municipalities. For household recycling to be effective, residents must be willing to recycle and programs must be readily available for the public (Halvorsen, 2012). Municipal officials can improve the process by identifying trends and habits specific to their communities in order to properly implement the most appropriate recycling programs (Schoot, 2011). For example, in a study done in the Borough of Burnley, England in 2002, data revealed several common factors that affect the participation of residents in recycling programs, such as convenience, knowledge of recycling centers, social values and norms associated with recycling, time constraints, and willingness to make the sacrifice (Martin, 2006).

Like many nations, Costa Rica faces serious environmental impacts from the inappropriate disposal of solid waste. Many residents resort to dumping trash into the rivers, instead of using solid waste management (SWM) methods such as composting and recycling. These habits may be attributable to a lack of education or insufficient access to waste management infrastructure. For instance, if collection trucks do not reach all residencies in each municipality, it is more difficult for residents to direct waste to landfills, recycling collection

centers, or composting centers. Inappropriate dumping of waste has negative secondary effects, including risk of flooding from the accumulation of solid waste in rivers and tributaries (PREVDA, 2010). Because of these threats, it is important to establish and implement appropriate plans to reduce these negative effects, as well as to encourage citizens to become active participants in the waste management process and take initiative themselves. One way residents can take initiative is to lessen the waste they dump into rivers and become familiar with the recycling process.

In response to the need to process waste more sustainably, Costa Rica has established an important law titled the Law for Integration of Solid Waste Management (ISWM)—a law that allowed lawmakers to pass decrees to improve solid waste management—to identify the entities responsible for SWM (Ley Para la Gestion Integral de Residuos 2010). It dictates that each municipality must take charge and handle the waste that its communities generate. To comply with this law, municipality leaders must develop a new department and assign a department leader to take charge of SWM, which includes the recycling process. The duties of this department are to develop a SWM plan for their specific area and to implement it; in addition, the department has other obligations related to minimizing harmful effects to the environment. In order to ensure compliance with the law, the Costa Rican Ministry of Health was named the governing body for SWM of the country.

The new IWM law names the key players for SWM and identifies their responsibilities with respect to SWM. Organizations such as The Commission of the Ordinance and Management of the basin of the Reventazón River (COMCURE) support municipalities to comply with laws such as the IWM legislation. This organization was created on October 24th, 2000 to assist with regulating and managing the Reventazón River. COMCURE's aim is to ensure that the area surrounding the Reventazón River and the river itself are protected and uncontaminated for the benefit of the surrounding communities. They have the power to initiate and implement plans as well as to organize committees amongst the communities along the river. The primary missions of COMCURE are to define and execute plans of management and regulation for the Reventazón River and to educate community leaders, business administrators, and residents about managing and protecting the river. The organization focuses specifically on geology, human health, protection of the environment, and Costa Rican culture.

Since the intervention of COMCURE, flooding and landslides have decreased along the river. The agency has measured an 11% increase in sediment trapping vegetation of the watershed, which reduces toxic runoff. Furthermore, in the past decade, COMCURE has implemented actions that have lowered the amount of anthropogenic debris that has reached dams by roughly 20%. COMCURE is dedicated to improving Costa Rica's natural environment, particularly along the Reventazón River; this includes the practice of recycling solid waste (COMCURE, 2012).

COMCURE has aided with the implementation of three recycling plans in communities located within the Reventazón River watershed (COMCURE, 2012). Jiménez, a municipality located within the river's watershed, has had a plan in place for a decade in the central district of Juan Viñas. The plan includes the separation of waste at the origin, which means that households and businesses both separate their own waste into specified bins according to waste type before it is collected by the city. The municipality then composts organic waste and recycles other solid waste such as plastic and glass (COMCURE, 2012).

Another municipality that COMCURE has been working with to improve recycling participation is Alvarado, which is also located within the river basin. Municipality leaders and community members have been working together to educate the residents of Alvarado about the recycling program that began in January, 2011. A private entity was contracted by the municipality's environmental management department to help with the recycling process including separation and sale of recyclables. Although a relatively new program, the community has been very proactive in tackling the problems that arise when implementing a new recycling project. Since being established, the program has performed studies on the disposal of solid waste, educated residents by approaching them at their homes, and began taking the steps necessary to build a composting center (COMCURE, 2012).

San Rafael, the central district in the Oreamuno municipality, has a relatively new program in place for the recollection and separation of solid waste. Unlike Alvarado, the separation of solid waste is done by the city government, instead of the residents and businesses. The municipality has established a collection center that is in charge of separating and recycling reusable materials (COMCURE, 2012).

In order to focus their efforts and measure the outcomes in each community, COMCURE wished to assess the habits and attitudes of residents in each of these communities. The team's

goal for this project was to evaluate the current recycling programs in Alvarado, Jiménez, and Oreamuno in order to identify successes and failures within the programs and to present recommendations for improvement and expansion of the programs. We identified several objectives in order to accomplish this goal. These objectives include evaluating the success of the educational programs, assessing the current state of the programs and their corresponding recycling centers, and completing an advantage and disadvantage matrix of the programs as a whole. Through a careful assessment and evaluation, we were able to better understand the current status of each municipality's plan, allowing us to make customizable recommendations specific to each community and identify successful aspects that may be reproduced in municipalities that do not yet have an established recycling program.

Chapter 2: Literature Review

As the population increases around the world, so do the impacts people have on the environment. A growth in population and increasing standard of living in developing countries has caused the amount of waste being produced to reach new levels (Schoot, 2011). An important concern for many of these developing countries is what to do with all of that waste. Costa Rica has recognized the importance of protecting the environment and has made that one of its priorities. In 2007, Costa Rica's president at the time, Oscar Arias, announced that he intended the country to be one of the first developing countries to become carbon neutral by 2021 (Long, 2011). In order to achieve this goal, Costa Rica began implementing various laws to reduce the damage caused by urbanization. Several municipalities in Costa Rica, including Alvarado, Jiménez, and Oreamuno, have taken the initiative by establishing systems to dispose of solid waste. In order to optimize the success of each program, it is important to consider the current social and legislative situations in the country, locate and study the municipalities of interest, and research other waste disposal strategies used around the world.

2.1 Recycling

Today, there are several methods for managing solid waste; some are more harmful to the environment than others. Figure 1 shows the hierarchy of the impacts waste management methods have on the environment (Tam, 2006).

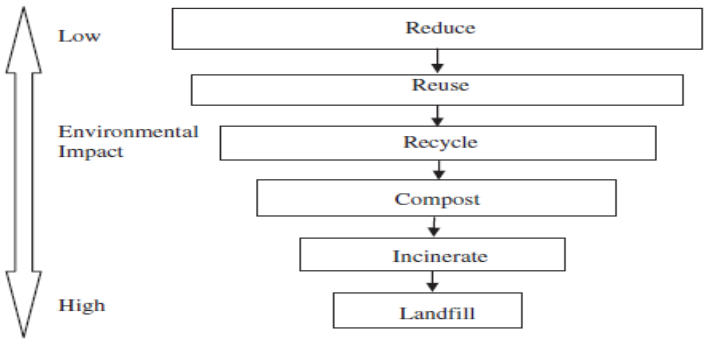

Figure 1: Hierarchy of Waste Disposal

(Tam, 2006)

Although reducing the amount of garbage being generated has the lowest environmental impact, the difficulty of implementing it lowers the efficacy. It is difficult to reduce the amount of waste created because more products are being made than ever before. With more developing countries, a higher percentage of the population is consuming more goods. This means they are buying more products and consequently disposing of more waste (McDonough, 2002). The next method with a low environmental impact is reuse. It is important to reuse materials, but impractical for things such as everyday household waste. This is where recycling comes into play as the next best option. Composting and recycling are both sustainable methods of disposing of waste; recycling is directed towards man-made items, while composting is a process for organic materials. These methods are considered to be sustainable because they maintain the quality of the environment, as opposed to improper disposal of waste which can be harmful to the environment.

Recycling is the recovery of materials that would otherwise simply be discarded as solid waste and the process of transforming them into products that can be used again. Instead of following the "cradle to grave" model, in which raw materials are converted into products that are sold and then thrown away into a permanent repository such as a landfill (McDonough, 2002), recycling follows the "cradle to cradle" model. This model takes materials that have already been made into a product and creates a new product with those materials. There are two types of recycling, defined by the similarities between first-generation and later generation products. These are called closed loop recycling and open loop recycling. Closed loop recycling is a process in which, after use, the product is recycled back into a new but identical or similar product (Schoot, 2011). For example, when old paper is recycled, it is typically transformed into new paper. Open loop recycling, on the other hand, refers to the process of transforming the material of one product into a completely different product (Schoot, 2011). An example of open-loop recycling is converting used plastic water bottles into plastic casings for pens.

There is currently a variety of household materials that can be recycled. In the United States and many other regions of the world, the most common household products recycled include paper products, glass jars and bottles, metal products like foil and cans, and many types of plastic containers (Curbside Recycling, 2012). These materials tend to have the shortest time in the first use phase, which is the time between the manufacture of the product and when it is used and discarded. Because so many of these products are made, used, and discarded at such a

fast pace, it is important to recycle them to reduce the amount of raw materials used to make new versions of these products. Because raw materials do not need to be extracted from the earth to make recycled products, recycling reduces the demand for energy usage. It also reduces the volume of waste and the negative effects on the environment associated with improper waste disposal because the materials are being reused. As leaders in the communities, country officials can help implement sustainable programs such as recycling in order for citizens to be encouraged to adapt to new day-to-day habits. The world's natural resources will be conserved in this way.

2.2 Costa Rica

Costa Rica is a country known for its diverse natural ecosystems, which has fostered a thriving ecotourism industry (Honey, 2003). By taking small steps toward economic development, Costa Rica has become a leader in the reduction of poverty in Latin America (PNUD, 2012). In 2000, the United Nations Development Program challenged the world to accomplish eight goals by 2015; one of these goals was to eradicate extreme poverty and hunger (PNUD, 2012). In the mid-1980s, the poverty rate in Costa Rica was at 40% and by 2004, it had decreased to 20% (Carstens, 2004). Not only did the country exceed in fighting poverty, but also the literacy rate is at an astounding 96% (UNICEF, 2004). This level of literacy is so high that it competes with and is at the same levels of countries that are more developed than Costa Rica such as the United States and Germany. This motivated and inspired Costa Ricans and kept them moving forward in the development of their country (Carstens, 2004).

2.2.1 Sustainability Initiatives in Costa Rica

In 2007, the Costa Rican government made a commitment to become carbon neutral by 2021, a pledge that few countries have made (UNEP, 2003). Reaching carbon neutrality in fourteen years is not an easy task and will not be accomplished by just turning off light bulbs and planting trees. According to an article on the government's plan of action, published on September 8, 2009 by a newspaper in Costa Rica, *Al Día*, carbon neutrality is a challenging goal (EFE, 2009). One of the biggest problems of becoming sustainable is the fact that diesel, the most popular fuel in Costa Rica, generated over five million metric tons of CO_2 in 2005. The remaining CO_2 emissions from industrial resources, livestock, agriculture, and landfills added up to another seven million metric tons (see Figure 2). However, reforestation increased from 40% to 50% throughout the previous decade. Other improvements include the preservation of forests

and planting trees in new areas. The funding for these undertakings originated from tax revenues, mainly tax on fuels. These efforts resulted in the removal of over two million metric tons of harmful greenhouse gases from the atmosphere (Environmental Entrepreneurs, 2012).

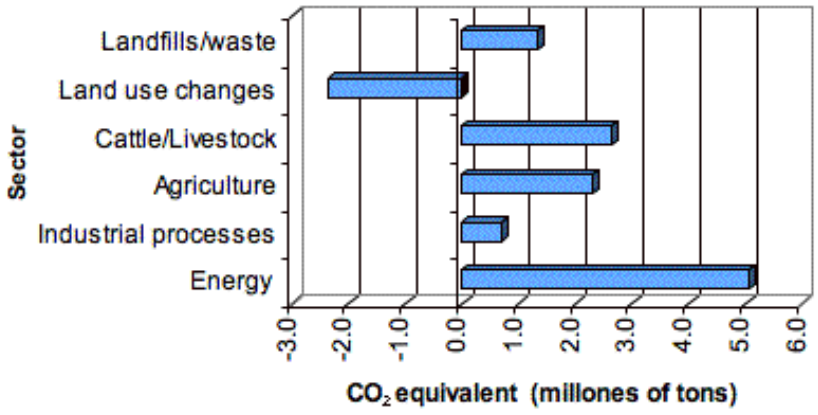

Figure 2: Emissions of CO_2 in Costa Rica

(Beall, 2012)

2.2.2 Recycling Initiatives

There are several programs throughout the country that motivate entire communities to recycle. Non-profit groups, like the Planeterra Foundation, are trying to inculcate good recycling habits among the youth. This foundation has been working with schools all around the world, including a school in Playa Matapalo, located along the west coast of Costa Rica. This foundation has invested money in the school's curriculum to establish a class where students are taught methods of "sustainable agriculture and rural community tourism management" (Planterra Foundation, 2012). Children are also taught to separate recyclables with safe equipment. Skills developed in these funded programs will allow underserved children to acquire future employment (Planeterra Foundation, 2012).

Another program in Costa Rica is called REDCICLA (in English, Recycling Web of Costa Rica), a community project established in 2004. Unlike the Planeterra Foundation, this program was founded and funded with the help of a foreign nation, Japan, in 2005. The Japanese embassy financed this program because they wanted to help the health, environment and economy sectors of Costa Rica. This program was established to inform communities of the three R's: reduce, reuse, and recycle. Rather than only teaching children, this program was aimed

toward the entire population, from the working mother to the business owner. REDCICLA offers advice for companies who need it and want to improve the current state of the country (REDCICLA, 2010).

There are also programs directed by the government and managed by a specific government division. An example of one of these programs is the *Programa de Reciclaje para la Asamblea Legislativa de Costa Rica* (Recycling Program for the Legislative Assembly in Costa Rica). This program is run by the Ministry of Health and led by Dr. Mario Martinez Bolivar. Unlike the previous two programs REDCICLA and Planeterra, this program is more detailed and explains step by step how to successfully achieve the goal of educating the community about recycling appropriately. With this approach, recycling is taken one step further and explains what products could be created with the materials that have been recycled. Dr. Bolivar's report mentions astounding facts such as that in the last 47 years humans have produced more waste than since the beginning of recorded history up to 1960 (Aguero, 2009). This gives skeptics more reasons to recycle.

Programa Regional de Reduccion de la Vulnerabilidad y Degradacion Ambiental (The Regional Program for the Reduction of Vulnerability and Environment Degradation, or PREVDA*)* is a program in which independent entities and the government work together to pass environmental laws in select regions of Costa Rica. Along with these laws, committees are created to govern programs and to enforce the laws (PREVDA, 2010). The *Comisión para el Ordenamiento y el Manejo de la Cuenca del Río Reventazón* (The Commision for the Management and Ordinance of the Basin of the Reventazón River, COMCURE) was created by law number 8023 thanks to the *Instituto Costarricense de Electricidad* (ICE) and the local government. The formation of COMCURE confronted the problems of sedimentation along the Reventazón River, the poor management of solid waste, and the inability for the communities along the river to understand these problems (SICA, 2009).

2.2.3 Solid Waste Management Law

In 2010 a law was passed by the legislative assembly of Costa Rica which outlined new guidelines for solid waste management (SWM) in the country. The goals of this law are to reduce as much solid waste as possible that is generated at the origin, meaning homes, to value and reuse waste material through the use of recycling programs, and to properly dispose of the remaining waste in the least harmful manner. In addition, this law transfers the responsibility for

solid waste management specifically to each municipal government. Each municipality must establish a new office in charge of SWM and a person to head this new department, called an environmental manager. Each environmental manager must then produce a SWM plan tailored to their area which must be consistent with the national plan and national laws (Ley Para la Gestion Integral de Residuos, 2010).

The plan that is created must encompass the entire SWM process from the place where waste is generated to the final place where this waste is deposited. It also emphasizes the fact that for the process to be successful there needs to be an integrated plan put in place. This means that the plan should not only cover the actual process of recycling, but also other aspects such as education, administration, financial resources, and operations. The schools in each municipality must follow the outlined national education plan to educate students about proper solid waste management. Not only students, but the entire population within each municipality must be informed. Each environmental management department is in charge of this, furthermore, environmental managers are also obligated to keep record of pertinent information related to SWM plans and community members must have access to information related to those plans. (Ley Para la Gestion Integral de Residuos, 2010)

Components that must be included in each SWM plan include planning instruments, information and education, promotion of the SWM plan, funding, and state obligations. The planning instruments encompass the process of ensuring that each municipal SWM plan is consistent with the other SWM plans in effect, such as the national SWM plan and plans established by waste generators. Information and education involves allowing the public to access information about each SWM plan and incorporating the national education campaign in municipal schools. In terms of the promotion of the municipality-specific SWM plans, the law is intended to ensure that companies have incentives to recycle as well as increase public participation. The Ministry of Health determines funding, however, each environmental manager manages this budget and decides the most efficient way to spend the money so that it benefits the municipality. Finally, individual municipalities are responsible for selling their own recyclable products.

The newly established environmental departments must guarantee that all residents receive collection services and are properly informed about these plans. Since each municipality must build a plan that specifies the amount that is generated per municipality, the processes vary

from municipality to municipality. In general, the set of processes that must be managed by each municipality consists of pick up, drop off, separation, and sale of these recyclables. The process begins at the place where waste is generated and can end at various different locations depending on the category under which these materials fall. This project focuses on the process that recyclables, including things such as plastic bottles and food scraps, must go through before they are treated at a recycling center. Depending on the given municipality there are variations of this process and the number of administrators (Ley Para la Gestion Integral de Residuos, 2010).

2.3 The Reventazón River Basin

The Reventazón River basin is divided into upper, middle, and lower sections (see Figure 3). The three municipalities studied in this project (Alvarado, Jiménez, and Oreamuno) are located in the upper section. Both the upper and middle sections are characterized by a dense population, commercialization, and increasing urbanization (Wang et al, 2010). In contrast, the lower section is characterized by forests and protected reserves. Due to the lower section's steep terrain and protected national forests, roads are not common and therefore this maintains a low population density (C.N.E., 2012).

The Reventazón River is an important source of hydroelectric power for Costa Rica. It receives the highest precipitation rate of all the rivers in Costa Rica. This results in a high water volume and therefore a higher flow rate, making the river an ideal candidate for the production of hydroelectric power, an alternative source of power. The Reventazón River is responsible for 27% of the nation's hydroelectric capacity, which is the highest for any single river in the country. The ready availability of hydroelectric power permits the country to obtain energy at a low cost, benefitting the country's economy (Locatelli et al, 2011). It is crucial to maintain the Reventazón River in optimal condition and establish various effective recycling plans in municipalities so that the hydroelectric power plants along the river can work effectively without

becoming congested with solid waste (Karak and Bhattacharyya, 2012).

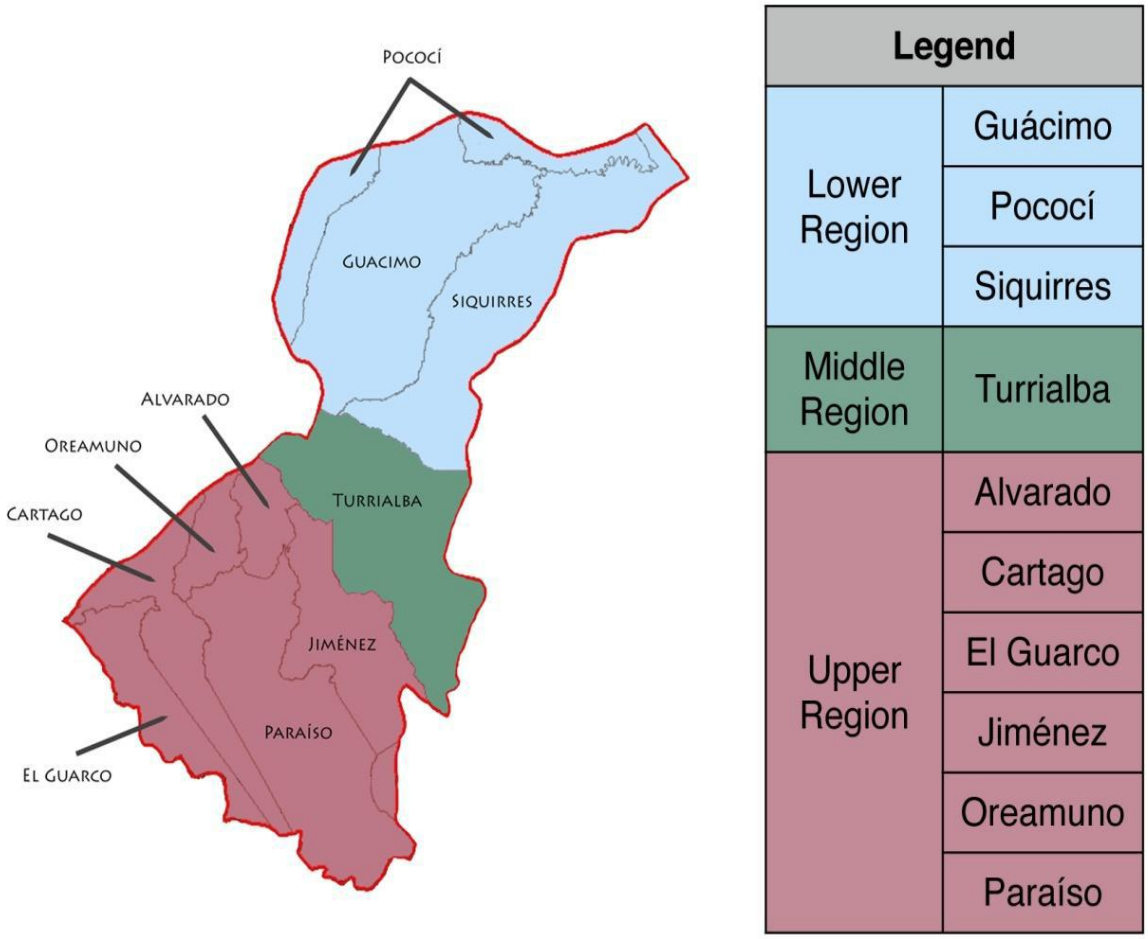

Figure 3: Surrounding Areas of Reventazón River

(Wang et al, 2012)

2.3.1 Urbanization and Waste Management in the Reventazón River Basin

Urbanization in all three municipalities has had many negative effects on the Reventazón River region. The population density has caused a higher demand for construction of houses and other resources. This demand is difficult to satisfy since some of the land close to the river is affected by sedimentation and is unsafe for new construction. More solid waste is being generated as the population increases, which puts a strain on current waste management plans. Water treatment plants cannot properly manage the poor water quality in the river caused by solid waste due to the lack of established plants (C.N.E., 2012). According to Costa Rica's

national census statistics, the percentage of people that recycle in urban areas is lower than the percentage of people that recycle in rural areas. For example, in Table 1a, only 31% of urban households separate their organic waste, whereas 50% of rural households do (Instituto Nacional, 2011). Residents of rural areas recycle more organic waste because they reuse it to make fertilizer for their crops. Residents of urban areas do not need fertilizers, so it is not a high priority for them to compost. Both urban and rural areas recycle about the same amount of plastic and cardboard because it is the same priority to recycle. Programs must be established that are tailored to the needs and convenience of each community.

Total Number of Households That Separate Organic Waste Costa Rica			
Region	**Yes**	**Unknown**	**Total**
Urban	255,776 (31%)	0	814,774
Rural	240,979 (50%)	0	482,748

Table 1-a: Total Number of Households that Separated Organic Waste in 2011 (Instituto Nacional, 2011)

Total Number of Households That Separate Plastic Waste Costa Rica			
Region	**Yes**	**Unknown**	**Total**
Urban	326,974 (40%)	0	814,774
Rural	193,539 (40%)	0	482, 748

Table 1-b: Total Number of Households that Separated Plastic Waste in 2011 (Instituto Nacional, 2011)

Total Number of Households that Separate Paper/Cardboard Waste Costa Rica			
Region	**Yes**	**Unknown**	**Total**
Urban	284,760 (35%)	0	814,774
Rural	164,056(34%)	0	482,748

Table 1-c: Total Number of Households that Separated Paper/Cardboard Waste in 2011 (Instituto Nacional de Estadística y Censos, 2011)

Not only is solid waste management (SWM) an issue for the municipalities along the Reventazón River, but it is also a concern all around the country. There are various techniques for disposing of waste besides taking it to a waste management center or having it picked up by a collection truck. Many residents resort to disposing of their waste into bodies of water or by throwing it into holes and burying it. Hence, organizations such as COMCURE are dedicated to protecting the river, and one employable strategy is through the implementation of recycling programs. In Table 2, methods of waste disposal are outlined for the central region of Costa Rica, which includes the Cartago province consisting of Oreamuno, Jiménez, and Alvarado (Instituto Nacional, 2011).

Disposal Methods	Amount Participated
Collection truck	813,787
Thrown in hole, buried	12,156
Burning	22,402
Thrown in vacant lot	1,384
Thrown in river, ravine	268
Other	21,101
Unknown	0
Total	851, 089

Table 2: Disposal of Waste, Central Costa Rica
(Instituto Nacional de Estadística y Censos, 2011)

As can be seen in the tables above, various harmful methods of solid waste management are used by community members Community members use various harmful methods of solid waste management as can be seen in the tables above. In the central region of Costa Rica alone, 37,302 of the residents that completed the national census answered that they discarded their waste in various harmful ways. Solid waste that is discarded into the Reventazón River and surrounding area produces a domino effect that impacts various industries. When garbage is thrown into the river, all of the systems that are dependent on the river are affected. Such is the case in all three of the municipalities that were the focus of this project. Improper disposal of solid waste causes flooding since the debris causes a reduction in the capacity of the water flow. Flooding affects the surrounding infrastructure as well as the land itself by disturbing the soil. Contamination of the water affects the health of surrounding communities due to the spread of

disease and harmful chemicals in the water. This contamination also affects biodiversity which is crucial for the country's ecotourism. Due to the multitude of harmful secondary effects that improper SWM methods have on the country, it is necessary to adjust current SWM plans. (C.N.E., 2012)

2.3.2 The Municipality of Alvarado

The municipality of Alvarado is composed of four districts, which are Cervantes, Villa de Pacayas, Santa Cruz, and Capellades. The population structure of Alvarado is explained by Table 3. According to the last census performed by the INEC, Instituto National de Estatisticas y Censos (National Institute of Statistics and Census), 14, 312 lived in the canton of Alvarado. Though Alvarado is mostly an agricultural municipality, most homes are still located in the urban areas where as only 40% of the homes are located in rural areas. The municipality is small geographically and by population when compared to the other two cantons of interest. The INEC also states that approximately 95% of the surveyed residents thought their homes were either in good or regular condition and the other 5% considered them in a bad shape. Employment data was also provided for Alvarado by INEC. Out of the 5,763 people that were able to work, 1.52% were unemployed while the rest of the residents are students, live off a pension, or obtain their income from renting property they own.

A total of 12,570 residents of Alvarado over five years old attend school. This number is about 95% of the total population over five that live in this municipality. The most attended school is primary school with 66% of the population. Students are faced with the option of choosing two types of secondary schools after their sixth grade. The path that most take is the academic secondary school which is only five years and then they can go to a parauniversity—for about a year—to get a small degree such as in the fields of culinary arts, graphic design, or accounting. Most students who attend the academic school, however, go to the four-year university to get degrees in fields such as engineering, medicine, or law. A student who chooses to go to a technical secondary school has to attend this school for six years, however, students leave with a small degree similar to the ones offered at parauniversities.

Currently, Alvarado uses a small landfill in Cervantes in which untreated waste is usually incinerated. Surrounding vegetable processing centers produce additional harmful waste from the agricultural industry, in addition to garbage that originates from households and businesses. This

particular municipality has the potential to greatly benefit from an established recycling process since less that 5% of the garbage that is disposed of cannot be reused, according to a study done by Competitividad y Medio Ambiente (Competitiveness and the Environment). This statistic indicates that a successful recycling program would considerably lower the amount of garbage taken to the landfill. The current coverage provided by collection trucks needs to be expanded since this service is not provided for 13% of the population. As a consequence, garbage is instead incinerated or left out in the open (Vega Díaz, 2012).

The municipality has been collecting separated waste since January 2007. This effort was started by a group of women that had the intention of cleaning up the rivers and streets of their community. A major concern for this area is the improper disposal of chemical waste since the municipality consists largely of an agricultural economy. Typically, chemicals used by farmers run off into rivers or ravines. However, farmers have also intentionally disposed of chemicals into the surrounding river and ground, as well as incinerated them. All of these methods have negative health effects on the community (Buenas Practicas, 2010).

In 2009, an agreement was reached with the Fundación Limpiemos Nuestros Campos (Foundation Clean up Our Fields) to establish containers for the proper disposal of chemicals and hazardous containers used by farmers. This prevented 27,000 kg of the municipality's chemical waste from being dumped into the environment. Currently the plan continues to operate through donations and loans from various organizations (Buenas Practicas, 2010).

2.3.3 The Municipality of Jiménez

The Canton of Jiménez has a total of 14,669 citizens, which is similar to that of Alvarado. Jiménez also is similar to Alvarado in that they both depend extensively on agriculture. The municipality produces mostly coffee and sugar cane. Since this municipality depends mostly on agriculture, most residents, even the ones who live in the urban areas, work on farms. Though most people are farmers in the municipality, the homes are evenly split between rural and urban areas. Just about 49% of the homes are located in the urban areas. While only about 5% of the surveyed residents considered their houses in bad condition in the other two municipalities, in the municipality of Jiménez almost one out of ten citizens said their houses were in a bad state because the agricultural business has gone down in the past couple years. Additionally, over 70% percent of the residents over 15 relied on pensions, rents, or a similar income to survive. Table 4

shows the levels of education in the municipality of Jiménez. The data mostly coincides with the other two municipalities.

Although Jiménez's recycling program has been established the longest in comparison to the other two municipalities, 60% of the waste is not properly handled. Many of the landfills are not designed to handle the waste that is deposited into them. Thus, some garbage is taken to "botaderos", or small dumps, which are not properly regulated and located in close proximity to the Reventazón River. The district of Juan Viñas established a recycling program in 2005, which has reduced by 10% the amount of garbage transported to local landfills (Personal Communication, Flores Guillermo, 2012).

Juan Viñas' plan, led by an environmental group that consists of municipality leaders and volunteers, includes both recycling and composting. When the waste management plan was put into effect, the environmental groups created informative posters and visited homes, schools, and churches to educate community members about the importance of recycling and composting. To date, this municipality has led five environmental awareness campaigns to educate community members. In 2004, the municipality built a compost center and established a system for the collection of organic waste twice a week. Since the land for composting did not come at any initial cost, a portion of the fertilizer produced is given back to the original landowners (Buenas Practicas, 2010).

The Jiménez waste management plan has great advantages that benefit the community. Community members benefit from the advantages of composting since it is not used for profit; instead fertilizer produced in the composting center is donated to local farmers. Since the recycling system was established, landfills are being used less than in previous years, which are causing contamination levels to drop in the surrounding rivers. Additionally, jobs were created as a result of the municipality's waste management program. Less money was spent on transportation costs due to a reduction in the number of trips to the landfill, which is located farther from the community (Buenas Practicas, 2010).

Municipality	Zone	Population	Homes
Alvarado	**Rural**	5,356	1,608
	Urban	8,956	2,388
	Total	14,312	3,996
Jiménez	**Rural**	6,958	2,443
	Urban	7,711	2,342
	Total	14,669	4,785
Oreamuno	**Rural**	5,703	1,391
	Urban	39,770	9,847
	Total	45,473	11,238

Table 3: Distribution of Population and Homes

(Instituto Nacional de Estadística y Censos, 2011)

Municipality	Citizens 5 yrs and older	Level of Education						
		Does Not Attend School	Special Education	Kinder Garden / Preschool	Primary 1^{st} – 6^{th}	Techincal and Acedemic Secondary	Parauniversity	University
Alvarado	13,195	625	48	281	8,273	2,974	128	866
Jiménez	13,627	668	78	288	7,787	3,431	176	1,199
Oreamuno	41 973	1,656	199	972	20,596	11,977	794	5,779

Table 4: Levels of Education

(Instituto Nacional de Estadística y Censos, 2011)

2.3.4 The Municipality of Oreamuno

The municipality of Oreamuno has a large population relative to the area. One of the five districts, San Rafael, has 17,000 residents, which is 2,000 more than all of Alvarado. The rural population in the municipality of Oreamuno has dropped dramatically in the last decade; in 2000 the rural population was 23,431. Now the rural population only accounts for 12.5 percent of the total population. Based on the information provided by the *INEC* in 2011, the municipality of Oreamuno had a total of 11,238 homes (Table 3). About 88 percent of these homes were urban. The INEC also provided information on the resident's assessments of the state of their homes in each municipality. Unlike previous years, information on each specific district was not provided. Out of all the residents surveyed by the INEC, 75% thought their homes were in good shape while 20% rated them in regular condition. The remaining five percent of the population considered the condition of their houses bad. The National Institute for Statistics and Census supplied information about the economic status of the residents in the form of employment. In 2011, there was a total population of 34,110 residents who were over the age of fifteen. Out of this figure, about 46% were not able to work. This means that these residents live off pensions, rent the property they own, live with their parents, or have a similar source of income. On the other hand there is a 54% of the population who was able to work. The unemployed residents (510) represented 2.77% of the residents who were able to work.

Table 4 shows the total number of residents over five years of age. Out of all of these residents, 1,656 did not receive any education. Primary school is the most attended school in the municipality of Oreamuno with a little over 49% of the total citizens over five. It is important to note that some parents choose to send their children to schools in other cantons. This happens because some schools might have a better educational program than others meaning these numbers are not very representative of the canton.

More recently the municipality of Oreamuno has begun to take steps towards establishing a solid waste management program. With the aid of various universities and governmental organizations, this municipality started a pilot program for recycling in 2010. The municipality's goals are to launch a center for the separation of solid waste and a bioreactor for the processing of organic waste. In this case, the profit obtained from fertilizer that the bioreactor produces will be used towards the education of community members about the solid waste management

system. Another strategy that this municipality uses is the placement of trash containers along national roads, with the ultimate objective of mitigating flooding caused by solid waste being dumped into rivers (Municipalidad de Oreamuno, 2012).

The collection of garbage is currently managed by the municipality and covers 81% of the population. In San Rafael, the most urbanized district, solid waste management has been successful; however, improper waste disposal continues. Chemicals and other hazardous waste used by agricultural companies are not properly discarded and often are thrown into the river. Flooding in this municipality has also occurred due to the large amount of construction in the areas surrounding the Reventazón River due to the current state of housing development in the municipality.

2.4 Recycling Programs

The initiative to recycle began in 1953 where in the United States, steel cans were introduced in packaging soft drinks and beers (Darnay & Magee, 2007). Recycled materials are sent to a facility to be sorted and remanufactured. The manufacturing process consists of remaking products with the recycled materials. To complete this "loop", consumers and recyclers buy the recycled materials.

There are three main steps to recycling a product. They are the collection and processing of the material, the manufacturing of new products (with the recycled materials) and the purchasing of recycled products. Within these three steps, the most popular methods of collecting recycled materials are curbside pickup and drop off recycling (Darnay & Magee, 2007).

2.4.1 Curbside Recycling

Curbside recycling involves local city waste management trucks traveling door-to-door and collecting recycled materials in containers or trash bags. It is generally more popular and convenient than recycling at drop-off locations (Saphores, 2012). Throughout the United States, numerous municipalities have successfully introduced and implemented programs. In Santa Fe, New Mexico, residents are charged $10.79 per month for the pickup service (Bond, 2003), and in Cheyenne, Wyoming residents are asked to pay a moderate fee of five dollars each month (Staff, 2009). In Indiana, a third-party waste company, Super Waste General, charges its customers only

$3.25. Due to this low cost, the company got forty percent of the population to participate in its first effort in curbside recycling (Writer, 1995).

Research shows that there are several factors that affect the success of curbside recycling programs. In St. Petersburg, Florida, the program is on the verge of being shut down. The charge for curbside recycling is only $2.75 a month, yet only 7,249 homes out of a total of 76,290 are using the service. The reason for the lack of success is due to residents not being satisfied with the company who provided the service; they indicated that it was disorganized (Bond, 2003). In Indianapolis, curbside recycling is a political issue. The cost of collecting and disposing waste was roughly $34 million, and even with participation of the community and profit through recycling, the revenue does not counterbalance the costs (Jarohz, 2011). Although many places embrace curbside recycling, these programs do not excel due to lack of participation. In terms of expenses, facilities that are maintained for take-back programs, which are programs that recycle large appliances and electronics that cannot be normally recycled from other recycling methods, are generally less expensive than curbside programs (Saphores, 2012).

2.4.2 Drop-Off Recycling

Today, drop-off recycling is the most common recycling program in the United States (Sidique, 2010). However, a recent study shows that most people are unaware of drop-off recycling center locations. Figure 4 depicts a web done by the Saphores surveying company that surveyed residents who have and have not recycled electronic waste (e-waste) as well as home waste. Figure 4a shows that all respondents of the survey believe that storing materials at home is safe. Figure 4b shows that the majority of the respondents did not know the distance to the nearest e-waste drop-off center. The results from Figure 4b show that drop off recycling is more of an inconvenience for residents but they believe that storing materials at home is safe. On the contrary, one article states that it is generally easier to execute than other programs and faster than take-back and deposit refund programs. It can be inferred that drop off recycling is generally easier to execute than other programs and faster than take-back and deposit refund programs because there is no need for organizing transportation vehicles and pick-up times (Sidique, 2010). Many people do not see the conveniences but rather see the inconveniences of drop-off recycling. Some recycling centers offer incentives for recyclable products such as cash-back or coupons. However, the inconvenience is that the person recycling must travel to the

drop-off location (Saphores, 2012). With a curbside recycling program, they have the comfort of leaving it outside of their home for city officials to pick up.

In Michigan, recent studies related recycling participation rates at drop-off locations to location distance, familiarity (with recycling) and social pressure. All of these are key factors in a recycling routine. In Maine, a study was done at the drop-off facilities and included factors such as fees, operation schedule and driving distance. These components were studied to examine the collection rate of computer monitors from 92 municipalities in Maine. Results showed that the facilities collected more recyclables when the fees were low and the numbers of days open were frequent. Driving distance was a minimal factor (Saphores, 2012).

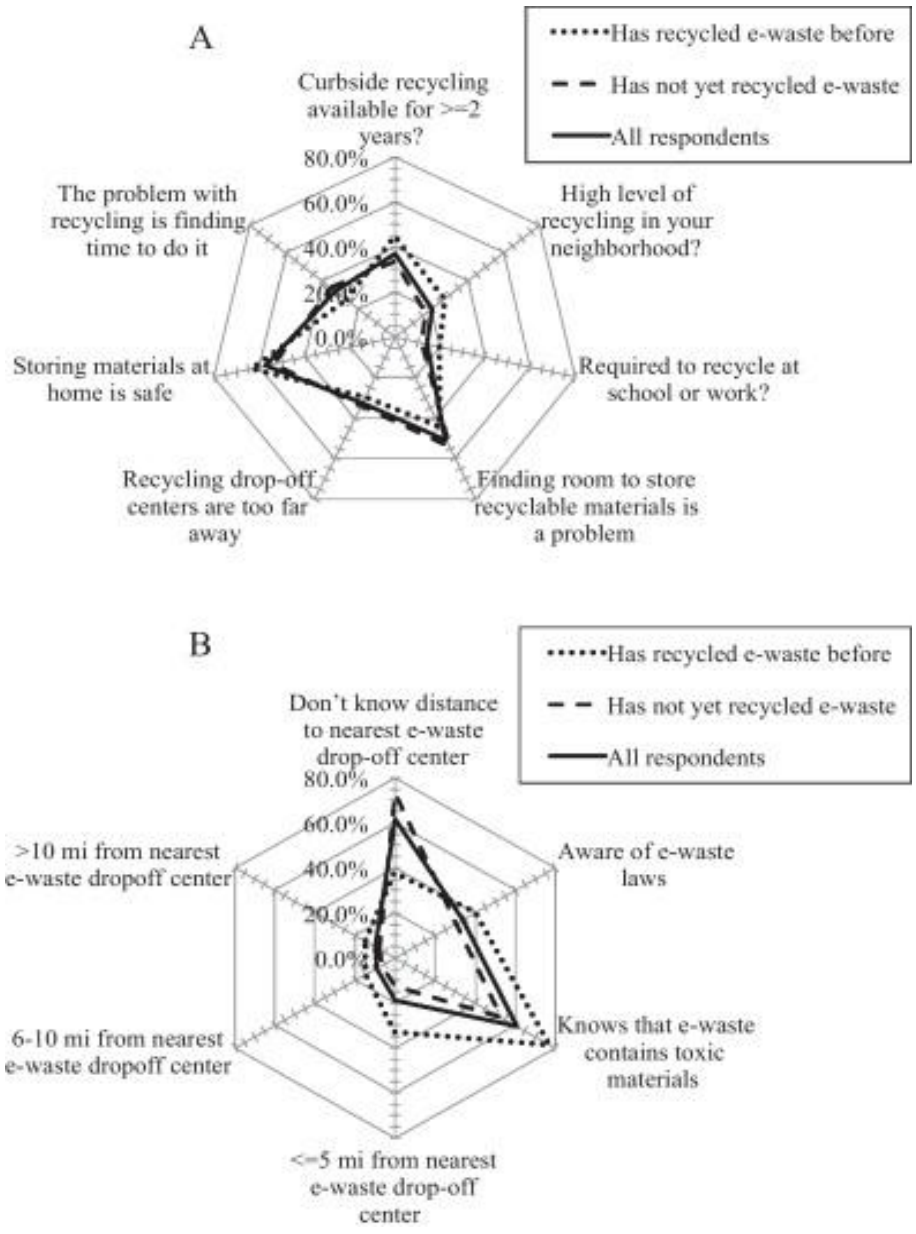

Figure 4: Key Factors of Recycling E-Waste at Curbside (a) and Drop-off (b) (Saphores, 2012)

2.4.3 Pay-As-You-Throw (PAYT)

A pay-as-you-throw program charges residents based on the amount of trash they throw away. This encourages citizens to generate less waste and recycle more. The Environmental Protection Agency in the United States supports PAYT since it incorporates three components to

positive recycling programs. These include environmental sustainability, economic sustainability, and equity. Communities that participate in PAYT have seen an increase in recycling as well as a reduction in waste. With more recycling and less waste, fewer natural resources have to be removed to produce new products. In terms of economics, the PAYT program allows communities to focus less on waste management fees. Instead of residents being charged a general fee for handling trash, they only pay for what they throw away, a sign of equity to all communities (Environmental Protection Agency, 2012).

There are several strengths and weaknesses to the pay-as-you-throw programs. Householders accept it fairly well showing that the program is popular. The program also increases the sorting of recyclables and encourages home composting. Weaknesses include increases in costs, illegal waste dumping and an increase in contaminants in recyclables (Dahlén, 2010).

Although communities face challenges like time commitment and poor organization, there have been benefits from PAYT. It is an environmental solution but also an economic one. In Worcester, Massachusetts, solid waste was reduced by 40 million pounds from 1992 to 1999 under PAYT. In Portland, Oregon, the recycling participation rate increased from seven percent to thirty-five percent only one year after implementing PAYT in 1992 because it became cheaper to recycle than pay to throw away solid waste (Canterbury & Newill, 2003).

2.5 Case Study: International Comparison

Halvorsen (2012) reported in a study executed in 2008 on the effects certain factors have on household recycling participation. This international comparison surveyed 10,251 citizens in ten OECD (Organization for Economic Co-operation and Development) countries. The countries surveyed included Norway, Sweden, Canada, France, Netherlands, Italy, Mexico, Australia, Czech Republic, and Korea. The survey was a "web-based panel" (Halvorsen, 2012) that posed questions relating to topics on household behavior. The topic this case study focused on was "household waste generation and recycling". Demographic information, household characteristics, and attitudes toward environmental issues were taken into consideration (Halvorsen, 2012).

One factor that was evaluated was the quantity of recycling services available. The types and amount of services available for the communities directly affected household recycling participation rates. The programs offered in the countries surveyed included door-to-door collection and drop-off centers or containers, which were the most common methods among the countries, and resulted in higher recycling participation rates compared to other strategies. Other methods included refunds on returns of recyclables such as plastic bottles and aluminum cans, as well as return centers that did not offer refunds. Furthermore, the increase of recyclable materials provided by the program positively affected the overall recycling participation from households. For example, if a drop-off center accepted many recyclable materials such as bottles, cans, cardboard and glass, households utilized that center more than a center that only accepted a couple of those materials (Halvorsen, 2012).

Monetary incentives also influenced participation among households. Although Pay-As-You-Throw programs have been successful in other countries such as the United States (EPA, 2012), this study suggests that this garbage disposal method actually reduces the amount of waste recycled. This is believed to happen because it implies that it is acceptable to pay a fee for garbage disposal instead of recycling, suggesting that lower-income families would be more inclined to recycle if it meant they save more money. However, the data in the survey shows that people with higher incomes tended to recycle more. The type of Pay-as-You-Throw method also affects how people dispose of their waste. Fee options include a flat-rate fee, a frequency-based fee, a volume-based fee, a household size based fee, a waste-based fee, or no fee. If households have to pay based on the volume of their trash, they are more likely to recycle more of their waste so they will have to pay less for their trash. If the program offers a flat-rate fee or no fee at all, households will not feel pressured to reduce their amount of garbage by recycling (Halvorsen, 2012). It is important to analyze the types of Pay-As-You-Throw fees and determine which method would be most successful in influencing households to recycle in specific communities.

Whether or not families felt that they had time to recycle also affected their decision to participate. If someone is not familiar with the recycling and sorting processes, it may take more time out of their day to sort their recyclables from trash. Many people may think it is too much of an effort, and therefore do not participate. Another reason people do not recycle is because they

believe the process should be done by someone else (Halvorsen, 2012) such as the government or businesses. They would prefer to pay for the service, and if it is not available, they do not participate.

This international case study revealed the factors that influence how people recycle, who recycles, and why they recycle. This helped analyze the profiles of recyclers in Costa Rica, and how to make it easier for them to contribute to their society through recycling. The team used these parameters to design the survey and interviewing questions.

2.6 Case Studies: Latin American Studies

In Costa Rica, many residents are not aware of the benefits of recycling due to a lack of education. Since Costa Rica does not have the same characteristics as more developed countries such as the United States, it is important to compare Costa Rica to similar Latin American countries such as those in Latin America (Soong, 2002).

Latin American countries use rewards to promote recycling and one reward is achieved simply through education, because the reward, in the end, is the preservation of the environment. The point of education is to make residents want to recycle rather than be forced to do it. In the countries of Argentina, Brazil, Chile, Colombia, Mexico, Panama, Peru, and Venezuela, TGI, a group of unbiased researchers—according to their website—conducted surveys of 48,885 people between the ages of 12 and 64 (Soong, 2002). The survey was a statement that read: "I recycle paper, bottles, etc." and residents were asked to answer yes or no. Figure 5 depicts a chart of the results by country. Out of all of the Latin American countries, Brazil has the highest recycling participation rate. According to the Brazilian Aluminum Association, roughly 80% of the 9.5 billion aluminum cans sold in 200 were recycled (Soong, 2002). This recycling is converted into profit for the country, which can have a positive impact on the economy. Brazil uses buy-back centers in densely populated areas that offer cash or food discounts when recyclables are turned in (Soong, 2002). This is a great way to gain participation, especially in low-income areas where food is a significant amount of a household´s budget. It would be a substantial motivator for these people to recycle.

The study went on to survey residents based on age and sex. Our background information did not provide any information that separates the participation of recycling by age and sex and

this would be a good aspect to look into while conducting our surveys. Figure 6 provides the final results and the data shows that recycling is much more common among older residents mainly from the age of 35 and onward in both male and female (Soong, 2002).

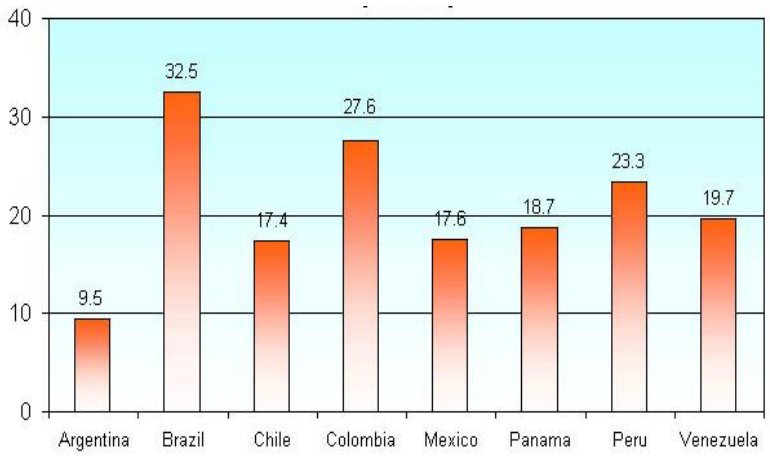

Figure 5: Percentage of People Who Recycle (by country)

(Soong, 2002)

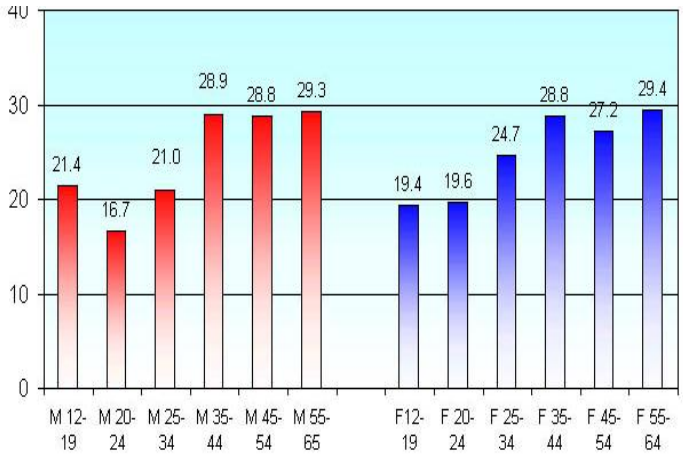

Figure 6: Percentage of People Who Recycle (by age/sex)

(Soong, 2002)

In 2000, a case study was completed in Mexicali, Mexico to determine the potential for recycling programs in communities in Mexicali and similar surrounding cities (Ojeda-Benitez, 2000). Mexicali, the capital city of Baja California, Mexico, has been developing more rapidly in recent years due to an increase in trade agreements with foreign countries hence, it has a higher per capita income rate compared to other Mexican states. This has caused an influx of

immigrants into the city, which has caused the population to double in the past two decades. With an increase in the population comes an increase in the production of waste or refuse, a term used when different types of waste such as food scraps, potentially recyclable products such as plastics or glass are mixed together in the same container such as a trash bin and are no longer able to be recycled. An example of this is when left over pizza is thrown away in its original pizza box. When they are discarded together, the pizza can no longer be used as compost and the cardboard box can no longer be recycled because it is contaminated with the food scraps. The amount of refuse in Mexicali has been steadily increasing by 3.3% annually, and a movement has begun to improve the management of household solid waste programs.

The case study was completed in two stages. The first stage consisted of sampling one community's amount of waste produced on a household level. A garbage collection truck's contents were weighed for one month. This provided the researchers with data on the volume of refuse produced each week. The study was 16 weeks long, with two 8-week phases, one in the spring and one in the fall. Approximately 200 households were sampled non-probabilistically. Three bags per week were collected from each family and weighed and classified according to specific categories which determined the composition of the waste. The categories were divided into two main groups: organic components and inorganic components. These subcategories were further classified as either "recyclable", "potentially recyclable", or "non-recyclable". At that point, none of the waste was being recycled. By determining how much waste could be recycled, however, they could better understand how much total material could be recycled, and thus how much they could decrease the amount of refuse produced. The second stage chose other surrounding communities with similar economic and social characteristics that were also rapidly growing and applied the results from the first stage and created a model. This model estimated that the similar communities had similar waste production rates, and therefore a similar recycling program could be used for these other communities (Ojeda-Benitez, 2000).

The results showed that almost 60% of the total waste produced was organic, and therefore could be composted. Food scraps made up 65% of that organic waste, and almost 40% of the total waste. If a composting facility was established, the community would easily be able to decrease their amount of waste. Sanitary waste made up the largest component of the inorganic waste: it was 27% of the inorganic waste, and 11% of the total waste. Figure 7

describes the reuse and recycling potential of the waste collected. The results also showed that 68% of the waste was potentially recyclable, and a total of 80% of the waste was either recyclable or potentially recyclable, meaning that it could be recycled if there were centers available to recycle them.

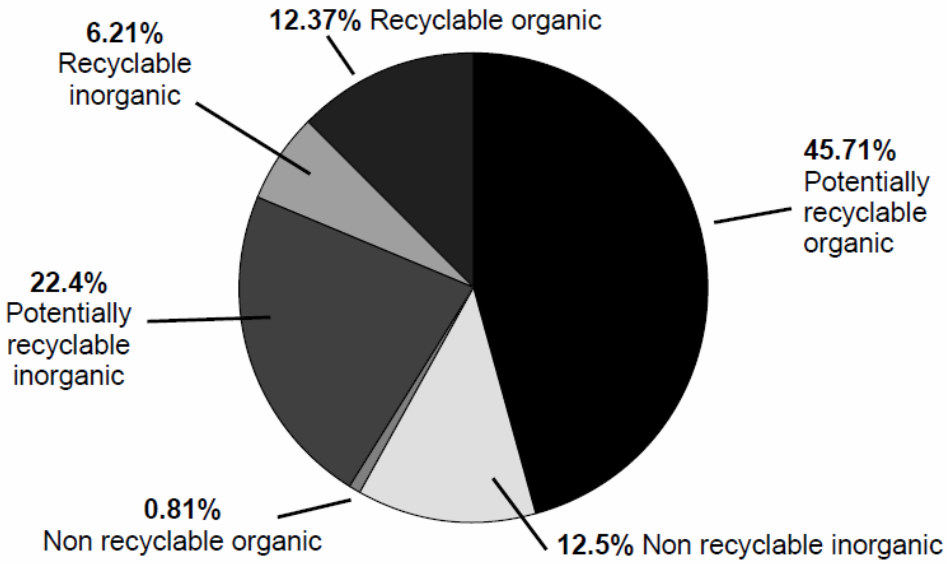

Figure 7: Recycling Potential of Waste Collected in Mexicali (Ojeda-Benitez, 2000)

There are currently recycling processing companies in Mexicali, but the data suggests that it is also important to establish a composting facility because most of the waste produced was organic. There is also a need for organizations, either managed privately or by the government, which will collect the separated waste and sell it to the processing companies. The dump in Mexicali is dangerous and is filling up fast with untreated and non-compacted waste. Since it is so expensive to build a new dump, and the city cannot afford it, it was vital to prolong the life of the dump. Recycling and reusing products is one way to extend the use of the dump. Recycling programs must be implemented to match the economic characteristics of each community. It is also important to educate the residents about recycling techniques and the benefits. This will increase participation rates, and therefore decrease the amount of trash discarded into the dump (Ojeda-Benitez, 2000).

Costa Rica also faced the challenge of rapidly growing dumps and landfills, and has turned to recycling to reduce the amount of waste produced. This case study shows that with efficient programs and helpful resources, a large amount of waste produced in Mexico, and many other countries, has the potential to be recycled.

Chapter 3: Methodology

This chapter outlines the various methods used to compare and contrast the success of recycling programs in Jiménez, Alvarado, and Oreamuno. The team's goal for this project was to evaluate the current recycling programs in Alvarado, Jiménez, and Oreamuno in order to identify successes and failures within the programs and to present recommendations for improvement and expansion of the programs. In this section, the team first describes the objectives for the project. Next, our methods used to collect data—surveys, site assessments and interviews, according to the listed objectives—are discussed. Accompanying each method, there is a description of the reasoning behind the group´s approach and the type of information attained. All three of these municipalities are at different stages in their recycling programs. Due to the lack of comparative data for these solid waste management programs, the municipalities were unable to assess their programs and effectively comply with the newly established Law for Integration of Solid Waste Management (Ley Para la Gestion Integral de Residuos).

3.1 Objectives

To achieve our project goal, we evaluated the effects that the recycling programs have on the communities as a whole through data collection in each of the three municipalities of interest. The areas of focus include assessing educational methods, evaluating the current status of each program, and advantages and disadvantages of each program. This project's first objective was to determine the effectiveness of the recycling education programs that have been put in place by each municipality. From the analysis of the quality and quantity of these programs, the team investigated how each has effected public participation. We investigated both the number and the types of educational programs through the use of surveys. . The team's second objective was to evaluate the current status of each program in order to make recommendations to improve each municipality's plan, as well as to recommend feasible aspects of each one that could then be established in other municipalities in the future. The final objective was to identify advantages and disadvantages that could be taken into consideration if a program needed to be implemented into a new municipality. To do this, the team-researched information pertaining to 3 general categories for each program: budget, environmental management department and education and participation. From this information, the team determined what aspects of each program were successful. In this project, we defined successful as a self-sustainable system, one that can

manage itself on its earnings. Furthermore, the program needs to a high participation rate. In order for the recycling program to be completely successful it needs to include both of these features. Once the team collected the data, we analyzed information and made recommendations for each program. Evaluations consisted of comparisons between the three municipalities' programs. Making recommendations is the most essential step of the project since these plans may be expanded and portions may be established in other municipalities.

3.2 Education and Participation

It is important to provide residents with information about the existence of the recycling programs available to them in their communities. Educating the people about how and what materials to recycle and the benefits the residents and their communities might achieve by recycling encourages them to participate (Troschinetz, 2008). To determine the efforts that have been made to educate the residents thus far, the team held interviews with each of the three environmental managers of the municipalities. During these interviews, the team inquired about educational campaigns currently used in schools, frequented areas, public assemblies and households. Additionally, the environmental managers gave their opinions on the educational methods that have and have not been successful in their municipality.

3.2.1 Surveying the Municipalities

Through the use of surveys, the team asked residents of the municipalities about their participation in the recycling programs in order to retrieve important information on the effectiveness of the educational programs. Basic demographic questions requested information about their socioeconomic class, relating to their age, gender, household size, and optionally their household income level. A few questions allowed for multiple answers. For example, the question regarding what types of education convinced the respondent to recycle asked to check all options that applied. The survey asked how often residents recycle their household waste and the factors that motivate them to recycle. They were also asked about the educational information they have received and if it has influenced them to recycle. This question was a very important one because it pertained directly to one of the projects goals. It aided in identifying the methods of recycling education used by the three municipalities and to determine that method's level of success. In addition to this question general questions related to demographics were included to search for correlations. Finally, the residents gave their opinions on any problems they have with the program and recommended any improvements they felt would be beneficial.

These questions related directly to the team's objectives such that they helped determine which residents are misinformed on recycling and the reasons for their lack of knowledge about recycling. Appendix 1 shows the complete text of the survey.

The same survey questions were used in each municipality; however, they were distributed differently according to the characteristics of each region. Before distributing the surveys to the municipalities, the group completed a prototype test in Spanish of the questions with an employee at the COMCURE office to ensure that the questions were easy to understand and not misleading. The team also reviewed the questions with the financial manager of COMCURE to determine if the options for each question were appropriate. For example, the options for the question related to household income were adjusted according to the average income level of Costa Rica.

3.2.2. Survey Strategy for Alvarado

In Alvarado, which is a rural region that is geographically widespread, the project team administered surveys in public places to save time and to acquire as many responses as possible. The team travelled to two districts in Alvarado, Pacayas and Capellades, on two separate days. On the first day in Pacayas (Wednesday, November 14th), we surveyed residents outside of an elementary school, a clinic, a grocery store, and on the streets in the town square. The next day, we travelled to Capellades, a more rural area. There, we walked up and down streets and surveyed storeowners and residents waiting at bus stops. A total of 53 surveys were collected in these two districts. All surveys were administered in Spanish, as we assumed that the majority of the residents would be more comfortable speaking Spanish. We worked at each location wearing matching attire provided by our liaison, Sr. Guillermo Flores Marchena, a director of COMCURE. We hoped that this professional attire would encourage more citizens to complete the survey. We began the survey procedure by asking citizens if they would be willing to complete a quick survey about their recycling habits. The team then gave a brief explanation of the purpose of the survey and that the goal of the project was to improve Alvarado's recycling program. The team's two best Spanish speakers read the questions to the residents and filled in the answers for them. Before beginning the survey, the residents were informed their responses would be completely confidential and that all questions were optional. The team asked the residents the survey questions and filled out the answers for them in order to be more time-

efficient. The team found that most residents were fairly willing to stop and answer the survey questions. During the survey, we observed that they were very firm and not hesitant to give answers.

3.2.3. Survey Strategy for Oreamuno

Oreamuno, a much larger municipality than Alvarado, has five districts: one is urban, and the remaining four are rural. Oreamuno has their own surveying distribution system and offered to distribute the surveys and compile the data for the project. The surveying was done through telephone by the Comptroller Services Department of the municipality of Oreamuno. In the municipality, residents perform deeds for the community such as painting a church and planting trees. These residents receive a certificate of acknowledgment for doing these projects. The residents were surveyed during the hours of 8:00 a.m. and 2:30 p.m. when the municipality called to do a routine check-up on the jobs that were being done at the time. These surveys were completed between the 15th and 28th of November and we received 92 surveys. Due to the survey format, only residents who were over fifteen and who had at least one child under eighteen years old were surveyed. The team made this decision because they felt that children under the age of fifteen would not take the survey seriously and at the time the survey was made, there was no option for a family to have children under 18. See Figure 8 below. This was, unfortunately, a human error and this small detail made the sample more selective therefore making the process longer than expected. All participants are from the Oreamuno canton and from the San Rafael, Cot, Cipreses, Potrero Cerrado, and Santa Rosa districts.

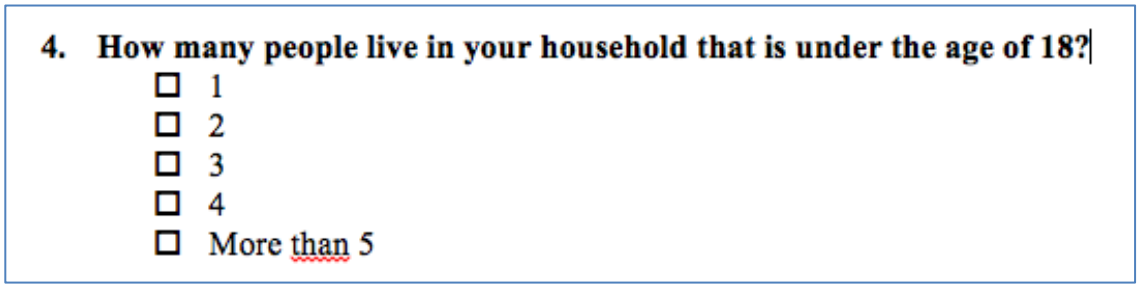

Figure 8: Survey question sent to Oreamuno's Comptroller Service

3.2.4. Survey Strategy for Jiménez

On Tuesday, November 27th, we travelled to Jiménez to distribute the surveys to the local residents. The team distributed the surveys in Jiménez using a similar strategy as in Alvarado. Because Jiménez is a rural municipality and is geographically similar to Alvarado, the team conducted the surveys in multiple neighborhoods in Juan Viñas. The team conducted these surveys in a manner similar to that employed in Alvarado by surveying shop owners and residents on the street. The team again obtained 58 surveys over a period from noon until 5 P.M.

3.2.5 Compiling and Analyzing the Survey Data

Once surveys were collected from each of the municipalities, the data was compiled in an Excel spreadsheet (Figure 9). A grand total of 203 surveys were collected between the three municipalities. To minimize transcription errors, each individual survey was assigned a row in the Excel spreadsheet. Next, each question was assigned a specific cluster of columns with each option being a specific column within that cluster. The three municipalities were also separated into different spreadsheets. The team sorted each survey and each question and then summed up the answers and made bar graphs and histograms that were representative of the total number of answers. By organizing each question and option by municipality, we could compare the graphs by municipality to identify correlations between which education programs have been successful in each municipality. Furthermore surveys where organized by one question then each subcategory was further rearranged according to yet another question. By reorganizing the spreadsheet this way with different combinations, correlations could be made between various questions.

	Sexo		Edad							ninos < 18 en su hogar					recicla los residuos solidos?				Separa sus residuos organicos?			
Survey Number	F	M	<15	15-24	25-34	35-44	45-54	55-64	>64	1	2	3	4	>5	Siempre	Seguido	A veces	Nunca	Siempre	Seguido	A veces	Nunca
1																						
2																						
3																						
4																						
5																						
6																						
7																						
8																						
9																						
10																						

Figure 9: Example of Excel Spreadsheet for Survey Results

3.3 Current State of Recycling Center

In addition to archival research, the project team completed site assessments in each municipality. These site assessments of recycling centers provided a visual representation and first hand observations of the current environmental status in each municipality. As we were outsiders analyzing the recycling program without prior opinions of the state of the recycling sites, we were able to look at all features of the recycling program without prejudice.

3.3.1 Site Assessments

During the visits to each municipality's recycling site, the environmental manager of that specific municipality accompanied the research team. Each manager conducted a tour of the premises and explained the operational procedures and management practices of their recycling center. Two team members gathered pictures of pertinent areas of the site, while the remaining two team members took notes on the processes of the center. By visiting the recycling centers in each municipality, the team was able to better comprehend the volume of recyclables by observing their actual size rather than just researching the defined weight in documents provided. In addition, these visits yielded more detailed information as to how the processes work at each recycling center. The team met with the recycling center employees, who were very open to sharing information on their daily routine at the centers of two municipalities. They explained to us how the centers became busy during certain times of the year and the residents' habits of dropping off waste. The people working at the center in Jiménez were not willing to speak to the team at all due to the amount of work they had. After observing these sites, the group compared the noted conditions to the descriptions of the sites that were obtained from the archival research. This helped us determine if the processes have been efficient. Table 5 below shows the dates and duration of time spent at each recycling center:

Location	Date Visited	Duration of Time
Oreamuno	Nov. 9th, 2012	9 A.M-10 A.M
Alvarado	Nov. 14th, 2012	9 A.M-10 A.M
Jiménez	Nov. 15th, 2012	9 A.M-10 A.M

Table 5: Dates and Times of Site Assessments

3.4 Advantages and Disadvantages

To aid the team in making recommendations, we considered the advantages and disadvantages of each recycling program and their corresponding educational programs. We categorized various aspects of each program in terms of budget, the environmental management department, and education and participation and were able to identify advantages and disadvantages of each program. This comparison was made considering that each one of the municipalities' programs and demographics are different.

To analyze how successful the recycling programs were in terms of their budget, we studied archival documents provided by the municipalities and COMCURE. The team reviewed the "Guia para el mejoramiento de la gestion de los residuos solidos en las Municipalidades" (The Guide to better the management of solid waste in Municipalities) given to us by our sponsor, COMCURE, as well as multiple documents provided by the three municipalities leaders, Sr. Maroto Pérez of Oreamuno, Sra. Gómez Chacón of Alvarado and the mayor of Jiménez, Sra. Lissette Fernandez Quirós. Many of these documents that we researched were internal documents and only intended for use by municipal authorities.

By interviewing the environmental managers of Alvarado and Oreamuno and the mayor of Jiménez, the team learned about the duties of each environmental management department. We then came up with advantages and disadvantages for the department based on how much time they have to spend on each aspect of the program, such as the collection system, managing the recycling center and overseeing a recycling educational program. We also considered the number of personnel that they have to complete these duties.

These interviews also informed us about the educational methods that are used in each municipality. The municipality leaders informed us of how each one deals with education and the team noted that all three were very different. The completed survey analysis also allowed us to reinforce what the leaders had told us. The demographics of each municipality were taken into consideration to determine how easy it is to educate the residents. For example, it might be easier for a smaller municipality to educate their residents in comparison to a larger municipality. Finally, advantages and disadvantages of the municipalities' educational methods were identified and noted.

Chapter 4: Results

After completing archival research and conducting site assessments of the three municipalities, the team assembled important information relating to the current state of each recycling program. By surveying the residents about their recycling habits and any education they received on recycling, the team identified successful methods of education. From the analysis of these surveys, we formulated recommendations to improve the educational programs in each municipality. The team visited each recycling center and assessed the current state of the site. We also interviewed the environmental managers from each of the three municipalities to get a further understanding of the advantages and disadvantages of each program. The group then made recommendations to improve each program and identified which aspects of each one have been particularly successful and that would be feasible to implement into new programs throughout the country.

4.1 Education and Participation

To gain insight into recycling practices and the success of recycling education methods, the team surveyed residents from each municipality. We acquired 53 surveys from Alvarado, 58 surveys from Jiménez, and 92 surveys from Oreamuno. The charts below describe the types of people that were surveyed. Figure 10 represents the ages of the residents and Figure 11 represents the genders of the residents. The number of residents between the ages of 45 and 54 amassed for the bulk of our surveys.. We tried to survey as many people as possible in each age group; however, it was difficult for the municipality of Oreamuno because the surveys were administered to residents that were called by the community's Distribution Committee. These respondents tended to be older than the residents that the team surveyed. This also altered the gender statistic. Many of the residents that were surveyed in Oreamuno were males. The "unknown" category for gender is most likely due to the fact that residents were surveyed by telephone, so the surveyors were sometimes unable to distinguish a man's voice from a woman's. Because of this, the sampling was not random. However, we tried to obtain representative samples of different types of people categorized by age and gender.

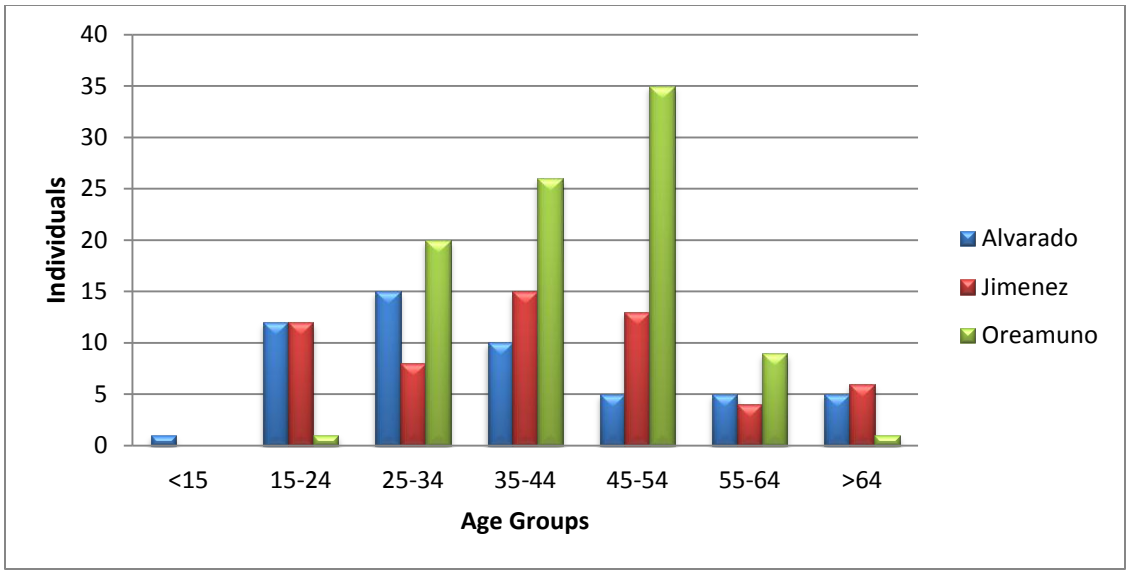

Figure 10: Ages of Residents Surveyed

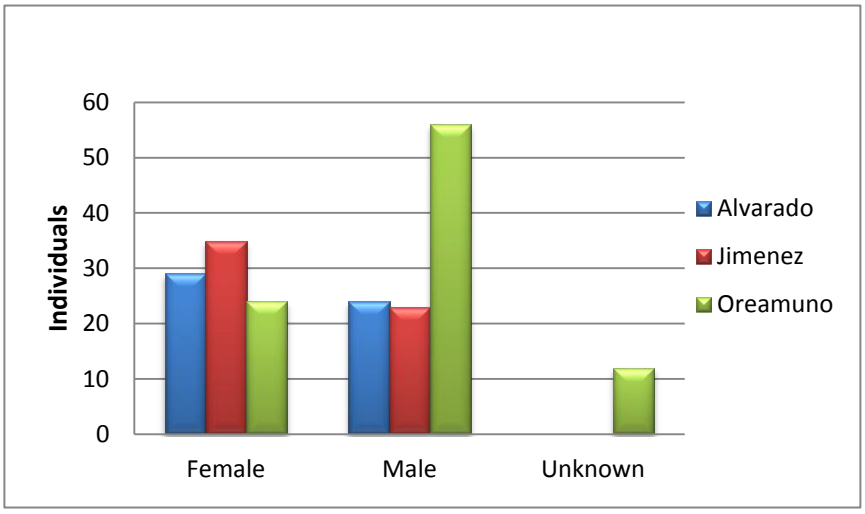

Figure 11: Genders of Residents Surveyed

Survey participants were asked about their recycling habits; and more specifically, how often they recycle and compost their household waste. Figures 12a, 12b, and 12c show the recycling habits of the residents in Alvarado, Jiménez, and Oreamuno respectively. Most residents answered that they "always" recycle, especially in Jiménez, where 98% of the residents chose that option. More residents in Jiménez answered that they "always" recycle because the municipality of Jiménez will not pick up the residents' trash if they do not recycle, whereas the municipality of Alvarado will still pick up their trash. The survey results for the

recycling and composting habits in Oreamuno were very different from those in the other two municipalities. Only 47% of residents in Oreamuno answered that they "always recycle". This may be due to the fact that there is no collection system available for the community, and people are unwilling to take more time out of their day to bring their recyclables to the center themselves. Another reason why the percentage of "always" responses is so different from the other municipalities may be because the residents of Oreamuno were surveyed by telephone, and therefore felt more comfortable answering more truthfully because their identities were even more unknown than the residents of Alvarado and Jiménez, who were surveyed in person.

While Jiménez is the only municipality with a public composting center, the team still questioned residents in all municipalities about their composting habits. The number of residents that compost in Alvarado is lower than the number for Jiménez; however, the majority of the Alvarado residents surveyed (64%) compost on their own. Still, 26% of the residents surveyed in Alvarado answered that they never compost, a statistic that will hopefully decrease with the implementation of the public composting center in February of 2013.

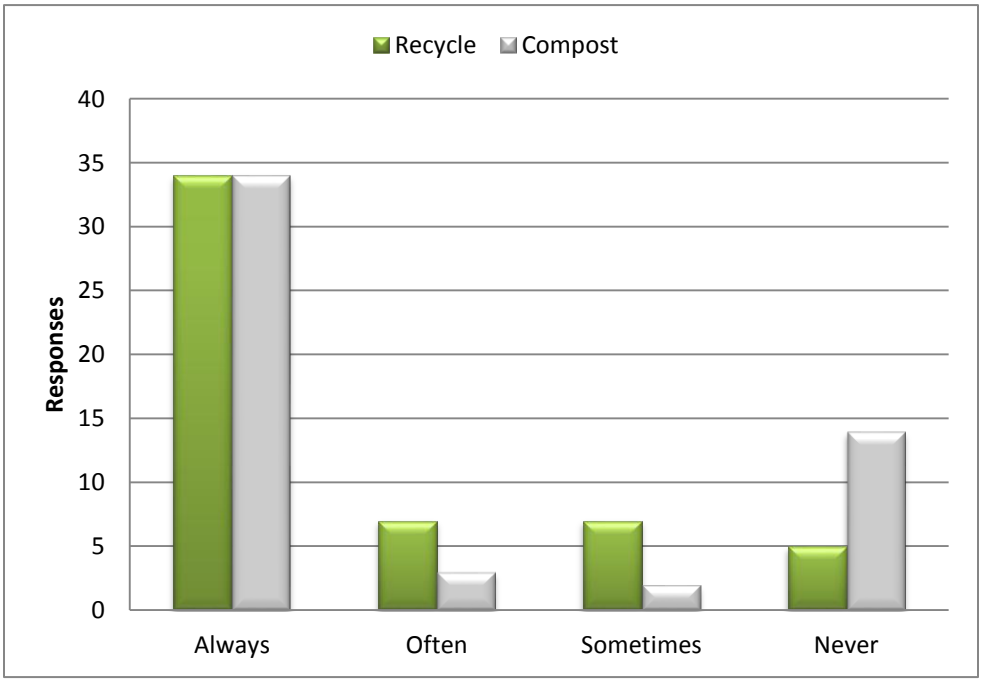

Figure 12a: Alvarado Residents' Recycling and Composting Habits

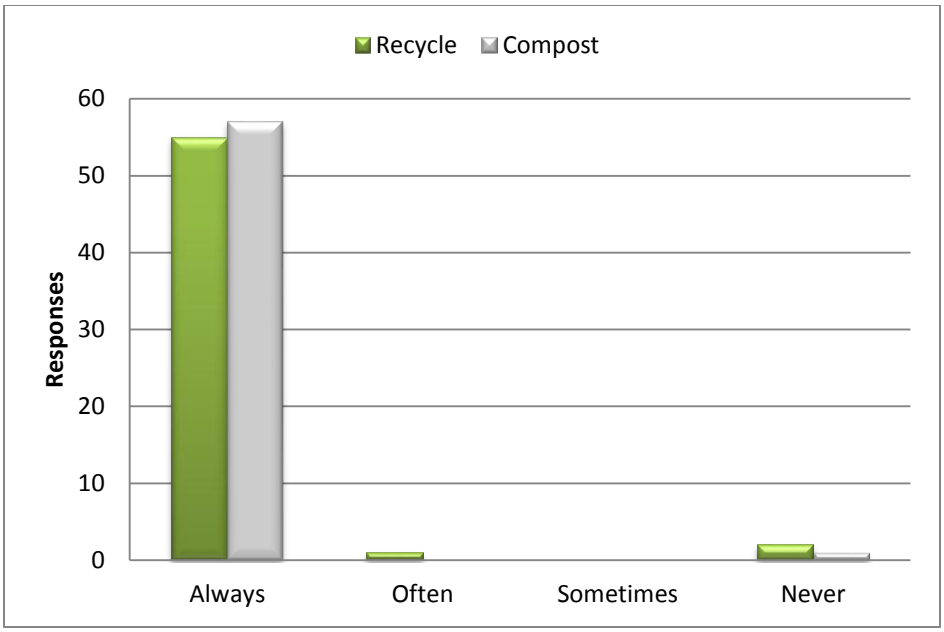

Figure 12b: Jiménez Residents' Recycling and Composting Habits

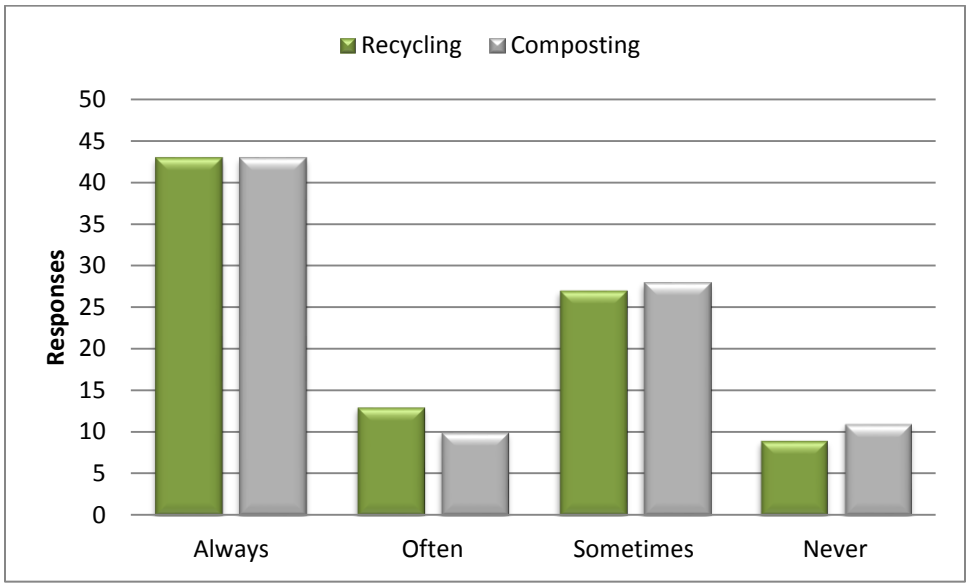

Figure 12c: Oreamuno Resident's Recycling and Composting Habits

It is important to note that the results from all three surveys show the same number of people that "always" recycle also "always" compost. With further analysis of the data, it becomes evident that it is not just the same number of people that recycle and compost, but that the same people that always recycle are the same people that always compost. The histograms in Figures 13a, 13b, and 13c show the percentage of residents that only recycle, only compost, and that participate in both. The residents of Jiménez recycle and compost the most, presumably due

to the fact that there are public recycling and composting centers and many of them are involved in agriculture so it is beneficial to them to use the fertilizer created from compost.

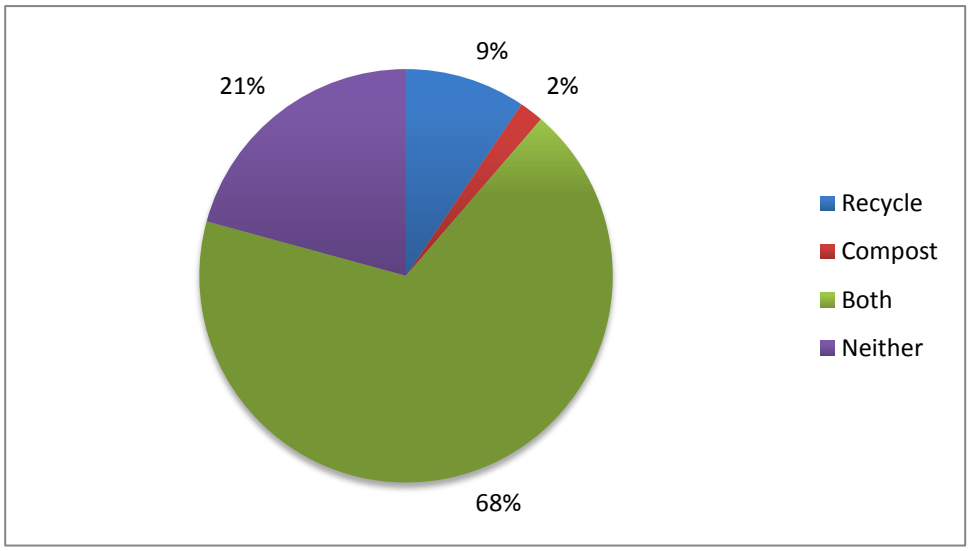

Figure 13a: Recycling and Composting in Alvarado

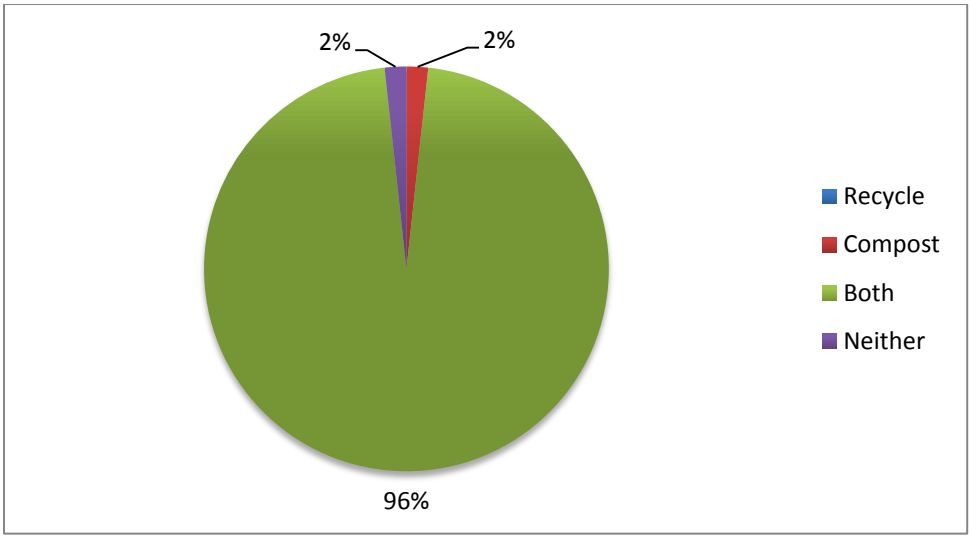

Figure 13b: Recycling and Composting in Jiménez

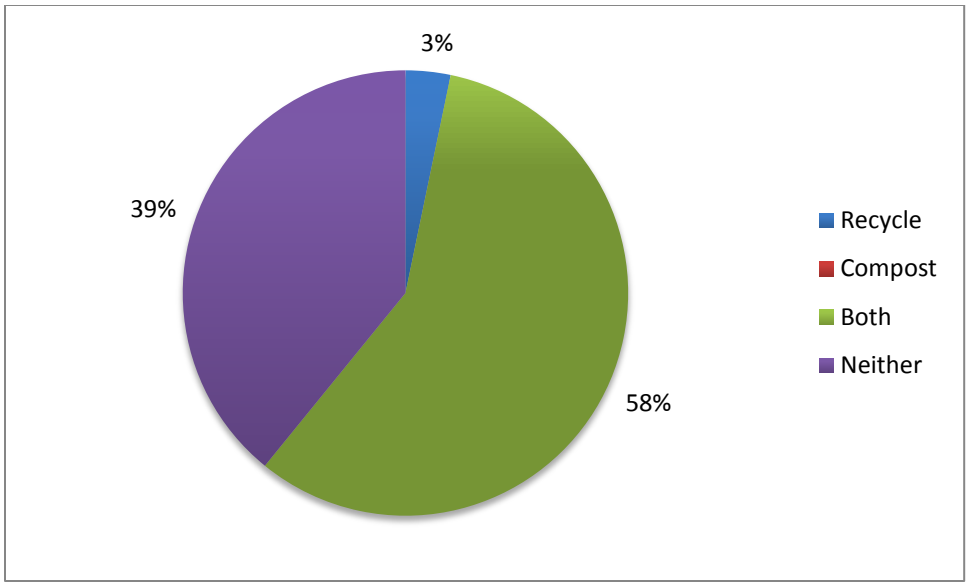

Figure 13c: Recycling and Composting in Oreamuno

As can be seen in the graphs above, most of the residents surveyed answered that they both recycle and compost. This suggests that there is great potential for composting centers in the municipalities that have not yet established one. In Alvarado, 68% of the residents recycle and compost even without an established composting program or center and in Oreamuno 58% of residents recycle and compost although residents do not solely compost. Since such a large amount of the population already composts on their own, it can be expected that there would be an even larger participation rate if a composting program was established. When considering the results for Jiménez, one can observe that all of the participants that take part in recycling also participate in composting. This shows that the addition of a composting program could potentially have just as high participation rates as the recycling program currently does. Once habits of separation are established for a recycling program, adding a composting program that incorporates habits similar to recycling would be relatively simple.

Residents were also asked about the main reasons they choose to recycle. Figure 14a, 14b, and 14c displays the reasons for each of the municipalities. The majority of residents in Alvarado and Jiménez answered that they recycle because it is beneficial to the environment. In Alvarado, 84% of residents surveyed, and 68% of those surveyed in Jiménez chose this response. Although most of the Jiménez residents answered that it was beneficial to the environment, many followed up the question with comments about the penalty they face if they do not separate their

solid waste. The penalty is that their trash will not be collected, which would cause aesthetic problems and be concerning to the environment. The team was unaware of this problem until after surveying the residents of Jiménez. Alvarado has a higher percentage of people who report recycling for environmental reasons, possibly because they have their own Environmental Management Department, which has solely focused on properly educating the residents and raising awareness about the importance of protecting the environment through the management of solid waste. This has convinced residents to recycle because it is beneficial to the environment, and not just because it is the law. Jiménez, however, has not established a specific department in charge of environmental management. Because of this, residents are not properly educated about the importance of recycling but are solely educated on how to do it, and told that there are consequences for not complying with the law (Personal Communication, Lissette Fernández Quirós). The results from residents surveyed in Oreamuno were very different from the other two municipalities. Instead of reporting that they recycle because it is beneficial to the environment, residents reported that they recycle because they feel that it is their civic duty. It is important to note, however, that the responses are much more varied than the other two municipalities. Again, this may be because the residents were surveyed by phone and felt more comfortable with giving truthful reasons instead of reasons they think they are expected to give.

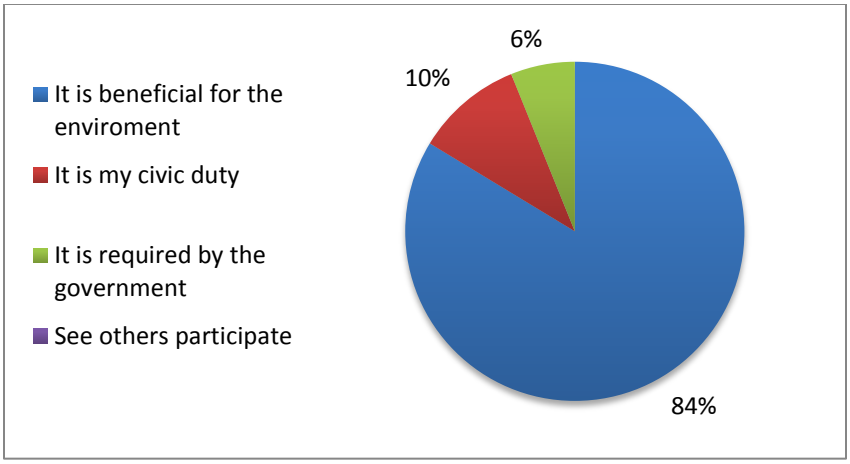

Figure 14a: Reasons Alvarado Residents Recycle

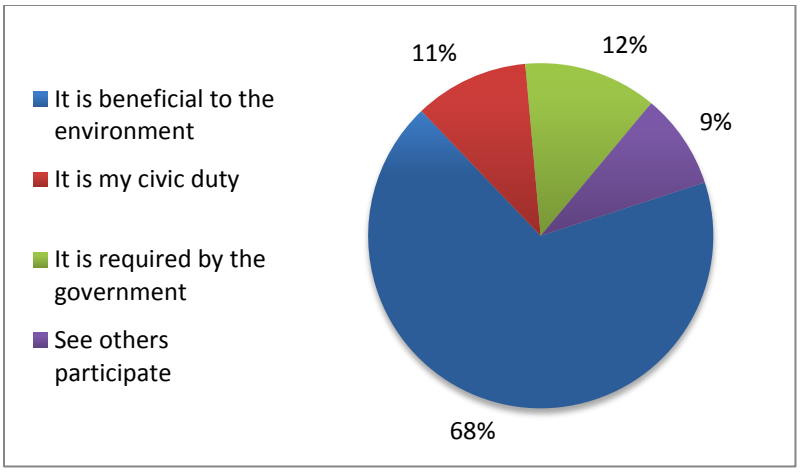

Figure 14b: Reasons Jiménez Residents Recycle

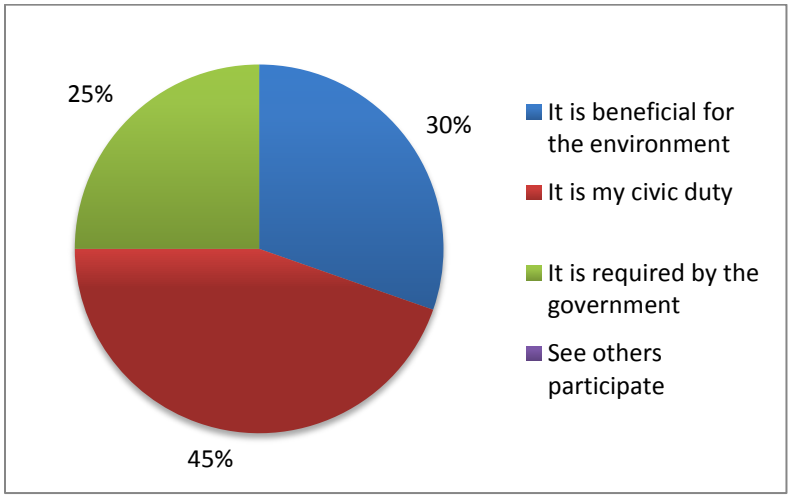

Figure 14c: Reasons Oreamuno Residents Recycle

Survey participants were also asked about the methods of education that have convinced them to recycle the most. They were told that they could provide more than one answer for this question, but most responded with one answer; only 7 from Alvarado, 5 from Jiménez, and 3 from Oreamuno municipality provided multiple answers. Figure 15a, 15b, and 15c shows which educational methods have been successful in communicating information to residents about recycling procedures in Alvarado, Jiménez, and Oreamuno. Alvarado has a large variety of educational methods that have been effective, not just a single strategy that has been the most successful. This is probably due to the fact that Alvarado has more time to spend on creating and administering different educational programs, and many have been successful. We can infer that

these methods have been successful from the analysis of the survey; the more residents that chose a particular method of education meant that it convinced more people to recycle. In Jiménez, college students from the University of Costa Rica travelled door-to-door to distribute educational brochures and discussed the recycling program with the residents, which is why the data shows that is the most effective educational method for that municipality.

The most effective educational method in a single municipality was education through schools in Oreamuno, which implies that children learn about recycling methods at school and teach their family members at home. Television commercials were also effective in Alvarado, although the municipality did not mention sponsoring any commercials. No residents answered "no education", which means that all reported having received at least some education about recycling.

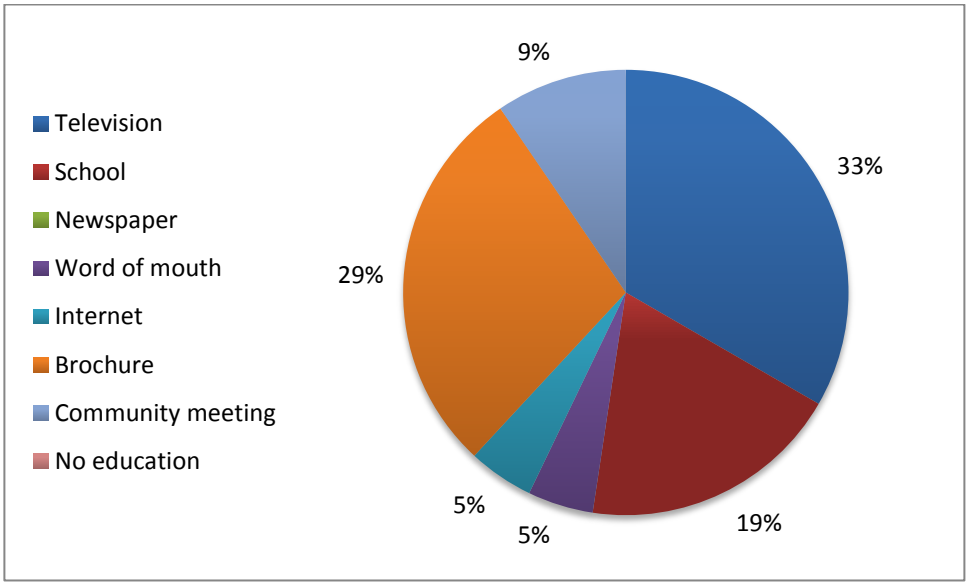

Figure 15a: Effectiveness of Educational Methods in Alvarado

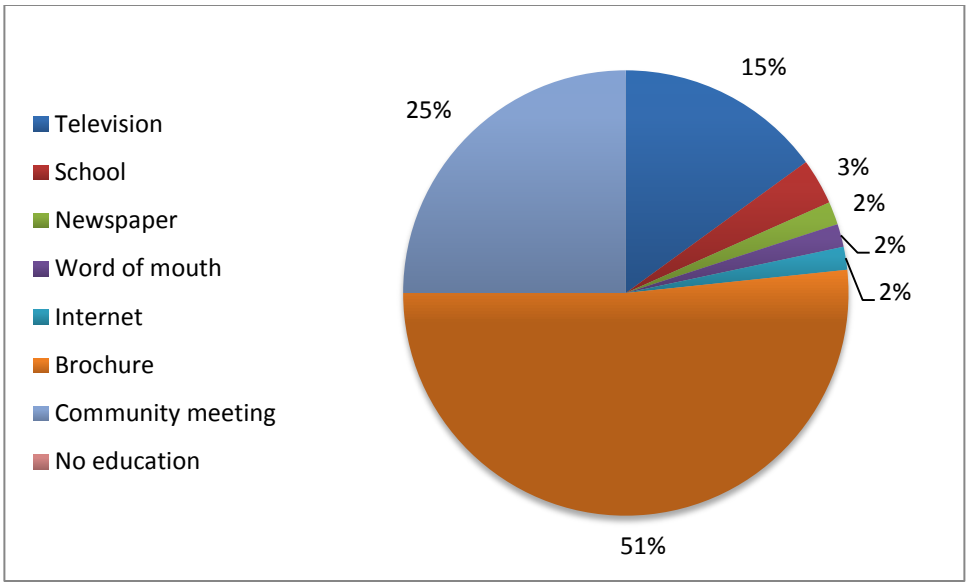

Figure 15b: Effectiveness of Educational Methods in Jiménez

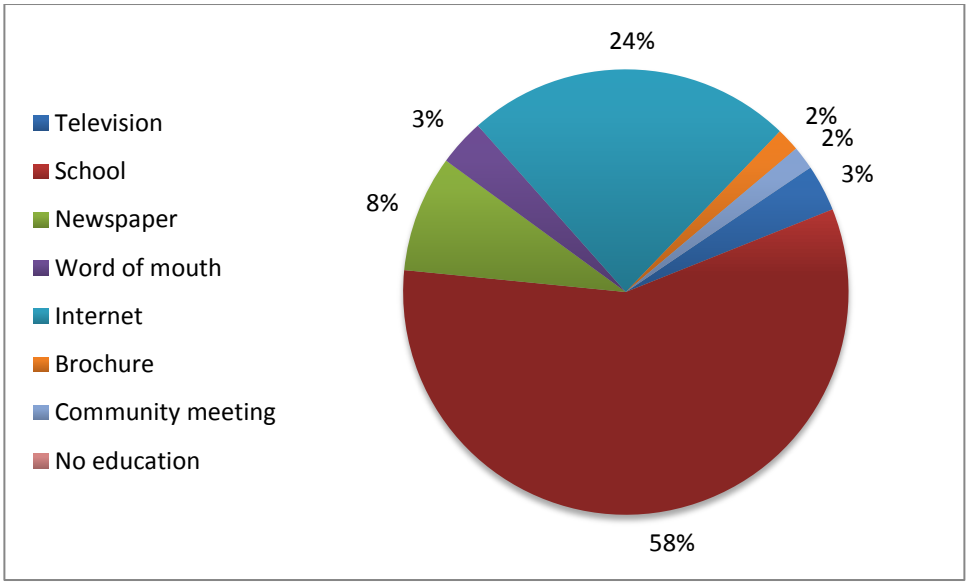

Figure 15c: Effectiveness of Education Methods in Oreamuno

Residents were also asked who is primarily in charge of recycling in their household, and the overwhelming response was that the female head of the household is responsible for the recycling. This statistic is not surprising because it may be common for women take care of the house, and recycling would be one of their duties. Figure 16 displays the statistic of who the primary recyclers are in the households of all three municipalities.

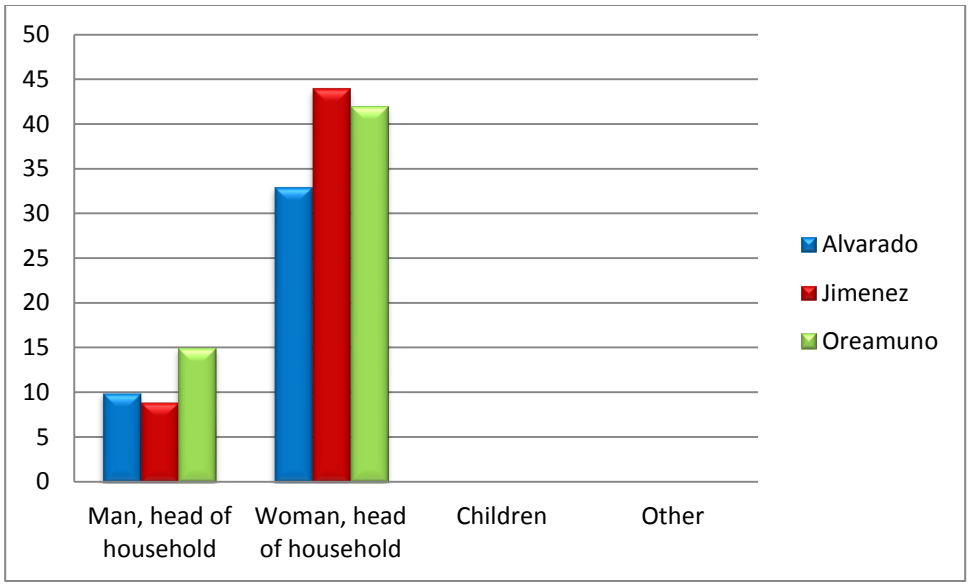

Figure 16: Primary Recyclers in Households

Once we observed that women were the principal recyclers in the majority of the households that were surveyed, we made a more specific analysis based on the answers that females gave for the question inquiring about the method of education that convinced them to recycle. We discovered that most women in Alvarado and Jiménez were educated through brochures that were distributed to their households. Oreamuno was not a part of this analysis because they did not distribute brochures to households. There is a connection between the fact that women learn from these brochures and that they are the primary recycler in their household. These brochures have proven to be effective because they targeted the primary recycler by delivering them to households during the day while the female head of the household was most likely at home taking care of her children and home. As can be seen in the following figures, the largest percentage of women in these two municipalities answered that the method through which they were convinced to recycle was through brochures.

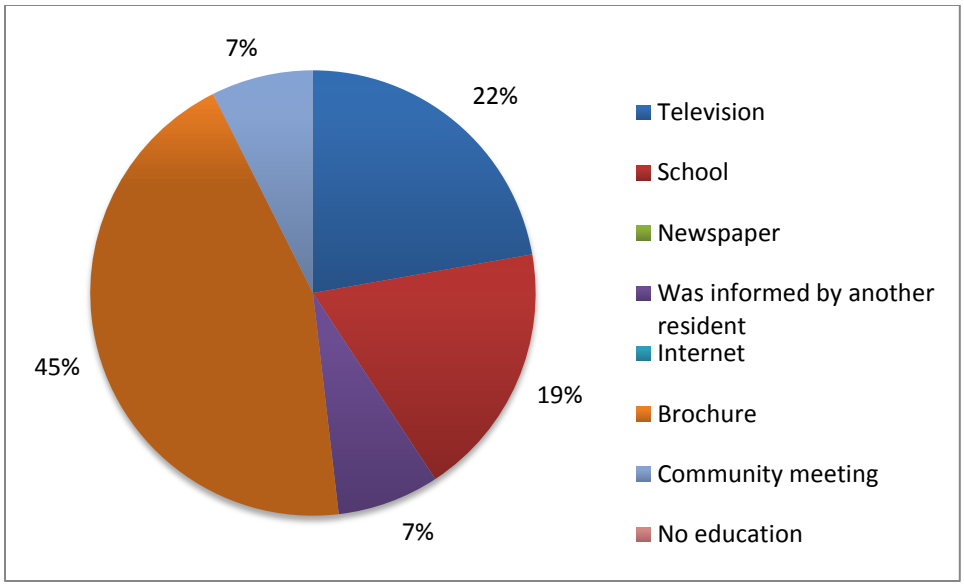

Figure 17a: Modes of Education Reported by Women in Alvarado

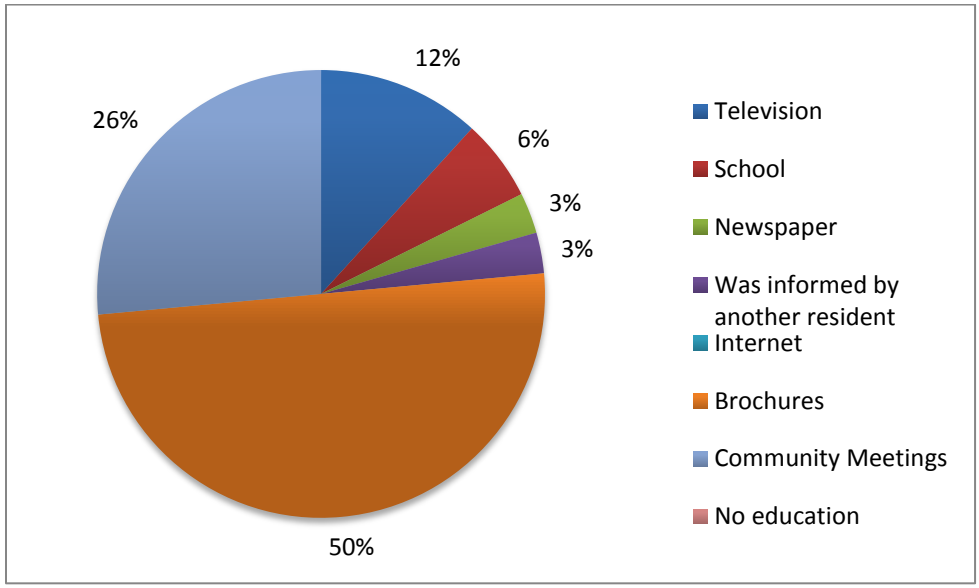

Figure 17b: Modes of Education Reported by Women in Jiménez

Furthermore, the reasons for which women were convinced to recycle were observed. According to the data the most popular response was “It is beneficial for the environment”. This response implies that they are more aware of the environment since the other responses do not consider the positive effects recycling have on the environment. This data reflects the

effectiveness of informing women about the environmental benefits that recycling programs have through the use of brochures.

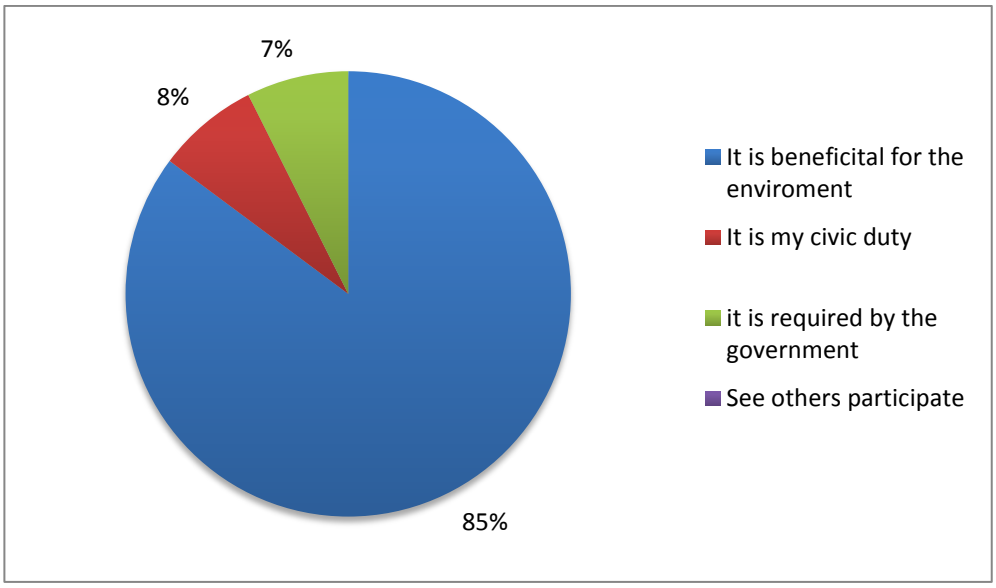

Figure 18a: Reasons Why Women in Alvarado Recycle

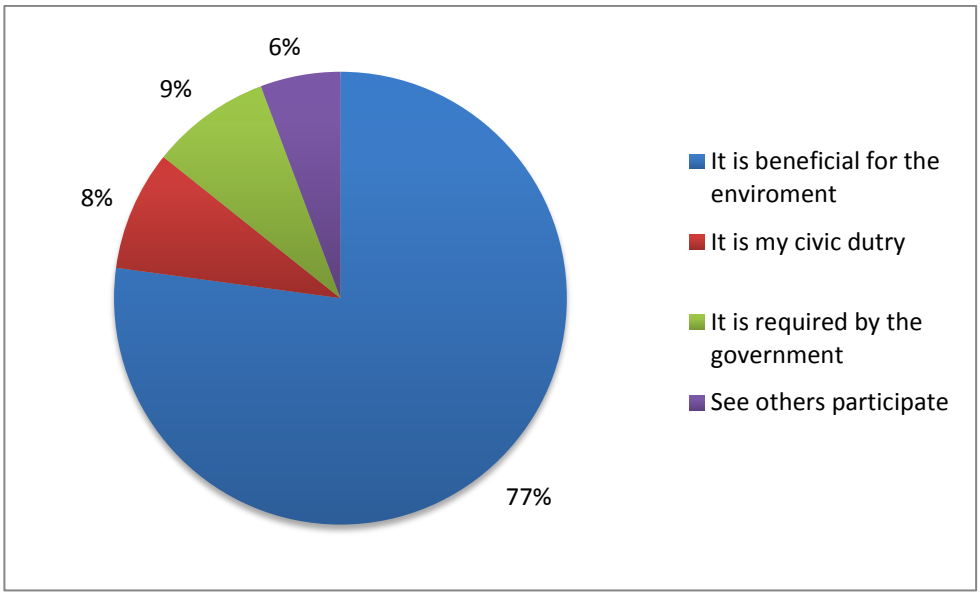

Figure 18b: Reasons Women in Jiménez Recycle

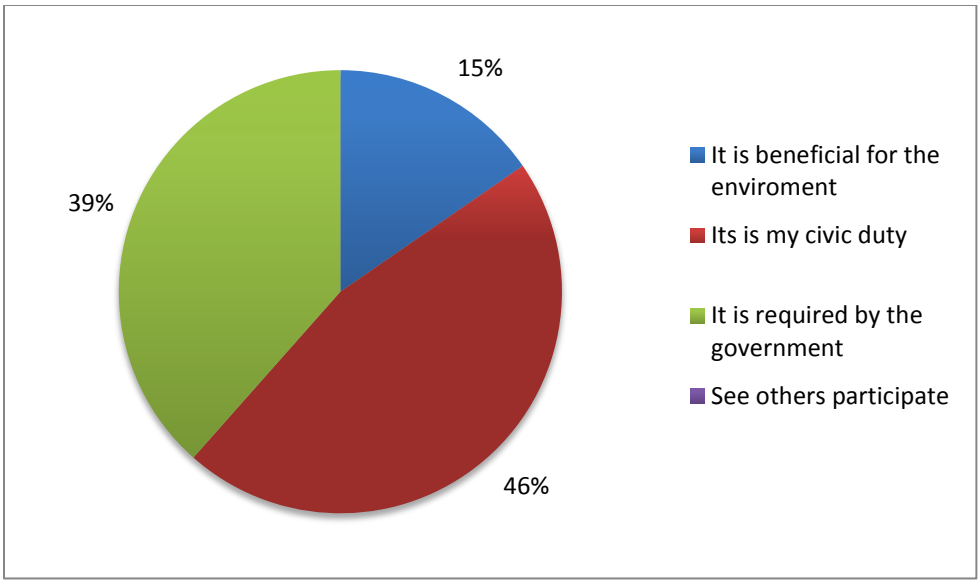

Figure 18c: Reasons Women in Oreamuno Recycle

Appendix 11 shows the further analysis of the survey questions. Histograms display the percentages of the reasons men in each municipality recycle as well as which educational methods convinced them to recycle. Unlike the analysis of women surveyed, there were no correlations between the reasons men recycle, the educational methods that convinced them to recycle, and other questions. There are also graphs in this appendix that display the answers to these two questions categorized by age and municipality. Again, no correlations were found between different age groups.

4.1.1. Public Recommendations

When the team surveyed residents about the recycling programs, they also asked for any recommendations they might have. After organizing all of the residents' responses into a chart, which can be found in Appendix 10, the team noticed correlations between the recommendations. Most recommendations could be broken down into three categories: education, containers, and collection. Table 6 below gives examples of the most common recommendations for each of these three categories. The education recommendations from all three municipalities mainly advocated for more education on recycling, implying that there is an inadequate amount. In the general recommendations section in the following chapter, the team recommends how to deal with this broad recommendation given by the public. Additionally, residents recommended that the municipalities should supply more public containers, specifically

in public areas such as bus stops. Only one resident in Jiménez made this recommendation although there are already numerous public containers throughout the municipality, so it is possible that this individual was just unaware of them. A picture of these containers is shown in Figure 19. Although more residents in Alvarado complained about the lack of public recycling containers in their towns, the municipality has containers that will soon be stationed in public places similar to Alvarado shown in Figure 20 below. These containers are labeled with each of these three categories: organics, recyclables, and non-recyclables.

The final category of recommendations involved the collection of recyclable materials. Over half of the respondents in Oreamuno suggested these recommendations. The recommendations related to collection from the other two municipalities were more general, but included that recyclables should be collected more often during the week and the collection process should be more organized. Because there were so many recommendations about collection from the residents of Oreamuno, they were further categorized into subcategories, which include the schedule, location, and the service of the recycling center. Many residents recommended that the collection center should be open for more hours during the week. Although this change would initially cost more money for the municipality, it may also allow the center to collect more recyclables because more people could bring them at times that are convenient for them and therefore, sell more recyclables and obtain a larger profit. Since bags are left outside of the center, as described by the environmental manager, and residents ask for additional hours, it is probable that by expanding their schedule the center will receive more visitors. They also recommended that there should be more locations for the collection centers since it is a hassle for some residents to drive out of their way to bring recyclables to a center that is not near their home. Again, this recommendation would initially cost more money, but could ultimately help people recycle more often and therefore create an even larger profit for the municipality. Although 98% of people responded that they do recycle, they made the recommendation to create more recycling centers because it would be more convenient for them. If there were more convenient locations, residents may be more inclined to bring their recyclables to the centers more often.

The final subcategory, the service of the recycling center, had the most recommendations. Almost all of these were to “improve the service” of the centers, which is a very broad

recommendation and could be interpreted many different ways. The team will describe specific recommendations for improving the service of the recycling centers in their own list of recommendations in the section below. In addition to improving the service of the center, residents recommended implementing a collection system for the municipality of Oreamuno. However, such a significant change would require lots of planning and budget spending, which may not be feasible for the municipality. The team considered each of the recommendations made by the residents when constructing their own list of recommendations, which are listed in the following sections.

	Alvarado	Jiménez	Oreamuno
Education	12 Responses	14 Responses	12 Responses
	• More awareness • Continue educating	• Educate about importance of recycling • More educational programs to make residents understand recycling better	• Unaware of how to recycle & how process works • Educate children
Containers	9 Responses	1 Response	9 Responses
	• More containers in public places	• Provide recycling containers	• More public containers • Public containers should be labeled
Collection	5 Responses	2 Responses	44 Responses
	• Be more organized • Improve center • Be more careful during collection • collect on time • More frequent pickups	• Don't leave garbage on the street, be more careful of pickup • More days to recycle: 2 days to recycle and 2 days to compost	*3 Sub-categories:* <u>Collection Center Schedule</u> 7 Responses • Expand Schedule, open at more times <u>Collection Center Locations</u> 15 Responses • More locations • Better locations <u>Service</u> 22 Responses • Expand and improve services • Offer pick-up services
Miscellaneous	4 Responses	4 Responses	4 Responses
	• Control theft of metal recyclables • Establish new composting system • "The people are the problem" • Separate	• Work on Juan Viñas odors • More work, still trash in street and rivers • Employment opportunities • Pick up trash	• Do not throw trash in street • Do not through trash in ditches along road • Separate at home • Do not like to recycle because it takes a lot of time
	• 10 people had no recommendations and answered that the program was running well • 15 people had no answer	• 33 residents said it was good • 6 residents did not answer	• 20 people had no answer

Table 6: Summary of Recommendations from Residents

Figure 19: Public Recycling containers in Jiménez

Figure 20: Recycling containers for Alvarado

4.2 Current Recycling Programs

Through archival research and interviews, the team learned about the processes of each recycling program, which are the steps taken to collect, separate, and recycle the materials. We also learned who manages the finances and the centers themselves. Each municipality, serving populations of different sizes, has distinct strategies for running its program. We also carried out

research on the economic status of each municipality in order to capture the current state of these programs. Drawing on this knowledge, the team recommended feasible recommendations according to each municipality´s financial situation.

4.2.1 Alvarado

Our interview with Sra. Gabriela Gómez Chacón, the Environmental Manager in Alvarado, revealed important information about the structure and function of Alvarado's recycling program. Alvarado is a small municipality (based on population) compared to the rest of the municipalities in Cartago. According to the 2011 census, only 15,000 people reside in the municipality of Alvarado (Instituto Nacional 2011). It is composed of four districts: Cervantes, Villa de Pacayas, Santa Cruz, and Capellades. However, since Cervantes is an autonomous district and they are currently working on improving their own solid waste management program, it was excluded from this research.

Alvarado has been collecting trash and recyclables since January of 2007. Around that time, the number of duties that needed to be managed overwhelmed the environmental manager in the municipality. Therefore, the municipality held a contest that year to hire an outside entity or individual to operate the recycling program. This contest consisted of finding a company, organization, school, or other party that offered the best plan to manage the municipality's waste. Only one person participated, Rodolfo Meléndez, but he met all the requirements, and thus was put in charge of their solid waste management through an agreement. This agreement states that Meléndez collects recyclables and non-recyclables door to door, separates the materials, stores the materials on his property, and sells the separated materials. All materials that cannot be recycled are taken to the landfill. The municipality does not control and therefore does not audit the privately run program, which is why it may be difficult to improve the condition of the recycling center. Profit that originates from the sale of these materials is Melendez's. The municipality pays Meléndez solely to rent his own collection trucks, so that if and when they break down, it is then his responsibility to fix the vehicle. This means that the only cost and concern of Alvarado's program is the rental of said collection trucks. This plan was chosen by the environmental manager and was brought up for approval at the municipality. The duration of the contract is unknown; however, there has not been another entity that has shown interest in the management of Alvarado's solid waste. Recyclables are collected every Wednesday while

organic waste and non-recyclables are collected on Mondays. On the last Friday of every month, non-traditional items are collected such as furniture, mattresses, old electronics, or other items. (Personal Communication, Gabriela Chacón)

4.2.2 Jiménez

The team met with the mayor of Jiménez, Sra. Lissette Fernández Quiroz, because this municipality currently does not have an environmental manager since it is not allotted in the budget. A waste manager exists and oversees the collection and composting centers. Sra. Fernández gave the team an overview of and answered questions about both the recycling and composting programs and some of the current projects. The municipality has had a composting center and collection center in the Juan Viñas district for seven years. The community is located on privately owned land that is used for coffee and sugar cane production. The same family that owns this land donated the land for about 50 years where the collection center is currently located. The municipality decided to establish these centers to reduce the use of dumps, transportations costs, and extend the life of landfills. Community members are responsible for separating and cleaning recyclables before they are collected; ordinary and organic waste are collected on Mondays and Fridays, and recyclables are collected on Wednesdays recyclables.

Recyclables are separated by a group of approximately 6-7 people that are employed through a program called Manos a la Obra (Hands to Work) that is run by the Joint Social Welfare Institute, or Instituto Mixto de Ayuda Social (IMAS). This program helps people that are unemployed and have difficulty finding a job due to a lack of education. Through this program people that apply and qualify are paid by the IMAS to perform communal work. The people that work on separating recyclables also sell the sorted materials. Profit that is produced goes to the workers themselves. In addition to being paid, the employees receive an allowance to purchase gloves and clothes for work. Each person is also insured in the case of an accident. The municipality renews its contract with the group of workers annually.

Not having an environmental manager is a disadvantage to this municipality since little time is spent educating the community. To help increase resident awareness, however, the municipality is working with students from the University of Costa Rica. These students voluntarily visit residents door to door and inform them of the recycling process and its importance. This is an effective strategy, and is even more beneficial to the community because

it comes at no cost to them. Before leaving each home the students ask the resident to sign a form that verifies that they have been informed about the recycling project. Additionally, Jiménez keeps the residents informed by distributing fliers that lists all the products that are recyclable (Personal Communication, Lissette Fernandez).

4.2.3 Oreamuno

Oreamuno, a much larger municipality than Alvarado, is made up of five separate districts. San Rafael, the most urbanized district, has a population of 17,000. The remaining four are much more rural. The municipality must take into consideration the needs of both the urban and rural areas when managing the solid waste. In the district of San Rafael, solid waste is collected twice a week, while in the four rural districts, it is collected once a week through the use of collection trucks. The municipality owns two 14-ton trucks for collecting trash specifically, and is planning on attaining two new 18-ton trucks in January to accommodate the amount of waste that is being collected. In the past, Oreamuno collected an average of 60 tons of waste per day, but with the establishment of the recycling center two years ago, that number has decreased to 45 tons per day (Personal Communication, William Maroto)

The recycling center, located in San Rafael, is open five days a week from 6 a.m. to 3:30 p.m. and residents must drop off their own recyclables during these hours. In even-numbered months, the municipality collects tires to be recycled, and in odd-numbered months, they collect electronics. The initial goal of the environmental management department run by the municipality was to create a self-sustaining recycling center. Presently, the center makes a net profit of about $2,000 a month, a large increase from the previous $10 a month profit when it was first established. This is due to an increase in participation and therefore an increase of recyclables sold. They use this profit for educational programs to inform the public about recycling. The municipality's goal is to expand the recycling program into its rural districts and build new centers throughout the regions. For this to be successful, however, they must educate the residents of the rural areas about the prospective programs.

According to Sr. Maroto, another option the municipality is researching to increase their profit is selling non-recyclables to a local company that turns waste into an alternative energy source through the process of incineration. The main concern, however, is that the company wants to convert the entirety of the solid waste into energy, which would completely negate the

work done by the recycling program because no materials would be recycled and therefore the recycling program would become unnecessary. The municipality is making an effort to formulate an agreement with the company so that the company may only buy non-recyclable waste from them. This would allow the municipality to benefit without undermining the recycling program. The company requires a minimum quantity of waste, which Oreamuno cannot meet since the weight of their non-recyclables is insufficient. To solve this problem, Oreamuno is working with the municipality of Alvarado to see if both recycling centers can combine their non-recyclable products to meet the minimum weight requirement that the company desires (Personal Communication, William Maroto).

4.3 Current Recycling Centers

Upon visiting the recycling centers in the municipalities, we looked extensively at how each recycling program was different. In assessing each center, the team considered various regulations set by the Costa Rican Ministry of Health. Each center, by law, is obligated to maintain certain conditions to ensure that the work area is safe for the workers and surrounding area. First, the center must comply with local regulations such as building and electrical codes, forestry laws, and regulations established by the Ministry of Health. In 2010, a set of regulations called Regulations for Collection Centers of Recoverable Waste was created (RCRRV). The regulations include confining any solid waste or liquid that may disperse from the recycling center as well as preventing odors and noise from affecting the neighboring areas. Consequently, each center must have a roof, loading and unloading must be conducted on the property, and vehicles must be stored on the property. Additional regulations were established to ensure proper working conditions for employees. The building must be constructed by using fire resistant materials, proper ventilation and illumination must be present, first aid kits must be stored in a place protected from the elements, fire extinguishers must be accessible, and if needed there must be a designated area for workers to eat meals. To correctly manage the volume of recyclables, piles may not rise above three fourths of the total height of the building. Finally, bathrooms must be provided according to the number of workers, separated by gender, and must be well equipped. Once these regulations have been met, each site must be evaluated annually by the Ministry of Health and receive approval.

In addition to considering the physical characteristics of each building, the team observed the procedures that take place at each center. Although there is a general process that takes place in all of the centers, the team noted variations according to the special demands of each community and to the resources available in each municipality. We observed how each process varied and if the variations led to increased (or decreased) efficiency. The team noted if there was an accumulation of materials or if they were being separated at a fast pace. After an initial visit to the centers, a subsequent interview was conducted with the environmental managers, where more specific questions were asked about the recycling program in each municipality.

4.3.1 Alvarado Site Assessments and Interview

The team visited was Alvarado where a private owner, Rodolfo Meléndez, runs the recycling center in this municipality. He was the winner of the competition for a private recycling business. When we visited the center, he informed us of how he manages the recycling center, and the processes that the recyclables go through before he sells them. He explained that he is responsible for the collection, separation, storage, and sale of recyclables. Sr. Meléndez chooses the buyers according to the best offer. This offer is not only in terms of profit but as well as execution of recycling the materials rather than dumping them in landfills, such as making sure to carefully separate all recyclables. The recycling center is different from that in Oreamuno, mainly because recyclables are not stored in an enclosed building. Ordinary waste that is not recyclable and is mixed in with recyclables is separated by workers and then compressed and stored in the right side of the truck, shown on the picture of Figure 21. The truck remains at the collection center and once the right side is filled, the contents are brought to a landfill. Many pieces of equipment at this recycling center were built from scraps. For example, a compressor was created from scrap metal and the hydraulics from the truck on the left side of Figure 21 is used to power the machine.

Figure 21: Truck Containers at Alvarado Recycling Center

The team observed that recyclables are separated by type of material: paper, cardboard, different types of plastic, and glass. They are kept separate by multiple posts that distinguish the line between each type of material. Figure 22 shows the posts that separate the plastic products. The posts do not actually contain the products, but only mark approximately where they are supposed to be kept. It is difficult to confine the products in a specific area because they are exposed to the wind and rain. The center manager wishes to receive a state loan to construct a building in which to house the recyclables. This improvement will enable products to be stored in a contained area and employees to work in better conditions shielded from the weather. The recycling center collects materials that are not separated, so the workers are required to conduct the separation themselves.

The lack of an enclosed structure exposes employees and recyclables to the elements and exposes the surrounding areas to noise and odor. However, there is a natural boundary (a stream and forest) that separates the surrounding areas from the site and neighbors have reported no complaints. There is a large truck container that serves as a working area and storage area for some materials and equipment. Loading and unloading does take place on the property, so there is no interference with public roads. All of the pieces of equipment including collection trucks are located within the perimeter of the site. The open area provides natural lighting and ventilation. Accumulation of materials is not an issue since there is sufficient area for materials

to be placed. No bathrooms or break areas were noted, which therefore could be a violation of the regulations previously mentioned.

Figure 22: Separating Posts at Alvarado Recycling Center

After visiting the recycling center in Alvarado, the team travelled to the site where a composting center is going to be built (Figure 23). The site is a cleared piece of land that is being compacted in preparation for the new building. It will cost roughly forty million colones (~$80 thousand) to construct, and is expected to be completed in February or March of 2013. Money for this center was saved throughout the years from the municipality. This composting center will be fully run by the municipality and Rodolfo Meléndez will not be involved with it; therefore all the profits will be for the municipality

Figure 23: Site of New Composting Center in Alvarado

The team also met with the environmental manager of Alvarado, Sra. Gabriella Chacón, to discuss the details of the recycling program and their plans for the future. She showed the team the plans and blueprints of the new composting building. It will be a basic rectangular shape, with separate sections inside that will house organic materials in different stages of decomposition. The collected organic materials will be put into the first section, and will be moved through each section by tractors after each stage. Once the materials are moved to the last section, they will be completely decomposed and transformed into fertilizer at which point it will be moved to a storage area. In the middle of the building, there will be a runoff collection system that collects the liquid that drains from the organic materials from the first stages of decomposition, and reintroduces it to the material at the final stages of the decomposition to speed up the rate of decomposition. Figure 24a below shows the three-dimensional model, demonstrating the design of the exterior of the building. Figure 24b shows the blueprint of the composting building, which indicates the different rooms that will house the organic material as well as a bathroom, break area, and office. Although the building is enclosed, which confines odors and heat to the building, workers may still work in appropriate conditions since the temperature in Alvarado is relatively cool. According to Sra. Chacón, the composting site is designed to follow all of the regulations, however is still waiting for approval from Ministry of Health.

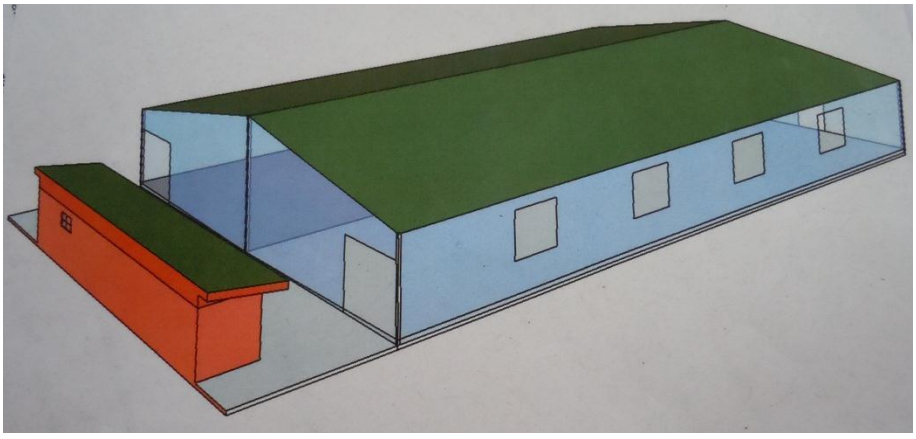

Figure 24a: 3-Dimensional Model of Composting Center in Alvarado

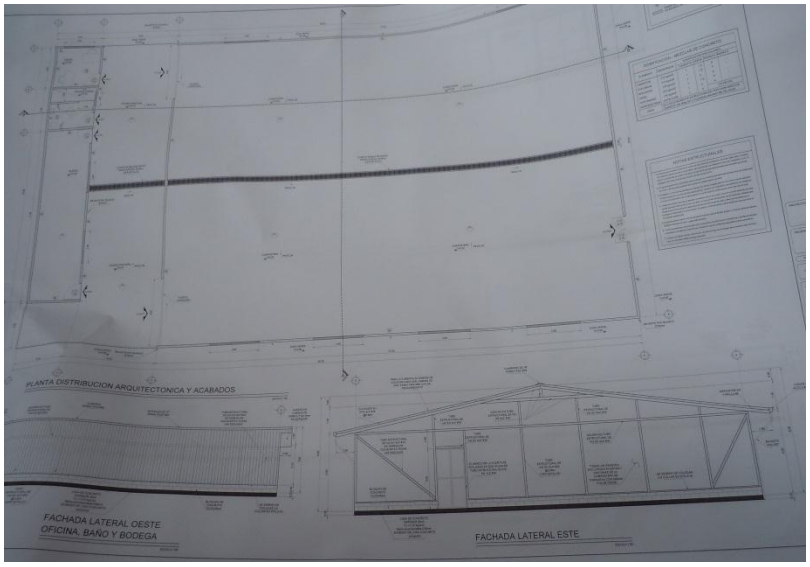

Figure 24b: Blueprints of Composting Center in Alvarado

4.3.2 Jiménez Site Assessment and Interview

The team also travelled to Jiménez's composting center and collection center for recyclables. During the visits to the composting and recycling centers, the presiding solid waste manager, Sr. Francisco Acuña Zúñiga, led the group as the town has yet to establish an environmental manager position. The team first visited the composting center, which consisted of a roof, cement floor, and support beams. The building is not completely enclosed since it lacks any type of wall; this gap in protection exposes the organic materials to the weather and scavenger animals. This exposure causes piles to become disorganized and produces more tedious work for the two employees that work there. Jiménez's warm weather speeds up the decomposition process and increases the strength of the odors that are produced. The lack of walls allows for natural lighting and ventilation but also exposes the surrounding area to the strong odors that are a byproduct of the decomposition process. Figure 25 shows the composting site.

Figure 25: Composting Center in Jiménez

According to the solid waste manager, the municipality hopes to install some sort of curtain system that would enclose the materials overnight and allow them to be left open to air circulation during the day; however theft prevents these sorts of improvements. The collection system that is used for liquid runoff from the decomposing organic material was not functioning at the time of the visit due to problems with the pipes. This caused runoff to be directed to the surrounding area. As organic material arrives at the center, piles are shifted using the same concept that was previously described for the Alvarado composting site. Figure 25 shows piles of compost at different stages of decomposition. The employee working at the center that day informed us that fertilizer produced is sold to local buyers. The farmer that owns the piece of land behind the compost center is one of their customers and he has benefited well from using the fertilizer.

Next, the team visited the recycling center in Jiménez, which is located farther away from the town than the composting center. When we arrived, we saw employees working on separating the recyclables at a table in the front of the building (Figure 26).

Figure 26: Employees at Jiménez Recycling Center

Employees were working quickly and were reluctant to speak to the students when they arrived due to the fact that new, unsorted recyclables had arrived that day. As was explained by the solid waste manager, sorting for recyclables that are collected weekly requires three full days of labor with five employees. First, materials are separated according to general categories, like plastic and glass, and then a second round of sorting further divides materials into more specific categories based on characteristics such as color and type of plastic or glass. Figure 27 shows the recyclables once they have been sorted and where they are stored before being sold. Depending on the buyer preference and material, recyclables are compacted into square packages. Transportation costs are reduced since buyers travel to the center to pick up materials. The buyer must pay the transportation cost instead, so they pay a lower price for the materials to compensate for those costs.

Figure 27a: Plastic Bags, Clear Plastic Bottles, and Opaque Plastic Bottles

Figure 27b: Plastic Bags

Figure 27c: Compressed Paper and Paperboard

The municipality owns the building, collects recyclables, and transports these materials to the collection center. Any refuse, or materials that cannot be recycled due to factors such as

contamination, are incinerated elsewhere. A large container shown in Figure 28 houses the non-recyclable materials before they are incinerated.

Figure 28: Storage for Non-recyclables

The recycling center building in Figure 29 is enclosed but has two large openings in the front, which allow easy access for unloading and loading of the recyclable materials. These openings allow natural lighting and ventilation to enter the area where employees work on sorting materials. The building is divided into four different rooms. Sorting takes place in the front two larger rooms and the two other rooms located towards the back are used for storage. There is insufficient lighting in the two back rooms since the lighting from the front of the building does not reach the back area and there is no artificial lighting. Piles did appear to be above the height that is allowed. Bathrooms are available for workers in addition to a lunch area. Proper training is given to employees that use equipment such as the compressor. Figure 29 shows the exterior of the building. There is also a sign hanging from the front of the building describing the types of material that can be recycled there; the poster is shown in Figure 30.

Figure 29: Exterior of Jiménez Recycling Center

Figure 30: Poster Depicting Items Recycled at Jiménez Recycling Center

4.3.3 Oreamuno Site Assessment and Interview

Sr. Maroto accompanied the students to the recycling center in Oreamuno and described the processes and explained the rules of the recycling center throughout the tour of the center. In Oreamuno, only ordinary waste is collected by trucks. If recyclables are left in waste bins or bags, they are brought along with the waste and are not separated or recycled. For this reason, residents who wish to recycle must bring their recyclables to the recycling center. The residents are required to separate recyclables according to categories, such as paper, glass, plastic and

cardboard. In addition to separating the materials, residents must also wash their recyclables prior to dropping them off at the centers. The team was informed that it is important for residents to wash recyclables at home since it reduces contamination and bad odors, which in turn reduces unwanted insects and sanitary problems. Once the products are separated, they are placed in large white bags and compressed in a compactor to roughly half of their original size. Below, Figure 31 shows the processing of the recyclables from separation to compression. In the first step, the employees make certain that all of the products are separated properly. Once separated, the recyclables are placed in large white bags approximately 6 feet tall. Next, the contents of the bag are placed in the compactor and compressed to the size shown in the final picture, which is approximately three cubic feet. Note that the plastic recyclables are separated even further, by color. The companies that buy plastic or glass bottles do not accept them with their caps or with any kind of fastener. The recyclables are compressed due to the fact that the municipality sells them by weight rather than by size and would like to transport as many recyclables at once to maximize net profit. This method reduces transportation costs since more materials can fit in a single truck.

Figure31: Separation Process at Oreamuno

Upon speaking with the employees, the team learned that residents tend to not follow the center´s requests for separation and employees at the centers are forced to separate the

recyclables themselves, which is a tedious task and causes the process to become inefficient. In addition, the lack of separation by residents is hazardous for the workers; for example, broken glass may be mixed with other recyclables. Another problem the recycling center faces is that some residents leave recyclables, as well as trash, outside of the center after hours and on weekends, when the building is closed. Local stray animals tear the bags open in search of food and cause the contents of these bags to be spread out onto the street. Since Costa Rica has a very wet climate, the scraps of food and recyclables are often washed into a stream approximately 20 feet away from the recycling center in Oreamuno, which leads into the Reventazón River. The picture in Figure 32 below shows the results of this undesired practice.

Figure 32: Trash along Stream near Oreamuno Recycling Center

While visiting the center in Oreamuno, the team first noted characteristics of the structure. The building was enclosed by a gate in the front that is kept open for people to approach and drop off their recyclables while the center is open for business. The open gate also allows natural lighting and ventilation to enter the building. An area behind the building is available for storage of vehicles and other recyclables such as glass that are not likely to be damaged by the elements. These materials are kept in large metal containers that keep the materials from dispersing. Unloading and loading of the products is conducted in the same area, which is easy to access through a driveway that leads to a road. By having an enclosed area, noise and odors do not affect the surrounding region. However, materials may reach surrounding areas due to the improper disposal of materials that occurs after the center closes, when some

residents leave waste outside, which is a violation of regulations. Once inside the building, the team noticed that materials were organized in an orderly fashion. However some of the piles were above the three-fourths limit that is allotted, as can be seen in the last picture in Figure 31.

4.3.4 Comparison of Recycling Centers

After reviewing each recycling center, the team compiled a checklist of different aspects of the center that comply with the Regulations for Collection Centers of Recoverable Waste (RCRRV, 2010) put in place for all municipalities in Costa Rica. Table 7 below depicts a checklist for each center that the team assessed. Some regulations do not apply to certain centers and are marked with "N/A", therefore affecting their total score.

Regulations for Collection Centers of Recoverable Waste	Alvarado Recycling Center	Oreamuno Recycling Center	Jiménez Recycling Center	Jiménez Composting Center
Confines solid and liquid waste to center	No	No	Yes	No
Confines odors to center	Yes	Yes	Yes	No
Noise level does not affect neighboring areas	Yes	Yes	Yes	Yes
Roof over materials	No	Yes	Yes	Yes
Loading and unloading of materials done on property	Yes	Yes	Yes	Yes
Vehicles stored on property	Yes	Yes	N/A	No
Building constructed of fire-proof materials	Yes	Yes	Yes	Yes
Proper ventilation	Yes	Yes	No	Yes
Proper lighting	Yes	Yes	No	Yes
Designated eating area for employees	No	Yes	Yes	No
Bathrooms available	No	Yes	Yes	Yes
Piles of materials do not rise above ¾ height of the building	N/A	No	No	Yes
Total number of “Yes” responses (Excludes “N/A” responses)	7/11	10/12	8/11	8/12

Table 7: Checklist for Recycling Centers

Each of the regulations serve as a guideline to determine to what degree each center has complied with the law. None of the recycling or composting centers met all of the requirements; therefore improvements need to be made for each one. A major concern for all centers except for the Jiménez recycling center was that the waste, both liquid and solid, was not being confined to the center. An example of this is shown in Figure 32, which shows trash alongside a stream next to the Oreamuno recycling center. Another example of this problem is the composting center which is located in the municipality of Jiménez. This composting center consists of only a roof and supporting beams, leaving it open to the surrounding environment. An open structure such as this attracts birds and other scavenging animals that scatter decomposing materials throughout the surrounding area which decreases the efficiency of the overall process. Under the new regulations, the piles of recycled products housed in each center should not rise above three quarters of the total height of the building. At the time that the team conducted the site assessments in Oreamuno and Jiménez, the piles were above the height limit. This height limit could not be determined in Alvarado's recycling center since it did not have a roof, and therefore was marked with an "N/A". It is important for each of the centers to follow this particular rule since high piles of recyclables could potentially be a fire hazard or a hazard for the workers since these piles could accelerate a fire and be physically unstable. The violations of these regulations are taken into consideration when making recommendations for each municipality's recycling program. The team will guide municipalities toward meeting the regulations set forth by the Ministry of Health.

4.4 Analysis of Major Advantages and Disadvantages

Previously, the team's goal was to analyze the cost effectiveness of each recycling program by evaluating the various expenses and profits that exist throughout the process of each municipality's program. Due to the limited quantity of data available to us, we were unable to carry out specific cost-benefit analyses for the three municipalities and their systems. Therefore, the team carried out a general comparative analysis of some of the major features of the three recycling systems. In these analyses, we focused on the major categories of budget, environmental management department and education and public participation. We identified each municipality's strengths and weaknesses in these categories, and present the results of this analysis in Tables 8a, 8b and 8c.

Our investigation indicates that the program in Alvarado results in the greatest benefits from the recycling program. Major advantages of the recycling program can be broken down into the three categories mentioned below. After our interview with Gabriela Gómez Chacón, the Environmental Manager for Alvarado, we learned that the municipality only has one cost for their recycling services, a monthly collection truck rental. This advantage also relates directly to the other two categories because this saves the municipality money that can be spent on educational programs and hiring administrators such as Sra. Gómez . Because the recycling program is managed by an outside entity, she does not need to handle any logistics and therefore, has more time to cover the task of planning recycling education programs for the municipality.

Although there are many advantages for Alvarado's recycling program, there are many disadvantages as well. Because the recycling program is run by a private entity, they do not sell the recyclables themselves and therefore do not make a profit. For this same reason, the environmental manager cannot control the condition of the recycling center. This is detrimental to the center because the private entity does not have the resources to abide by the regulations set in place by the Ministry of Health. There is also no sole person that inspects the center to make sure they are following these protocols. We were unable to find any major disadvantages to their educational programs due to the positive feedback we received from the surveys.

	Budget	Environmental Management Department	Education
Advantages	Only pay for one service: collection truck rental	One environmental manager in charge Only focuses on education program	Small municipality, not as many people to educate Can reach people that live in towns and the farmers in rural areas
Disadvantages	No profit gained from recycling sales	No control over condition of recycling center	No disadvantages

Table 8a: Advantages and Disadvantages of Alvarado

In the municipality of Jiménez there are very few advantages to the recycling program. One advantage that the program does have is that the land that the recycling center is on came at no cost to the municipality. The family that owns the municipality of Jiménez donated the land for about 50 years. In terms of education, students from the University of Costa Rica volunteer their time to help the municipality by distributing brochures door to door to educate residents on recycling. This was beneficial to the municipality because it was a method of education that came at no cost to them. There is no advantage to the Environmental Management Department category because there is no environmental manager.

Jiménez has more disadvantages than advantages. Their main problem is that there is no designated environmental manager, which makes it difficult to manage the recycling program, especially for such a geographically large municipality. Because this position is not filled, the mayor, who is very limited on time, is currently in charge of the recycling program. This makes it difficult for plans to be made for educational programs. The main reason why there is no established environmental manager is because the budget did not allot for this position, another

disadvantage that the municipality must handle. With this budget, the municipality must pay for the labor, maintenance, and rental costs associated with the recycling programs.

	Budget	Environmental Management Department	Education
Advantages	No cost for recycling center land	No advantages	UCR students helped educate residents for free
Disadvantages	No budget for environmental manager	Do not have anyone in charge of department Mayor must handle all of the duties of department including her own	No variety of educational methods

Table 8b: Advantages and Disadvantages of Jiménez

Finally, the team compiled the advantages and disadvantages of Oreamuno. Oreamuno's main advantage is that they attain a $2,000 profit from selling the recyclables collected at the recycling center. An advantage of this profit is that it can be used to fund their education programs and an environmental manager.

Although they have an environmental manager, it is not enough manpower for such a large municipality. It is difficult for one person to handle all the responsibilities for this position but there is not enough money in the budget to hire more personnel. Because the municipality is so widespread it is also difficult to reach out to all the residents and educate them effectively. Additionally, the municipality must handle all the monetary costs associated with the recycling program such as maintaining the recycling center, paying the employees and funding the educational programs.

	Budget	Environmental Management Department	Education
Advantages	Keeps all the profit from the sale of recyclables	Head of department handles all duties	Can use their profit for their education programs
Disadvantages	Must pay for all aspects of the program	Only one employee for department	Large population, so difficult to educate everyone

Table 8c: Advantages and Disadvantages of Oreamuno

Chapter 5: Recommendations

After extensive research and compilation of data, the group was able to determine the advantages and disadvantages of each recycling program which were discussed in the previous chapter. The team considered the data and constructed recommendations to improve each municipality's program and potentially expand similar programs to other cantons that currently lack a recycling program. This is important since it is mandatory to establish a recycling program and Costa Rican municipalities that lack such a program will need a starting point.

5.1 General Recommendations

After collecting data from surveys, interviews, and site assessments, the team noted that there are many variations in the areas that need improvement. Although these variations require more detailed and customized recommendations, there are some general issues that all three of the municipalities must improve upon. Other municipalities that are implementing new recycling programs should also take these general recommendations into consideration. Although these are general recommendations, they are still categorized by our three objectives. The first category is based on the educational programs. The second derives from our objective to analyze the advantages and disadvantages of the major components of the program. Finally, the last category of recommendations pertains to the status of the recycling center.

5.1.1 Public Participation and Education

Continued efforts are needed to inform and educate the population of each municipality. From analyzing the recommendations given by the public, it was clear that they wanted more education, especially in the municipalities of Alvarado and Jiménez, where it was the most popular response given by the residents, which can be seen in Table 6 in the Public Recommendations section of the Results chapter. Not only must residents receive introductory information about each program but also additional outreach to residents for those that have not been educated and as motivation to other residents for continued participation. Such as the case in Jiménez, where residents needed reinforcement of the rules for separation because cross contamination continues due to improper recycling at homes. As a result, the team recommends that educational programs remain in municipalities' short and long term plans for the recycling programs. Although continued education programs may not initially be in municipalities' budgets, it is important to take them into consideration for these reasons. By continually

educating, the municipalities can make sure that the residents are still motivated to participate and the younger generations will become properly informed. Different educational methods that will be discussed in the following paragraph may be used for specific municipalities depending on its characteristics and demographics.

Various strategies need to be implemented to not only reach the highest number of people but to reach those that have the principal responsibility to recycle in each household, From our data analysis, we discovered that the female head of the household is most frequently in charge of recycling within the household. We also discovered that most of the women were convinced to recycle by brochures that were distributed to their homes. According to Sra. Gómez, women tend to stay home during the day to take care of their children and home, so they were the residents most likely to receive the brochures that were delivered during the day. Direct and indirect methods are all effective in reaching various industries and demographics. For example, when residents were surveyed about the educational methods in their community, they commented that their children bring lessons learned from school to their homes. This method directly teaches children and indirectly teaches the adults in the household. From the surveys, various methods of advertisements that proved effective include lessons in schools, brochures, television, and community meetings. For this reason, the team recommends that municipalities continue to educate children in schools about recycling, reinforce recycling practices through brochures, begin using television to reach residents and organize meetings about recycling in combination with other meetings that attract residents.

5.1.2 Status of Recycling Center

Currently all of the recycling centers are in need of improvement. Although all of the municipalities established their programs at different times, the current condition of each is not a reflection of the length of time they have been operating. For example, the recycling center of Oreamuno follows more of the regulations provided by the Ministry of Health compared to the recycling center in Jiménez, which has been operating for a longer period of time. The regulations that were established for the recycling centers are meant to protect the workers as well as the surrounding environment, which is why it is important for each of the municipalities to comply with them. According to the regulations that were established for these centers, the team recommends that improvements be made to each location based on the laws and regulations

so the center is can appropriately handle all of the incoming materials. Although it will cost the municipality more money to comply with all of these regulations, it will potentially make the center more efficient.

5.1.3 Major Components of Programs

Since municipalities are required to establish an Environmental Management Department and handle the obligations that come with that department, each aspect of the programs needs to be considered. The Environmental Management Department must have appropriate personnel to oversee the various fields that must be managed such as administration, education, and finances. Where there is a lack of resources, whether it is time or money, the balance between managing each obligation is crucial. Leaders that were interviewed reported being short staffed and in need of additional resources to tackle their responsibilities. Therefore, the team recommends hiring additional part-time personnel to help the environmental managers in handling the large workload. If there is no budget to hire extra personnel, another recommendation would be to borrow personnel from other departments of the municipality, especially for small-scale projects such as lecturing students at schools on recycling education.

5.2 Customized Recommendations

Due to the varied structures of each municipality's current recycling program, the team made an assortment of recommendations that are specific to each one. These customized recommendations are meant to help each municipality improve their programs so they may all reach a condition that complies with all of the regulations that are included in the solid waste management law and Regulations for Collection Centers of Recoverable Waste. If each center attains the standards that have been established, they will become more effective and continue to be an example for the municipalities that do not have a program established.

5.2.1 Alvarado

Public Participation and Education

When reinforcing recycling practices, the team recommends continuing to educate residents using the door-to-door technique. Since the population of Alvarado largely consists of an agricultural community, there is a large geographic distribution of people, making this method very effective, which can be seen by the survey results. According to the survey data, 29% of residents answered that they were most convinced to recycle from the brochures that were

distributed to their homes. Since this municipality has used this method before, the environmental manager is familiar with the procedure that is distributing brochures door to door.

The team recommends continued presence of recycling education in schools since the third largest response to survey question inquiring about the educational methods that convinced residents to recycle was education through schools. This reflects the efforts that have been made to include education about recycling in school. Tangible items, such as recycle bins in schools, could also have a positive impact.

Since a large portion of the residents surveyed responded that they were educated through television, the team recommends incorporating this important resource to inform residents. While commercials may be expensive, news networks may be contacted for a segment on the municipality's recycling program. It is recommended that multiple municipalities pool their budgets to pay for a television commercial that could reach out to inform more people.

Due to the agricultural characteristic of the Alvarado population the team recommends that the municipality continues to reach out to and educate these residents at agricultural meetings and by collecting containers that store chemicals in order to ensure that they are properly disposed of.

Major Components of Programs

This is the only municipality that has privatized a portion of the duties of the environmental manager. As described by the environmental manager of Alvarado, the agreement that was reached with Sr. Meléndez is responsible for collecting, storing, taking remaining waste to landfill, and selling recyclables. Sr. Meléndez is in charge of managing the recycling center and is allowed to choose who to sell the materials to. Although Melendez carries the burden of managing this portion of the program, the team recommends that the municipality take an active role. The municipality must become more involved in the management of certain aspects of the program since the regulations for the recycling center continue to apply to the program whether or not it is public or private. For example in the case of selling recyclables, in Oreamuno, the municipality chooses buyers based on best offer and on which company will best treat the recyclables. In contrast, Sr. Meléndez chooses buyers simply based on best monetary offer, something that could potentially hurt the efficiency of the recycling program. By taking an active

role in the management of this recycling center, the environmental manager could support the center to comply with all the regulations it must meet, and help it avoid any possible penalties in the future.

Status of Recycling Center

The recycling center in Alvarado is in need of structural improvements as well as the addition of amenities such as break areas for employees. Because Sr. Meléndez privately manages the center and the financial responsibilities that come with that duty, he is in charge of improving the site and adding the needed structure. When we met him at the recycling center, he informed us that he was currently seeking a loan from the government to fund this construction. Currently recyclables are exposed to the elements and are not confined within an enclosed area. Ventilation, lighting, use of fireproof materials, and the limit on height of piles are not an issue, because there is no building. While working, employees are exposed to elements such as rain, wind, and cool temperatures, as was the case the day that the team conducted the site assessment. There is also neither a break area nor bathroom on the premises for employees to use. The team recommends that Meléndez continue his efforts to construct a building according to the regulations previously outlined to ensure that workers are working under proper conditions and recyclables are managed effectively.

After compiling the data from the surveys, in comparison to Jiménez, Alvarado had ten times more comments that referred to the placement of containers for recycling in public areas. In Jiménez these types of containers are placed outside of banks, next to bus stops, outside of schools, inside of city hall, and along frequented roads. For this reason the groups recommend that Alvarado use the same technique for placement of containers since both municipalities have similar agricultural characteristics.

5.2.2 Jiménez

Public Participation and Education

In Jiménez, residents are required by the municipality to recycle. If they do not separate their recyclables from non-recyclables, their waste does not get collected and therefore is left at their household. The team recommends that Jiménez not only informs residents that recycling is mandatory, but also the environmental benefits that result from proper SWM. Currently, the major educational method used in Jiménez is the distribution of brochures to households. The

team also recommends that the municipality expands their types of educational methods. These methods include visiting schools to inform children of recycling and displaying posters in public areas such as supermarkets, banks, and other municipal buildings. We are aware that these methods will cost more money, and will be difficult to implement without an environmental manager, but these changes do not need to happen immediately and can be carried out over a period of time.

Major Components of Programs

As previously mentioned, Jiménez currently does not have an environmental management department. The people that manage the duties which an environmental management department would handle are the mayor and a SWM manager. This addition of responsibilities is difficult for the employees, as was explained by the mayor of Jiménez. The SWM law specifically states that each municipality must establish an Environmental Management Department. Currently, the municipality has not allotted a budget for this department (Personal communication, Sra. Lissette Fernández Quirós). Because this department is fundamental for the recycling program, the team recommends that the municipality creates such a department and hires an environmental manager to continue improvements to the recycling and composting programs.

Status of Recycling and Composting Centers

The composting center in Jiménez did not comply with all of the guidelines in the Regulations for Collection Centers of Recoverable Waste. When the students approached the center there was a very strong odor that was not confined due to the open structure. There is only a roof and supporting beams, which allows odors to escape to the surrounding areas. An ideal composting system is considered to be odorless; therefore the presence of odors indicates that the piles are not turned sufficiently, and that there is either too much "brown" or "green" material. "Brown" components refer to carbon-rich materials such as straw, dried leaves and saw dust. "Green" components refer to nitrogen-rich materials such as grass clippings and fruit and vegetable scraps (Environment and Heritage). Moisture is produced from the presence of "green" materials. Foul odors are caused by too much moisture in the composting pile; therefore it is necessary to add "brown" materials to minimize the moisture. The team recommends that piles are turned more often and that certain materials be added in order to keep a balance between nitrogen and carbon–rich materials. This will evenly distribute the moisture in the piles and minimize odors.

Another reason for bad odors in composting centers is the addition of fats, meats, and dairy. If piles contain non-plant matter such as this, bad odors can arise because of the differences in the decomposition process. These bad odors can attract animals, such as was described by the recycling center employees. This scenario reflects the improper separation of organic materials, therefore the group recommends reinforcing the separation of composting which would reduce these types of odors. Residents must be told not to compost food scraps such as meat and dairy, and instead must just discard them with their ordinary waste. (Environment and Heritage, 2012)

Since materials in the composting center are exposed to the elements and scavenger animals can easily reach the composting materials, the team recommends enclosing the area with some sort of metal fence. This will prevent vandalism and keep animals away from the composted materials.

5.2.3 Oreamuno

Public Participation and Education

From the residents surveyed, 58% answered that they were convinced to recycle due to information offered through schools. Therefore, the team recommends that the municipality expands their education at schools and holds information sessions at schools and other public meetings to explain the process and environmental benefits of recycling to the residents. Many residents responded that they were unaware of the recycling process and how to recycle. Since the recycling program has been established for a relatively short amount of time, parents today probably were not taught while they were in school, but it is feasible that they learned about recycling from their children who bring the lessons they learned home to their parents. Recycling education programs offered for adults would increase the awareness to the older population.

The team also recommends that the municipality posts visual aids such as posters and advertisements throughout the area in public locations similar to those mentioned in Jiménez. This would be especially helpful because the municipality is very urban and many residents would see them. Although this would initially cost the municipality money, it would save the environmental manager time with the educational component of the recycling program.

Major Components of Programs

Oreamuno has an Environmental Management Department but only a single person is in charge of managing the entire department for the municipality's large population. By having total control of all of the components that make up a recycling program, the municipality is able to keep all profits of the center; however the Environmental Manager, Sr. Maroto, must carry a large workload. During the interview with him, he disputed about the difficulty of having to manage all of his responsibilities because the municipality is so large. He also explained that large projects may take up additional time and other duties must be pushed aside since he is the only person that can attend to issues such as broken down collection trucks. The team recommends that the municipality hires at least one part-time employee to aid Sr. Maroto with his duties of managing the Environmental Management Department. The profits gained from selling the recyclables could be used to fund the salary for this additional employee.

Status of Recycling Center

Workers that are in charge of further separating materials at the collection center claimed that one of the issues they have with the process is the improper separation at homes. This is a hazard for workers since broken glass has been found mixed in with other materials. The team recommends a stronger enforcement of separation of recyclables at homes. A method of enforcement that has proved to be effective in Jiménez is turning away recyclables and general waste if not properly separated. Although this enforcement would be effective during operating hours of the center, it would be difficult to enforce when residents drop off their recyclables when the center is closed.

After further speaking with the workers of the recycling center, we found out that many residents would leave recyclables as well as trash in bags outside of the center on weekends and after operating hours. This practice caused stray animals to rip open the bags in search of food, causing trash to spread out in the area surrounding the center. In Alvarado, the team encountered a cage featured in Figure 33 that was enclosed but had a small hole for residents to deposit their recyclables into. The team recommends that the municipality explore the option of having this outside of the center so that residents can deposit their recyclables on weekends and after operating hours. This cage should have a sign that clearly states that the recyclables must be clean. This cage would mainly be for plastic bottles and cans; however multiple cages may be

used for other materials such as cardboard and glass.

Figure 33: Recycling of Bottles and Cans (Alvarado)

Chapter 6: Conclusion

Costa Rica is being proactive about sustaining the environment, which requires various participants to work together. Entities such as COMCURE focus on sustaining the environment by protecting certain natural resources, in this case, the Reventazón River basin. COMCURE asked WPI students to evaluate the current state of recycling programs that have been established in three municipalities, Alvarado, Jiménez, and Oreamuno, which are located within the Reventazón River basin. Recycling in these municipalities is one technique to sustain the Reventazón River and its surrounding environment since this serves as an alternate method of managing solid waste that is more environmentally friendly than others, such as incineration or dumping. These municipalities took the initiative to become more environmentally sustainable by implementing recycling and composting programs in their communities. Since the Law for Integration of Solid Waste Management (ISWM) was established in 2010, these municipalities have been striving to improve their existing programs so that they may fully comply with the regulations that have been established and reduce their impact on the surrounding environment, such as the Reventazón River. COMCURE was interested in identifying various aspects and characteristics of these programs that have been successful as well as making suggestions to improve programs that have not. The end product of this project is a series of recommendations that are designed to help improve the programs that are already established and to recommend ideas, methods, and concepts to other municipalities in order to help them implement recycling programs and comply with the ISWM law.

One aspect the team focused on for this project was evaluating the recycling education programs in each municipality. The current state of each municipality's program and recycling center was also evaluated to recognize current traits of each program and its recycling center. Furthermore, an advantages-disadvantages analysis was completed for the major components of each program in order to take into account variations between each one of the three programs as well as to consider tangible and intangible gains and losses. Through survey analysis, the team was able to understand reasons why residents recycle in each municipality, and what educational methods have been effective in convincing residents to recycle. We discovered through archival research that each municipality had unique socio-economic traits, as well as different methods of recycling that were chosen based on these traits. We were able to evaluate the current status of each recycling and composting center based on our observations from site assessments. Meetings

with Environmental Managers of each municipality highlighted the pros and cons of their programs and provided explanations for certain decisions that were made pertaining to the establishment and management of the programs.

The purpose of this project was to outline improvements that are need to be made in order to comply with the law and achieve a higher efficacy in addition to providing other municipalities with a starting point to begin their own recycling program. Recommendations were made according to the data collected through surveys, archival research, site assessments and interviews in order to achieve each of the outlined objectives. The team noted that there can be multiple strategies to achieve a single goal, in this case, improving a recycling program. For instance, the same recycling program cannot be implemented in various areas with different socio-economic traits. For this reason, our recommendations were categorized by general recommendations as well as ones that were specific to each municipality. We also considered that there are various restraints for each of the municipalities due to lack of resources. Although there are various complexities associated with the successes and failures of these programs, the most significant aspects of the programs were evaluated and recommendations were made to improve these aspects. It is important to note that some of the recommendations that were presented require more involvement than others and therefore should be expected to be accomplished over time.

We believe that through perseverance and collaboration between the municipalities and COMCURE, these recycling programs have the potential to greatly improve. We present these recommendations to help COMCURE improve the areas surrounding the Reventazón River by supporting the municipalities that wish to advance their recycling center and those that are implementing a program of their own. Through continued effort and communication of ideas, the current condition of the river can continue to improve. In the future, the team recommends another IQP project to evaluate the environmental impact these programs have had, just as this project has evaluated the successes of the programs themselves. Through continuous reevaluation of these programs, the ultimate goals of efficiency, sustainability, and compliance can be met.

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Appendices

Appendix 1: Survey Questions

This survey is intended to help us understand the recycling habits of residents as well as their attitude towards recycling.

Please help us increase the amount of recycling participation by providing us with information about your recycling habits. This survey is completely confident and your identity will not be revealed in any way. Please answer this survey as accurately as you can. By helping us you will be helping the environment as well, Thank You.

1. **Please circle the municipality in which you reside:**
   - ☐ Alvarado
   - ☐ Jiménez
   - ☐ Oreamuno
   - ☐ Other _____

2. **Are you:**
   - ☐ Female
   - ☐ Male

3. **Please select the range of age that's best applies to you:**
   - ☐ Less than 15
   - ☐ 15-24
   - ☐ 25-34
   - ☐ 35-44
   - ☐ 45-54
   - ☐ 55-64
   - ☐ Over 64

4. **How many people live in your household that is under the age of 18?**
   - ☐ 1
   - ☐ 2
   - ☐ 3
   - ☐ 4
   - ☐ More than 5

5. **How often do you recycle?**
   - ☐ Always
   - ☐ Often
   - ☐ Sometimes
   - ☐ Never

6. **Do you compost?**
   - ☐ Always

- ☐ Often
- ☐ Sometimes
- ☐ Never

7. Do you bring your organic waste to a composting center?

- ☐ Yes
- ☐ No
- ☐ Other_____

If you responded "no" to either 5 or 6, please skip to question 11.

---

8. Who is primarily responsible for recycling in your household?

- ☐ Man, head of the household
- ☐ Woman, head of the household
- ☐ Children
- ☐ Other _____

9. What is the main reason why you recycle?

- ☐ It is beneficial to the environment
- ☐ It is my civic duty
- ☐ It is required by the government
- ☐ I see other people do it

10. What educational methods convinced you the most to recycle? (Check all that apply)

- ☐ Television
- ☐ School
- ☐ Newspaper ads
- ☐ Word of mouth
- ☐ Internet
- ☐ Brochures
- ☐ Town Meetings
- ☐ I was not informed of a recycling service

11. What is the reason you do not recycle and/or compost?

- ☐ Not enough time
- ☐ Not familiar with the process
- ☐ Lack of interest
- ☐ Not enough space to store recyclables/compost
- ☐ Do not have containers to store recyclables/compost
- ☐ Not sure of collection times
- ☐ I am not aware of a recycling program

---

12. What suggestions do you have for improving the recycling program in your municipality?

---

13. Optional Question: What is your monthly salary (in thousands of Colones)

- ☐ Less than 100
- ☐ 100-199
- ☐ 200-299
- ☐ 300-399
- ☐ 400-499
- ☐ More than 500

Thank you for taking the time to complete this survey, your opinion will make a difference!

Appendix 2: Interview Questions for Municipality Leaders

1. Can you tell us a little bit about your process of recycling in _____?
    a. How are recyclables collected? For example: truck, drop off, etc.
    b. Do residents separate their own waste by type? Plastic, Glass? Or do the recycling centers?
2. Who manages the recycling program?
3. In your opinion, how effective has the recycling program been in your municipality?
    a. Why do you think it has been/not effective?
    b. What would you do to solve the current problem? (if there is one)
4. What is one thing you would recommend to another municipality that is trying to start a program like yours?
    a. Why did you choose this?
    b. Are there any other things you would recommend?
5. Can you name one aspect of your program that you would recommend avoiding to a municipality that is trying to start a program?
    a. What went wrong with this?
    b. Did you try to solve it? If you did, how?
6. In your opinion, what do you think motivates residents of your municipality to recycle?
    a. Why do you think this is?
7. Since your program has been established, have you seen any changes on the streets/river of your municipality?
    a. If so, could you be more specific?
    b. Do you think these changes would have occurred if your program was not in place?

    Thank you for your time, I realize you are all busy so we appreciate you guys taking the time to respond to our question.

Appendix 3: Interview questions for recycling/composting center employees

1. Is your recycling center usually busy?
    a. When is the center the busiest?
        i. What type of people do you see at these times?
    b. When is it the least busy?
        i. Why do you think people don't recycle at these times?
2. How long have you been working on this job?
    a. Would you feel comfortable training people if you were needed?

Thank you for your time, I realize you have a lot of work.

Appendix 4: Interview questions for recycling/composting center managers:

1. How many employees do you have working for your recycling center?
    a. Do you need more employees or volunteers?
    b. Do you have the budget to add more employees if you needed more?
2. What kinds of material are recycled here?
3. Do you keep records of how much gets recycled over a certain amount of time?
    a. How accessible is your data?

Thank you for your time

Appendix 5: Encuesta Sobre Participación en Programas de Reciclaje

Por favor ayuden a aumentar la cantidad de participación en reciclaje al proveer información sobre sus hábitos de reciclaje. Esta encuesta es ofrecida por un grupo de estudiantes del Instituto Politécnico de Worcester patrocinados por la entidad COMCURE. Sus respuestas son completamente confidenciales y su identidad no será revelada de ninguna forma. Por favor responda con la mayor precisión posible. Al responder estas preguntas usted estará ayudando al medio ambiente, Gracias.

1. **Por favor marque la municipalidad en la que reside:**
   - ☐ Alvarado
   - ☐ Jiménez
   - ☐ Oreamuno
   - ☐ Otro_____

2. **Por favor seleccione su sexo:**
   - ☐ Femenino
   - ☐ Masculino

3. **Por favor seleccione el rango de edad en que usted cabe:**
   - ☐ Menos de 15
   - ☐ 15-24
   - ☐ 25-34
   - ☐ 35-44
   - ☐ 45-54
   - ☐ 55-64
   - ☐ Mas de 64

4. **¿Cuántos niños menores de 18 años viven en su hogar?**
   - ☐ 1
   - ☐ 2
   - ☐ 3
   - ☐ 4
   - ☐ 5 o mas

5. **¿Usted recicla los residuos solidos de su hogar?**
   - ☐ Siempre
   - ☐ Seguido
   - ☐ A veces
   - ☐ Nunca

6. **¿Separa usted sus residuos orgánicos del resto de la basura?**
   - ☐ Siempre
   - ☐ Seguido
   - ☐ A veces
   - ☐ Nunca

7. **¿Sus residuos orgánicos son llevados a un centro de compostaje?**
   - ☐ Si
   - ☐ No
   - ☐ Otro_____

Si usted contesto "Siempre" o "Seguido" a pregunta 5 o 6, por favor conteste preguntas 8,9, y 10. Si contesto "A veces" o "Nunca", por favor siga a la pregunta 11.

---

8. ¿Quien en su hogar tiene la responsabilidad principal de reciclar?

- ☐ Hombre; Cabeza de la familia
- ☐ Mujer; Cabeza de la familia
- ☐ Ninos menores de 18 anos
- ☐ Otro_____

9. ¿Cuál es la razón mas importante por la que recicla? (Por favor solo escoja una opción)

- ☐ Es un beneficio para el medio ambiente
- ☐ Es mi deber civico
- ☐ Es requerido por el gobierno
- ☐ Porque veo a los demas hacerlo

10. ¿Cuál, si existe alguna, lo/ la convenció a reciclar? (Por favor seleccione todos los que aplican)

- ☐ Televisión
- ☐ Escuela
- ☐ Avisos en el periódico
- ☐ De otra persona
- ☐ Internet
- ☐ Folleto
- ☐ Reuniones comunales
- ☐ No fui informado de los servicios de reciclaje

---

11. ¿Cual es la razón por la que no recicla?

- ☐ No tengo suficiente tiempo
- ☐ No conozco el proceso
- ☐ No tengo mucho interés en participar
- ☐ No tengo suficiente espacio para almacenar los materiales de reciclaje y/o compostaje
- ☐ No tengo los recipientes necesarios para reciclar
- ☐ No estoy seguro(a) de los tiempos de recolección
- ☐ No sabia que existía un programa de reciclaje

---

12. **¿Qué puede hacer su ciudad para mejorar su programa de reciclaje?**

_____

_____

---

13. OPCIONAL: ¿Cuál es su ingreso mensual promedio neto? (en miles de colones)

- ☐ Menos de 100
- ☐ 100-199
- ☐ 200-299
- ☐ 300-399
- ☐ 400-499
- ☐ Mas de 500

¡Gracias por tomar el tiempo para completar esta encuesta!

Appendix 6: Preguntas dirigidas a Líderes de Municipalidades

1. ¿Nos podria decir un poco sobre su processo de reciclaje en_____?
    a. ¿Como se colectan los reciclables?
    b. ¿Los residentes separan sus residuos por tipo? ¿Plástico? ¿Vidrio? ¿O lo hacen los centros de reciclaje?
2. ¿Quien esta encargado de el programa de reciclaje?
3. En su opinión, ¿qué tan efectivos han sido los programas de reciclaje en su municipio?
    a. ¿Porque cree que ha sido/no es eficaz?
    b. ¿Qué podría hacer para resolver el problema actual? (si hay alguno)
4. ¿Qué recomendaría a otras municipalidades que están tratando de empezar un programa similar al suyo?
    a. ¿Por qué esta recomendación?
    b. ¿Hay alguna otra sugerencia quisiera dar?
5. ¿Puede nombrar un aspecto de su programa que recomendaría evitar a otro municipalidad que esta tratando de empezar un programa?
    a. ¿Qué fue mal?
    b. ¿Lo trato de resolver? Si es así, ¿como?
6. En su opinión, ¿qué motiva a los residente de su municipalidad a reciclar?
    a. ¿Porque cree que esto los motiva?
7. Desde que su programa ha sido establecido, ¿ha visto algún cambio en la condición de las calles o ríos de su municipalidad?
    a. Si es así, ¿podría ser mas especifico?
    b. Piensa que estos cambios hubieran ocurrido si sus programas no hubieran sido establecidos?

¡Gracias por su tiempo! Sabemos que están muy ocupados y les agradecemos que ustedes pudieran tomar el tiempo de responder a nuestras preguntas.

Appendix 7: Preguntas de Entrevista para los empleados de los centros de reciclaje y compostaje

1. Usualmente, ¿Este centro esta muy ocupado?
    a. ¿Cual es el horario en el cual el centro esta más ocupado?
        i. ¿Qué tipo de gente ve durante estas horas?
    b. ¿Cuándo esta menos ocupado?
        i. ¿Por qué cree que la gente no recicla en este horario?
2. ¿Cuánto tiempo lleva trabajando en este centro?
    a. ¿Se sentiría cómodo(a) enseñando a otras personas si es que fuera necesario?

Gracias por su tiempo, sabemos que debe estar muy ocupado(a).

Appendix 8: Preguntas de Entrevista para administradores de centros de compostaje y reciclaje:

1. ¿Cuántos empleados trabajan en el centro que esta administrando?
    a. ¿Necesita más trabajadores o voluntarios?
    b. ¿Tiene suficiente presupuesto para agregar más empleados?
2. ¿Qué tipo de materiales son reciclados aquí?
3. ¿Mantiene un registro de cuanto se recicla sobre cierta cantidad de tiempo?
    a. ¿Que tan accesible son sus datos?

¡Gracias por su tiempo!

Appendix 9: Survey Results

Survey Number:		Alvarado	Jiménez	Oreamuno
Sexo (Sex)	Female	29	35	24
	Male	24	23	56
Edad (Age)	<15	1	0	12
	15-24	12	12	0
	25-34	15	8	1
	35-44	10	15	20
	45-54	5	13	26
	55-64	5	4	35
	>64	5	6	9
Niños < 18 en su hogar (Children under 18 living in household)	0	15	25	1
	1	14	14	0
	2	15	17	51
	3	6	2	30
	4	2	0	8
	>5	0	0	3
Recicla los residuos solidos? (Do you recycle household waste?)	Siempre (Always)	34	55	0
	Seguido (Often)	7	1	43
	A veces (Sometimes)	7	0	13
	Nunca (Never)	5	2	27
Separa sus residuos organicos? (Do you compost your organics?)	Siempre (Always)	34	57	9
	Seguido (Often)	3	0	43
	A veces (Sometimes)	2	0	10
	Nunca (Never)	14	1	28
Sus residuos organicos son llevados a un centro de compostaje? (Do you bring your compost to a recycling center?)	Si (Yes)	0	51	11
	No (No)	0	0	46
	Otro (Other)	0	0	40
Quien tiene la responsabilidad principal de reciclar? (Who is in charge of recycling in your household?)	Hombre (Man)	10	9	0
	Mujer (Woman)	33	44	15
	Ninos (Children)	0	0	42
	Otro (Other)	0	0	0
Cual es la razon mas importante por la que recicla (What is the most important reason why you recycle?)	Beneficio para el medio ambiente (Beneficial to the environment)	41	38	0
	Mi deber civico (Civic duty)	5	6	17
	Requerido por el gobierno (Required by the government)	3	7	25
	Veo a los demas hacerlo	0	5	14

	(Other people do it)			
Cual lo/la convencio a reciclar? (What has convinved you to recycle?)	Television (Television)	21	9	0
	Escuela (School)	12	2	2
	Avisos en el periodico (Newspaper advertisements)	0	1	34
	De otra persona (Word of mouth)	3	1	5
	Internet (Internet)	3	1	2
	Folleto (Brochure)	18	31	14
	Reuniones comunales (Community meetings)	6	15	1
	No fui informado de los servicios de reciclaje (No education about recycling)	0	0	1
La razon por la que no recicla? (What is the reason why you do not recycle?)	No tengo tiempo (Do not have time)	1	1	0
	No conosco el proceso (Do not understand the process)	0	0	10
	No tengo mucho interes (Am not interested)	1	0	7
	no tengo suficiente espacio (Do not have sufficient storage space)	0	0	4
	No tengo los recipientes necesarios (Do not have containers needed)	0	1	4
	No estoy seguro(a) de los tiempos (Not sure about the times)	0	0	7
	No sabia que existia un programa (Did not know a program existed)	2	0	4
Que puede hacer su ciudad para mejorar su programa de reciclaje (What recommendations do you have for the recycling program?)		See Appendix 10 for complete list of recommendations		
OPCIONAL: Cual es su ingreso mensual promedio neto? (Optional: What is your net monthly income?)	<100	6	3	0
	100-199	8	5	3
	200-299	5	5	2
	300-399	3	0	5
	400-499	1	0	11
	>500	0	1	56
	No answer	30	44	15

Appendix 10: Complete List of Public Recommendations

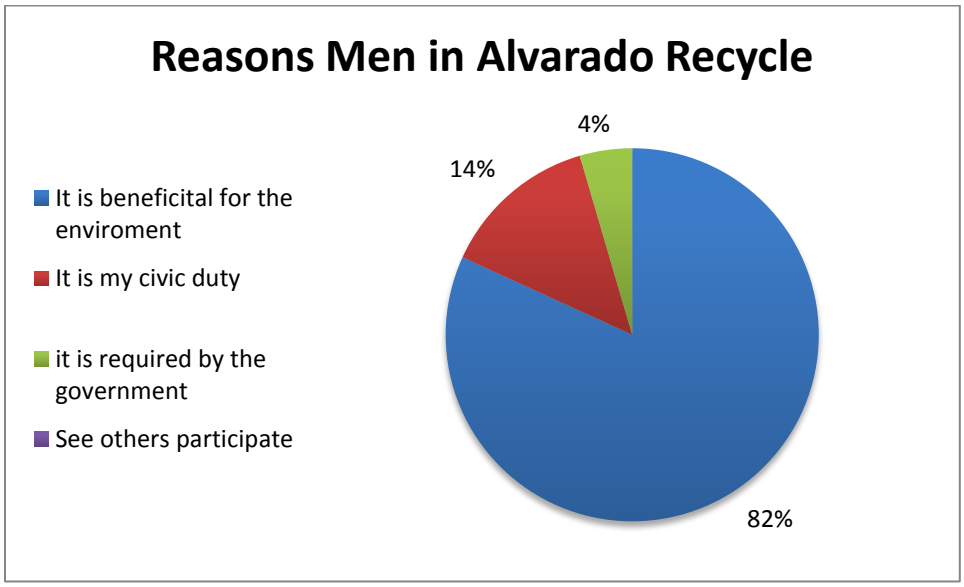
	Alvarado	Jiménez	Oreamuno
Education	• More info about recycling • More information, but good that they collect once a week • More awareness • More awareness • Continue educating • Continue Educating • Inform and Convince • More information • More advertisements • Educate more adults, not just children • More Advertisements • More education about composting	• Make people aware of importance, understand more • Make people aware of importance, understand more • Another way of educating to make them understand more • Difference of opinions, be consistant with educating • More motivation from teachers educating about recycling • Improve awareness • More programs • More community involvement • More awareness and participation • More education • Have parent set example, teach not to mix • More informantion • More education in schools • More awareness about separation	• Need education • Don't know how to recycle • Don't know how to recycle • Don't know about recycling • Do not know the process • Teach how to recycle • More education for children • Teach at a young age • More environmental education • Educate residents • More information about recycling • More education in schools
Containers	• Put bins in town centers • Bins in center • More locations for containers • Add containers to bus stops • Need more containers • Exclusive bins for recycling • Colored bags • Different sized bags • More containers and bags	• Provide recycling containers	• Municipality should provide containers • Better trash containers • More public trash containers • Label public containers • Label public containers • Label public containers • Better containers • More containers • Specialized trash containers

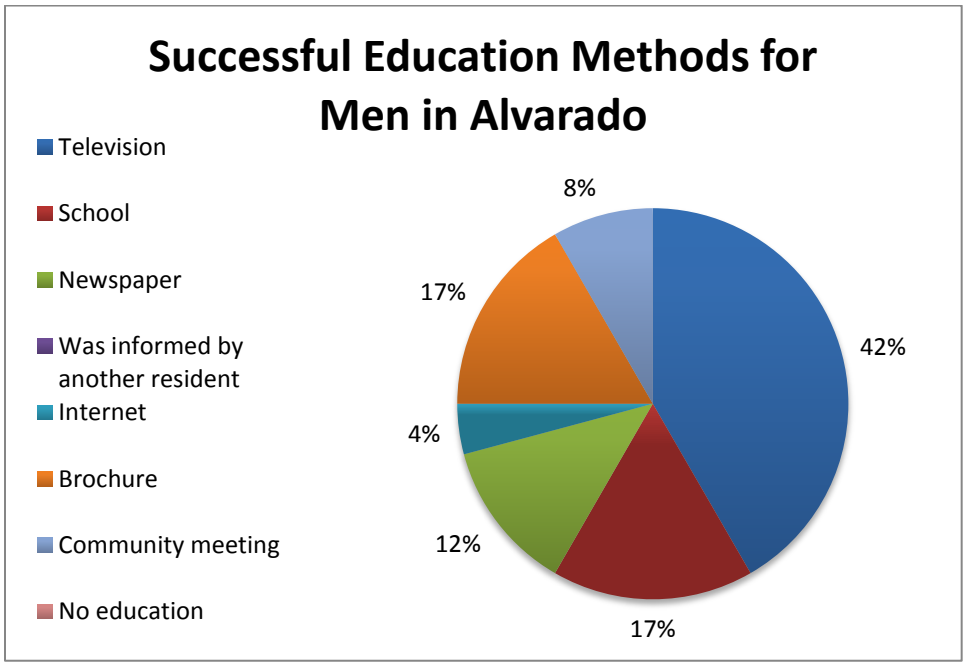
Collection	• Be more organized • Improve center • Be more careful during collection • collect on time • more frequent pickups	• Don't leave garbage on the street, be more careful of pickup • More days to recycle: 2 days to recycle and 2 days to comopost	**Collection center schedule:** • Better schedule for center • Better schedule • Better schedule for center • Expand center schedule • Improve schedule for center • Better schedule • Improve schedule for collection center **Center locations:** • More locations • More collection centers • More collection centers • More locations for centers • More collection centers • More collection centers • More collection centers • More collection centers • Not enough center locations • More center locations • More locations for center • More collection centers • Better locations for center • More centers • Better locations **Service** • Need better recycling center • More recycling programs • Expand services • Expand service • Expand Service • Expand service • Offer more services • Better service • Pickup services instead of drop-off • Better service • Improve service • Improve service in COT • Better communication and collection centers • Better service • Pick up recyclables door-to-door • Better collection service • Better collection service • Better service • Implement program in COT • Pick up recyclables at home • Expand services • Better collection center

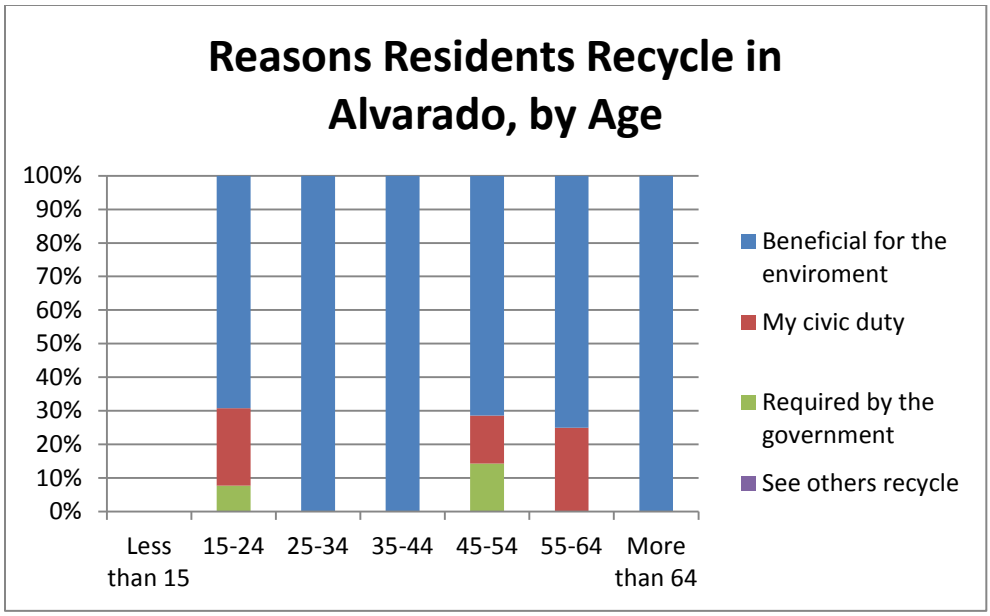
Miscellaneous	• Control theft of metal recyclables • Establish new composting system • "The people are the problem"	• Separate • Work on Juan Viñas odors • More work, still trash in street and rivers • Employment oportunities	• Pickup trash • Do not throw trash in street • Do not through trash in ditches along road • Separate at home • Do not like to recycle because it takes a lot of time
	• 10 people had no recommendations and answered that the program was running well • 15 people had no answer	• 33 residents said it was good • 6 residents did not answer	• 20 people had no answer

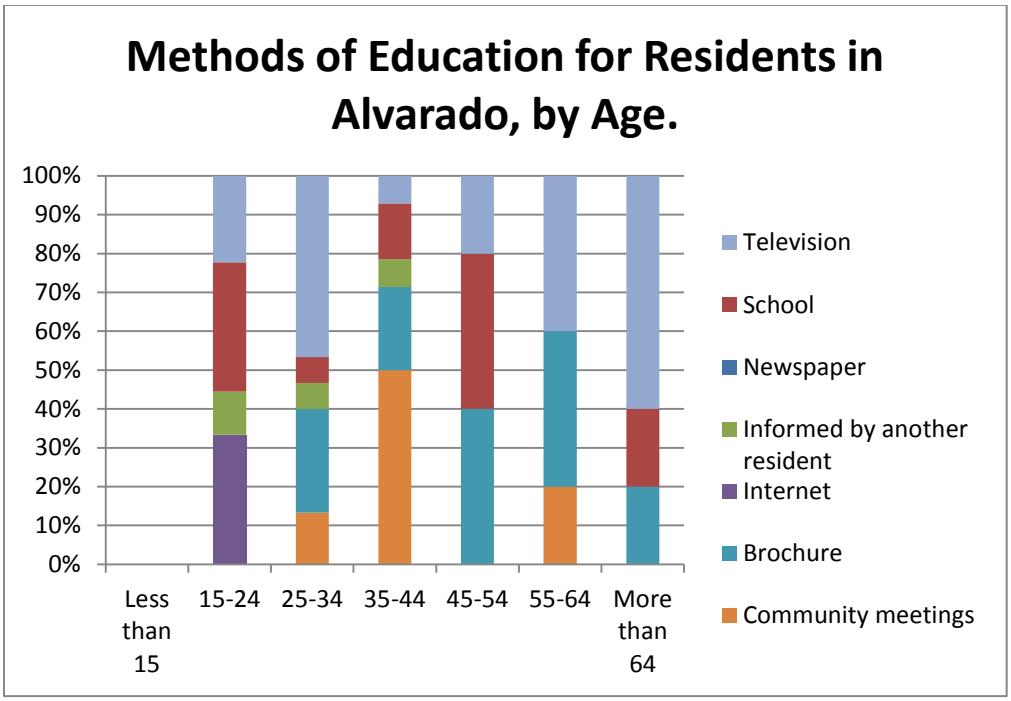
Appendix 11: Graphs derived from data

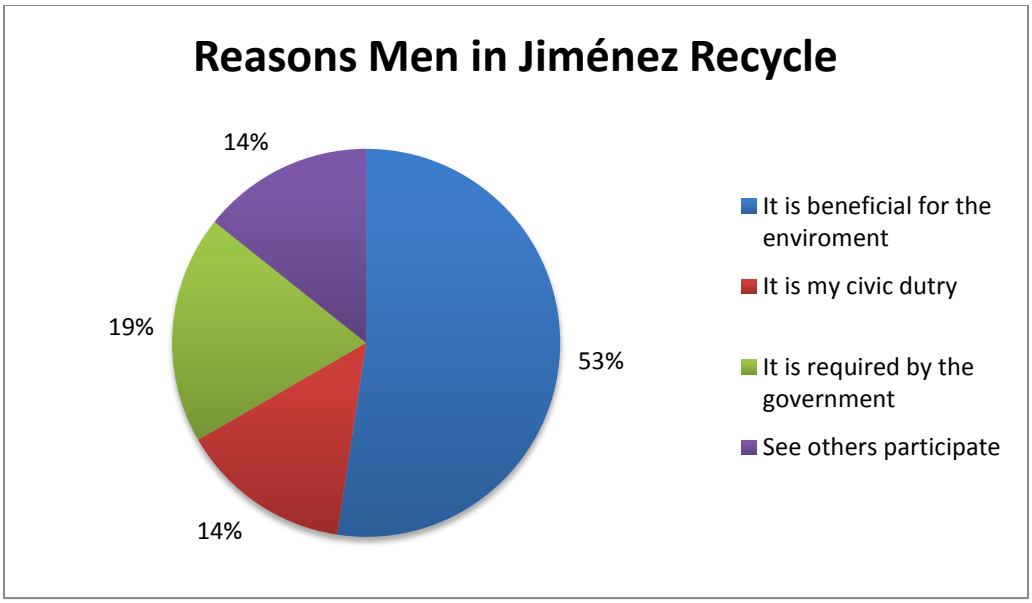
Statistics by Gender and Age Groups

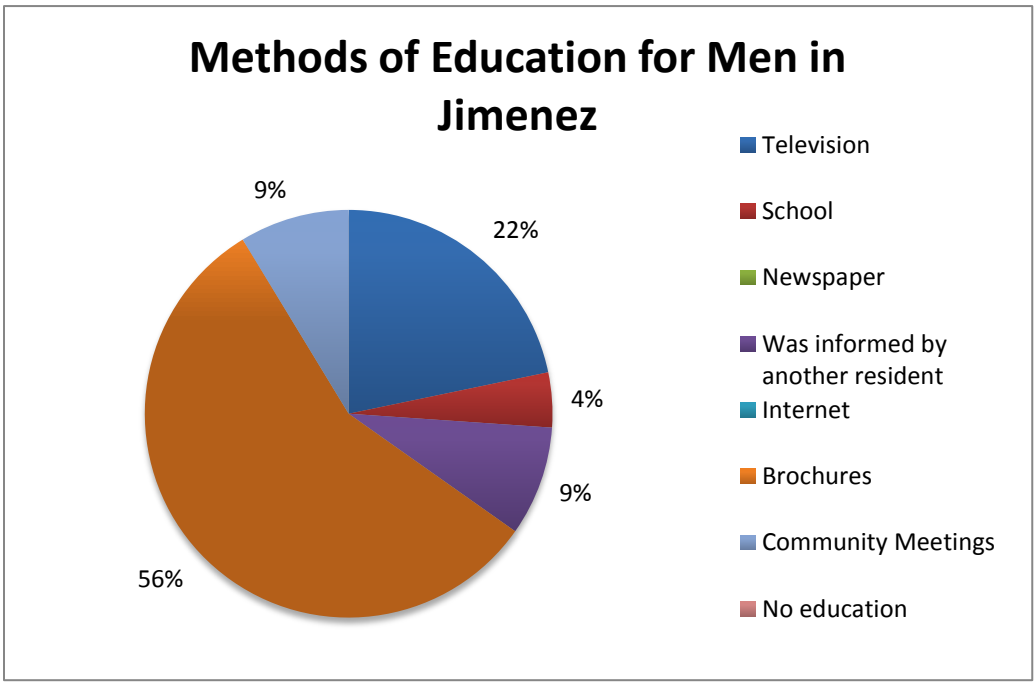


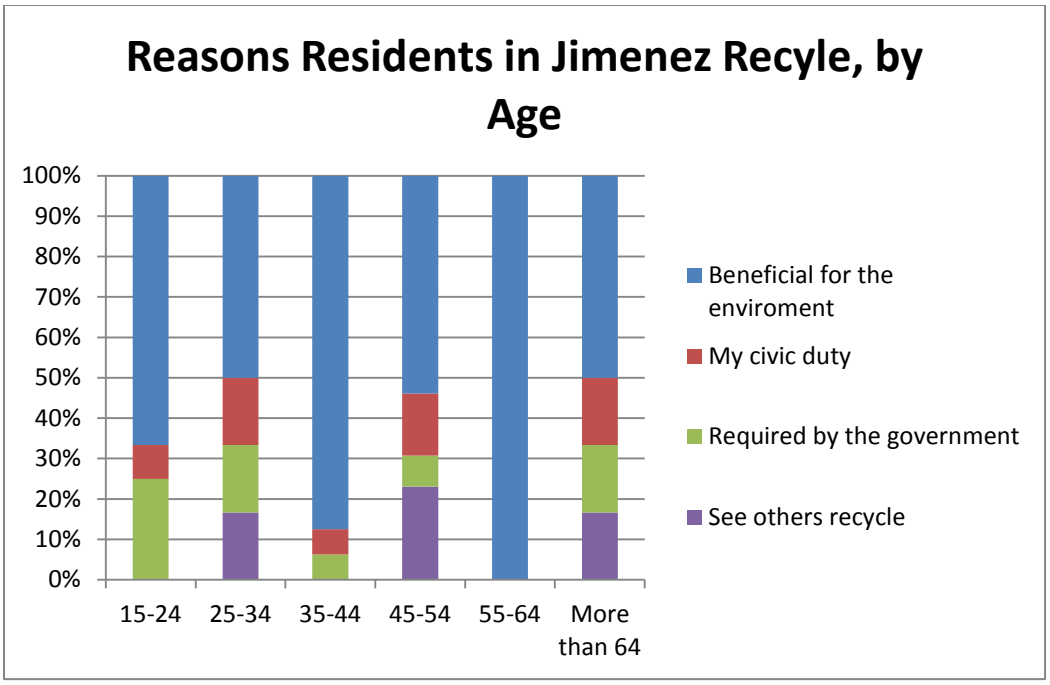


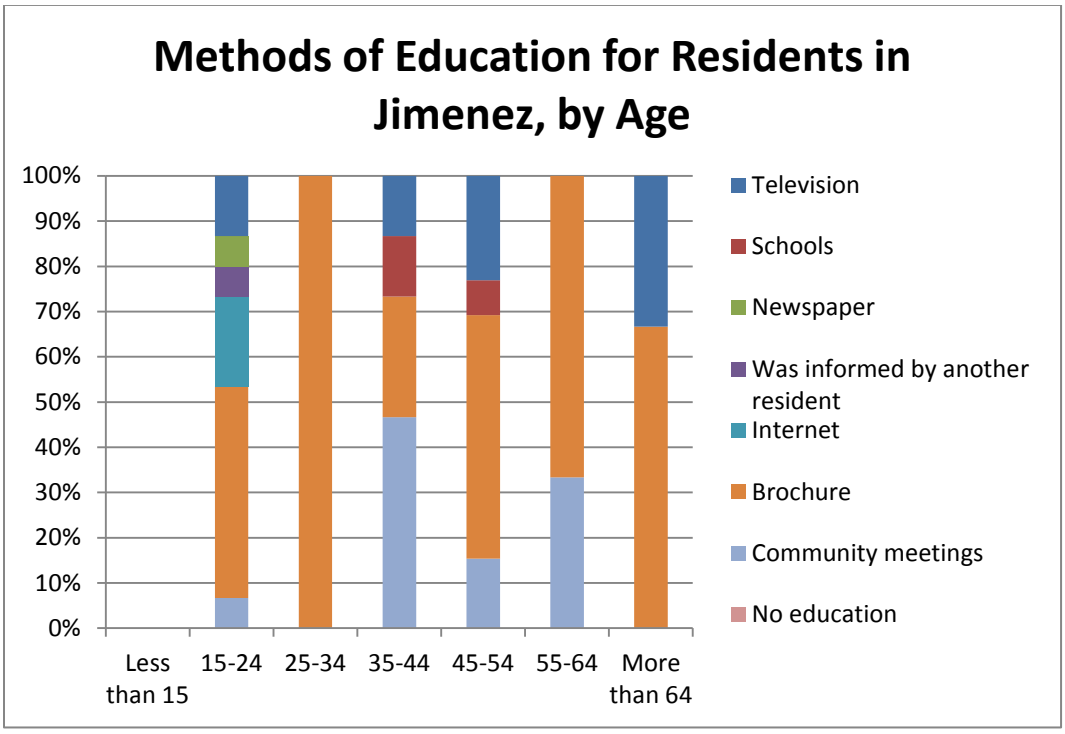

Reasons Residents Recycle in Alvarado, by Age
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Less than 15
15-24
25-34
35-44
45-54
55-64
More than 64
Beneficial for the enviroment
My civic duty
Required by the government
See others recycle

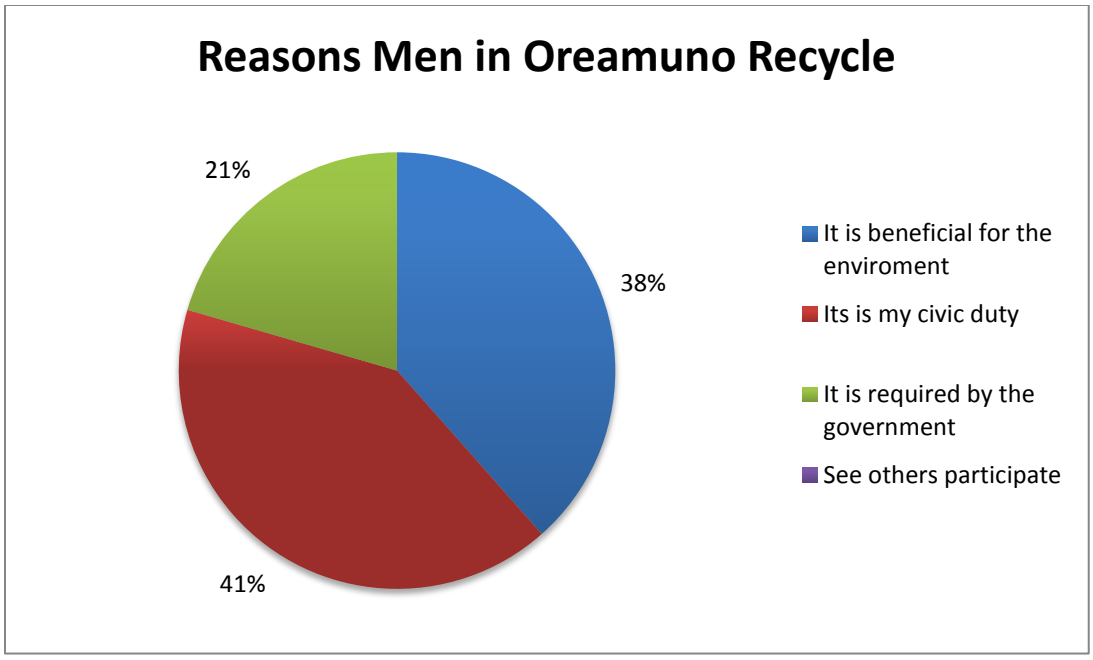

Methods of Education for Residents in Alvarado, by Age.
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Less than 15
15-24
25-34
35-44
45-54
55-64
More than 64
Television
School
Newspaper
Informed by another resident
Internet
Brochure
Community meetings

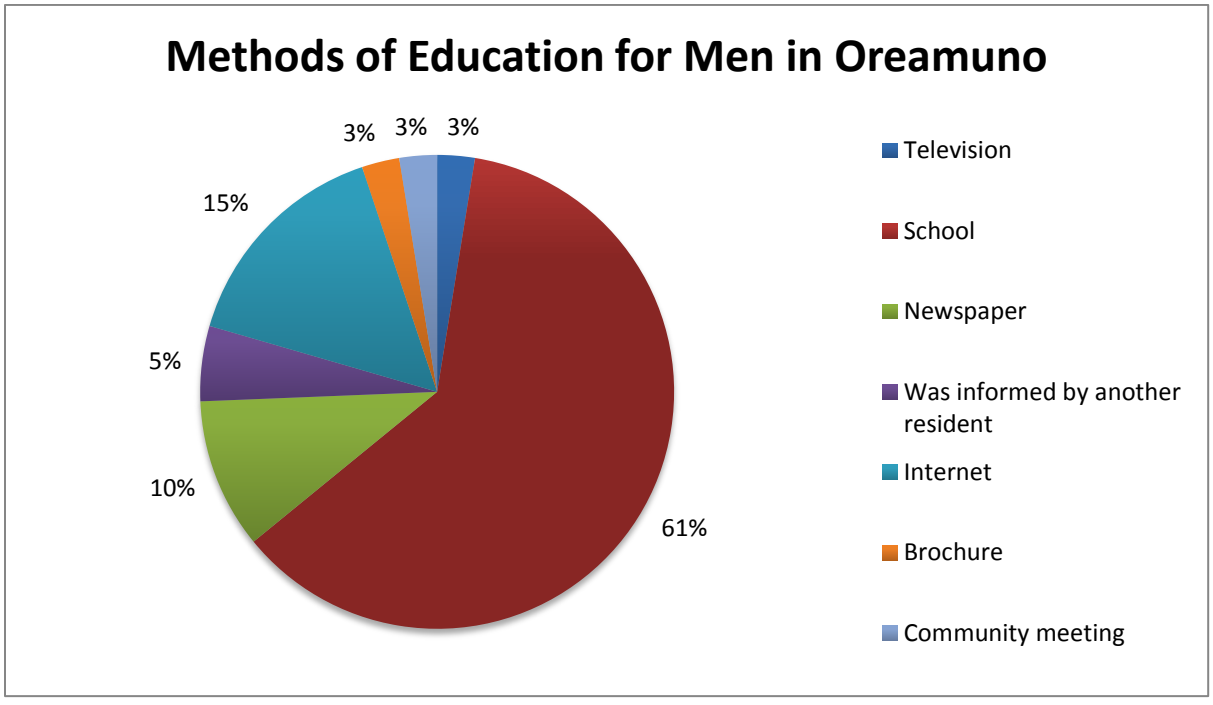

Reasons Men in Jiménez Recycle
14%
19%
53%
14%
It is beneficial for the enviroment
It is my civic dutry
It is required by the government
See others participate

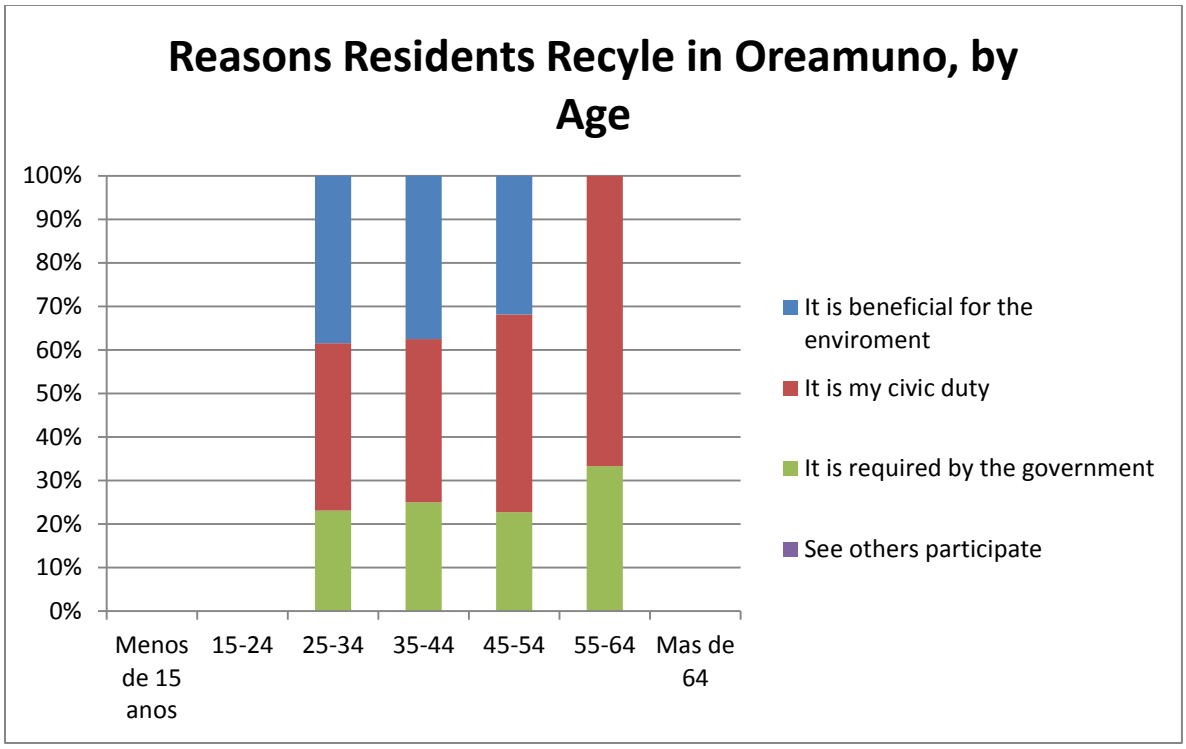

Methods of Education for Men in Jimenez
9%
22%
4%
9%
56%
Television
School
Newspaper
Was informed by another resident
Internet
Brochures
Community Meetings
No education

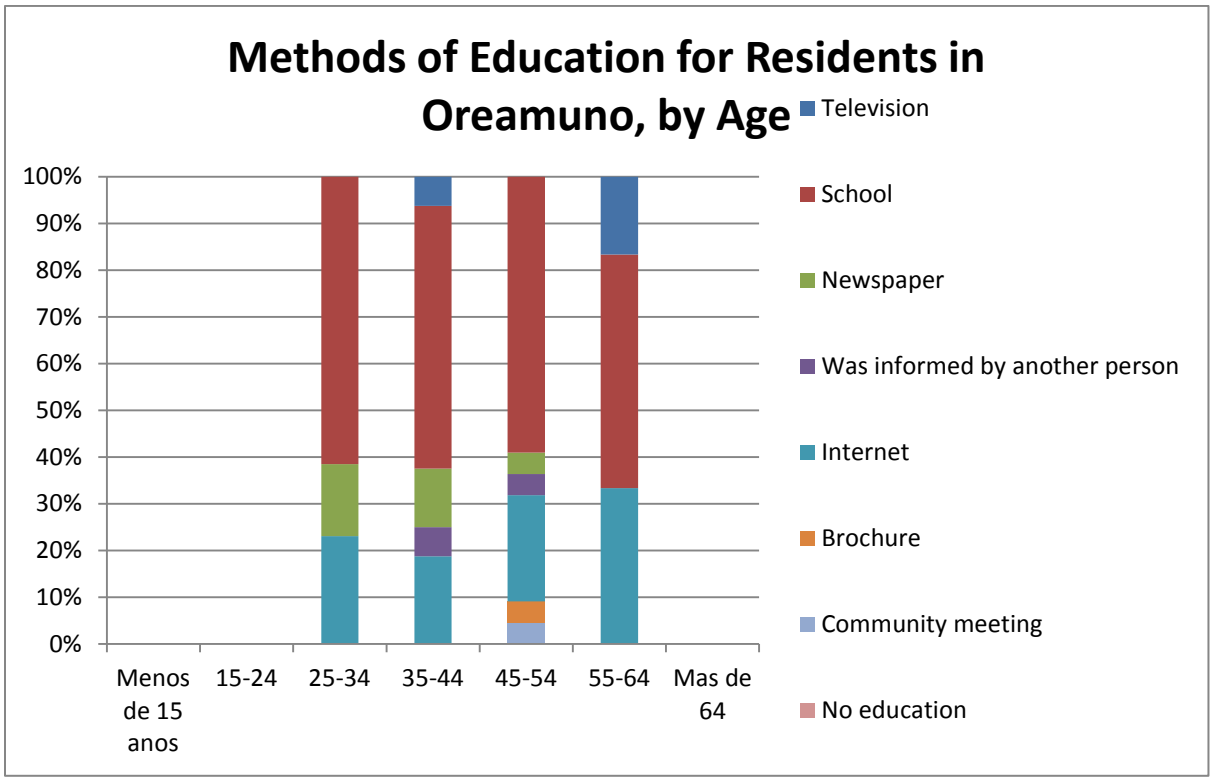

Reasons Residents in Jimenez Recyle, by Age
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
15-24
25-34
35-44
45-54
55-64
More than 64
Beneficial for the enviroment
My civic duty
Required by the government
See others recycle


Methods of Education for Residents in Jimenez, by Age
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Less than 15
15-24
25-34
35-44
45-54
55-64
More than 64
Television
Schools
Newspaper
Was informed by another resident
Internet
Brochure
Community meetings
No education


Reasons Men in Oreamuno Recycle
21%
38%
41%
It is beneficial for the enviroment
Its is my civic duty
It is required by the government
See others participate


Methods of Education for Men in Oreamuno
3%
3%
3%
15%
5%
10%
61%
Television
School
Newspaper
Was informed by another resident
Internet
Brochure
Community meeting


Reasons Residents Recyle in Oreamuno, by Age
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Menos de 15 anos
15-24
25-34
35-44
45-54
55-64
Mas de 64
It is beneficial for the enviroment
It is my civic duty
It is required by the government
See others participate


Methods of Education for Residents in Oreamuno, by Age
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Menos de 15 anos
15-24
25-34
35-44
45-54
55-64
Mas de 64
Television
School
Newspaper
Was informed by another person
Internet
Brochure
Community meeting
No education

Appendix 12: Interviews

First Interview with Environmental Managers:

The interviews were done on October 21st in the offices of COMCURE which are located in the municipality of Cartago. The meeting started at 9:30 in the morning. The team was told that three municipality leaders were going to be at this interview, but two, Gabriela Gómez Chacón and William Maroto Pérez, attended the interview. It was then that the group learned that these municipality leaders were the environmental managers of each of cantons Alvarado and Oreamuno, respectively. The team also learned that the municipality of Jiménez did not have an environmental manager and that the mayor was in charge of the solid waste management of this area instead. The team proceeded to give them an overview of the whole project and explained to them what the overall goal was.

After describing what the project was about, we asked the first question that was to give us an insight on how their recycling program ran (See Appendix 2). The first individual to speak was Sra. Gómez . She explained how the privately run program worked and how there is an agreement between a private entity run by, Sr. Rodolfo Meléndez, and the municipality. She then went on to talk about how the department educated the residents by going door to door with brochures. Sra. Gómez also talked about a new composting center that will be built in 2013, which will be run by the municipality. After about fifteen minutes, Sr. Maroto talked about the municipality of Oreamuno. Their program is a little different than Alvarado's since Oreamuno is geographically larger and more urban. The collection center consists of a drop off only system and there is a profit of one million colones, or 2,000 dollars, per month. Sr. Maroto also mentioned that because of the recycling program, the amount of waste taken to the landfill has been greatly reduced. The municipality educates the residents by giving talks to schools.

The next topic discussed was that of the Department of Environmental Management. This department was created by a law and every municipality should have one. Both Sr. Maroto and Sra. Gómez agreed that they had a lot on their plates with the education of the public, protection of the environment, collection of solid waste, and cleaning of public places. All this hard work has paid off and the municipalities look much better than before. After talking about the improvements on each municipality, the site assessments were discussed. The team set up dates

for the visits to each municipality and center. The visits were set for Wednesday, November 14th (Alvarado) and Friday, November 9th (Oreamuno). This concluded the interview with both environmental managers.

Follow-up Interview with Gabriela Gómez Chacón:

The follow-up interview with Sra. Gómez was done on November 14th at the offices of the municipality. This was a short interview since the team had already spoken to her previously. Sra. Gómez first gave the group a presentation on the Department of Environmental Management in Alvarado. This is where the team learned more about the details of the education of the residents. The group was also shown some modules that were going to be put at bus stations for people to recycle. These were cylindrical containers that were about one meter in diameter and a little less than one meter tall. After the environmental manager showed us the recycling bins, the team asked about surveys. They were told that to conduct these surveys they should go to the more populated districts of Villa de Pacayas and Capellades and visited public places such as banks or markets. Gabriela mentioned that residents usually would be willing to cooperate. The discussion of surveys concluded the interview and was followed by the site assessment.

Follow-up Interview with William Maroto Pérez:

The follow-up interview with the environmental manager William Maroto was done on November 9th at the offices of the municipality. This was also a short interview and did not last very long. The first topic discussed was about the expansion of the program to different districts. The municipality is looking into installing drop-off centers throughout the municipality. This led to the education of the residents. In order for the program to be successful however, residents have to be first educated and have to want to recycle. The group also asked about the process of selling the recyclable products. It was found that the municipality sells the products to the same companies and that they don't usually change. Afterwards, the team asked how the surveys would be given. William mentioned that the comptroller department could apply them to residents. The discussion of surveys concluded the interview and was followed by the site assessment.

Interview with Lissette Fernández Quiróz:

Since the Municipality of Jiménez did not have an environmental manager, the group had to meet with mayor Lissette Fernández Quiróz. The mayor knew about the recycling process in detail. She first gave us background information of how the program started. Sra. Fernández then proceeded to tell the group that though there is not an environmental manager, however there is an employee who oversees both the collection and composting center. The group learned that it has been a long process since the beginning but they are starting to see the benefits. The mayor talked about the entity IMAS that handles the separation and sale of the recyclables for the municipality and how they pay the workers in the recycling center. The municipality is trying to improve both centers by expanding them and improving the overall state of the structure. There have been a lot of changes throughout the years such as putting recycling bins at strategic places. She also gave us information on how they have been educating the residents and what has been working and what has not. Mayor Fernández also talked about how she wanted to expand the program to Pejiballe, another district of Jimenez, next year. We then proceeded to talk about the composting center and the changes it has undergone. There are still more changes that need to be done but it will take some time since it is a slow process. The team also asked where they could give out the surveys and she suggested visiting the district of Juan Viñas, a populated part of Jiménez. The discussion of surveys concluded the interview and was followed by the site assessment.