Waste Management Plan for the Technological University of Panama: Campus Victor Levi Sasso

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Abstract

With relatively new infrastructure, a rapidly growing population, and a desire for a more sustainable campus, the Technological University of Panama (UTP) seeks to create an advanced waste management system that accommodates all types of waste. By gathering information concerning current waste management, engaging with stakeholders, researching methods for recycling in Panama, and predicting future waste of the campus, we were able to create a comprehensive waste management plan for UTP emphasizing recycling and incorporating all classifications of waste.

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- **Jennifer Tapia**, Graduate Student, Civil Engineering of UTP
- **Avril Diaz**, Undergraduate Student, Civil Engineering of UTP

Waste Management Plan for the Technological University of Panama: Campus Victor Levi Sasso

The Technological University of Panama (UTP) was founded in 1981 and is growing at a rapid rate. With relatively new infrastructure and a desire for a more sustainable campus, our goal is to create an advanced waste management system for UTP that appropriately deals with all types of waste. First, we conducted interviews and a waste audit to understand the location of disposal sites, waste composition on campus, and the overall waste management process currently in place. To gauge the feasibility of implementing a new waste management plan, we surveyed students and faculty at UTP, interviewed local recycling companies, and conducted a case study of a campus focused on sustainable initiatives in close proximity to UTP. With this qualitative information, along with quantitative information on the amount and composition of waste and the campus population, we projected the waste management needs of the campus for the coming years. We used these projections to propose a waste management plan that can accommodate the predicted growth of the campus. The plan includes recommendations for recycling stations and bins, strategies for managing all classifications of waste determined through the waste audit, and communication and training strategies about the new initiative.

Did You Know?

In Latin America, only 22% of the urban population has access to waste disposal and collection systems that are safe for the communities and the environment (Finpro Mexico, 2010).

Authors

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Background

To combat the negative implications of improper waste management, individualized waste management systems are created to meet the particular needs of the site. For the fast-growing area of Panama City, which relies on only one landfill, named Cerro Patacón, the waste management challenge is enormous. Cerro Patacón opened in 1987 and within the first ten years of operation held 2.5 million tons of waste (Linowes, Hubert, 2006).

"Large institutions...play a unique role in advancing... waste management systems"

Large institutions such as universities, hospitals, and military bases can play a unique role in advancing more effective, large-scale waste management systems. These more innovative systems are typically created for these settings since they tend to deal with large amounts of waste that impact budgeting and environmental footprints. Large institutions are often viewed as a role model for the community and many citizens may therefore be willing to mimic their actions if they can be feasibly implemented. If a waste management plan is designed appropriately for the waste profile of the site, the system can lead to cost savings and a significant reduction of waste going to landfills.

On the outskirts of Panama City, the Technological University of Panama's main campus, Victor Levi Sasso, is furthering the development of sustainable practices. An emerging concern is the management of waste generated at the university. Since the campus opened in 1981, all waste has been combined in a dump truck owned by the school and brought to Cerro Patacón. As a new university with a rapidly growing campus population, currently at 16,000 members, UTP has recognized the need for developing an adequate waste management system for the growing needs of the community.

"Develop a waste management plan, including a recycling station, for the Campus Victor Levi Sasso of the Technological University of Panama"

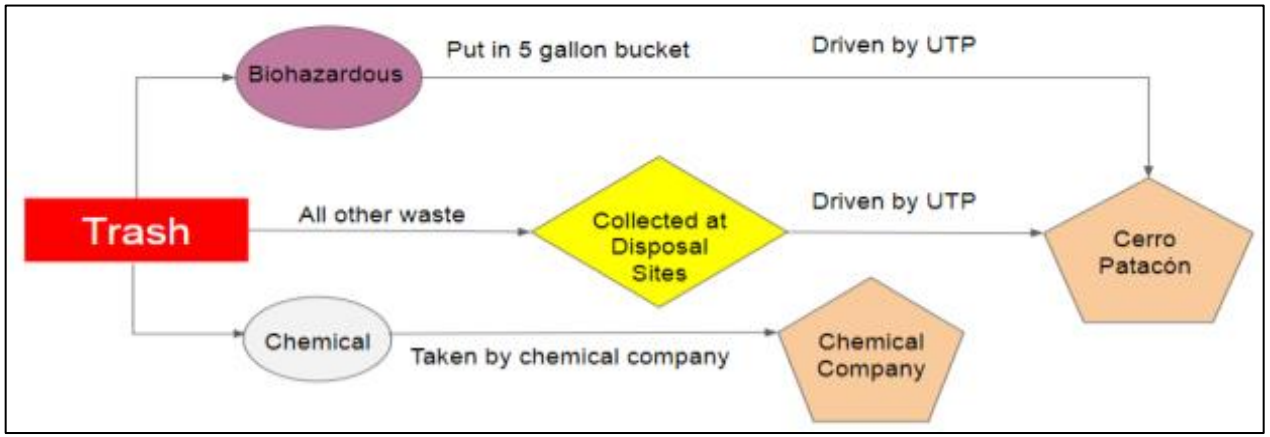

Figure ES1: Current Waste Management Process at UTP

Methodology

The goal of this project was to develop a waste management plan that would include recommendations for the collection and disposal of all types of waste on the campus, details about the recycling process, and communication and training to support the new proposed initiatives. We achieved this goal by assessing the current waste management system at UTP, engaging with key stakeholders, projecting waste management needs at UTP, and developing a waste management plan for UTP.

Assessed the Current Waste Management System at UTP

This gave our team the foundation of knowledge necessary to determine the scope of our waste management plan. We interviewed the General Services, Cafeteria, and Maintenance departments of the university and conducted a waste audit to determine the composition and amount of waste being produced.

Engaged with Key Stakeholders

This objective enabled us to understand the feasibility and acceptance of a new waste management plan on campus. We interviewed recycling companies around Panama, surveyed students and faculty at UTP concerning recycling habits and communication strategies, and conducted a case study of a campus focused on sustainable initiatives close to UTP.

Projected Waste Management Needs at UTP

We estimated the quantity of waste UTP will potentially produce, and the cost of this waste disposal. Using projections of campus

population for the next 4 years, we estimated the quantity that UTP will send to Cerro Patacón as well as the price.

Developed a Waste Management Plan for UTP

Our final objective was to create a waste management plan for the campus. This included recommendations for collecting, sorting, and methods of communication and training about sustainable practices. Our plan incorporates suggestions that are mainly focused on solid, electronic, organic, and recyclable waste.

Findings and Analysis

Waste Audit

By completing the waste audit, our team was able to document the percent composition of waste by category. These statistics provided an estimate of the actual composition of waste. Since Cerro Patacón and most recycling companies we contacted use weight to figure the cost of disposal, we thought it appropriate to do our measurements in the same fashion.

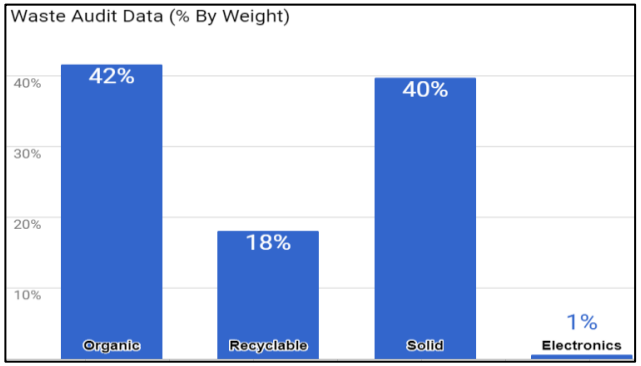

Figure ES2: Waste Audit Data (% By Weight)

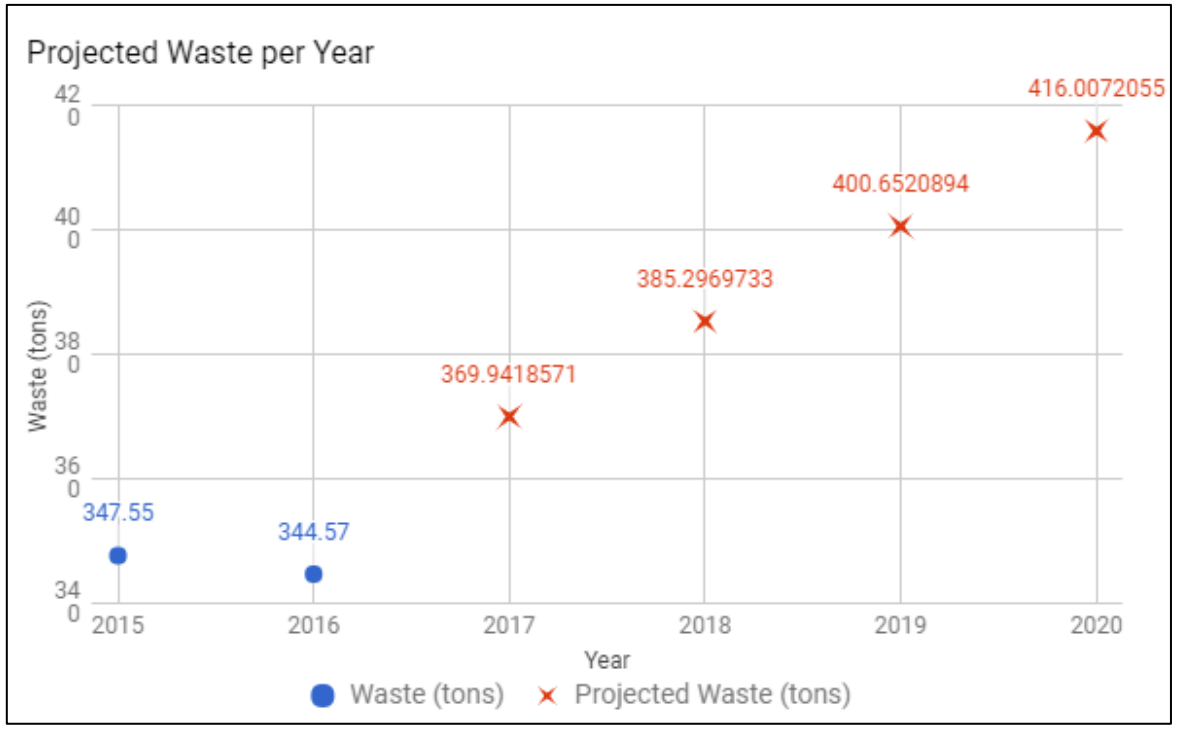

Figure ES3: Projected Waste per year to 2020

Recycling Habits

The campus survey provided insight into the recycling habits and possible acceptance of a recycling initiative. A key question asked was "Do you recycle elsewhere?" We received 85 responses with 71.8% of students stating they do not recycle elsewhere, but that 95.3% are interested in recycling. These results illustrated the necessary addition of communication and training to our proposed waste management plan.

Projections

Using the trend line from our projected population and the calculated average waste per person per year, which we found to be 41.07 pounds, we projected the amount of waste that may be seen in the coming years on UTP's campus. We also projected the cost of waste disposal based on the total waste projection. This helped us develop a waste management plan that would accommodate all classifications of waste from the audit and the volumes.

"71.8% of students… do not recycle elsewhere"

Waste Management Plan

Recycling

We are suggesting the addition of recycling bins that incorporate the sorting of paper, plastic, metal, and other trash along with a warehouse to store the waste material in different waste categories. The bins use differently shaped and sized holes to indicate which type of waste goes in each section. The bags within the recycling bins should be clear so that workers in the warehouse can easily see the contents of the bag. Within the warehouse, there should be designated locations for the bags of paper, plastic, and metal waste while the solid waste can continue to be taken to Cerro Patacón. We recommend that UTP makes a sustainability club, or "green team", that would assist with sorting recyclables in the warehouse and help spread the word about recycling around campus.

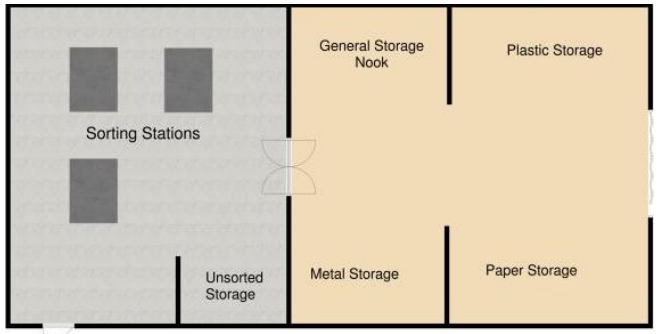

Figure ES4: Proposed Warehouse Design

Solid

Solid waste was found to be one of the biggest components of total waste, mainly comprised of Styrofoam take-out containers from the cafeteria, solid waste from the bathroom that was not flushed, and wrappers. We have recommended two courses of action for the take-out containers, biodegradable and reusable containers. For the solid waste from the bathroom, we recommend an initiative to encourage flushing bathroom waste.

Electronic

If there is a rise in electronic waste on the campus, we recommend a system for reducing and reusing electronic material. The reuse policy can then prompt the use of extra electronics as a demonstration in the classroom or as additional parts that could be used in the lab.

Organic

We are recommending the addition of a specific bin for organic waste in the cafeteria to communicate the goal of the initiative before starting to compost. Our suggestion for composting includes two types, windrow and in-vessel composting. Although an initial investment would be required for the purchase of composting containers or the clearance of land, the savings from disposing of cafeteria waste could be reinvested into this campaign.

"Separation at the source is key"

Figure ES5: Highly Recommended Poster

Communication and Training

The survey on recycling habits for the members at UTP revealed that ~71% of people on campus do not recycle in their everyday lives. Because of this, our team decided upon a form of community outreach to raise awareness on campus involving a poster campaign and supplementary informative flyer. Seven posters were presented to the community, and four were rated as highly desirable. The posters were designed for different purposes and locations around campus. Some are meant for a quick absorption of information and will be placed in areas of low loitering times, such as hallways. Others will be placed in areas with a higher loitering time, such as waiting areas and outside of elevators, that provide more in-depth information. The supplementary informative flyer is meant as a more individualized approach for advertising the ideals and benefits of recycling. This will hopefully be passed out by teachers and the green team we recommend be established on campus.

Conclusion

Possible effects of proposed waste management plan:

~18% of waste is recyclable, which will now be going to FAS Panama

~42% of the waste is organic, which will now be going to UTP's garden area

~41% of the waste will still be going to Cerro Patacón classified as solid and electronic

~60% of the waste currently going to Cerro Patacón will now be reduced

Summary of proposed plan:

As seen in Figure ES6, our proposed plan includes all categories of waste at UTP. On the right, chemical and biohazardous waste maintain their respective processes currently going on at the university. On the left are the waste classifications that will be sorted at the recycling bins. Paper, plastic, and metal will be sorted and then taken to the warehouse at UTP. From there, the university maintenance drivers will take the waste to FAS Panama which consists of 18% of the waste on campus.

Organic waste will only be sorted in the cafeterias, and will then be taken to the garden and composted for further use. This process consists of 42% of the waste on campus. Lastly, solid and electronic waste will be taken to Cerro Patacón and consists of 40% on campus.

With UTP's leading position in sustainability, the implementation of a new waste management plan will aid in the reduction of their environmental footprint. This type of initiative can further this position for UTP to also become a recognized leader in waste management for the coming years.

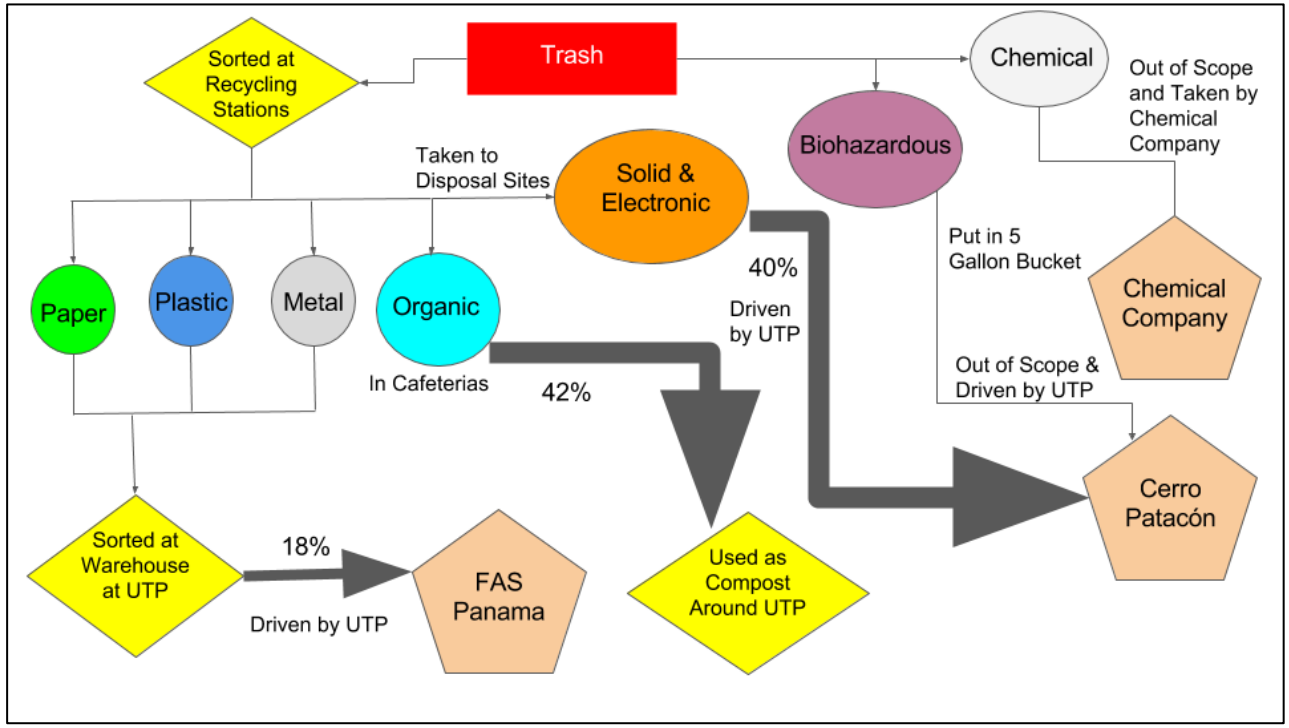

Figure ES6: Illustration of Proposed Waste Management Plan

Figure ES7: Presentation for UTP's administration and staff

Authorship

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2.1 Urbanization and Waste Management in Latin America	Colette and John
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Section 1: Introduction

In Latin America, only 22% of the urban population has access to waste disposal and collection systems that are safe for the communities and the environment (Finpro Mexico, 2010). Unsafe waste management systems bring forth harmful conditions that can incorporate pollution and disease. To combat the negative implications of this problem, individualized waste management systems are created to meet the needs of the consumer. Systems are most effective when they are designed to accommodate the particular volume, type, and collection of waste generated by the growing population.

Today, Panama City relies on one landfill, named Cerro Patacón. It is important to address the many issues that may arise when all classifications of waste are treated equally. For example, most recyclable materials have long decomposition times and take up a significant amount of space in a landfill. The runoff coming from the landfill is also detrimental to the environment with its potential to contaminate groundwater. Since a portion of the waste is biologically hazardous, such as used bandages, needles, and chemicals, these issues are compounded and illustrate the problems associated with large landfills. The appropriate sorting of waste products can greatly reduce the amount of recyclable and reusable materials going to landfills and can mitigate against harmful chemicals entering the environment. In turn, this can positively influence the wildlife and citizens living in close proximity to these landfills by reducing local air and groundwater pollution from landfill sites.

Large institutions, such as universities, hospitals, and military bases, can play a unique role in advancing waste management systems. Large-scale waste management systems are typically created for these settings since they tend to deal with large amounts of waste that impact budgeting and environmental footprints. If a waste management plan is designed appropriately for the waste profile of a site, the system can lead to cost savings and a significant reduction of waste going to landfills. Furthermore, an exemplary waste management plan can help an institution become a leader in sustainability initiatives and demonstrate best practices. This is because large institutions are often viewed as a role model for the community and many citizens may therefore be willing to mimic their actions if they can be feasibly implemented.

On the outskirts of Panama City, the Technological University of Panama's main campus, Victor Levi Sasso, is furthering the development of sustainable practices. An emerging concern is the management of waste generated at the university. Since the campus opened in 1981, all waste has been combined in a dump truck owned by the school and brought to the Cerro Patacón landfill. As a new university with a rapidly growing campus population, currently at 16,000 members, UTP has recognized the need to develop an adequate waste management system for the growing needs of the community. This system will be needed to accommodate the growing population of the university while also adopting a more innovative waste management system that will reduce the impacts of the waste generated by the growing population.

The goal of our project is to create recommendations for a waste management plan for UTP's Victor Levi Sasso Campus. The steps we took to achieve this goal were to understand the current waste management system in place at UTP, explore the feasibility and acceptance of a new system, and design the methodology of establishing a new system that encompasses a more sustainable and environmentally friendly approach. We coordinated with faculty to produce estimates of the waste coming from the campus in future years, developed methods of diverting this waste away from Cerro Patacón, and created recommendations for a comprehensive waste management system.

Section 2: Background

Throughout Latin America, communities are becoming aware of the need for more efficient systems to manage the growing volume of waste being produced. There have been successful attempts at creating advanced systems, but sometimes a developing community may not have the infrastructure available to construct an effective system. When mishandled, waste can alter the relationship between the environment and surrounding communities. As Panama City's population and economy grows, the research around advancing their waste management process has been a top priority.

2.1 Urbanization and Waste Management in Latin America

According to Atilio Savino, writer for Waste Management World, "Latin America generates around 522,000 tonnes of waste per day, its average being 0.9 kg/day per person." Savino also illustrates the struggle behind proper waste management in Latin America, with the statistic showing that only 30% of the waste collected in these countries has a formal, clean, and environmentally conscious final collection site (Savino, 2015). Landfills in these areas are running out of space for more trash, which displays the difficult issue of finding a large piece of open land for a new landfill. With the increase in urbanization, many citizens of Latin America are moving closer to the cities and establishing settlements on available land. This means people are starting to live closer to the landfills, which can disturb their lives due to the smell and fumes coming from the waste. The open areas also attract unhealthy environments including insects, vermin, and disease (Wrap, n.d). In many countries of Latin America, waste management is coordinated on a municipal basis rather than by private companies. In many cases municipalities face challenges in expanding services and infrastructures rapidly enough to accommodate growth. It is also difficult to arrange if the city does not have the financial resources to provide waste collection coverage for the entire population. If citizens feel as though they cannot rely on the waste management system in place, it has been shown that they take it into their own hands to provide waste collection sites. This leads to the creation of informal landfills that may not be safe for the environment or people living in close proximity.

The multiple occurrences of underdeveloped waste management systems, within Latin American countries and elsewhere, can lead to a global impact. Gases produced from the waste once placed into the landfill, such as CH_4, contribute to global warming. About 90% of the emissions from waste come from landfills around the world. This accounts for about 18% of human-induced global greenhouse gas emissions, which has risen from 14% in 2004 (Savino, 2015).

2.2 Cerro Patacón: Panama City's Only Landfill

Cerro Patacón, the only landfill serving Panama City, opened in 1987 and within the first ten years of operation held 2.5 million tons of waste. By 1998, the country felt the consequences of this landfill and its quick accumulation of waste when it caught fire and burned for nine days. With the mixture of various chemicals, due to the lack of separation of trash within the facility, deadly fumes sent over 25 people to the hospital. Dirección Metropolitana de Aseo (DIMA or the Metropolitan Department of Cleanliness) is a government entity that is responsible for collecting, transporting, and disposing of waste at Cerro Patacón, and therefore drew public attention when this fire occurred (Linowes, Hubert, 2006).

Since Panama relies mostly on landfills, the waste related pollution is mainly found in water sources and air pollution. For example, Cerro Patacón has three large ponds where leachate is stored. Leachate is the term used to describe the liquid byproduct or runoff of decomposing waste. The local government is setting new standards for the landfill's operations because of the concern regarding contamination of water sources from the leachate ponds ("Cerro Patacón Landfill", n.d). With only about 90% of the population having access to potable drinking water in Panama, contamination of water is a strong focus for sustainability groups. Furthermore, the greenhouse gases and production of methane from Cerro Patacón are detrimental to the environment and people's health. It has been shown that when food scraps are put into landfills, the methane produced is 70% stronger at trapping heat than other greenhouse gasses ("Benefits of Composting",n.d).

In the area of Panama City, Cerro Patacón is known as a modern sanitation facility. This is because it was one of the first landfills planned to serve the entirety of Panama City and the surrounding areas. Another reason Cerro Patacón was seen as modern was because of a law

stating that scavengers would not be allowed to pick through the garbage brought to the landfill. However, scavengers are still seen on a daily basis searching for items worth selling. After the fire, DIMA started to sort trash, but only distinguished between materials that could be burned and those that could not. They also saw scavengers as a way to generate income from the waste coming to Cerro Patacón. This was the first recycling "initiative" seen within Panama's waste management system. About 35 scavengers and their families were paid to go through trash and resell items they found. Linowes and Hubert suggest that the government tolerated the informal revenue from these practices and saw no reason to change waste practices, in spite of the health and environmental risks they presented (Linowes, Hubert, 2006).

The history of waste collection and management at Cerro Patacón reflects the predominant waste management practices throughout the country. Institutions have become accustomed to combining all waste with little focus on modern practices in their waste management system. However, the work at Cerro Patacón demonstrated the country's growing interest in creating an innovative approach to waste management.

2.3 Waste Management at Large Institutions

Institutions, as mentioned in the Introduction, face a unique challenge due to the large amounts of waste that accumulate and impact their administration. To effectively deal with this massive amount of waste being acquired in a short period of time, these organizations have to first address the classification of this waste. For these settings, waste can generally be categorized into six broad categories. These categories are electronic, biological, chemical, recyclable, solid, and organic, as seen in Table 1 below, and can be modified depending on the waste found at any given institution ("Waste Management Plan", n.d).

Table 1: Waste Classifications

Electronic	Appliances, office, information and communication equipment, as well as anything with electrical components or circuit boards
Biological	Waste that contains anything with the chance to spread diseases or infections including but not limited to used bandages, needles, and blood
Chemical	Any chemicals, hazardous or not, that are produced on any scale and then disposed of
Recyclable	Glass, metal, paper, and certain plastic materials that can be reused or broken down and reformed
Organic	Anything containing carbon, including food, paper, and oils
Solid	Any waste that is not organic or recyclable which is put in a landfill (eg. styrofoam, food wrappers)

An example of an institutional waste management system can be seen at St. John's University in the United States. Its waste management plan "is intended to provide a roadmap for the proper management of wastes generated." This plan breaks up the waste into six categories: chemical, special, universal, red bag/medical, radiological, and regular trash. Within each category, the type of trash that complies with the standards of the university is clear and easy to understand. Once the type of waste has been determined, the information regarding handling, storage, and disposal is readily available for users. The university also describes the department which oversees the maintenance of the plan throughout the year. This department is known as the Environmental, Health and Safety department and its contact information is clearly marked within the plan in case there are questions regarding waste disposal or the content within the written waste management plan. The setup and presentation of the waste management goals and methods are straightforward, clearly written, and very descriptive. The university has also created a credible waste management plan by citing the laws and regulations of the state that have helped to guide the methods for waste disposal ("Waste Management Plan", n.d).

Dalhousie University, located in Nova Scotia, Canada, presents a credible waste management plan by demonstrating that it was created by communicating with many different facets of the community. The information included was agreed upon by students, staff,

government representatives, the office of sustainability, and the Resource Recovery Fund Board. By combining the opinions from all contributors to the university's community and its waste reports and guides, Dalhousie's waste management plan addresses concerns that may not have been addressed otherwise. The first section of this plan illustrates the contacts that are available for any questions or concerns. It describes the departments and their contributions to the plan in order to illustrate the plethora of views incorporated. The second section describes the waste streams and the categories into which the university has divided waste on campus. These are as follows: "fibre, organics, plastics, recyclables (plastics, metals, and glass), white goods, universal waste, construction and demolition waste, and garbage." The streams for general waste collection include specific locations for paper, organic, recyclables, refundables, and garbage. The university also goes on to include more specific breakdowns of the material that is acceptable to place in each stream. This information is also included through visual aids on the garbage collection sites. Within the waste management plan this breakdown of materials for each garbage stream is put into a categorization chart as a summary of the section. A major challenge Dalhousie University encountered was the tracking of how well the new waste management plan was working. With the current system in place, Dalhousie found it was not getting accurate weights of each type of trash and has plans to look into this issue in the future. Overall, Dalhousie University's waste management plan was designed to be broad enough that it could be implemented at other universities, while meeting all the specific needs on its campus ("Solid Waste Management Plan", 2015).

Waste management plans, as mentioned in the above examples, require participation of the community to make an effective impact. Advertising is a powerful tool used to influence and persuade groups towards certain viewpoints. However, if the advertisement is done poorly, it may have no impact on sales or may even negatively impact sales (Thomas, 2016). Thomas, in *Advertising Effectiveness*, suggests that surveying the target audience is a vital way to know what is necessary to persuade a specific demographic, and many advertising firms have skipped this part of the process. One example of effective advertisement coinciding with the implementation of a waste management plan is illustrated by a study done at the University of Wisconsin-Whitewater. The goal of this study was to understand the effects of different marketing techniques for recycling on a college campus. Students were broken up into five groups based on their dorm locations, which included a control group (no marketing techniques), a passive

marketing group (poster campaign), an educational programming group, an eco-rep program, and a Facebook marketing group. Of all five groups, the passive marketing group had the largest effect with an increase of 3.2% in recycling efforts. The educational program, eco-rep program, and the Facebook marketing group had increases of 3.1%, 2.6%, and 1.2% in recycling efforts, respectively. The results from the passive marketing group are seen as 95% statistically significant. This study was done over the course of three years and overall the recycling efforts of the the passive marketing group increased by 16.5%, compared to an increase of 9.11% in the control group (Marks, 2013). As stated before, advertising can be effective when implemented correctly. The University of Wisconsin-Whitewater was able to prove through different techniques that mindsets can change when the audience is properly targeted.

2.4 The Technological University of Panama: Emerging Leader of Sustainability

The Technological University of Panama's Campus Victor Levi Sasso sees about 16,000 students and staff within their population per year. The university has recently begun to take part in innovative approaches to promote sustainability. Examples of these initiatives include a garden and planned forest conservation area, participation in the Solar Decathlon, and efforts revolving around the sorting of trash and recycling.

One of the university's main sustainability efforts has been through the garden. This garden is behind the Administrative Offices of UTP, and produces a variety of flowers, fruits, and vegetables year round. This provides the university a way to offset the need for purchasing food from outside food sources. Currently, the size of the garden area does not allow for enough food production to substantially decrease the cost of food. If expanded upon, the cost of buying food from an outside source and paying for the transportation of the food would impact the university's budget. However, this does not diminish the importance of this area. Waste from fallen leaves, rotten fruit, and clippings all provide the makings of composting fertilizer. The university has already begun to use this fertilizer by incorporating the compost in soil, with plans to expand the amount of compost they produce by using leftover food from the cafeteria in the future. Furthermore, there are ideas in place to turn the garden, seen in Figure 1, into a wildlife preserve for animals indigenous to the rainforest. By using plants indigenous to the area, UTP

plans to create a sanctuary for birds and monkeys that were once living where the campus was built, thereby reducing the strain of campus expansion on the habitats of indigenous species (Appendix E).

Figure 1: Section of the UTP Garden Area

In 2015, the Technological University of Panama, along with Western New England University, competed in the Solar Decathlon. This is an international competition among universities which incorporates ten challenges around designing and building full-size, solar-powered houses. The Solar Decathlon challenges teams from universities to think outside the box when it comes to solar energy and emphasizes the fact that solar power is a cleaner alternative to fossil fuels. The ten competitions not only focus around the design and building of the solar powered house, but also challenge teams to think about comfort, health and safety, and marketing aspects when it comes to the houses they build. UTP and WNEU placed 14th overall out of 16, yet tied for first in the Affordability Contest and placed second in the Energy Balance Contest ("Solar Decathlon", n.d).

Another recent environmental project at UTP focused on the air quality around the campus due to the university being more cognizant of its environmental footprint. A team of fellow WPI students conducted a project concurrently with this project, setting up multiple sensors around campus which measure major air quality indicators such as, humidity, carbon dioxide, nitrogen dioxide, and temperature. The data will be compiled into an interactive webpage that shows the current sensor readings and graphics for past readings. This webpage will then be viewable to anyone who goes on the main website for UTP.

Furthermore, in 2016, a recycling campaign at UTP through the Ministry of Economy and Finance (MEF) was started to address sorting the waste produced. The Ministry of Economy and Finance, a government entity, oversees recycling on campus and provides the personnel to handle recycling. However, this did not last very long due to internal and external issues.

Internally, the MEF wanted personnel to gather all of the trash at the disposal sites and sort it there. However, this approach was unsuccessful because it did not have the necessary work force behind it. The amount of workers on campus was not enough to sort all of the waste at the disposal sites, and more help was never provided. In this situation, the lack of workers provided by MEF led to this effort's failure. Externally, only the front end of the recycling plan was developed. The departments of Student Health, Civil Engineering, and Environmental Engineering placed bins around campus for the sorting of trash. Once the trash was sorted, no plan was implemented for the trash to then be taken to its respective locations for disposal or reuse. Another attempt with recycling bins was done by a business that places recycling bins in Panama City and tested the system on campus. However, this company failed to come back and retrieve the bins, therefore leaving the university maintenance no choice but to mix all the waste going to the landfill, Cerro Patacón (Appendix F).

Section 3: Methodology

The goal of this project was to develop a waste management plan that included recommendations for the collection and disposal of all types of waste on UTP's campus. It also included details about a recycling process that could be implemented at the university, along with communication and training to support the new proposed initiatives. Below, we have broken down the process we followed to generate a waste management plan for the campus:

1. Assessed the current waste management system at UTP
2. Engaged with Key Stakeholders
3. Projected Waste Management Needs at UTP
4. Developed a Waste Management Plan for UTP

3.1 Assess the Current Waste Management System at UTP

Assessing the current waste management system at the Technological University of Panama gave our team the foundation of knowledge necessary to determine the scope of our waste management plan. To do this, we interviewed members of the university and conducted a waste audit to determine the composition and amount of waste being produced.

Interview Process

We conducted interviews with representatives from different departments in order to gather qualitative and quantitative data regarding the current waste management system, past waste management initiatives, and the amount of waste produced at the campus.

To accomplish this objective, we identified the individuals we thought were the key personnel on campus to interview. Through discussion with our sponsors, Deeyvid Saez and Analissa Icaza of the Civil Engineering Department, we determined the heads of the important departments from which we wished to gather information. These included the General Service Department, the Cafeteria Staff, and Campus Maintenance. Prior to speaking with these selected stakeholders, we developed talking points specifically for each department (Appendix A and C). The interviews varied in length. For example, the cafeteria reviewed our questions over the course of a few days, whereas the General Service Department and Campus Maintenance

answered our questions immediately during our meeting. Our bilingual sponsors and/or a bilingual graduate student were present during the interviews with the General Service Department and the Cafeteria Staff. For the interview with Campus Maintenance, we worked as a group to communicate with the staff.

The first interview conducted was with Nobdier Barrios, head of the General Service Department, to learn about basic waste management on campus. From this interview, we gathered data regarding the population on campus for the past five years and the specific times during the day when waste is brought to Cerro Patacón. Furthermore, this interview allowed us to learn about the final destination for specific categories of waste, such as biohazardous waste and chemical waste.

The second department head we spoke with was Judith Barrios from the Cafeteria Staff. The objective of this interview was to understand how many students ate at each cafeteria, each meal, every day to learn how much waste is produced. When determining the total daily waste around campus, we found the cafeteria an important place to gather data due to the student population passing through this area daily, and the constant production of waste from food.

Our team also interviewed Pedro Martinez, Director of Maintenance. This interview was about the current initiatives for sustainable waste management, and the future plans being discussed with the administration. By speaking with Mr. Martinez, we gathered qualitative information that became helpful in providing a clearer understanding of current sustainability efforts on campus.

Waste Audit

A waste audit is an important investigation as it helps generate an understanding of the composition of waste generated on the campus ("How to Conduct a Waste Audit, n.d"). Using the waste classifications of electrical, organic, biohazardous, solid, chemical, and recyclable, we conducted an audit to estimate the composition of waste and recyclable material at UTP's Victor Levi Sasso Campus. To plan out a waste audit, we first identified the disposal locations at UTP. This helped us understand where the daily trash is collected and combined from all locations on campus. These sites were all described to be outdoors, but were not specified by location. By speaking with Mr. Barrios, we received basic information on where these disposal sites were.

Once each site was identified, we gained the ability to examine what was being disposed of at each location across campus.

In order to estimate percentages of waste per category, we sampled one random trash bag from each of the five waste disposal sites on three consecutive days, totaling to 15 bags of waste. The bags were collected at two in the afternoon on each day, as this was the time that had the highest trash output (Barrios, pers. comm.). The bags were opened at the disposal sites when we collected them, and the trash was sorted by category into smaller bags. The categories we separated the waste into were the same categories mentioned in Section 2.3, which were solid, organic, recyclable, and electronic. Each smaller bag of categorized waste was weighed individually. As seen in Figure 2, we used the weight of a team member while holding the trash subtracted by the weight of the team member not holding the trash to find the weight of the sorted trash.

Figure 2: Weighing Sorted Trash

We used this approach to lower biases that may have been present between days, and also to quantify the waste at the individual disposal sites. This information then gave us a general sense of the waste that each building produces as well as the whole campus. From the information on student population, the interviews we conducted, and the percentages of waste found in the audit, we were able to generate an approximation of how much and what kind of waste is produced per day.

3.2 Engage with Key Stakeholders

The second objective was to understand the feasibility and acceptance of a new waste management plan on campus. We accomplished this objective with three main components. These components included interviews with recycling companies around Panama, a survey of students and faculty at UTP concerning communication and training, and an in depth interview and case study of a campus focused on sustainable initiatives close to UTP.

To understand which companies would be willing to partner with UTP in a recycling initiative, we worked with a student from the Civil Engineering Department of UTP to contact recycling companies in the Panama City area. Out of the eight companies we contacted, we received information from four of them. This communication aided in the definition of final waste disposal procedures.

The second component included a survey sent out to students at UTP with the help of our sponsors, Professors Icaza and Saez. The intention of the survey was to gauge interest regarding recycling habits and community outreach strategies, such as possible posters for increased awareness on campus.

The final component was conducting a case study of Ciudad del Saber, an institution that is making efforts to improve sustainability through Leadership in Energy and Environmental Design (LEED). We set out to learn about the system in place at Ciudad del Saber, as well as to understand if there were any specific recommendations about how to implement a successful waste management system at UTP. An interview with the manager of its Environmental Management Department supplemented our recommendations for recycling practices at UTP and enabled us to learn valuable information about the recycling process in the country of Panama.

3.3 Project Waste Management Needs at UTP

Before generating recommendations for a waste management plan, it was necessary to estimate the quantity of waste UTP will potentially produce in the future. To do this, we compiled information to make projections about the population of students and staff, the amount of waste that would be sent to Cerro Patacón, and the pricing from Cerro Patacón for the waste brought to the landfill.

The maintenance department and online records of the university were instrumental in the development of this data and the extrapolated results. Using the university's online population records for the previous five years, predictions were made to estimate the population for the next four years. With this population data as well as waste weight data, we estimated the waste that will be produced in the coming years. We then projected the cost that will occur due to waste being transported to Cerro Patacón. This information helped us understand the components of a waste management plan that needed the most focus in regards to the Victor Levi Sasso campus of UTP.

3.4 Develop a Waste Management Plan for UTP

Our final objective was to create a waste management plan for the campus consisting of three main components to illustrate our research. These included recommendations for collecting, sorting, and methods of communication and training about sustainable practices. Our plan incorporates suggestions that are mainly focused on solid, electronic, organic, and recyclable waste. For the recyclable material we determined the most important components to research would be the design of the sorting bins, the location of bins around campus, and the process of collection. In regards to solid waste found on campus, we determined feasible courses of action to alleviate waste going to Cerro Patacón. For the purposes of the solid and electronic waste, we developed options to reduce the amount of waste produced. In addition, we developed a separate component of communication and training aids to further the success of a new initiative.

Section 4: Findings and Analysis

Detailed below are the findings our team compiled to construct our waste management plan for the Technological University of Panama.

4.1 Current Waste Management at UTP

The findings on the current waste management at UTP enabled us to comprehend the areas to focus on in a new waste management plan.

Disposal Sites on Campus

As discussed in Section 3.1, our team evaluated the waste collection at the Technological University of Panama. This process first involved finding the disposal sites located around the Victor Levi Sasso Campus, and then conducting a waste audit over the course of three days at each site. From the interview we conducted with Mr. Barrios, the head of the General Service Department, we learned that there are five total disposal sites across campus, from which a truck collects trash every morning at 6:00 AM. These sites were all described to be outdoors, but were not specified in location.

Our team surveyed the campus on foot and identified each garbage disposal location. The sites all had a similar appearance and below we have provided a sample image along with their locations on a map.

Key:

A: Building 4 Site

B: Building 1 Site

C: Building 3 Site

D: Administration Site

E: Building 8 Site

Figure 4: UTP Disposal Site Locations and Sample Image

Waste Composition

By completing the waste audit, our team was able to compile the total weight of the waste and create statistics of the percentage composition by category, which provided a rough estimate of the actual composition of waste. Since Cerro Patacón and most recycling companies we contacted use weight to figure the cost of disposal, we thought it was appropriate to do our measurements in the same fashion.

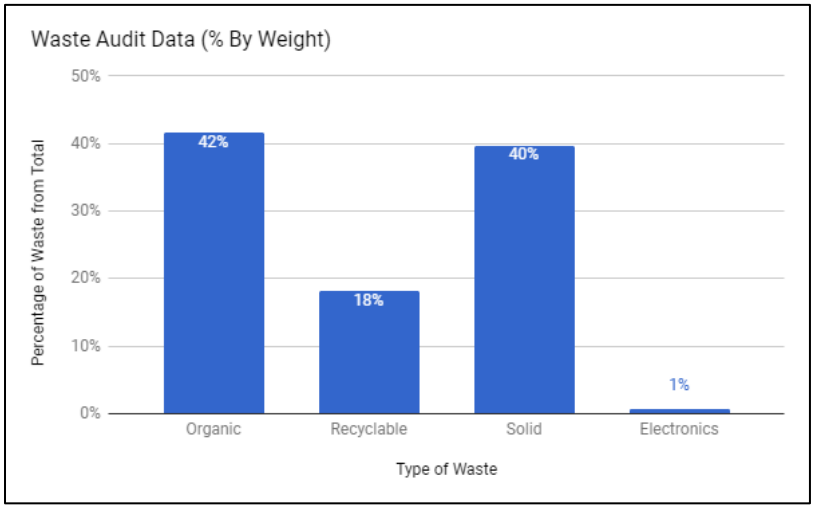

Figure 5: Composition of Waste Observed in the Waste Audit (% By Weight)

The raw data from the 15 sampled garbage bags can be found in Appendix G. Our direct results from the waste audit showed that the largest sections of waste found on campus are organic, recyclable, and solid waste.

Current Waste Management Processes at UTP

Chemical

From our interview with Mr. Barrios, we learned significantly more about the system currently in place for chemical waste. Chemical waste, in the context of UTP, is comprised of any chemicals that are used in experiments in classrooms and laboratories. Whenever chemical waste is produced, it is brought to a specified location for collection on campus. The chemicals are put into large vats that classify and separate the contents. The university has employed a separate company that is responsible for collecting and disposing of the chemical waste that is produced.

Biohazardous

Our interview with Mr. Barrios also gave us substantial information on the system for biohazardous waste. The only source of biohazardous waste on campus is from the clinic, which produces less than 1% of the total waste on campus. This small amount of biohazardous waste is placed in a five gallon bucket with a gasket lid that is collected once a week by general services and taken to Cerro Patacón.

Organic

Currently, there is no initiative for separating organic waste for composting by the general population at UTP. However, from our interview with Mr. Martinez of the Maintenance Department, we learned that all of the environmental organic waste from the garden is used to make compost that fertilizes the garden.

Solid, Recyclable, and Electronic Waste

From our interview with Mr. Barrios, we learned that there was no system in place to sort solid, recyclable and electronic waste. This waste is combined and sent to Cerro Patacón unsorted. Through further investigation, our waste audit revealed that electronic waste produced was approximately one percent of the total waste sample, while solid waste was approximately 40% of the total waste and recyclable was 18%. It became clear that by recommending new

methods of collection for solid and recyclable waste, we would be able to aid in UTP's reduction of waste being sent to Cerro Patacón.

4.2 Stakeholder Engagement

Survey Results

As mentioned within Section 3.2, a survey was done to understand current recycling habits and obtain an accurate understanding of which posters connected with the target audience. The survey received a total of 85 responses for the questions "Would you recycle?" and "Do you recycle elsewhere?", 21 responses for the question "If you do recycle elsewhere, where?", 122 responses of likes for all posters, and 118 responses of dislikes for all posters,. These responses came from the students at the technological university, and resulted in the following data:

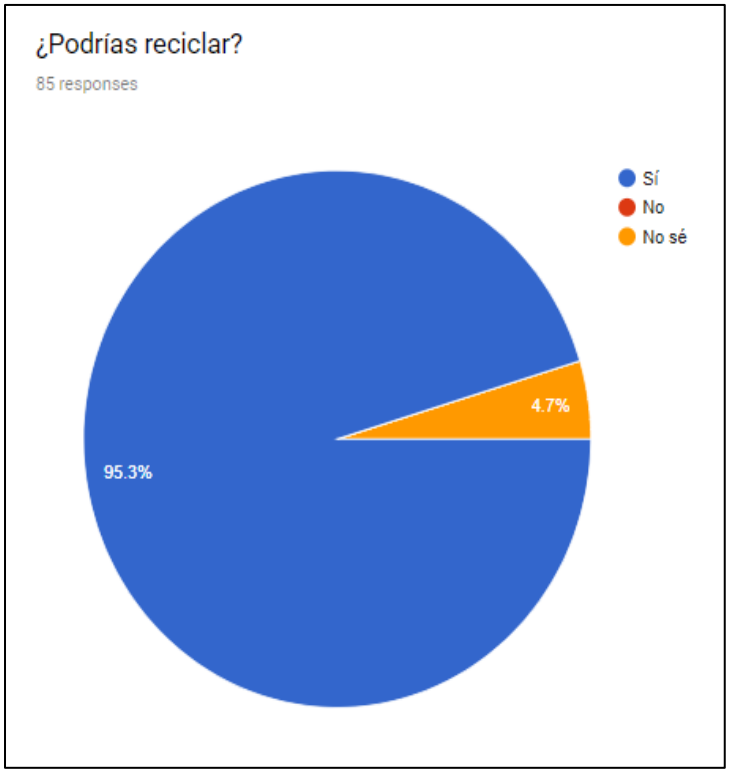

Figure 6: "Would You Recycle?" Results

Figure 6 asked the participants if they would recycle if a recycling initiative was started on campus. It is important to note that zero participants said no.

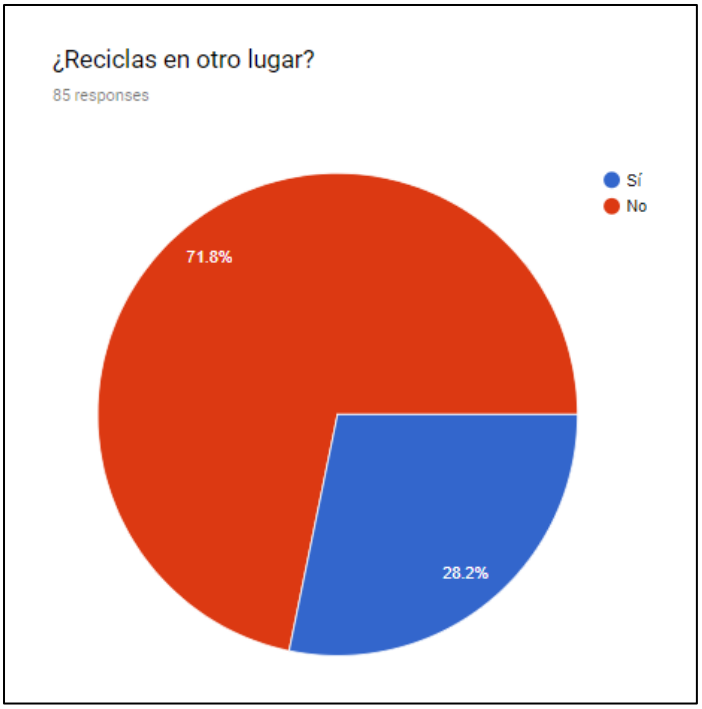

Figure 7: "Do You Recycle Elsewhere?" Results

Figure 7 asked the participants if they have recycled elsewhere in their lives. ~72% said no and ~28% said yes. It was then recognized that members of the UTP campus were not used to recycling and their habits had to be changed for the success of a recycling initiative.

Table 2: "If You Do Recycle Elsewhere, Where?" Responses

Area	Number of Students
Home	8
Streets	1
Work	2
Supermarket	3
Visiting England	2
UTP	1
Universidad Católica Santa María La Antigua	1
Malls	1
Recreation Areas	1
Televisora Nacional	1
The first thursday of the month	1
When recycling is available	2

Table 2 shows the various locations that participants of the survey said they recycled at. It can be shown through the information above that the locations are scattered and not consistent, reinforcing the idea that recycling habits for the students on campus are not well established.

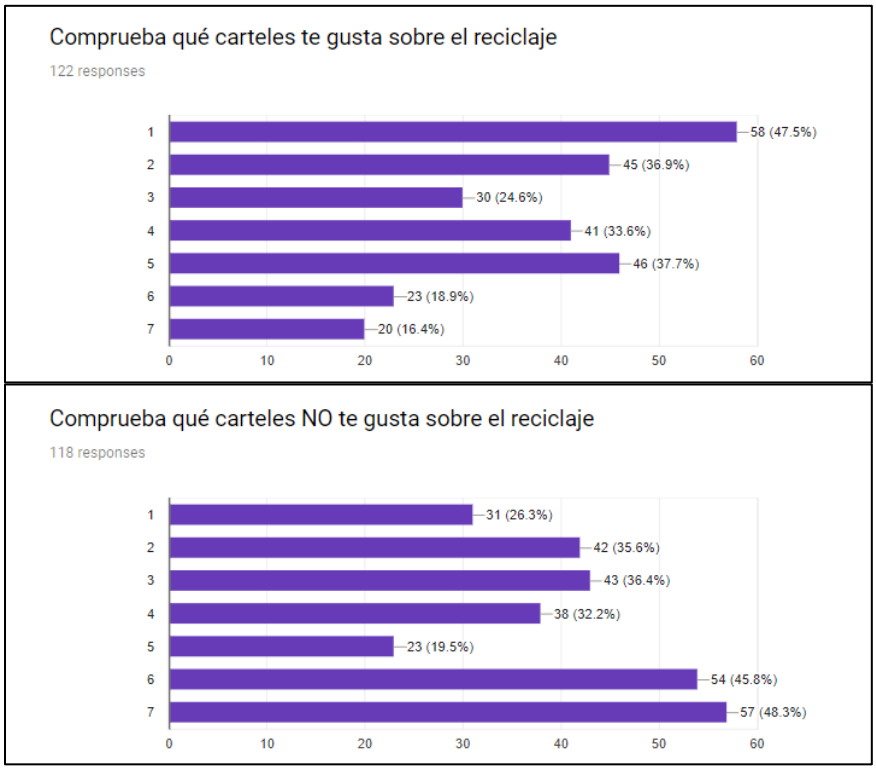

Figure 8: Results of Posters LIKED and DISLIKED

Figure 8 displays each poster number along with the amount of likes and dislikes voted on by the participants of the survey. These results helped us form conclusions on which posters should and should not be used, which is further detailed in Section 5.5.

Responses from Recycling Companies

In order to make recommendations for recycling collection from UTP, we contacted companies in the Panama City area to learn about their services. The responses below are summarized from a conversation between the companies and a UTP student who helped with the Spanish translation. More information regarding our survey questions for each company can be found in Appendix K.

Gesvil

The materials recycled by this company are iron, metal, aluminum, bronze, cans, paper, cardboard, plastic, soda bottles, air conditioners, electronic boards, and batteries both with and without acid. For collection, the school would have to sort the material beforehand and bring it to the collection site. The price by weight is given when the trash is brought to the site, and does not have a specific range. The company does serve the area where the Victor Levi Sasso Campus is located and is a half hour drive away (Gesvil, pers. comm.).

FAS Panama

FAS Panama accepts newspapers, printed paper, plastic containers (No. 1 and No. 2), oil (except fish oil), tin plate, aluminum cans, cartons, small ink cartridges, electronic scrap, batteries, and directories. Since the car the company operates is currently damaged, the materials need to be taken to FAS Panama's location. Furthermore, the company did not specify any price for services. FAS Panama does serve the area surrounding the campus, but does not provide the containers necessary for sorting and waste pick up. When bringing the recyclables to the site it would be best if the material was separated, but the sorting can also be done on site (FAS Panama, pers.comm.).

Panama Recycling Group

This company recycles cardboard, paper, and plastic, but specified there should not be any tetrapak material brought to the site. Panama Recycling Group does serve the area where the campus is located and will collect the material from the school, but it depends on the volume that needs to be picked up. If it fills a truck, then the company will be prepared to take care of it when the trash arrives at the collection site, but the school has to arrange the transportation. When the material is brought to the collection site, the company compensates the school for the material based on weight and type. The compensation prices are as follows: $60/ton of cardboard, $60/ton of plastic, $20/ton of Polyetherketone plastic (PEK), and $20/ton for No. 2 plastic (HDPE). If the material is brought to Panama Recycling Group, this compensation increases about $10, and if packed, increases $10 as well. Furthermore, the material must be free of organic waste when brought to the site. If the university begins to work with this company, the plastics can be mixed at first, but Panama Recycling Group must see that there is a plan in place to begin separating the material. For three months the company will separate plastic, but UTP needs to separate paper, cardboard, and aluminum. After six months, the university must separate all six types of plastic.

There was not any information provided about the containers for waste sorting and pick up (Panama Recycling Group, pers. comm.).

Aceros Caribe

Aceros Caribe only recycles metals and can collect materials on campus, or the material can be brought to the company's collection site. For iron, the compensation is $150/ton, and for aluminum, $0.5/lb. The total price will depend on the quantity, quality, and location of the material. The company will serve the campus, but there must be a considerable amount of waste for Aceros Caribe to collect it directly from the UTP's Victor Levi Sasso Campus. If the company picks up the material on campus, Aceros Caribe will collect all the waste, classify it into specific containers, and take it back to the work site. The material does not have to be sorted before pick up, but Aceros Caribe does charge for mixed waste and prefers the waste to be sorted. If Aceros Caribe does make a plan to work with UTP, the company is willing to work on a deal to provide sorting containers for the university if necessary (Aceros Caribe, pers. comm.).

Results from Ciudad del Saber Case Study

The following information about recycling at Ciudad del Saber is summarized from an interview on September 21st, 2017 with the Manager of Environmental Management, Alessa Stabile.

The campus of Ciudad del Saber is about 296 acres and has a waste management plan comprised of just two categories, recyclable and non-recyclable. For recyclable materials, there is an agreement in place with FAS Panama to manage a program. The responsibilities of FAS Panama include receiving recyclable waste, sorting this waste into its respective components, and finding buyers. Ciudad del Saber subsidizes the car that is used and pays the difference between the cost of recycling and the amount sold. Ciudad del Saber is also in charge of paying the wages of the five workers who sort through the collected material. Furthermore, FAS Panama does not have a washing station. Therefore, if participants throw away dirty recyclables the material is unusable. Residential participants are responsible for bringing their recycling to the sorting station, but any communal containers are collected by maintenance workers. The sorting station is a warehouse where there are designated locations for each type of recyclable material, and can be seen below in Figure 9.

Figure 9: Sorting Warehouse at Ciudad del Saber

The five full time workers each sort approximately five tons of waste per month and the center receives about 25-30 tons of waste per month. Ms. Stabile recommended the setup of a point for recycling material collection for each building to simplify the collection process. She also stated she would be able to recommend an approximate amount of space needed for the warehouse in order to start a program. For the design of collection bins, it was determined through our interview with Ciudad del Saber that having separate streams of materials is key to success. Ms. Stabile also stated that it is important to put recyclables in clear plastic bags to help the sorters determine what is inside.

When asked about the success of the program, Ms. Stabile stated that there has definitely been a rise in the amount of recycling material being collected, but Ciudad del Saber has not measured how much waste is being diverted from Cerro Patacón. A follow up question about the success of the program regarded the issues Ciudad del Saber may have faced when starting its recycling initiative. It was found that the process of separation is the most difficult, as most people are not used to it. Participation in the program is also a constant struggle because it is the start of a cultural shift towards sustainable practices. Because of this, Ms. Stabile recommended the addition of a spokesperson or group to spread awareness and volunteer to keep the program

running. One example of Ciudad del Saber's constant efforts to increase participation can be seen when there are events on campus. It is required that a participant of the event be present near a recycling bin in order to demonstrate best practices among the group.

Aside from recycling at Ciudad del Saber, we were also able to gain information about the recycling system in Panama as a whole. We learned that the only materials which are transformed in Panama are paper recyclables. All other forms of recyclable material are exported to different countries for transformation. The process is very dependent on the buyer and the global market, which is why they store the material until they fell it is a profitable time to sell. There are also often strict regulations on the material that can be bought. For example, labels of cans need to be torn off before exportation. During this interview we also became aware of an already existent relationship between FAS Panama and UTP's Tocumen Campus which brings oil to the collection site at Ciudad del Saber. The costs that would be incurred by the setup of this program would include the establishment of a warehouse and the wages of workers who would need to separate the waste. For Alessa Stabile's contact information regarding the recycling campaign at Ciudad del Saber see Appendix K.

4.3 Projected Waste Management Needs of UTP

From our interviews with general services we were able to obtain information about the student population on the Victor Levi Sasso Campus for the year of 2016. We were also able to gather information about the amount of waste going to Cerro Patacón for the past couple years. As seen in the chart below, the highlighted numbers are totals for years 2015, 2016 and the total through August of 2017. This chart was used to make projections for total cost and expected weight of waste in the coming years. The worked hours column reports the total hours worked by the maintenance department.

Table 3: Waste Weight and Cost 2015

Year	Month	Worked Hours	Weight (Tons)	Cost of weight	Diesel Used	Cost of Diesel
2015	January	125	24.82	$412.20	301.110	$294.52
	February	96	16.87	$285.01	40.380	$107.09
	March	104	24.20	$405.76	171.164	$168.38
	April	120	28.83	$492.68	61.655	$233.85
	May	104	24.20	$405.76	171.164	$168.38
	June	130	35.02	$548.78	279.977	$268.90
	July	139	42.26	$699.88	295.218	$198.55
	August	117	32.98	$549.09	229.308	$141.45
	September	134	36.02	$599.95	244.782	$144.10
	October	142	43.86	$737.85	268.911	$246.26
	November	88	29.22	$480.20	163.326	$94.34
	December	58	9.27	$160.31	113.628	$62.00
2015 total	**JAN-DEC**	**1357**	**347.55**	**$5,777.47**	**2,340.623**	**$2,127.82**

Table 4: Waste Weight and Cost 2016

Year	Month	Worked Hours	Weight (Tons)	Cost of weight	Diesel Used	Cost of Diesel
2016	January	112	17.17	$302.09	193.866	$108.95
	February	106	23.59	$401.03	216.828	$100.64
	March	124	31.68	$539.12	226.040	$109.27
	April	126	27.10	$456.62	216.437	$107.64
	May	129	42.16	$719.44	226.892	$125.04
	June	139	42.17	$713.72	237.751	$138.19
	July	125	23.74	$406.01	244.437	$143.21
	August	113	24.91	$422.65	227.399	$126.79
	September	137	36.12	$613.78	221.413	$125.81
	October	134	37.09	$630.59	277.350	$164.81
	November	98	23.33	$388.54	164.406	$95.30
	December	69	15.51	$262.62	118.056	$70.00
2016 total	**JAN-DEC**	**1412**	**344.57**	**$5,856.21**	**2,570.875**	**$1,415.65**

Table 5: Waste Weight and Cost JAN-AUG 2017

Year	Month	Worked Hours	Weight (Tons)	Cost of weight	Diesel Used	Cost of Diesel
2017	January	122	28.52	$499.14	216.565	$137.37
	February	112	34.44	$570.08	158.119	$99.97
	March	135	31.67	$545.59	210.050	$129.21
	April	113	39.08	$663.26	233.470	$142.73
	May	149	54.11	$908.46	220.973	$133.96
	June	143	47.83	$801.80	340.836	$202.23
	July	136	49.11	$832.75	422.058	$245.03
	August	137	54.20	$828.95	310.740	$194.26
2017 current	**JAN-AUG**	**1047**	**338.96**	**$5,650.03**	**2,112.811**	**$1,284.76**

With the information of how much waste was produced in 2015 and 2016, we determined the average waste generated per person by dividing the waste produced by the total population on the campus for both years. The resulting waste produced per person was 41.07 pounds. In comparison, the total waste at the end of 2016 was 344 tons, whereas through August of 2017 338.4 tons have already been produced. This is a large increase from 2016, in which only 232.52 tons of waste had been produced by this point in the year. In Figure 10, the total waste per month is illustrated for the years 2015, 2016, and through August of 2017. This demonstrates the clear increase in waste per month for the year 2017 compared to other years.

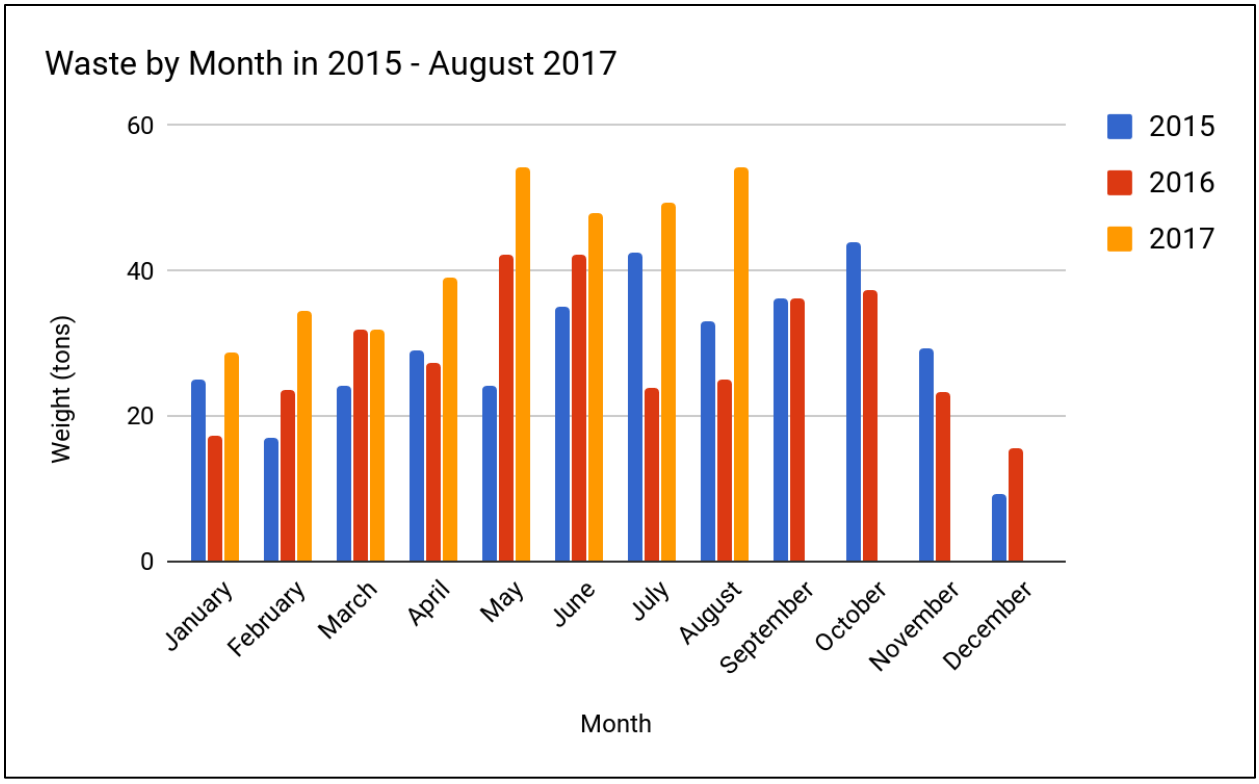

Figure 10: Total Waste by Month 2015 - August 2017

For the months that do not have waste data for 2017, we used the average of the respective months from 2015 and 2016 and added this to the total through August. For example, we averaged the waste from September of 2015 and 2016 and then used this number as the total waste for the month of September for 2017. This gave us approximately 450 tons of waste for 2017. Due to a minimalistic range of data obtained by our team, we believe that the final projection of the year 2017 can fluctuate based off of our rough estimate. By extrapolating the population data, obtained through UTP's website, we were able to find a trend and make predictions for the population in the coming years. We then constructed general predictions on waste for the next few years based on the population trend and the average waste per person in 2015 and 2016. These results are shown in the following figures.

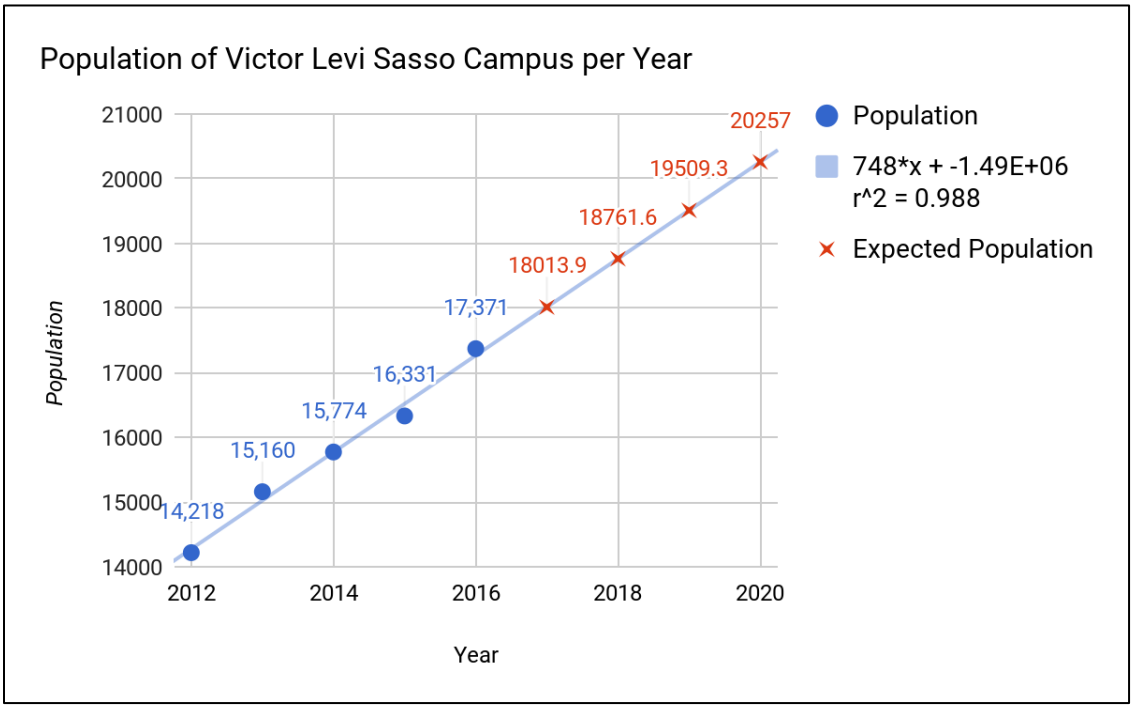

Figure 11: UTP Population Projections To 2020

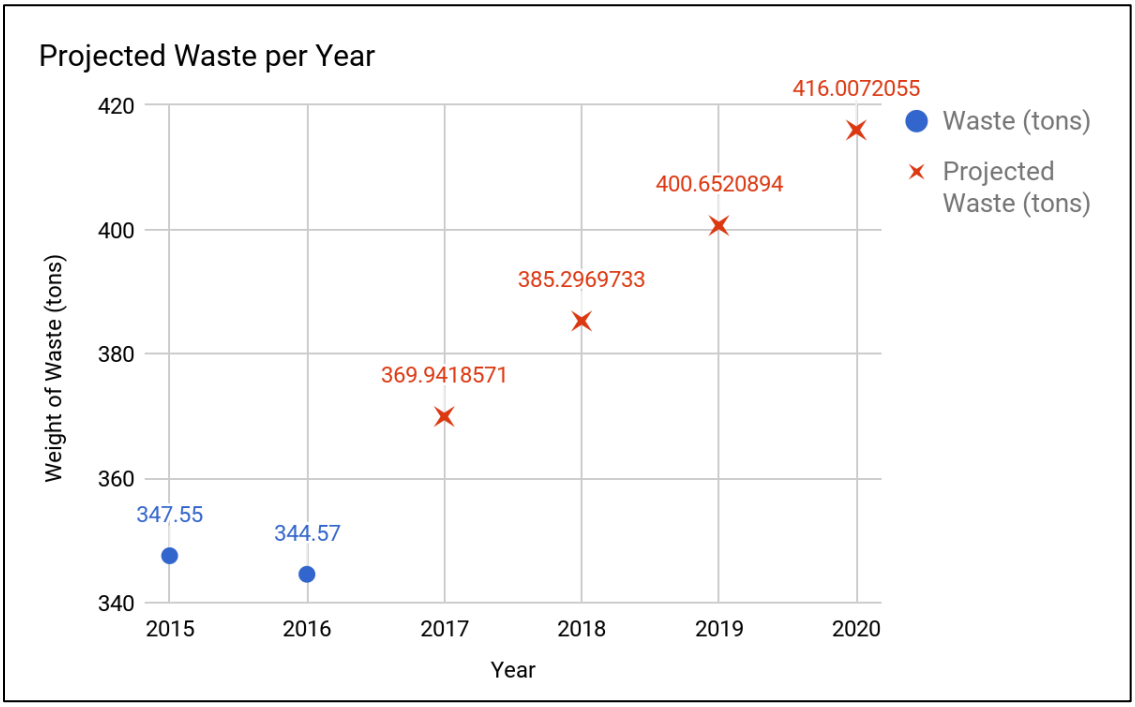

Figure 12: Projected Waste Per Year to 2020

In order to make a more robust waste management plan, we made projections on the population, waste, and cost of waste through the year 2020. Based on our projections, at the end of 2017 UTP will have accumulated approximately 357 tons. Since through the month of August the campus has seen 338.96 tons of waste, this would leave an approximated 19 ton increase for the remaining four months. This prediction for the remaining four months of 2017 had an average of five tons per month, and out of the two full years of data we received, the lowest waste produced in a given month was nine tons. This lead us to believe our predictions for the coming years may have a high degree of uncertainty. The predicted cost of waste was then generated for the predicted waste of the coming years. To do this, we calculated the average price per ton for disposal at Cerro Patacón. Our cost predictions include diesel, but not labor or equipment, and can be seen below in Figure 13.

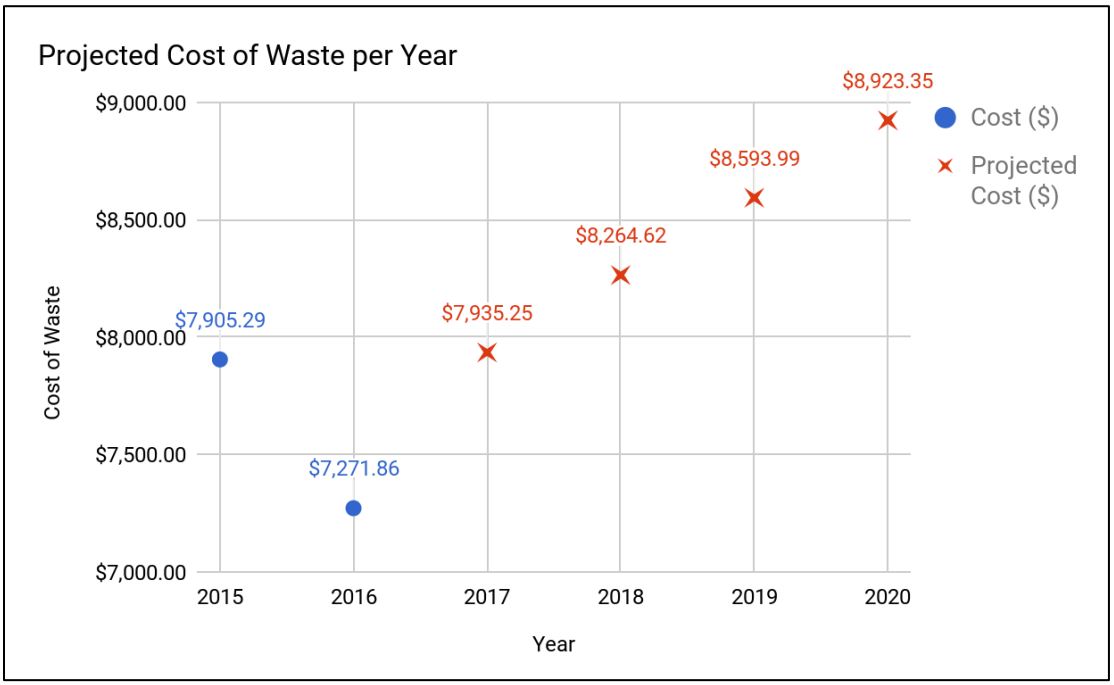

Figure 13: Projected Cost of Waste per Year to 2020

These projections are rough estimates and, while helpful to get a very general idea for our project, are subject to much variability due to external factors. These external factors may include the increased number of buildings on campus, utilization of refillable water bottles, or a fluctuating expected job market for students of the university which affects the number of incoming students. The costs may also vary based on diesel prices and the price Cerro Patacón charges for waste.

Section 5: Recommended Waste Management Plans for UTP

With a full understanding of the current waste management plan in place at UTP, as well as the amounts of the different types of waste produced, the next step was to create a new plan to accommodate all categories of waste. With a system already in place that is safe and effective for chemical and biohazardous, we are recommending the continuation of these programs and have not made any modifications to the current processes. Along with accommodating for each in-scope waste classification, recommendations for communication and training are included within our plan.

5.1 Recommendations for Solid Waste

Solid waste was found to be one of the biggest components of total waste coming from the campus. This waste mainly comprised of styrofoam take-out containers from the cafeteria, solid waste from the bathroom that was not flushed, and wrappers. To combat the production of this waste, we have produced a few recommendations.

We believe a feasible recommendation to alleviate styrofoam waste from the cafeteria would be to use biodegradable materials for the take-out containers. These biodegradable food containers could help reduce the environmental footprint of the university by not changing the habits of students or faculty in any way. This would be a simple change that could be done without much planning or delay, as the only change is to replace the current take-out containers with new biodegradable ones. These containers are able to decompose, however if they are taken to the landfill there is the concern of not being exposed to enough oxygen. Without the proper amount of oxygen, these containers may not fully be able to decompose. For this we recommend sorting these new containers with any organic waste, as they decompose in the same way as most organic materials (Bois, n.d).

To counteract the production of waste from styrofoam take-out containers we would like to also recommend the implementation of reusable containers. Compared to our first recommendation, reusable containers are seen as a long term solution whereas the biodegradable containers are an immediate course of action. A similar process has been implemented at WPI,

where a student pays $5 to receive a metal clip as a form of identification for ownership of a reusable container. This process is illustrated in Figure 14 below. The student can then trade in the clip for a reusable take-out box to bring anywhere on campus. Once finished with his or her meal, the student can return the container even if the box is still dirty. If implemented at UTP, the cafeteria would need to take on the extra work to make sure the containers would get washed before reuse. When the student is done using the program they can return the metal clip and container to get a refund for their initial $5 deposit. This deposit helped to make the initial investment of purchasing the containers for the school community. Once there was a reduction in the amount of trash the cafeteria produced, WPI was able to use the extra money to give refunds to students who decided to stop using the program ("What's Happening", n.d). Although the initial investment may be a larger upfront cost than expected, the investments from students would help to alleviate this cost.

Figure 14: WPI Reusable Container Initiative

From our observations during the waste audit we found a significant amount of solid waste was coming from the bathrooms. To reduce this amount of waste, we recommend the initiative of having signs and notices to encourage the action of flushing toilet paper waste. Although this may differ from customs at home for many students, it would aid in decreasing the amount of waste coming from the university's campus. This would then reduce the price for

waste going to Cerro Patacón which could be invested otherwise, such as in a reusable cafeteria container campaign. More so, UTP would have to verify that the septic system could handle the added amount of waste.

By implementing these initiatives, the campus would be able to cut their solid waste significantly. From our waste audit we found the amount of solid waste was about 40% of the total. If the students and staff take part in reducing the amount of waste coming from the bathrooms and the cafeteria, there would be a noticeable reduction in the amount of trash being sent to Cerro Patacón. If the population of the school became invested in these initiatives the possibility of cutting a third of the waste produced on campus would become possible.

5.2 Recommendations for Electronic Waste

With the growing population at UTP, there is the possibility that more electronic waste will be produced in the future. If this does happen, we recommend a system for reducing electronic waste instead of forming a contract with an electronics recycling company. For example, the spare electronic parts can be given to the electrical engineering department at UTP to start a reuse policy for electronics. The reuse policy can then prompt the use of these excess electronics as a demonstration in the classroom or as additional parts that could be used in the lab.

5.3 Recommendations for Organic Material

We also learned there is a plan set to begin in a few years to start composting the organic waste from the cafeteria. We are recommending the addition of a specific bin for organic waste in the cafeterias to communicate the goal of the initiative before starting to compost.

Our suggestions for composting include two types: windrow and in-vessel composting. Windrow composting would include long rows of piled organic waste, while in-vessel composting would utilize a storage container to house the organic waste in a controlled environment. For the campus, the main benefits of windrow composting would be the easy set-up and small amount of maintenance required. Windrow composting is also adaptable to seasonal weather change, which would be appealing for the large difference between the wet and dry seasons here in Panama. However, some downfalls of windrow composting would be the

large area needed on campus, the unsightly appearance, and the potentially unfavorable odor. Comparatively, in-vessel composting uses a container to store the organic waste as it decomposes. This type of composting would allow for faster decomposition and lower odors on the campus. In-vessel composting would be functional on campus in all weather conditions but requires constant monitoring and greater aeration than windrow composting. Aeration of the organic waste is necessary for both in-vessel and windrow composting and can be provided by maintenance with physical turning of the material or an aeration pipe. To force aeration in in-vessel composting a blower needs to be attached to the aeration pipes and this may increase the cost of composting to the school (NRMED, 1999). These two types of composting can be utilized to create a method that may best fit the school's needs. Although an initial investment would be required for the purchase of composting containers or the clearance of land, the savings from cafeteria waste could be reinvested into this campaign.

Figure 15: Example of windrow composting

Figure 16: Example of in-vessel composting

The addition of this system is important for the sustainability of the campus because it has the potential to reduce around 42% of the waste going to Cerro Patacón. This would save the school a significant amount of money through several ways. The first reduction of cost would come from not having to bring this massive percentage of waste to Cerro Patacón through external or internal resources. Another cost reduction comes from a growing food source on campus through the increase of compost. Plants will now flourish at a greater rate, and an expansion of the garden will now take less time and be more affordable. With the technological university's continuing expansion, a reduction in budget from any department can be very helpful.

5.4 Recommendations for Recycling Management

Within this section are our recommendations for recycling management. Our recommendations consist of several parts including the overall process, recycling bins, labor, and a list of components that will incur a cost.

Overall Process

We are suggesting the addition of recycling bins that incorporate the sorting of paper, plastic, metal, and other trash. Depending on the resources available and the cost, plastic and metal can be combined in the sorting bins. The next step of the recycling process would be to have a warehouse to store the waste material based on classification. We recommend the

warehouse to be on campus to reduce the need for transportation between the disposal bins and storage, which saves time and money. This location could be built or utilize any available space in a building on campus, such as a basement. Within the warehouse, there should be designated locations for the bags of paper, plastic, and metal waste while the solid waste can continue to be taken to Cerro Patacón. Using these guidelines, we created a proposed floor plan for the warehouse. There are two main areas, one for sorting the incoming recyclable materials, and another for storing these materials after separation. The dimensions we created were approximations based off of our observations at FAS Panama's warehouse. The proposed warehouse design can be seen below in Figure 17.

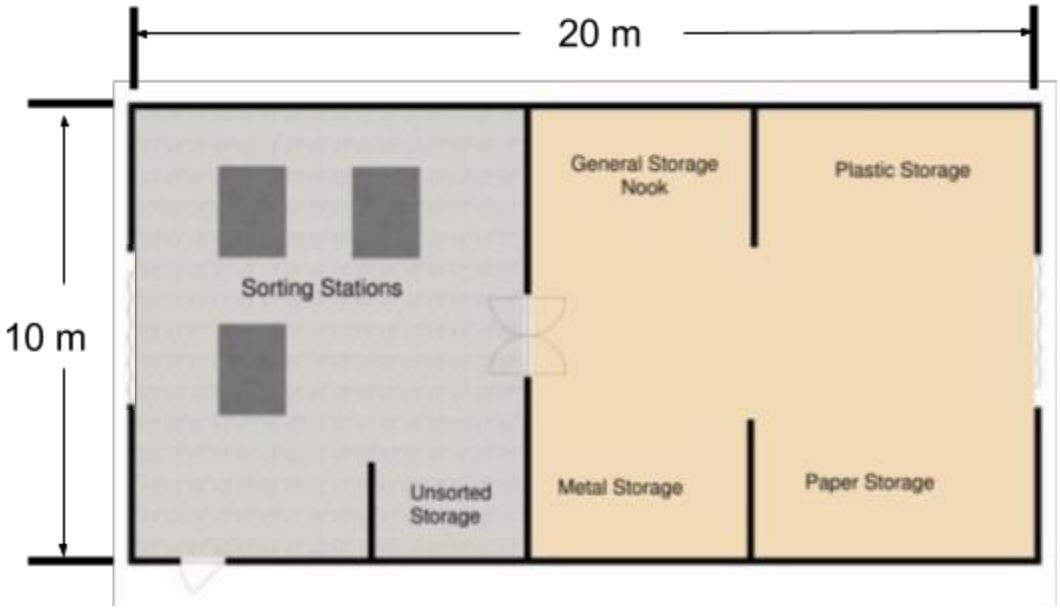

Figure 17: Proposed Warehouse Design

Since UTP already has internal transportation to bring solid waste to Cerro Patacón, Ciudad del Saber verified in our interview that this transportation could be used to bring the three types of recyclables to FAS Panama. The only type of trash that is transformed in Panama is paper product, while all other recyclables are sold and exported to other countries and need to be stored in bulk. Any profits obtained are dependent on the global market and go directly to FAS Panama, which is how the company supports itself financially. Since FAS Panama cannot front all costs that are incurred, Ciudad del Saber supplements the difference, which can be expected for a program with UTP as well. However, we were not able to get the privileged information of knowing the exact price. Currently, UTP already has a relationship with FAS Panama to recycle

oil from their Tocumen Campus. With this ongoing relationship already in place, FAS Panama would have the incentive to negotiate a more inclusive recycling plan for UTP's Victor Levi Sasso campus.

Recycling Bins

After speaking with Alessa Stabile, the manager of the Environmental Management Department at Ciudad del Saber, we were able to learn the key to success for this initiative would be "separation at the source." Because of this, we are recommending specific designs for the separation bins. Through our talks with Ciudad del Saber, we discovered this institution separates waste through two categories: recyclables and non-recyclables. However, Ms. Stabile stated that if she could go back and change Ciudad del Saber's recycling ways, she would have taken a more in depth approach to the first step in the sorting process. Therefore, when it comes to our recommendations for the recycling bins at UTP, we suggest that paper, plastic, metals, and solid waste have their own respective bins. In the cafeterias, these four bins will exist with the addition of a separate bin for organic waste Furthermore, the bags within the recycling bins should all be clear so workers can properly define the waste without the need to open up the bag. Another important design aspect is the holes by which the waste is disposed of through the recycling bins. Through the interview at Ciudad del Saber, we learned that people were not properly recycling when the holes looked the same. The institution decided to change this, and had a different shape for each hole to alert those that do not read the sign on which form of waste is acceptable. For the same reason, Ciudad del Saber took the words off the signs above the bins and replaced them with pictures to see if this will increase the amount of recyclables placed in the bins. Through this acquired information, we decided our recommended recycling bins would also have differently shaped holes. The following picture is currently what Ciudad del Saber uses in their offices, and is the type of separation that we recommend UTP should have for all bins:

Figure 18: Recycling Bin Recommendation

In pedestrian areas such as sidewalks, hallways, and large common areas the bin pictured above is the appropriate size. However, to achieve the goal of sorting in every classroom, the size of this bin may be too big. Therefore, our team has recommended that each classroom sort paper, plastic, and normal trash that is half the size of the recycling bin in Figure 18. If it is decided to place bins outside, which we recommend, then UTP has to then be aware of designs that prevent animals and water from getting into the waste. Therefore, an ideal design would be one that is raised off the ground, has small openings, and has a cover over it.

Once we developed a recommended bin design for the Victor Levi Sasso Campus, we looked into the proper locations for the placement of the bins. From a study done at the University of Houston, researchers O'Connor, Lerman, and Fritz suggested the location of the bins is more important than the amount of containers that are available. The study was conducted by keeping the same amount of recycle and trash receptacles on campus, but simply changing their locations between inside and outside of classrooms. The results illustrated that when bins were placed in a classroom, a place where beverages (ex: water bottles) are consumed, the amount of bottles being recycled doubled. They also found that the recycle bin should be within two meters of a trash can, otherwise the consumer will be more inclined to combine all types of

trash (O'Connor, Lerman, Fritz, 2010). Throughout another study done at the University of North Carolina, recycle and trash bins were moved between classrooms and hallways. In the hallways about 40% of cans were recycled while in the classrooms the number rose to 63%. The same study was conducted in a separate building resulting in the amount of cans recycled rising from 35% to 71%. Overall, the researchers determined that even though there would be a larger initial cost if recycle bins are placed in all classrooms, the placement of these bins could double the amount of cans recycled each day (Ludwig, Gray, Rowell, 1998).

Labor

We recommend UTP makes a sustainability club or "green team" that would volunteer sorting recyclables in the warehouse described above, and help spread the word about recycling around campus. If students on campus volunteered or were required to volunteer, we feel that they would be more likely to participate in this initiative. Ciudad del Saber demonstrates a course of action to reduce the lack of participation in their recycling campaign by requiring that for any event on campus, there must be a volunteer at trash receptacles. This is to make sure the regulations for sorting are being followed. This volunteer position is a job that could be useful when having weekend events on UTP's campus that attract people from all over the city.

Our project has led us to believe that the Victor Levi Sasso campus should have a recycle bin and trash can in every classroom while increasing the amount of sorting bins in areas where students congregate to eat meals and study. While these added bins may suggest a necessary additional workforce, if the community is willing to volunteer for the sorting process, there would not be a need for more maintenance workers. Since the maintenance department already has workers go to all classrooms to collect waste daily, the additional separate sorting bins would not disrupt this routine.

Incurred Cost

The various processes and implementations that coincide with our recommendations for recycling include a predicted curation of cost. Listed below in Table 6 are the components we believe will incur a cost and why.

Table 6: Components that will Incur Cost

Component	Why?
Bins	Materials for building the bins
Warehouse	Materials for constructing the warehouse
FAS Panama	Cost of the contract between UTP and FAS Panama
Labor	Before the green team is implemented, UTP will need added labor for sorting in the warehouse

5.5 Communication and Training

As mentioned in Section 2.4, a reasoning for the failure of UTP's previous recycling initiative was a lack of awareness around the subject. Because of this, our team decided upon a form of community outreach to raise awareness on campus. To reinforce our community outreach and why communication and training is an important aspect of our waste management plan, a few questions about recycling habits were asked of members of UTP. This gave us a better understanding about the recycling experience of members of the university's community. Introducing a new concept that changes old habits is a difficult task. From the data, 71.8% of the survey participants feel they need to be educated and/or encouraged when it comes to recycling and its benefits. Additionally, there were zero participants from the survey who answered no to the question concerning willingness to recycle. This illustrated a positive reinforcement for our proposed recycling initiative. Furthermore, an important aspect to note is that out of the small number of participants that do recycle elsewhere (28.2%), the locations are sparse and at times not even in Panama. Lastly, if 95.3% of people on campus do recycle as recorded from the "Would you recycle?" question of the survey, 17.2% of the 18% recyclable material found from the waste audit would be accounted for in future waste management practices. This number would significantly reduce the amount of waste going to Cerro Patacón and aid in the university's sustainability efforts. Through several reasons mentioned below, we determined that making a poster campaign and informative flyer were great ways to change the habits of the people at the Campus Victor Levi Sasso.

Poster Campaign

A poster campaign was chosen based on findings from research and outreach. A study found that among posters, printed ads, and television ads, posters had the highest return on investment (Studie von Brand Science des FAW, 2010). Another study went on to state that 74% of the people surveyed found posters to be the friendliest and most appealing type of advertising (INNOFACT AG, n.d). Along with this, posters are available to be read at all times of day, unlike a television advertisement that has a specific time it is aired. With morning, afternoon, and night classes, people on campus will always be walking by these advertisements. More so, posters can be put up at other campuses (e.g. Tocumen) because if UTP community members go to these campuses for any reason, they will still be reminded of the initiative within the university as a whole. To see a poster, one has to simply walk around campus which almost every member of the campus does each day.

To determine what posters should and should not be used, a like and dislike differential table was created. The differential table we created was based on the likes and dislikes for each poster, and subtracted dislikes from likes to get the final differential. The table can be seen below:

Table 7: Like/Dislike Poster Differentials

Poster	+/- Differential	Conclusion
1	27	Highly Recommended
2	3	Recommended
3	-13	Not Recommended
4	3	Recommended
5	23	Highly Recommended
6	-31	Not Recommended
7	-37	Not Recommended

Our team instantly knew that if there was a negative differential, that these posters had no positive reinforcement behind them and would be marked as not recommended for use (Red). That left us with Posters 1, 2, 4, and 5. Posters 1 and 5 had the highest amount of likes and a

clear lead in their differentials, and were therefore marked as highly recommended for use (Yellow). Posters 2 and 4 were harder to determine. These two posters received a high amount of likes, but also received a high amount of dislikes. In the end, the differential is still positive and we are recommending these posters for use (Blue), but are leaving it up to the university to make the final decision here. Here is a visualization of the final posters for highly recommended and recommended:

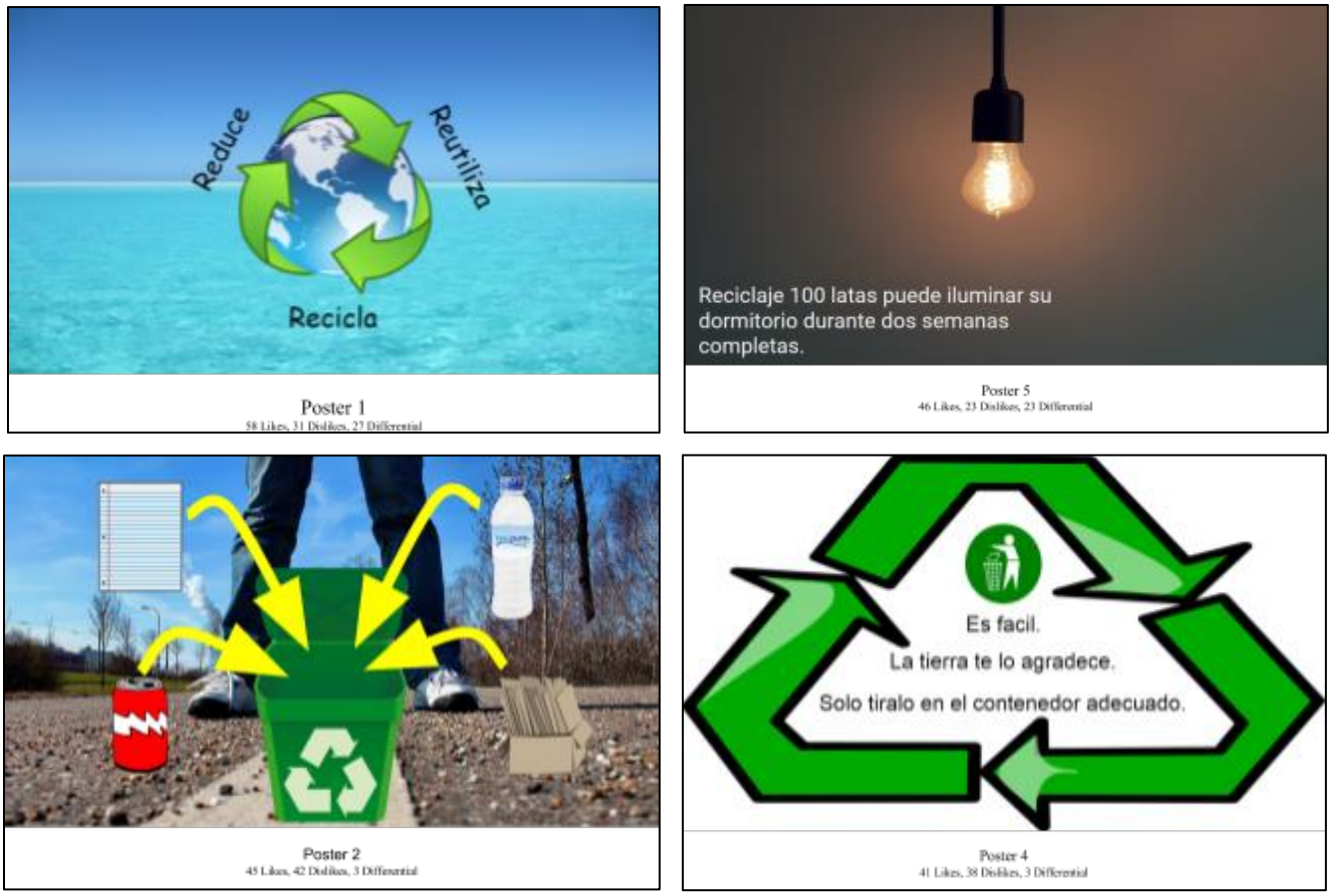

Figure 19: Highly Recommended (Top) and Recommended (Bottom) Posters

Our team has also designated locations and purposes for the four posters decided upon from our survey results. Poster 1 and Poster 2 are heavily illustrated with little to no words. These posters are designed to be placed within locations that have heavy foot traffic and low loiter time. Areas such as hallways and pedestrian areas fit these categories. Poster 4 and Poster 5 include illustrations with matching phrases. Meant to deliver a meaningful message by requiring time for a thought process, these posters should be placed within areas of medium-high loitering times, and can have low to high foot traffic. Classrooms, sitting areas, and outside of elevators

are perfect locations to meet the prior requirements. Lastly, each recycling bin we have designed should have one of these posters above it. In a study done at the University of North Carolina, it was found that placing signs over trash and recycle bins increased the amount of sorted material from 51% to 84% (Ludwig, Gray, Rowell, 1998). With a clear visualization and a reminder to recycle, the members on campus are now prompted and reminded to sort properly.

Informative Flyer

To supplement the poster campaign on campus, we also created a flyer to promote the recycling initiative. We included information on the benefits of recycling and the ways students and staff can do their part on a daily basis. This will give the department a tangible flyer that can be passed out in classes or in meetings to illustrate their desire to take part in becoming a more sustainable campus. The flyer was created on the foundation of making recycling and the idea of "Reduce, Reuse, Recycle" a welcoming and important aspect of everyday life through bright colors and inviting context. The negative effects that come about when one does not recycle and ways that an individual can make a difference were also stated. Lastly, we decided to write the flyer in Spanish due to the majority of Spanish speaking people on campus. This flyer can be seen below:

Figure 20: Informative Flyer

5.6 Summary of Proposed Waste Management Plan

Our waste management plan within this section is extensive and at times hard to visualize. The following tables and chart sum up our findings and illustrate our recommendations.

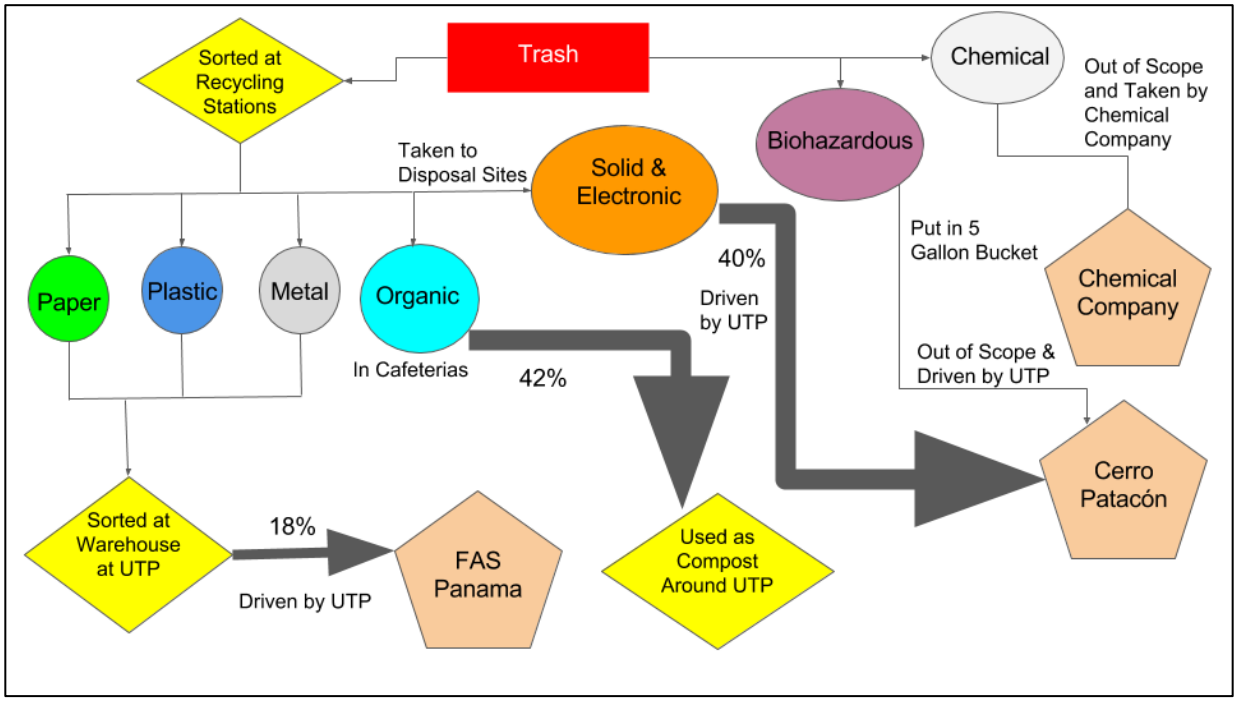

Figure 21: Illustration of Proposed Waste Management Plan

As seen in Figure 21 above, our proposed plan includes all categories of waste at UTP. Off to the right, chemical and biohazardous waste maintain their respective processes currently going on at the university. Off to the left are the waste classifications that will be sorted at the recycling bins. Paper, plastic, and metal will be sorted and then taken to the warehouse at UTP. From there, the university maintenance drivers will take the waste to FAS Panama which consists of 18% of the waste on campus. Organic waste will only be sorted in the cafeterias, and will then be taken to the garden and composted for further use. This process consists of 42% of the waste on campus. Lastly, solid and electronic waste will be taken to Cerro Patacón and consists of 40% on campus. Electronic waste will be taken out of this process if the reuse initiative is implemented by UTP, however, for the sake of the figure above it does not include this initiative.

Table 8 below summarizes the recommendations we have decided upon for each type of waste, while Table 9 goes on to state the possible effects of our proposed waste management plan.

Table 8: Overall Recommendations

Subsection	Recommendation Explanation
Solid	Usage of biodegradable containers and the flushing of bathroom waste to reduce solid waste
Electronic	Create a program for electronic reuse
Organic	Separate organic waste from the cafeteria to be used in a composting system
Recycling	a. Sorting bin design b. Warehouse (recycling station) for further separation and storage c. Partnership with FAS Panama and further contact with Ciudad del Saber d. Establishment of environmental awareness student and/or faculty volunteer team e. Transportation of Waste
Communication and Training	a. Two highly recommended posters to support the new sustainable initiative b. Two additional posters left up to the university's discretion to implement c. Supplemental informative flyer

Table 9: Possible Effects of Proposed Waste Management Plan

Possible Effects of Proposed Waste Management Plan
~18% of waste is recyclable, which will now be going to FAS Panama
~42% of the waste is organic, which will now be going to UTP's garden area
~41% of the waste will still be going to Cerro Patacón classified as solid and electronic
~60% of the waste currently going to Cerro Patacón will now be reduced

Section 6: Conclusion

Our research and projections have helped us present initial findings and recommendations for a new waste management initiative at UTP. To make a more complete plan before beginning steps of implementation, we are recommending additional steps for the students and staff to undertake to further their knowledge on the subject.

The first recommended course of action is to conduct a more comprehensive waste audit for more precise projections on the amount of waste and cost to the school. This may include smaller classifications of material, such as plastic number one and plastic number two. These specific classifications would demonstrate a more complete picture of the waste coming from the campus for further modifications of the waste management plan. The addition of volume measurements would also aid in determining a size for the sorting warehouse within the recycling process.

We also recommend further research to understand the capacity for dealing with each type of waste. For example, before it can be recommended to flush solid waste from the bathrooms, the university's septic system should be analyzed to validate its ability to handle the increased amount of waste. This initiative would also require the need to address the social behaviors that may need to be changed from the personal lives of students and staff. To go along with the poster campaign on recycling awareness, posters that advise people to flush solid waste could be placed within restrooms to raise awareness about this subject.

For organic material, we suggest there should be further research into the most effective method of composting based on the volume of waste coming from the cafeteria and the space available to the university. Another course of action for the cafeteria would be to determine if a reusable container system or biodegradable containers would be the best fit for its needs.

Once the university has determined its ability to collect each type of waste being produced on the campus, there should be further research into the follow up processes. For example, there should be contact with Ciudad del Saber to learn specific details about their recycling initiative with FAS Panama, information about the recommended size of a warehouse, and possible upfront costs of implementing this initiative. These upfront costs may include wages for workers who would be needed to sort the waste. Earlier, we recommended the establishment of a team of students and staff that would run this project, labeled as a 'Green

Team, and if implemented may alleviate the need for designated workers in the warehouse. This team would also have the responsibility of determining whether the two additional posters will be implemented around campus along with the most liked posters from our surveys. This would incorporate another field of further research since the students on this campus all commute from home. Without a residential component within the university, this may present a challenge to bring such a group together. This team would also be able to find specific locations for the posters and the most effective way to distribute the informative flyer to increase participation.

Overall, we believe that this plan met all of our goals for the project but there is still work to be done in these areas before steps of implementation can begin. From our work, we determined the waste that has the possibility of being diverted from Cerro Patacón and describe these possible impacts above in Table 9. With UTP's leading position in sustainability, the implementation of a new waste management plan will aid in the reduction of their environmental footprint. This type of initiative can further this position for UTP to also become a recognized leader in waste management for the coming years.

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Appendix A: Survey for the General Services Department

- What is your name and contact information (email)?
- What is the total weight of waste per semester for the past two years?
    - Is there information on how much each load of trash taken to the landfill weighs?
    - How many loads are taken to the landfill each semester?
    - How many loads are taken to the landfill each day?
- How many times a day is waste collected?
    - What times are these collected?
- At what time is the most waste being produced?
- Is there any trash produced by groundskeeping?
    - If so, what kind?
    - How much?
- Do you do anything special with hazardous waste? (eg. Batteries, Paints, Aerosols, chemical products)
- Is litter a problem here?
    - Is litter collected on a regular basis?
    - How much litter is being collected?
    - What does this litter consist of? (solid trash, recyclables, etc.)
    - What areas have the most litter?
    - Where is this litter taken to?
- How much waste does each building generate?
    - Where are the waste disposal pickup sites for each department/building?
    - What type of waste does each building generate the most of?
    - Per department what are the percentages of waste? (chemical, recyclable, hazardous, biological, organic)
- Is the trash sorted for recycling at any point?
    - If so, how is it separated?
    - What is done with the recyclable material?
    - Are there any recycling plants that you are currently in contact with?
- Are there any initiatives for reuse of waste/materials?

    - If so, can we have contact information for them?
- Where is the waste taken? (both hazardous and general if different)
    - Are there records of how much waste is taken, and how often it is being taken?
    - What is the price per unit weight?
- Number of students per semester for the past 2 years?
- Is there any hazardous biological waste?
    - Where does it come from?
    - How is it handled?
    - How much is being produced?
- Is there chemical waste?
    - How is it handled?
    - Where does it come from? (what department)
    - How much is there?
    - Are hazardous and non-hazardous separated?
- Is there a significant amount of electronic waste? (circuits, appliances)
    - What is being done with it?
    - Are there any efforts to reuse the spare parts?
- How many trash cans are there are on campus?
    - Is there a map with the locations of the trash cans?

Appendix B: Summary of Interview with General Services

- Once a day (Monday-Friday) they collect everything at 6:00 am to be weighed and sent
    - Within the building they collect at 1:00pm 7pm and 5am
- 3 campuses for the school in Panama City, and all 3 campuses are weighed together
    - 1 ton per day across all campuses ($18 per ton)
- The construction material is separated to be dealt with separately
- The path from the 3 campuses takes 6 hours to collect
- Each building has its own trash can (dumpster)
    - 5 trash cans total
    - 1 dumpster for the other two campuses
- In building 1 the dumpster is shared with the regular trash and cafeteria
    - At the other two campuses, they do the same with their 1 dumpster, and include construction
- In the gardens and green areas, they use the grass clippings as fertilizer
- The clinic has no separation of biological hazardous waste. Everything goes in one bucket.
    - The clinic waste is less than 1% of total waste
    - Clinic waste is only collected once a week
    - Goes directly to Cerro Patacón
- For chemical waste
    - They pay a separate company for collection
- Electronic waste
    - It is put in with other type of trash (general trash)
    - People can get into Cerro Patacón and collect the trash and sell it
- Litter
    - Almost nobody throws trash on the ground
    - 85 people every day 24 hours a day to pick up litter
- Trash spills over on the weekend during special events (there's more than the trash cans can hold)
    - Not collected again until Monday

- There is no total for each building individually, just total for the 3 campuses
- The chemistry labs are in building 3 and when they dispose of the chemicals, it goes through piping that automatically bins it.
- There is no separation of recycling “because it has never worked”
    - They used to have 3 trash bin system (with labels), but got rid of it at some point
- There is no initiative for reusing anything
    - Besides people generally conserving paper
- Only dangerous biological waste is from the clinic
- The company that has contract for disposing of chemical waste comes after the work day to pick up the chemicals
- The Panamanian constitution has a law where the economic and finance administration forces the campus to keep track of all belongings (chairs, tables etc)
    - broken stuff is kept in a warehouse
    - 3 times a year the broken things are taken to a government place to replace them
    - The process is called discarding
    - There is a small label on each item to keep track of everything
    - The government owns everything because it is a public university
    - Everything is collected and brought to the warehouse on this campus
    - Other campuses take it directly to the warehouse
- There is no record of where every trash can is on campus
    - There is at least 1 trash can in every room(required)
    - There are 140 classrooms
    - 200 trash cans that are outside
    - Almost 40 for all the hallways
    - Approximately 380 in total
- In the midday is when the most amount of trash is produced

Appendix C: Population Data for 2016

	# of People
Undergrad	13,857
Undergrad By Major:	
Civil	3,600
Electric	1,784
Industrial	3,575
Mechanical	1,927
Computer Systems	2,419
Science and Technology	552
Graduate Students	2,737
Teachers	777
Total:	17,371

Appendix D: Survey for the Cafeteria Department

- How many students visit each cafeteria location each meal?
- What types of waste does the cafeteria produce besides food?
- How often are the trash bins emptied each day per cafeteria location?
- Where is the cafeteria trash taken per location?
- What is done with it once it gets to the disposal sites?
    - Is it sorted or all thrown together?
- How much waste in total does each cafeteria produce each meal?

Appendix E: Summary of Answers from Cafeteria

How many students visit each cafeteria location each meal?

1st semester 2017: January to April

- Building 1 total per day: 1675
    - Breakfast: 540
    - Lunch: 337
    - Dinner: 798
- Building 3 total per day: 960
    - Breakfast: 437
    - Lunch: 200
    - Dinner: 323
- Central cafeteria total per day: 453
    - Breakfast: 183
    - Lunch: 270

2nd semester 2017: April to August

- Building 1 total per day: 1296
    - Breakfast: 636
    - Lunch: 303
    - Dinner: 357
- Building 3 total per day:
    - Breakfast: 561
    - Lunch: 425
    - Dinner: 237
- Central cafeteria total per day:
    - Breakfast: 50
    - Lunch: 352

What types of waste does the cafeteria produce besides food?

- Paper products, styrofoam, cans, plastics

How often are the trash bins emptied each day per cafeteria location?

- Cafeteria sitting area: 5 trash cans emptied 5 times a day
- Kitchen: 3 trash cans emptied 3 times per day

Where is the cafeteria trash taken per location?

- The trash from the cafeterias are put into the big dumpsters for each building

What is done with it once it gets to the disposal sites?

- The trash collecting truck for the university brings it to Cerro Patacón

Is it sorted or all thrown together?

- Not sorted, all together

How much waste in total does each cafeteria produce each meal?

Average of 660 lbs daily per cafeteria

Appendix F: Summary from Interview with Pedro Martinez and Victor Valdez

In the garden behind maintenance

- Spoke to Pedro Martinez
- Guaya plants
    - Used for fruit salad to sell in the cafeteria
    - Gives lots of fruit on the trees all year round
    - Economical
- Going to start to plant watermelon by cutting the top of a zapayo plant and replanting the watermelon plant on top
- They compost organic material from the garden (ex: dead trees) and in the future the plan is to incorporate waste from the cafeteria
- Horizontal garden: project being started in 2018 to promote sustainability In the garden in order to be as efficient as possible with water usage
- Future plan to turn the forested area around campus into a mini conservation park to help the animals and wildlife around campus
- Other plants in the garden: cocoa, coffee, chili peppers, orchids (national flower, had 100 plants)
- By 2019 they will have 4 new buildings and are thinking that the trash will double
- On Wednesday Victor Valdez will give us records for 2015, 2016 and 2017 about trash collection, cost and weight at 10AM

Appendix G: Follow up questions from 9/6

Reasons why the 2016 initiative did not end up being a success:

- Internal reason
    - MEF (Ministry of Economy and Finance) is in charge of recycling on campus as well as providing the personnel to handle the trash. The issue was that there were not enough people to gather the trash from the disposal sites and also spend time sorting the recyclables. Basically, they needed more people to help, but that help would not have been provided by the school and it was never provided by the MEF
- External Reason
    - Department of student health, civil, and environmental engineering department had been the groups that put the bins in place on campus. However, when they recommended the plan, they did not recommend methods for then getting these recyclables taken off campus at the end
    - There was not enough communication and training about the initiative for people to be aware and be conscious of their actions
    - At one point the business that puts recycle bins in Panama City also put a big sorting bins (like recycle bins at Ciudad del Saber) on the campus, but they never came to pick up the trash that was placed in the bin, so campus maintenance just combined this sorted trash with everything else going to Cerro Patacón

Appendix H: Raw Data From Waste Audit

Day 1: Weights (lbs) and Percentages

	Building 1	Building 3	Administrative	Post Grad	Cafeteria
Organic	55	3.5	0	0.5	0
Recyclable	0	0.5	8.1	1.5	0
Solid	0.5	3.5	0.5	6.7	2
Electronics	0	0	0	0	0
Total weight	55.5	7.5	8.6	8.7	2
Organic %	99%	47%	0%	6%	0%
Recyclable %	0%	7%	94%	17%	0%
Solid %	1%	47%	6%	77%	100%
Electronics %	0%	0%	0%	0%	0%

Day 2: Weights (lbs) and Percentages

	Building 1	Building 3	Administrative	Post Grad	Cafeteria
Organic	0	0	0.5	0	0
Recyclable	1	1	2.5	2.4	1.2
Solid	9	18.4	12.3	2.4	12.3
Electronics	0	0	0	1.2	0
Total weight	10	19.4	15.3	6	13.5
Organic %	0%	0%	3%	0%	0%
Recyclable %	10%	5%	16%	40%	9%
Solid %	90%	95%	80%	40%	91%
Electronics %	0%	0%	0%	20%	0%

Day 3: Weights (lbs) and Percentages

	Building 1	Building 3	Administrative	Post Grad	Cafeteria
Organic	0	0.5	0	0	18.6
Recyclable	5.8	0.6	6.8	2.8	0
Solid	0.2	3.5	0	2.8	1
Electronics	0	0	0	0	0
Total weight	6	4.6	6.8	5.6	19.6
Organic %	0%	11%	0%	0%	95%
Recyclable %	97%	13%	100%	50%	0%
Solid %	3%	76%	0%	50%	5%
Electronics %	0%	0%	0%	0%	0%

Appendix I: Poster Survey Questions

Encuesta de Carteles

Esta es una encuesta corta para que usted diga que los carteles que te gustan y no les gusta. Zoom si es necesario. Gracias!

Comprueba qué carteles te gusta sobre el reciclaje

☐ 1

☐ 2

☐ 3

☐ 4

☐ 5

☐ 6

☐ 7

Comprueba qué carteles NO te gusta sobre el reciclaje

☐ 1

☐ 2

☐ 3

☐ 4


Al reciclar 100 latas puedes iluminar tu dormitorio durante dos semanas completas.

☐ 5


Al reciclar una lata de aluminio ahorras suficiente energía para escuchar un álbum completo en tu iPod.

☐ 6

☐ 7

SUBMIT

¿Podrías reciclar?

- ○ Sí
- ○ No
- ○ No sé

¿Reciclas en otro lugar?

- ○ Sí
- ○ No

Si es así, ¿dónde?

Short answer text

Appendix J: Questions for Waste Management Companies

- What materials can you recycle?
- Do you collect materials on site or does the school have to bring it to the company location?
- What is the average cost of your recycling services?
- Does the company serve the area where the Victor Levi Sasso campus is located?
- If you do pick up materials from the university, what is the system you follow?
- Does the material need to be sorted before pick up?
- Do you provide containers for waste sorting and pick up?

Appendix K: Further General Service Questions

- Who is the current company that picks up chemical waste?
- Is there a contract in place between the university and any specific companies for waste disposal?
- Students on campus for the past 5 years

Appendix L: Alessa Stabile's Contact Information

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