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Worcester Polytechnic Institute

Waste Reduction Through A Reusable Container Program

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Abstract

WPI waste generation rates are rising, meaning increasing costs and environmental pressures. On campus, much of this waste is from disposable food containers. This study's purpose was to reduce disposable waste by assessing current waste management practices, researching new initiatives, and evaluating the feasibility of these initiatives. Students and faculty involved with sustainability initiatives were interviewed, and the WPI community was surveyed. All relevant data was analyzed to develop recommendations related to the implementation of a campus-wide reusable container program.

Executive Summary

The goal of our project was to reduce the WPI waste stream by improving or implementing initiatives related to waste reduction on campus. The project began as a broad study of the current waste management practices and initiatives at WPI. Our team then researched new initiatives and evaluated the feasibility of these initiatives on the WPI campus. In the end, our team found that implementing an improved reusable container program on campus would not only reduce the waste stream, but also save WPI money.

In order to develop recommendations our team completed the following tasks. The team collected relevant information and data regarding the current state of waste reduction efforts at WPI through various interviews with key members of the WPI community involved with sustainability. The team researched potential new initiatives and practices to be implemented at WPI through interviews, a survey of the WPI community, and analysis of a peer institution's waste reduction efforts. Our interviews to develop new initiatives were structured interviews conducted with stakeholders involved with sustainability at companies and peer institutions. A survey was distributed to WPI students, faculty, and staff and was intended to explore current community habits and opinions on new initiatives. The analysis of a peer institution was intended to identify waste reduction efforts that have potential to be implemented at WPI.

After conducting these interviews, survey, and analysis, our team concluded that implementing a reusable container program on the WPI campus would reduce disposable waste and therefore reduce the overall waste stream. To evaluate the feasibility of such a program, our team conducted more interviews with stakeholders involved in waste reduction efforts at WPI. Additionally, our team reached out to a representative from a reusable container program company to discuss the logistics and costs involved with implementing the program. The team received a formal quote from the company, which was then compared with current disposable container costs at WPI in a detailed cost analysis.

Through our interviews with sustainability stakeholders at WPI, our team was able to understand the state of WPI waste reduction efforts and identify areas of potential improvement. We learned that there are thousands of pounds of disposable containers being thrown away in the Rubin Campus Center each month. These disposables are not only costing WPI money to purchase, but also to be picked up by Waste Management after only one use. By eliminating or at least reducing disposable use in the Campus Center, WPI can save money on upfront costs and waste management costs.

To identify ways to reduce disposable use on campus, we looked to peer institutions who have made disposable waste reduction efforts. In researching and talking with peer institutions, our team found that implementing an enhanced reusable container program at WPI could both reduce disposable use significantly and decrease the overall campus waste stream. The survey our team conducted explored WPI community opinions regarding the implementation of such a reusable container program, and found that the majority of the community would be willing to participate. The cost analysis our group performed indicates that WPI will both save money and reduce waste, which are both central objectives in the WPI Sustainability Plan. The project concludes with recommendations to implement a commercial reusable container program intended to reduce disposable waste on campus. Additionally, our group gives recommendations for future project work and more in depth studies.

Acknowledgments

Our team would like to thank our advisors, Derren Rosbach and Suzanne LePage, for their guidance and help throughout our project. Also we would like to thank Elizabeth Tomaszewski, Kayleah Griffen and Nicole Luiz for educating our team about the current state of sustainability on the WPI campus and the past efforts from the Department of Sustainability and the WPI Green Team. We would like to also thank Joe Kraskouskas from dining services for his time and providing us with the information we needed to create a thorough cost analysis for our recommendations. We want to give special appreciation for Alex French, the Sustainability Coordinator at Clarkson University, for explaining his experience at Clarkson University which helped us greatly in creating a very detailed recommendation for a reusable container program. In addition to everyone listed above, we would like to thank everyone in the WPI community that took our survey. We were able to pull very useful information from the survey thanks to your participation.

Authorship

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1.0 Introduction

One of the most daunting issues today is the mounting global waste problem, as about 2.12 billion tons of waste are generated throughout the world annually. In the United States alone, Americans produce over 250 million tons of trash yearly. Daily, only 1.51 pounds of the 4.4 pounds of waste each person generates is recycled or composted. Americans are producing waste at a rate that cannot be managed in an environmentally sound and economic manner. This pressing waste management problem needs to be mitigated and dealt with before the environment is irreparably impacted. Institutions and Universities around the United States need to take steps to decrease waste and become waste minimization role models for US citizens.

The WPI Sustainability Plan was written on the principles of ecological stewardship, social justice, and economic security. Through this plan, the institution encourages its students and staff to participate and improve their own sustainability practices. In accordance with this plan, WPI has already implemented a campus-wide single stream recycling program. Previous IQPs have researched the current recycling program and given various recommendations regarding potential improvements, some of which have been addressed. However, there are still many improvements that can be made throughout campus to reduce waste and make WPI more sustainable.

In November 2017 a student organization, the WPI Green Team, accompanied by students, faculty, and community volunteers, conducted the 7th annual waste audit (Green Team, 2017). The two buildings explored in the waste audit were the Rubin Campus Center and the Gordon Library, two of the largest buildings on campus. The audit found that waste in both

buildings consisted predominantly of general trash, take-out containers (clamshells), plastic, liquid, food waste, cardboard, and paper. Much of this waste, such as the take-out containers, can be avoided by using reusable replacements. The audit results show a large amount of waste that is unnecessary and avoidable in the Campus Center and the Library.

The focus of this IQP was to reduce waste on the WPI campus. In order to achieve this goal, our project aimed to:

- Assess current waste management practices
- Research new practices and initiatives, and
- Evaluate the feasibility of these new initiatives.

Our research identifies and helps the WPI community better understand what makes a waste reduction initiative successful, and allows WPI to make progress in reducing the on-campus waste stream. This research will ultimately lower WPI's waste stream through specific recommendations which suggest further research and target key areas on campus where waste can be effectively reduced.

2.0 Background

Global waste accumulation is increasing annually, meaning rising costs for governments and serious environmental impacts all over the world. The vast amount of waste being produced needs to be diminished through reduce, reuse, and recycling to ensure the earth will be a sustainable environment for generations to come. Without immediate waste reduction efforts from nations, cities, and universities around the world, the earth is in trouble. This chapter

summarizes relevant, published, and available material related to the topic of waste reduction on college campuses. The chapter begins by introducing waste management on a global scale then takes a closer look into waste management in the United States. The chapter then moves towards waste management at WPI and looks into recent efforts and initiatives on campus. Finally, there is a close look into sources of waste at WPI and related sustainability initiatives intended to lower waste around the country.

2.1 Waste Management

According to the World Bank, in 2010 the global municipal solid waste (MSW) generated was approximately 1.3 billion tons per year. That number is expected to increase to about 2.2 billion tons per year by 2025 with current waste management practices throughout the world. Although the averages are broad estimates because waste production rates vary considerably by region, country, and city, it is clear that these numbers are too high. In fact, according to a former World Bank urban specialist, “The amount of garbage humans throw away is rising fast and won’t peak this century without transformational changes in how we use and reuse materials”(Hoornweg. 2013).

Old waste management practices are out of date and becoming more and more insufficient. “The traditional approaches to waste management of ‘flame, flush, or fling’ are outmoded customs which have resulted in an unsustainable society.” (Seadon, 2010)

Traditionally, waste is only managed and dealt with when the pressure to handle the problem rises above the convenience of disposal. This creates harsh economic and environmental impacts according to an article by Jeffrey K. Seadon in the Journal of Cleaner Production and traditional waste management practices are failing in a number of ways, below are a few key reasons.

1. Effort is spent collecting and analyzing immaterial data. For example, conducting annual surveys of household waste composition when waste management practices do not change.
2. Solutions are based around short-term goals rather than longer term sustainability thinking.
3. Disregard or undervaluing the side effects of intervention.
4. The focus on fixing individual problems rather than the viability of the waste management system.
5. Reliance on linear extrapolations of recent short-term events.

The transition to a more sustainable society is unquestionably necessary but will be a difficult challenge. Everyday, disposable items are thrown away without any regard to the consequences of such disposal. It is important to realize the true impact of disposables and begin to transition to reusable items whenever possible. The world needs to move away from thinking short-term and look more into long-term goals related to sustainability. By doing so, the world has potential to evolve into a more sustainable global environment and society.

2.1.1 Waste Management in the United States

In total, the United States is the leading waste producer in the world. **“**In 2013, Americans generated about 254 million tons of trash and recycled and composted about 87 million tons of this material, equivalent to a 34.3 percent recycling rate. On average, we recycled

and composted 1.51 pounds of our individual waste generation of 4.40 pounds per person per day." (EPA, 2016) Although there has been improvement in the United States, as recycling and composting rates have increased significantly, waste production remains a growing and pressing problem. **Figure 1** shows the increase in waste production in the United States from 1960 to 2013.

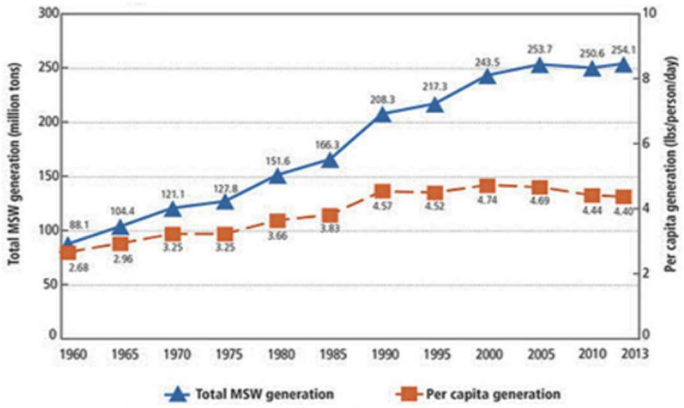

Figure 1. MSW Generation Rates, 1960-2013

https://archive.epa.gov/epawaste/nonhaz/municipal/web/html/

Although the waste has been increasing there also has been an increase in recycling rates. According to the EPA the total waste recycled in 1960 was 6.4% and has now jumped to 34.3% in 2013 (EPA, 2016). The 34.3% recycling rate leads to the prevention of 87 million tons of waste being disposed. According to the EPA, this prevented the release of 186 million metric tons of carbon dioxide, equivalent to taking over 39 million cars off the road for a year. **Figure 2**

shows the climb of the recycling rates in the United States from 1960-2013. Additionally, **Figure 2** shows that the increase in recycling rate is beginning to plateau, especially when comparing

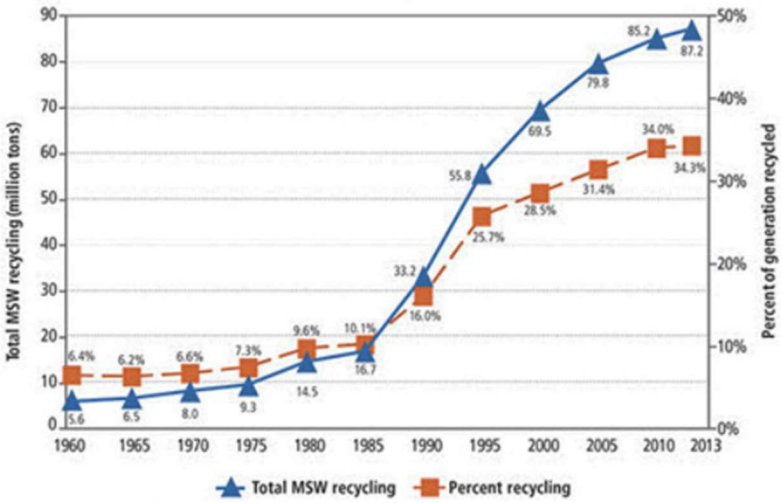

Figure 2. MSW Recycling Rates, 1960-2013

current rates to the jump in the 1990's.

https://archive.epa.gov/epawaste/nonhaz/municipal/web/html/

Although recycling rates are beginning to plateau, there is no sign of waste production slowing down, which is the opposite of what the United States needs right now. Recently China, who is the United States' main recycling export customer, has changed their regulations. While the gap between recycling and waste production is widening in the United States, China's recycling standards are becoming more strict, limiting recycling rates even further in the US. According to an associate professor of global environmental politics at the University of California Berkeley, Kate O'Neill, China imports about half of the United States plastic recycling material (Siegal & Bell, 2017). China has recently placed restrictions on imports of 24

kinds of solid waste from other countries. They have lowered the allowable contamination levels for recyclables from about 3% to about 0.5% (Hobson & O'Neill, 2018). Recycling contamination occurs when incorrect items are put into the recycling stream or when correct items are put into the recycling stream in the wrong way (i.e., food residue in containers). The United States is facing a significant challenge figuring out how to address the growing number of recyclables accumulating around the country. The United States was not ready for China to implement these new recycling restrictions, and is now scrambling to find a solution (Profita & Burns, 2017). There are two options: one is to find other places to ship our material, and the other is to upgrade our country's recycling system to meet China's restrictions. In order for the second option to work, the United States is forced to invest in recycling facilities and companies to meet these new contamination standards.

As waste management and recycling companies invest in their own companies and facilities, there is going to be an increased need for funding. Consequently, the amount of money people pay to have their waste and recycling managed is very likely to increase. China's sudden change in their recycling contamination standards has put the United States in a bit of a waste crisis. The need for more efficient and proactive waste management practices is imminent.

2.1.2 Waste Management on College Campuses

According to Mitchell Thomashow, college campuses offer the best hope for raising awareness about sustainability. Colleges or universities have the capacity to engage and educate students, employees, and faculty members on sustainability and other crucial issues arising in the

world. (Thomashow,2014). Colleges need to take action to minimize waste production and optimize waste management. Waste reduction programs and initiatives, such as composting and reusable programs, have and can make significant positives impacts on college campuses (University of Waterloo Sustainability, 2018). These positive impacts can include things like campus-wide waste reduction, higher recycling and composting rates, lower costs on disposables, and many more things. The main focus of any waste management initiative is to mitigate environmental and economic pressures that negatively affect the sustainability of the institution. Embedding sustainability culture and awareness in students while in college can translate to bigger and better changes to the world as a whole (Thomashow, 2014). Colleges need to take sustainability efforts seriously, and need to consider the growing national waste problem when considering sustainability.

2.2 Waste Management and Sustainability at WPI

In December of 2007, WPI started the President's Task Force on Sustainability. This task force has now evolved into the Office of Sustainability and deals with related issues. Recently, the Office of Sustainability has focused on campus waste production problems. One initiative that has been implemented to address waste production problems is the installation of water bottle filling stations around campus in an effort to encourage reusable containers and reduce the quantity of plastic water bottles. Furthermore, to simplify the recycling process on campus,

single-stream recycling was implemented in 2014. Despite these efforts, the school's total waste accumulation has still been over 715 tons annually and the recycling rate has decreased from 30.9% in 2014 to 22.91% in 2017.

The WPI Sustainability Plan demonstrates WPI's commitment to the well-being of the earth and promotes sustainability initiatives throughout campus. The Sustainability Plan is meant to advance three main goals of sustainability. These goals are ecological stewardship, social justice, and economic security. There are also four more specific goals outlined in the Sustainability Plan, and reproduced below:

1. Academics, described as WPI students leaving campus with the understanding and abilities to develop sustainable solutions to the world's problems. Additionally, it states that all students will have the opportunity to incorporate and evaluate aspects of sustainability in their education.

2. Campus operations, which will demonstrate the principles of the WPI sustainability guide and actions.

3. Research and scholarship, which is meant to make significant contributions to technologies, policies, and attitudes to help assure a sustainable campus.

4. Community engagement, in which the entire WPI community is involved in promoting a culture of sustainability to enhance current and future welfare globally.

In order to gain funding for projects and initiatives that are going to help achieve or further the goals outlined in the Sustainability Plan, the WPI Sustainability Department has recently started the Green Revolving Fund (GRF). The purpose of the GRF is to support and fund projects that enhance on-campus sustainability. Along with projects, the fund finances efficiency, renewable energies, and resource conservation, and will grow as a result of the

savings from these projects. Once an investment from this fund is given to a project, the savings the project provides for WPI will be returned to the GRF so other projects can be explored and invested in.

In order for a project to receive an investment from the GRF, there needs to be a proposal submitted to the GRF board. The GRF board consists of the Director of Sustainability, various budget representatives, a Department of Facilities representative, a Faculty representative, a Staff representative, and student representatives. There are two kinds of proposals that can be submitted, a proposal for a project costing over $10,000 which is known as a large, capital-intensive project and a proposal for a project that costs under $10,000. When submitting a proposal for a large, capital-intensive project, the proposal requires a complete Funding Allocation Request, with a detailed financial analysis of cost and payback. For the smaller projects, the proposal requires a Sustainability Project Proposal application with the possibility of needing to complete a Funding Allocation Request depending on the nature of the project.

The WPI Green Team is a student organization that is dedicated to making WPI a more sustainable campus. This organization is responsible for holding annual events to educate the WPI community about sustainability. One major annual event is the campus waste audit, in which the Green Team goes through the trash and recycling bins of various buildings on the WPI campus in order to analyze WPI's waste and recycling practices. The report released from each audit is extremely useful because it allows the WPI Office of Sustainability see how waste

management practices and recycling rates are changing yearly on campus. This information is also helpful in determining if WPI is on track with the goals outlined in the Sustainability Plan. Another major event the Green Team participates in is Recyclemania, which is a national competition devoted to raising recycling rates and awareness on campus. This competition is meant to raise recycling rates but is also intended to change the sustainability culture and reduce the overall waste at the colleges participating in the competition throughout the United States.

2.2.1 WPI Switch to Single-Stream Recycling

WPI made the official switch to single-stream recycling in 2014 with hopes that the change would encourage more recyclable materials to be placed in the recycling bins. Unfortunately, according to a previous IQP completed in 2015 and the 2013 and 2014 Green Team waste audits, the recycling rates at WPI did not go up but actually went down (Green Team, 2016). When looking into why this was happening, the former IQP group was told by Elizabeth Tomaszewski, Assistant Director of the Office of Sustainability, that one of the causes for the low recycling rates was the lack of communication between facilities and the WPI community about the shift of recycling policies. There was a lot of confusion on what could and what could not be recycled. As a result of the data the IQP group from 2015 found, they decided to focus their project on increasing the recycling rates by improving waste sorting at WPI. The team educated the campus about the policy switch and created signs that clearly labeled what can and what cannot be recycled.

2.2.2 Food Waste Sorting

WPI has made strides in dealing with the campus' food waste. According to Elizabeth Tomaszewski, with the 2018 recyclemania competition just completed, WPI ranked 4th in the country for food diversion (RecycleMania, 2018). WPI was able to achieve this very impressive ranking through two different food diversion programs. One program is separating the scrap food waste from the rest of the trash in the WPI Dining Hall. This food scrap is then sent to a local pig farmer. This program helps divert about 3800 lbs of post-consumer food every week. Right now this program is being used in the Pulse on Dining Center (WPI Dining Hall) but there is a plan to implement and expand this program into the Rubin Campus Center, which will increase our campus-wide food diversion rate. The other program is a pre-consumer food diversion program. Whatever food that is not eaten but has been cooked and prepared is donated to Friendly House, non-profit organization, that betters the Worcester community however they can. This program mainly takes place in the Campus Center and produces about 100 lbs of food a week for homeless and less fortunate members of the Worcester community.

2.2.3 Sources of Waste at WPI

The waste produced on the WPI campus comes from various sources. Some major sources of waste are cardboard, food, and plastics. Research and recommendations from previous Interactive Qualifying Projects (IQPs) provide valuable information about these sources of waste, and identify areas where waste management can be improved and waste can be reduced. From the "Improving WPI Campus Community Recycling" IQP came a recommendation to look

at the potential of recycling bulk scrap industrial plastics from manufacturing labs on campus. Another source of waste mentioned in the same IQP was the disposable waste produced in the Rubin Campus Center. These two sources of waste are further explained and analyzed in the next two sections.

2.2.4 Industrial Plastics

The "Improving WPI Campus Community Recycling" IQP was investigating the viability of an incentive program to improve on-campus recycling rates, and their research made note of two sources of waste on campus that could be recycled or replaced with greener alternatives (DiMestico, Musgraves, Wang, & Whitworth, 2017). One source of plastic waste on campus is "scrap" acrylic, polycarbonate, and other plastics that are normally thrown away in on-campus manufacturing shops and labs. These plastics have a Resin Identification Code of #7, meaning that they are not eligible for single stream recycling. However, if the scrap plastic is collected to a volume of 1 to 2 gaylords (48" x 40" x 36" collection containers), it can be taken to a post-industrial plastic recycling company instead. These facilities specialize in processing a variety of materials and will sometimes pay for the scrap itself.

2.2.5 Disposables

A second, broader range of recyclable and non-recyclable sources of waste are the plastic containers and cups used for food and beverages on campus, specifically in the Rubin Campus Center. The volume of non-recyclable waste produced in the Campus Center is both an expensive problem and an inefficient process. Dining services purchases the disposable items to

be used only once before consumers put them in the trash. Facilities staff then empty the trash bins around 4-6 times a day and transfer the trash to the dumpster. Finally, the trash is picked up by Waste Management and WPI is charged $80 per ton of trash and $30 per ton of recycling removed.

In addition to this, the Campus Center's Dunkin Donuts provides thousands of plastic and styrofoam cups to students and faculty per month and while the plastic cups are recyclable waste, the straws and lids are not. This waste can be reduced by students bringing their own beverage containers to be filled. Reusable containers produce less physical waste, as well as less waste per use, than their disposable counterparts. This following paragraph and table (**Table 1**) will take a look at the environmental impacts of each option and will clearly identify reusables as the better option.

A study conducted by the University of British Columbia's Sustainability Office (Chan & To. 2018) looked at the environmental impacts of the use of paper and ceramic plates. For example, every time a paper plate is thrown out, its physical waste is added to a landfill and must be replaced with another paper plate. The table below shows the CO2 produced and the water used to make one paper plate vs one ceramic plate.

	Grams of CO2 Produced (per plate)	Gallons of Water Needed (per plate)
Paper Plates	104 grams	8
Ceramic Plates	10-60 grams*	⅛ - ⅞ *

* Assuming dishwasher is loaded with 24 plates

Table 1: Grams of CO2 produced, and gallons of water used to produce a paper plate vs a reusable ceramic plate

This study suggests that reusable items have less environmental impact than their disposable counterparts. It is in the school's best interest to promote reusable containers because as you can see in the table above, the water use and grams of CO2 produced of the reusable plates are significantly less than those of the disposable plates.

2.3 Potential Waste Reduction Strategies at WPI

This section examines some peer institutions and what they have done to try to reduce waste. It is important to look at these peer institutions because they have a similar size and campus culture to WPI. When looking into these schools, common themes and/or programs were considered to identify the best solutions to mitigate WPI's waste problem.

2.3.1 Case Study: Waste Reduction Strategies on College Campuses

Tufts University, Cornell University, and Clarkson University are great campuses to look to for waste reduction guidance as each have campus wide efforts toward enhancing waste management practices to reduce waste and improve sustainability. There is a common theme in

reducing waste at these peer institutions which centers around recycling initiatives and programs that aim to reduce or eliminate the use of disposable items which are predominate in college waste streams. All sustainability initiatives and practices mentioned in this section can be found in the respective university's Sustainability Websites.

Tufts University has a recycling and waste management program which focuses directly on waste reduction. All sustainability initiatives and practices at Tufts can be found on the Office of Sustainability Website. Tufts promotes the wise use and disposal of resources and has a vision in which each member of the community carefully considers the impacts that result from using and disposing of objects and that they choose the options that best promote waste reduction. In fact, Tufts has a waste reduction plan that aims to reduce waste by 3 percent each year through source reduction, waste management strategies, and behavior change. Recently, the Center for Engineering Education and Outreach at Tufts purchased reusable cups printed with information about waste and deforestation to distribute during their summer workshops. This initiative ultimately reduced waste from approximately 5,000 disposable cups and provided sustainability education to elementary school students.

Cornell University also has a waste management program that focuses on proactive recycling and waste reduction initiatives. All of Cornell's solid waste recycling is tracked and measured in efforts to minimize waste while maximizing recycling, composting, and the reuse of materials. Cornell believes that using reusable mugs, water bottles, and tote bags on their campus can reduce the waste stream by several tons.

Clarkson University is also making strides in their waste management programs. Initial efforts from the school revolved around facilities and academic degree programs. Lately though, the school has made a push to integrate sustainability into everything they do on campus. This push to implement sustainable practices on campus besides just in the classroom is something WPI is doing well.

2.4 WPI Recent Efforts

In order to meet the goals outlined in the WPI Sustainability Plan, there have been recent efforts and projects completed. The majority of these projects and initiatives have been focused on reducing waste and creating a more sustainable culture on campus. Not all of the projects and efforts at WPI have been a success, but each project still offers valuable insight whether it succeeded or failed. Evaluating the past efforts to see what has worked and not worked will provide crucial information needed to provide recommendations on new initiatives that have potential to thrive on the WPI campus.

2.4.1 Green2Go

In 2016, the WPI Green Team started a "Green2Go" program to reduce the amount of disposable food container waste produced on campus. The program was designed to be a cheaper alternative to already-existing commercial programs, such as OZZI-2-Go, which allow students

and faculty to utilize reusable take-out food containers instead of the disposable paper or plastic ones.

For accountability reasons, the WPI Green2Go program requires a $5 deposit for students and faculty to rent a reusable take-out food container. Once used, the container can be returned to a Green2Go machine located in Founders Hall in exchange for a carabiner, which can then be exchanged with Goat's Head staff for a clean container.

2.5 Summary

Waste management is an increasingly important issue. It is essential that the earth's finite resources are respected and used efficiently. Consequently, institutions like WPI should take steps to improve both academic and environmental sustainability. Despite continued efforts, there is still room for improvement in waste production throughout the WPI campus to both increase recycling and decrease overall waste accumulation. Through these improvements, WPI will contribute even more to local and global sustainability.

3.0 Methodology

The focus of this IQP was to reduce disposable waste produced on campus by evaluating current waste management practices and exploring the viability of new initiatives. In order to achieve this goal, our team completed the following objectives:

1. Assessed the current waste management initiatives and practices on the WPI campus.
2. Researched new initiatives and practices that could reduce the amount of waste that enters the waste stream and therefore mitigate rising waste levels on campus.
3. Evaluated the feasibility of the new initiatives and practices, and the improvement of current initiatives and practices.
4. Recommended new waste reduction and sustainable practices and initiatives, along with improvements to the current waste reducing practices to WPI.

This chapter illustrates the steps our IQP group took to reduce disposable waste on campus using the objectives above as guidance. The techniques we used to achieve our objectives are discussed in detail throughout this chapter. We performed various interviews with campus faculty and staff, sustainability professionals, and campus professors. Along with interviews, we discuss how we incorporated past surveys and our own surveys to gather information regarding the WPI community and the past efforts to reduce waste on campus. By accomplishing our four objectives, we were able to provide the WPI community with valuable recommendations for the implementation of a new commercial reusable container program and an industrial bulk plastics recycling program. These recommendations will have one goal, to reduce the waste on campus.

3.1 Objective 1: Assessing the Current Waste Management Practices at WPI

By evaluating current waste management practices at WPI, our team was able to better understand the sustainability and current state of waste management on campus. First, we looked into various recommendations given by previous IQPs. These recommendations allowed us to explore previously identified waste reduction strategies on campus. Additionally, we reviewed various literature related to waste reduction. After gathering relevant information, we conducted interviews with campus staff, and key students to gain further insight and knowledge about the current practices at WPI. Having a complete understanding of the current waste management practices and initiatives helped identify problems on campus and areas for improvement.

3.1.1 Interviews with Campus Staff

In order to gather information on past waste reduction efforts and how they affected the campus, we conducted a structured interview (Drexel University, 2018) with Elizabeth Tomaszewski, the assistant director of sustainability at WPI. The team came up with specific questions that Ms. Tomaszewski would be able to answer. We decided to interview Ms. Tomaszewski because of her role as the Assistant Director of Sustainability and she is also the Facilities Systems Manager at WPI. We felt that for us to have the chance to implement a program that will reduce the campus waste, Ms. Tomaszewski was a crucial member of the WPI community to talk to. We felt this because Ms. Tomaszewski has played an important role in the implementation of past projects and has experience with trying to gather funding for these projects.

The team met with Joe Kraskouskas, Director of Dining Services, on Tuesday April 3rd in his office located in the base floor of the Campus Center. The interview with Joe Kraskouskas was crucial for our project because he was able to supply us with a rough quantity of how many

disposables are used in the Rubin Campus Center on a monthly basis. Mr. Kraskouskas was able to provide the team with numbers for the most commonly used products. With this information, the team was able to weigh the products on a scale to come up with a total amount of waste generated at the Campus Center per month. Waste Management charges $80 a ton for waste and $30 a ton for recycling. Unfortunately the team was not able to get the costs of these products from by Mr. Kraskouskas, so costs were taken from WebstaurantStore.com. Using the costs from the website, the team was able to see how much the school spends on disposable waste. With this information, the team was able to conduct a financial analysis comparing the costs of the disposables and the cost of implementing a reusable container program.

3.1.2 Interviews with Key Students on Campus

To effectively reduce waste on campus, it was important to obtain information on past efforts and understand the effects of these efforts. Consequently, we conducted interviews with two students heavily involved in sustainability efforts on campus, Kayleah Griffen and Nicole Luiz. These students have worked closely with the Green Team and Sustainability Office on numerous sustainability projects on campus. Throughout the course of the project, we conducted two structured interviews with Kayleah Griffen, who is a sustainability intern, and one structured interview with Nicole Luiz, who is the Green Team Vice President.

3.2 Objective 2: Research New Initiatives and Practices for WPI

After completing objective 1, our group used the information gathered to identify successful and unsuccessful programs. Having an understanding of the current waste management practices currently used at WPI, we investigated new initiatives and practices that the WPI community can implement. To do so, the team gathered relevant information from what WPI's peer institutions are doing to reduce their waste. Efficient waste management and

recycling practices are essential to the sustainability of any institution. It was important we looked to other institutions who have more effectively addressed the problem for guidance, and to other institutions who have failed for advice. The waste management programs at these other institutions offered valuable insight because they have similar engineering culture, climate, population, and campus size. Additionally, we interviewed various people that have key knowledge related to waste reduction.

3.2.1 Interview Warehouse Plastics Co, Inc. Representative

The team had an over the phone meeting with a representative from an industrial plastics recycling center located in Millbury, Massachusetts called Warehouse Plastics Co, Inc. We contacted this representative to find out the minimum requirement of scrap industrial plastics needed for the company to purchase and pick up from WPI. Also, we gathered information about the plastic collection process.

3.2.2 Interview with the Clarkson University Sustainability Coordinator: Alex French

When looking at peer institutions to see how they have tried to reduce the disposable waste on their campus, we found that Clarkson University implemented a commercial reusable container program called OZZI-2-Go. The team decided to perform an over-the-phone structured interview with the Clarkson Sustainability Coordinator, Alex French. Interviewing Mr.French provided us with valuable information on the Clarkson University reusable program and how it was funded. Mr.French allowed us to record the phone call so we did not miss any valuable information or data. Using the information gathered from Mr.French we set up interviews with faculty and staff members like Joe Kraskouskas to explore the feasibility of implementing such a program on the WPI campus.

3.2.3 Survey of Students and Faculty On Campus

After gaining insight into potential initiatives and practices, a survey was conducted to gather additional data. This survey was given to WPI students and faculty online through Qualtrics in order to gather valuable data on current sustainability practices, what practices they would be open to adopting, and how to effectively implement those practices. All relevant results and data from the survey can be found in **Appendix B** and is discussed in Chapter 4.

3.3 Objective 3: Evaluating the Feasibility of the New Initiatives and Practices

Research and earlier interviews led us to two potential waste reduction programs were considered for this project: overall waste reduction in the Campus Center through the increased use of reusables and bulk scrap industrial plastic recycling in the Washburn Shops. The team talked to Ian Anderson, Washburn Senior Lab Technician, to gather information about the industrial plastics produced in washburn labs. We also met with Joseph Kraskouskas, director of Dining Services, to discuss the feasibility of implementing a reusable container program intended to reduce disposable waste in the Campus Center.

3.3.1 Interview with Director of Dining Services: Joe Kraskouskas

The team met with Joe Kraskouskas of Dining Services on Tuesday April 3rd in his office located in the base floor of the Campus Center. In our structured interview we asked him questions regarding the waste stream in the Campus Center, the most common waste items in the Campus Center, and discussed his opinion on any changes or improvements that he believes will reduce the Campus Center's waste. Based on the information we learned from the Clarkson Sustainability Coordinator, Alex French, we asked Mr. Kraskouskas about the problems Clarkson faced with their reusable program in order to prevent the same issues at WPI. The team

felt that interviewing Mr. Kraskouskas was very important because if a reusable container program was implemented Dining Services would play a pivotal role of cleaning the containers.

3.3.2 Interview with Washburn Lab Senior Lab Technician: Ian Anderson

In order to explore the viability of recycling waste plastics produced in Washburn Labs, we met with the Washburn senior lab technician Ian Anderson. We asked him questions regarding how much plastics are produced in Washburn, the available space in the Lab for a collection bin, and the current recycling practices in the Lab. Ian was able to give us some very good information that lead us to make a recommendation on the industrial plastics that will be found in the next section.

3.4 Objective 4: Implement and/or Recommend New Practices and Initiatives to WPI.

Lastly, we assessed our stakeholders' recommendations on sustainability initiatives, and analyzed the information gathered from our interviews and surveys. The information we analyzed was mostly focused around the funding of implementing a waste reducing program, a cost analysis of a reusable container program, and the student opinions of a reusable container program. From this we determined what new initiatives, as well as changes to campus waste management practices, our team can feasibly recommend.

Taking the information given to use by Joe Kraskouskas about the quantities of the disposables used in the Campus Center we were able conduct a cost analysis. Taking the quantities of the disposables given, the team then weighed the individual disposable containers and looked up pricing for these containers online. After gathering all this data the team was able to generate a cost analysis for how much the school spends on purchasing and throwing away the

disposables. Using this information the team compared the total cost of disposables to possible reusable container programs to determine if the program would be cost effective and feasible.

Based on the cost analysis, we determined the feasibility of an expanded green2go program. With this information, we made recommendations to the WPI community and future IQP/MQP groups that are interested in tackling the waste management issues on campus. We provided the research and information on other initiatives we were unable to implement and provided the future groups direction for these initiatives.

4.0 Findings

The team compiled data from stakeholder interviews, and WPI community survey responses. As research progressed, the team found that certain initiatives produced less waste than initially thought but should still be considered in the future, while others required more-immediate attention. It also became apparent that some areas of interest required further investigation. This auxiliary research was conducted to complement our initial findings and better understand their significance.

4.1 Waste Generated on Campus

WPI facilities and the Green Team have collected data on the weight of trash and recycling produced on the WPI campus in a year. **Figure 3** below shows the reported weights over the last 11 years.

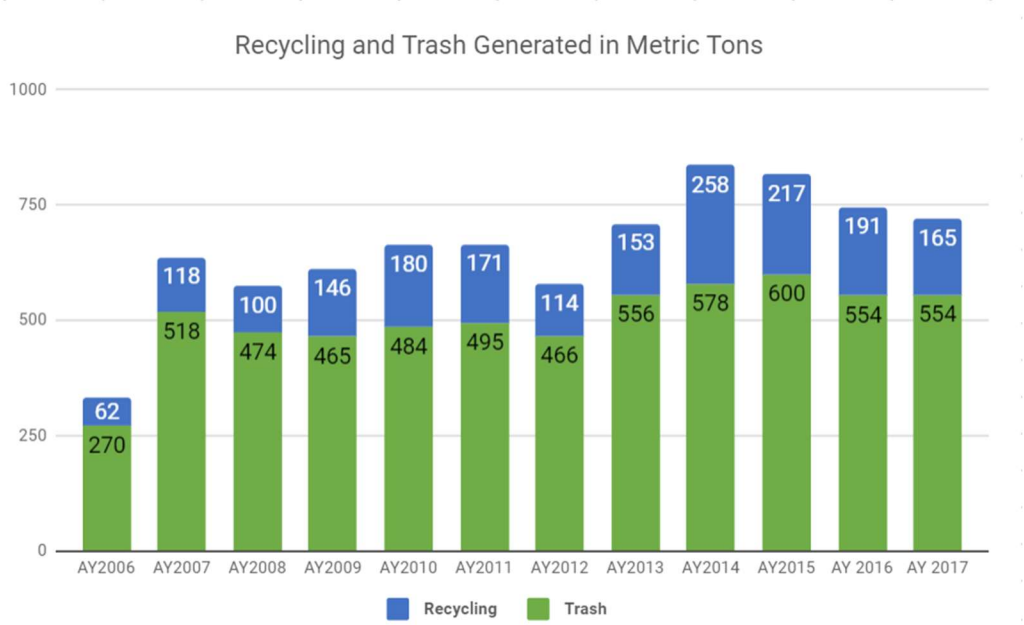

Figure 3: The weight of trash and recycling produced at WPI since 2006.

This graph shows that waste generation at WPI has been gradually trending upwards over time. While the weight of recyclables has also trended upwards, WPI sustainability stakeholders say that waste reduction and implementing reusables are better sustainability practices. Elizabeth Tomaszewski noted that many sources of waste in the Campus Center could be mitigated either by incentivizing a reusable alternative, or by employing disincentives that make it harder for students and faculty to produce the waste in the first place.

Using the monthly list of Campus Center disposables provided by Joe Kraskouskas and the data collected from weighing said disposables, the team was able to estimate the total weight of waste generated in a month. A list of Rubin Campus Center disposable products with their respective quantities and weights is can be found and is talked about in-depth in **Table 3 in Section 4.4.1.** This table shows that the disposables generated from the Campus Center produce an estimated

2410 pounds of waste per month. This equates to an estimated 21,690 pounds generated over the active school year and accounts for approximately 1.4% of all waste generated by WPI in 2017.

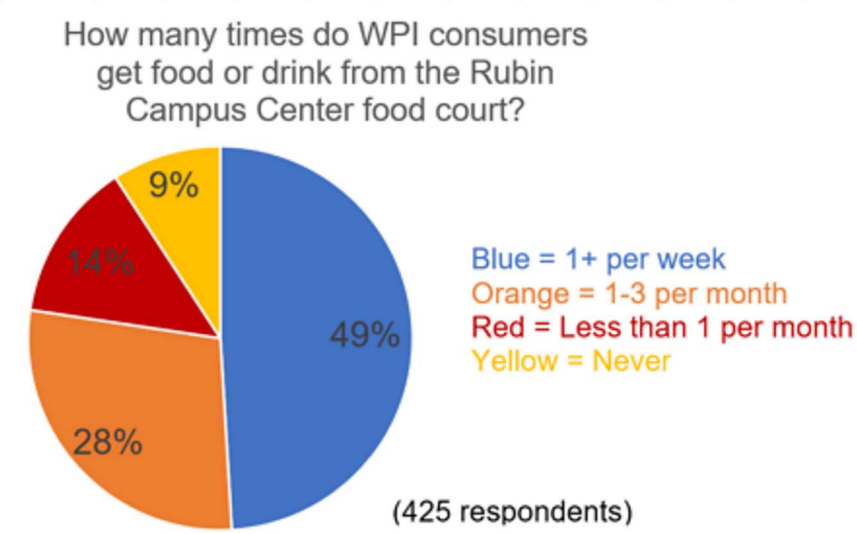

Figure 4: How many times the respondents of our survey use the Rubin Campus Center

Survey results (**Figure 4**) showed that 51% of respondents used the food court only a few times per month or less, while the other 49% used it one or more times per week. This means that half of WPI consumers contribute to the majority of disposable waste produced in the food court. The chart below (**Figure 5**) shows the most commonly used disposable products used by this 49%.

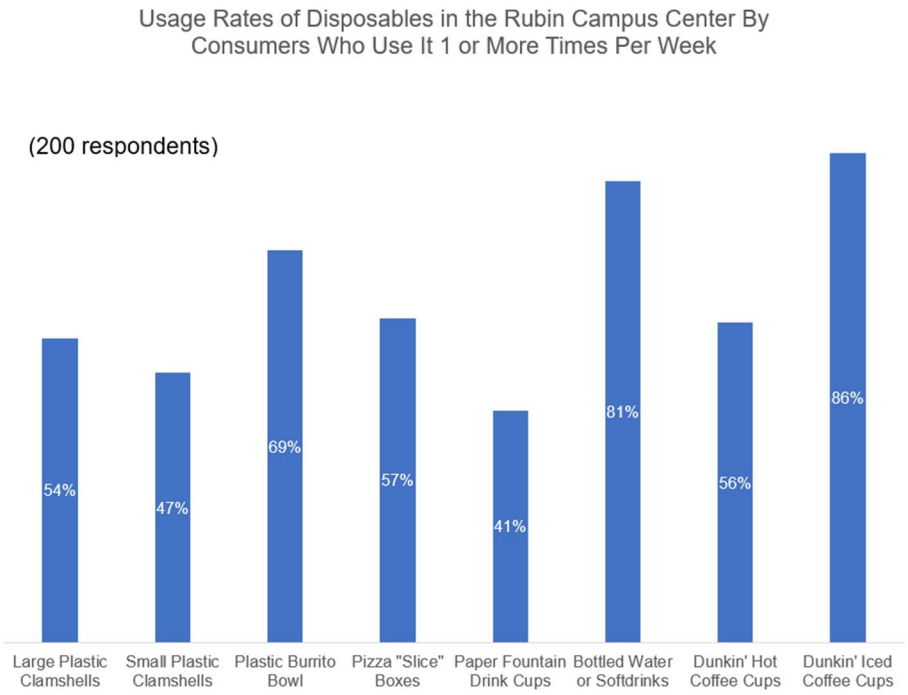

Figure 5: Commonly used disposable products out of the WPI members who go to the campus center 1 or more times a week

The top four categories are Dunkin' Donuts iced coffee Cups, bottled soft drinks or water, plastic burrito bowls, and large plastic clamshell containers. With the implementation of a reusable food container and beverage container program these categories could be significantly reduced and as a result the total waste produced by disposables on campus will decrease. The other categories such as the pizza slice boxes, Dunkin' Donuts hot coffee, small plastic clamshells, and the paper fountain drink cups can also be significantly reduced or eliminated with the implementation of the same reusable food container and beverage container program.

4.2 Sustainability Practices at WPI

Last year WPI made many improvements regarding campus-wide sustainability, but efforts to reduce waste and increase recycling rates are ongoing. Initiatives to reduce single-use

waste have been largely ineffective. For example, since the launch of the reusable container program in 2016 according to the Green Team, only 231 students and faculty have bought into the program.There were successful steps taken to move towards composting on campus, beginning with food separation in the Morgan Dining Hall and the Rubin Campus Center.

4.2.1 Composting and Biodegradables

In speaking with Elizabeth Tomaszewski, the assistant director of sustainability at WPI, the team determined that the most-effective sustainability practices focus on reducing and reusing rather than just recycling. In discussing waste from food containers, Elizabeth stated that even biodegradables and compostables are ineffective as they are often thrown away inside of a plastic garbage bag and aren't subjected to the strict environment required for them to decompose. Kayleah Griffin, a WPI sustainability intern had similar feelings on compostable containers. "*...composting is tough on campus because all the 'biodegradable' containers would overwhelm the quality of the compostables, which in turn ruins soil quality."* Instead, the team was told that WPI should focus first on separating food from the general waste stream instead of jumping straight to composting. Food separation is currently in place at the Pulse on Dining (POD) food hall in Morgan campus but there are now plans to expand the program. Kayleah Griffen and Nicole Luiz from the WPI Green Team have been working hard to propose a plan to expand the food sorting program into the Rubin Campus Center. The POD food hall is primarily used by freshman students living in the dorms, but the campus center is used by everyone. Expanding this program into the campus center will help significantly reduce the total food waste produced by the campus.

4.2.2 Current Reusables Programs

WPI currently offers two types of reusables: standard dine-in dishware for use in the food court, and reusable to-go containers through the Green-2-Go program. The team's interview with Joe from Dining Services revealed a few problems with the dine-in program. Unfortunately, it is not uncommon for students to throw out or steal dishes and silverware from the food court. This results in students using disposable silverware in the absence of reusable ones. Additionally, Joe claimed that most consumers prefer the convenience of the disposable to-go containers, and that it was common for consumers to use a disposable container even when dine-in dishware was available. This is likely the result of students wanting to take their food with them for later if they are unable to finish it during their meal in the food court.

A program that would seemingly remedy this, is the Green-2-Go program run by the WPI Green Team. This program allows students to rent, use, and return a reusable to-go container from Dining Services and is advertised by the WPI Green Team. Dining Services initially purchased 500 large reusable food containers for the program and the Green Team constructed a machine that would accept used containers and dispense a carabiner, which could be redeemed for a new container. The following flowchart (**Figure 6**) helps explain the Green2Go system step by step. Accountability of the users to return their container in a reasonable timeframe was also a problem that they have faced.

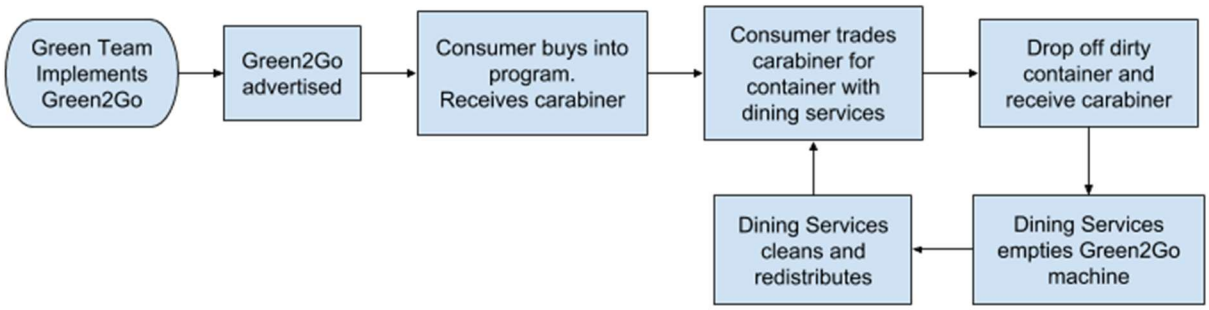

Figure 6: The steps of the current Green2Go program

A major issue with the current Green2Go system that both Nicole and Kayleah identified was getting students, staff and faculty to enter the program. They have done their best to spread awareness of the program but a lot of the faculty, staff, and students on campus don't know that this program exists. When our team went to investigate the Green-2-Go machine in the Founder's Hall Lobby, we found that it was broken (**Figure 7**). Interviews with Kayleah Griffin confirmed that the machine was built for only $300 and is prone to malfunctions.

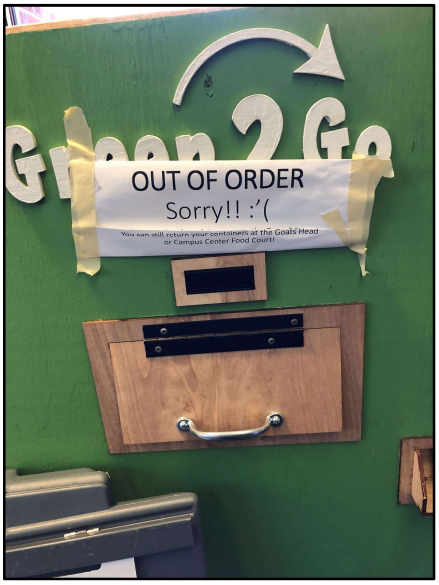

Figure 7: The current Green2Go collection machine out of order

Based on a survey of the WPI community, 59% of respondents had heard of the program but only 8% were actively involved in it, these results can be seen in **Figure 8**. Survey respondents were asked why they did not use the Green-2-Go program and responses fell into two main categories, complexity and user experience. A sample of common responses is provided in **Table 2**.

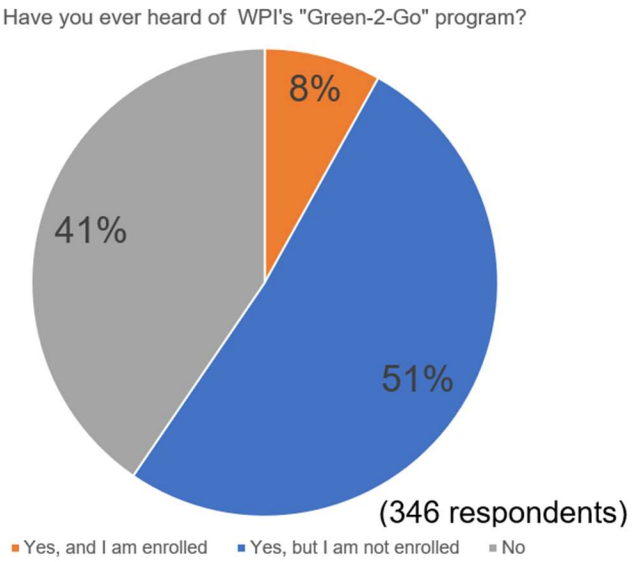

Figure 8: Results of a survey question asking if the individual has heard of the current Green-2-Go system at WPI.

Category	**Response**
Complexity	*I don't know where or how to sign-up.*
	It seems too difficult to use.
User Experience	*I don't want to carry the container around*
	I lost my carabiner to redeem my new container
	I shouldn't have to pay $5 to be more environmentally friendly
	I don't eat in the food court often enough

Table 2: Examples on why WPI consumers do not use the Green2Go Program

These responses clearly show that there is a lack of WPI community awareness about the Green-2-Go program. Students, faculty, and staff are commonly not aware the program even exists or how to participate. In the future, it is important that the reusable container program on campus is advertised heavily and explained in detail to promote participation in order to reduce disposable waste. Additionally, these responses show that there is a convenience issue in the

current Green-2-Go program. WPI community members commonly lose carabiners, don't want to pay a fee, etc.

4.3 OZZI-2-Go / A better reusable container program

After talking with Kayleah Griffen and Nicole Luiz it was clear that the current Green2Go program hasn't worked as anticipated. The machine used to return containers is often out of order and there isn't a lot of campus awareness for the program. Taking this into account, the team explored alternative options for a more effective reusable program to be implemented at WPI.

After researching various peer institutions, a common theme is seen in sustainability around the United States; many schools are trying to implement some sort of reusable beverage or container program. One such program is OZZI-2-Go, a system that replaces the disposables used on campus with reusable containers, bottles, bowls, etc.. The system is designed for college dining halls, food courts, and essentially anywhere that serves food or beverages in disposable containers. This system is similar to the current Green2Go system on campus but there are some very important differences. One main difference between the OZZI system and Green2Go is the use of a return machine with card swipe technology. OZZI is a commercial reusable program that uses reliable machines with CBORD Gold card swipe technology, the same technology that powers WPI ID cards. The program works similar to the current Green2Go but is more reliable and takes the program to a commercial level. An example of the OZZI-2-Go machine can be seen in **Figure 9**.

Figure 9: An example of an OZZI-2-Go machine

http://agreenozzi.com/wp-content/uploads/2015/08/brochure.pdf

In the current Green2Go system, users buy into the program, for $5, and get a container. After consumers uses the container they return it for a carabiner either at the Green2Go machine in Founders Hall or to Dining Services. When they want another container, they exchange the carabiner for a new container. However, with the OZZI machine, when consumers want to get food, the cashier will swipe the users' card which will show that he/she took out a reusable container. After that, the consumer will return the container to the OZZI machine and will swipe their card to verify they returned the container. Additionally, the OZZI program offers multiple reusable containers such as large entree containers, beverage containers, and soup containers. All the containers the OZZI program offers can be found **Appendix C.**

The implementation of a program such as OZZI has potential to make drastic differences on the WPI campus and the campus wide sustainability culture. The program offers economic

and environmental benefits as it would save the school costs on disposable containers and reduce disposable waste on campus.

4.3.1 OZZI-2-Go at Clarkson University

Clarkson University implemented an OZZI-2-Go program in 2013 but it had several issues that are worth considering before implementing a similar system at WPI. Clarkson's goal was to reduce waste on campus by encouraging students to use reusable food containers instead of disposable ones. Alex French, an environmental economist and the sustainability coordinator at Clarkson, also believed that the school could save money over time with the implementation of a reusable container program. The program took off faster than the school anticipated and Clarkson was not prepared for the rapid transition to reusables. The school has analyzed their first implementation and concluded that the reasons the program faltered were dishwashing capacity, student accountability, and facilities willingness to help the program succeed. According to Alex French the OZZI program changed dining culture rapidly, resulting in an influx of containers for Dining Services to wash. Consequently, there was a dishwashing capacity issue, Alex French said that only 8 containers fit in a traditional dishwasher and suggested that a commercial, conveyor belt style, dishwasher would work much better and decrease the likelihood of a capacity issue. Additionally, the tokens consumers receive after dropping off their used container in the OZZI machines were dispensed irregularly, sometimes not giving consumers a token or giving them too many. Dining Services did not feel comfortable charging consumers for a lost container, because of the possibility that it was returned and the

machine malfunctioned. Clarkson now plans on reintroducing the program again within the next two years, after taking into account their mistakes from the past and redesigning the program. They now plan on adding "card swipe technology" as the OZZI company has introduced a card-swipe upgrade for the machine that allows users to swipe their college ID to check in and out containers eliminating the need for the tokens. Knowing why Clarkson's program faltered offers valuable insight we can use to help WPI better prepare for implementation of a successful campus wide reusable program. The flowchart below (**Figure 10**) describes both Clarkson's and the team's proposed program would work.

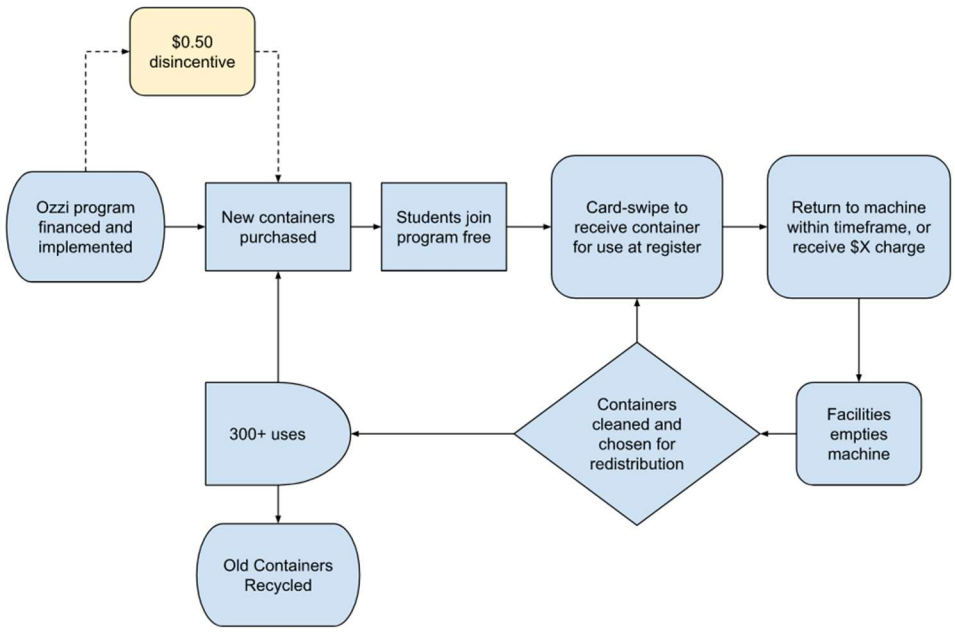

Figure 10: The process in which the OZZI-2-Go program is run at Clarkson University

4.3.2 Consumer Opinions of a Reusable Container Program

To better understand what WPI consumers would want in a reusable container program, the team conducted a survey of 425 WPI students and faculty. The team was specifically interested in the opinions of consumers who ate in the food court most-often. Respondents were asked the open ended question: "Is there anything that would entice you to use a reusable food and beverage container program?" A sample of common responses is shown below.

Category	**Response**
Complexity	*Easier access to the container drop-off.*
	Not having to put down a $5 deposit / Free entry.
	More advertisement and clearer instructions.
User Experience	*If the program had more presence in the Campus Center.*
	Being able to bring my own container.
	Discounts on food and drinks.

Table 3: Examples of answers to the survey question; "Is there anything that would entice you to use a reusable food and beverage container program?"

These responses show a commonality of issues with the current reusable container program. Members of the WPI community are often either not aware of the program, or don't know the logistics of the program and how to participate. Additionally, respondents find the Green-2-Go collection machine ineffective and inconvenient, which further discourages consumers from participating in the program.

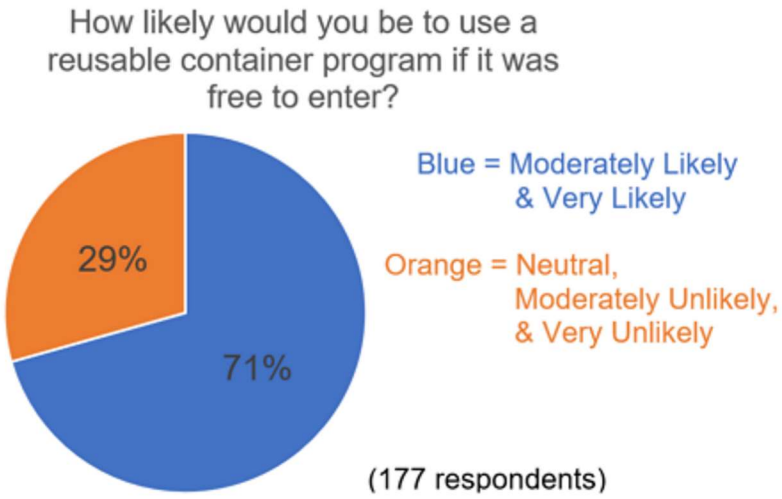

Figure 11: The likelihood of WPI consumers joining a reusable container program if entree container was free

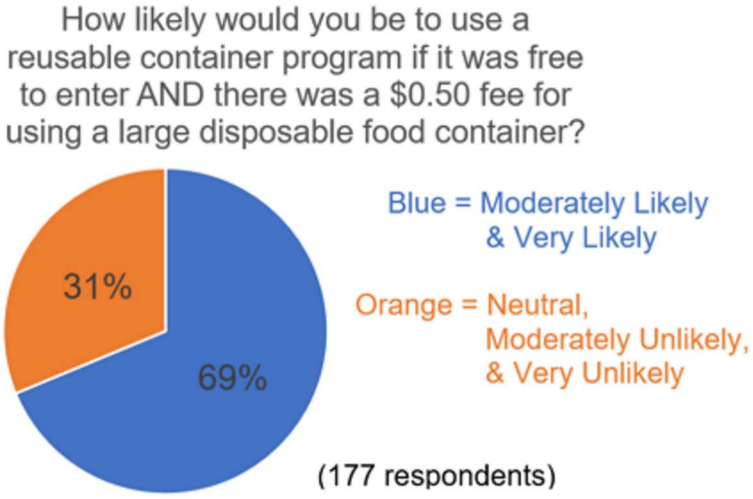

Figure 12: The likelihood of WPI consumers joining a reusable container program if entree container was free and there was a $0.50 fee on disposables

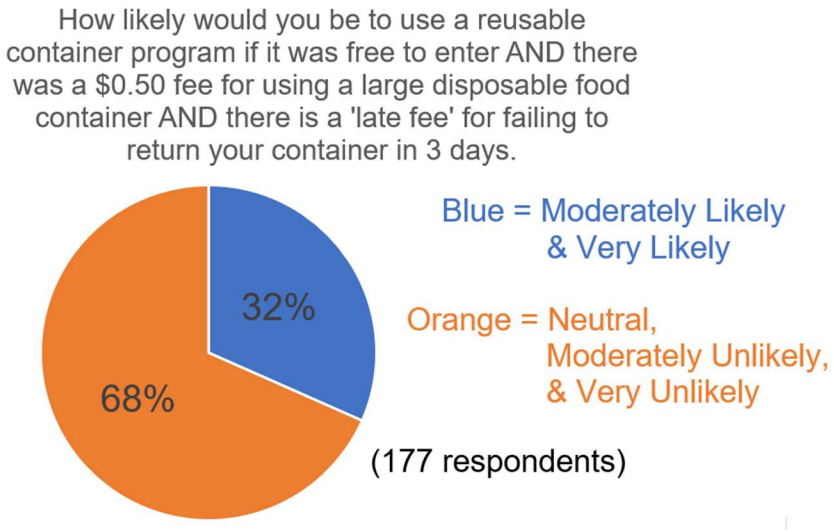

Figure 13: The likelihood of WPI consumers joining a reusable container program if entree container was free, a $0.50 fee was put on disposables, and there was a timeframe to return the container

Figures 11, 12, and 13 outline the responses from the 49% of consumers who use the campus center one or more times per week. Results show that 71% of respondents are likely to use a reusable container if it is provided to them for free, while 29% said they are not as likely to use one. These results remain almost unchanged with the addition of a $0.50 fee for using disposables: 69% of respondents were likely to use reusables and 31% were not as likely. With the further addition of a 'late fee' however, only 32% said they were likely to use a reusable container while 68% said they were less likely. This may be the result of a poorly formatted question that encouraged respondents to compare the various systems and choose the system they prefer rather than if their financial incentives made them more likely to use the program.

4.4 Financial Analysis

4.4.1 Costs Associated With Disposables

Cost estimates of various food court disposables were determined using the webstaurauntstore.com website. Additionally, the items were weighed using the scales in the Rubin Campus Center food court, which are accurate to one-hundredth of a pound.

Location	Product	Cases per month	Count per case	Total count per month	Estimated cost per case	Total cost per month	Weight per case (lbs)	Total weight per month (lbs)
Food Court	Coffee cup	1	1000	1000	$35.55	$35.55	30	30
	Coffe cup lids	1	1000	1000	$25.20	$25.20	10	10
	32 oz fountain drink cups	2	480	960	$41.76	$83.52	19.2	38.4
	24 oz fountain drink cups	3	1000	3000	$63.97	$191.91	30	90
	16 oz fountain drink cups	2	1000	2000	$41.68	$83.36	20	40
	Fountain drink cup lid (32 oz)	1	1000	1000	$25.99	$25.99	5	5
	Fountain drink cup lid (24 oz)	3	1000	3000	$24.99	$74.97	4	12
	Fountain drink cup lid (16 oz)	2	1000	2000	$22.99	$45.98	3	6
	Bottled beverages	24	144	3456	$24.99	$599.76	8.6	206.4
	Straws	2	1800	3600	$6.59	$13.18	5.4	10.8
	Burrito Bowl	7	252	1764	$43.40	$303.80	12.6	88.2
	BB Lids	7	252	1764	$36.99	$258.93	10.1	70.7
	Plastic Clamshells (Large)	28	200	5600	$34.99	$979.72	14	392
	Plastic Clamshells (Small)	16	500	8000	$37.69	$603.04	15	240
	Pizza Boxes	24	200	4800	$46.40	$1,113.60	14	336
	Monthly Totals					**$4,438.51**		**1575.5**
Dunkin' Donuts	Iced Coffee Cups	24	600	14400	$59.50	$1,428.00	30	720
	Lids	24	600	14400	$16.33	$391.92	2.4	57.6
	Straws	24	600	14400	$2.49	$59.76	1.8	43.2
	Paper Bags	9	500	4500	$5.75	$51.75	1.5	13.5
	Monthly Totals					**$1,931.43**		**834.3**
	Monthly Grand Totals					**$6,369.94**		**2409.8**

Table 4: List of the quantity, estimated cost, and weight of the disposables used in the Rubin Campus Center on a monthly basis

The grand totals outlined in **Table 4** show that Dining Services spends an estimated $6,370 on disposable products every month and produce an estimated 2410 pounds of non-recyclable waste. With the cost of waste removal at $80 per ton, this adds an additional cost of $96 per month. This makes the estimated total monthly cost of buying and disposing these products $6,466.

For simplicity, and to better-mimic the initial program implemented at Clarkson, costs associated with only large food containers were analyzed and compared. This includes Large

Plastic Clamshells, Burrito Bowls, and Pizza Slice Boxes which produce an estimated total monthly cost of $2692.

4.4.2 Costs Associated With Reusables

Sue Mariani, a sales representative from OZZI-2-Go provided pricing of the OZZI-2-Go products and generated an official quote for buying a machine or leasing it for 60-months, purchasing new containers, and all the necessary accessories. These can be found in **Appendix C**

Using suggestions made by the OZZI-2-Go sales representative, **Table 5** outlines and compares the estimated monthly costs of buying and disposing of large disposable food containers, as well as the estimated upfront and monthly costs of buying and leasing a machine and replacing disposable food containers with OZZI-2-Go reusables. These costs were then extrapolated into a cost-over time analysis based on the percentage of students participating in the reusable container program. The analysis is shown in **Figure 14** below.

Current Disposables		Purchase an Ozzi-2-Go Machine		Lease an Ozzi-2-Go Machine	
Item	Cost	Item	Cost	Item	Cost
		Ozzi Machine	$13,999		
		Card Swipe Upgrade	$ 2,900	Card Swipe Upgrade	$2,900
		3 Ozzi Carts	$ 1,797	3 Ozzi Carts	$1,797
		1000 Labels	$ 750	1000 Labels	$ 750
		500 Large Container	$ 2,050	500 Large Containers	$2,050
Burrito Bowl Bases	$ 304	1000 Tokens	$ 230	1000 Tokens	$ 230
Burrito Bowl Lids	$ 259	Capital Cost	$21,726	Capital Cost	$7,727
Large Plastic Clamshells	$ 980				
Pizza Slice Boxes	$1,114	1000 Broken Containers Replaced in 20 Months	$4,100	1000 Broken Containers Replaced in 20 Months	$4,100
Monthly Disposables Cost	$2,656	Monthly Broken Container Replacement	$205	Monthly Broken Container Replacement	$205
886.9 Pounds of Waste Produced With A Removal Cost Of $0.04 Per Pound					
Monthly Cost of Removal	$35	Monthly Licensing Fee	$109	Monthly Leasing Fee	$499
Total Monthly Cost	$2,692	Total Monthly Cost	$ 314	Total Monthly Cost	$ 704

Table 5: Comparing the monthly costs of disposable vs the OZZI-2-GO program

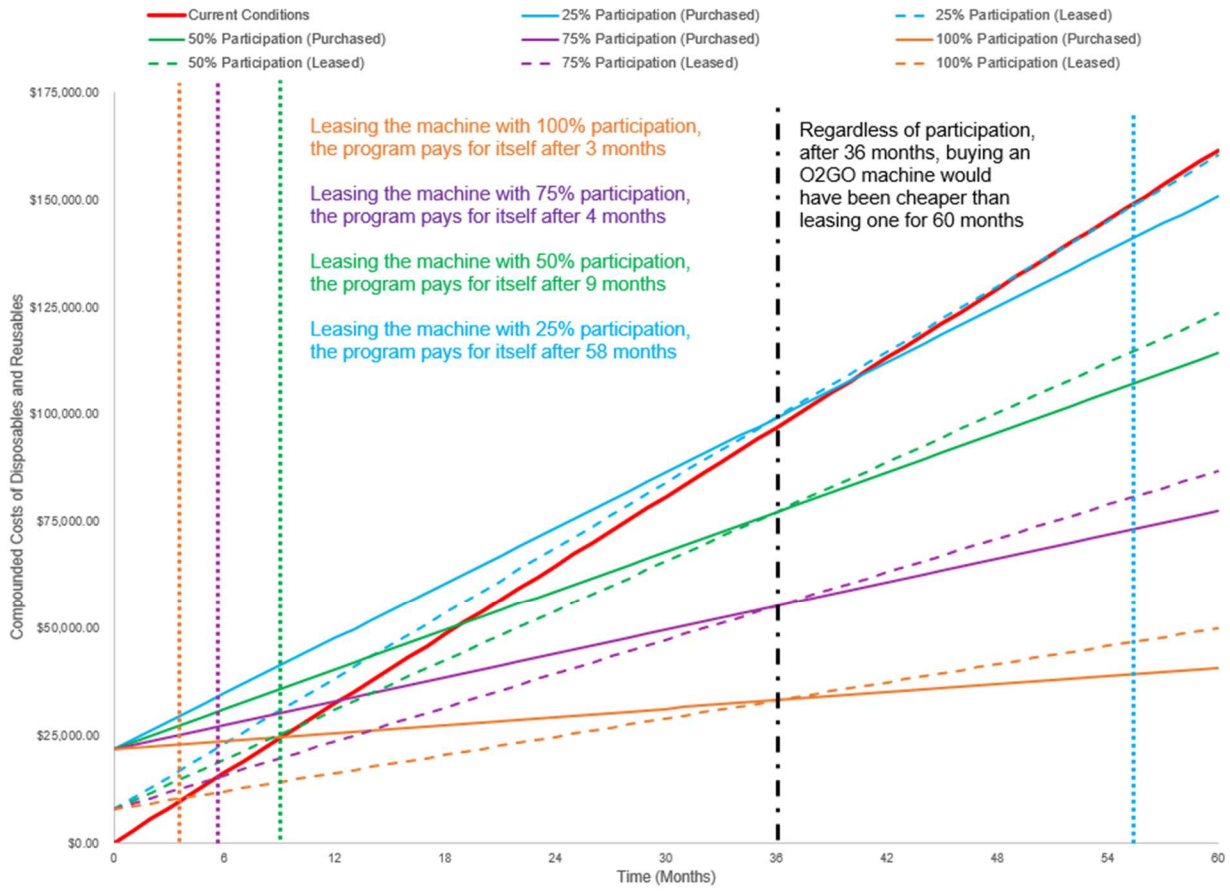

Figure 14: How much current disposables cost compared to the OZZI programs costs and the breakeven points based off of what % of the WPI community uses it.

Both **Table 5** and **Figure 14** depict a higher capital cost of $7,727 associated with the OZZI-2-Go machine. However, this is offset by the lower monthly costs of the reusables ($704 per month) compared to the monthly cost of disposables ($2692 per month). **Figure 14** shows that at 25%, 50%, 75%, and 100% community participation, that the OZZI-2-Go program pays for itself in 58, 9, 4, and 3 month respectively. Since the OZZI-2-Go machine has a 60-month lease, the team also calculated the total cost-saving over time based on percentage of students participating, outlined in **Figure 15** below.

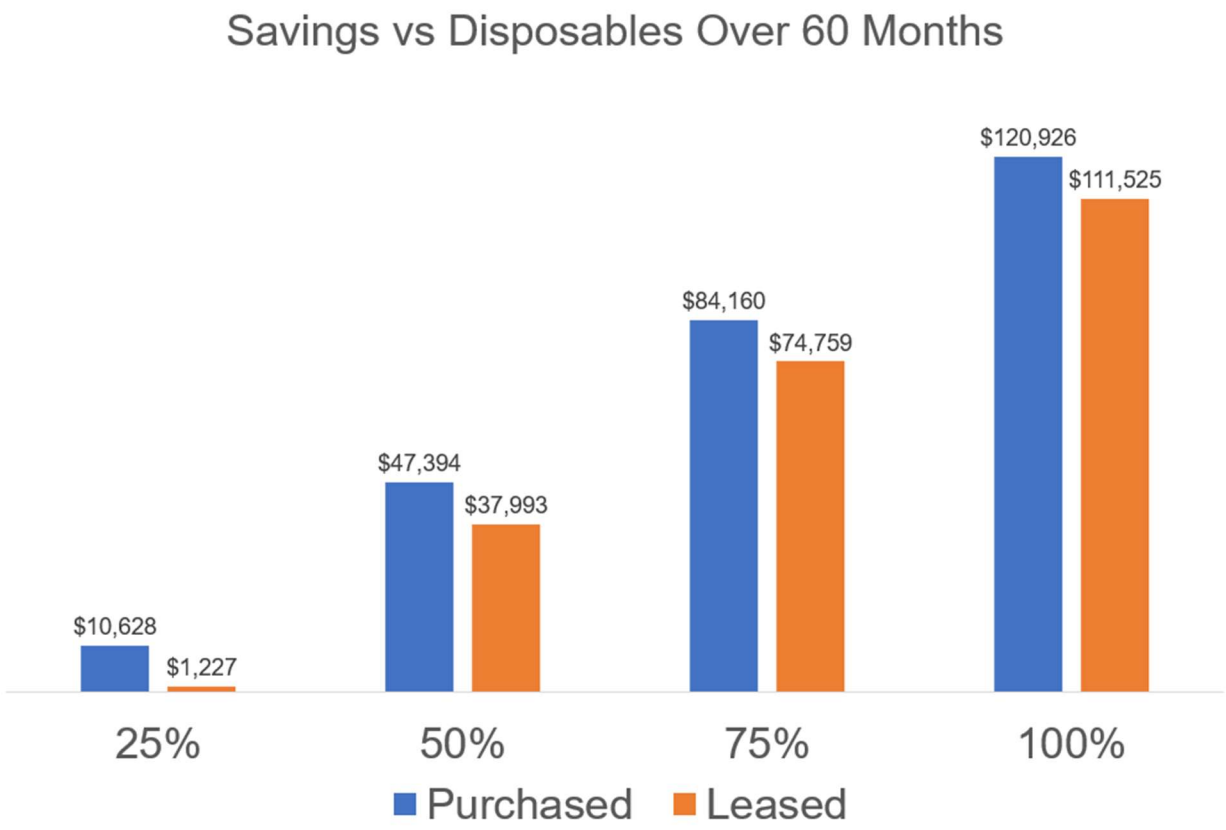

Figure 15: Money WPI would save over 60 months by the percentage of students using the program.

This shows that a reusable container program could save WPI thousands of dollars over the long-term.

4.5 OZZI-2-Go Proposed Program

The OZZI program is a more upscale and commercial reusable program that would increase the effectiveness of WPI's already existing program. The hope is to implement this program in the campus center and then eventually expand it into a campus-wide program. As the team investigated potentially new initiatives to reduce waste, they used Clarkson's experience

with Ozzi-2-Go as a model for WPI's implementation. The team learned that such a program would be most effective by improving the WPI consumer's experience, and creating a firm yet fair financial disincentive for not using the program.

4.5.1 Initial OZZI-2-Go Implementation

While the return on investment analysis showed that it would be cheaper to purchase the machine, it is possible the school will be hesitant to invest the estimated $21,726 capital cost. Therefore, the team recommends that the school starts by leasing the machine. This carries with it lower initial costs estimated at $7727, and if the school finds the program promising, the money spent on leasing the machine can be credited towards purchasing it. The team recommends that either the Green Team or a future IQP group should contact Elizabeth Tomaszewski from the Sustainability Office with our financial analysis in order to create a Funding Allocation Request for submission to the Green Revolving Fund board. If additional or auxiliary funding is needed, they should also contact Joe Kraskouskas from Dining Services, as he initially funded the purchasing of the Green-2-Go Containers. Additionally funding may be generated from the WPI student government and other sources on campus.

All of the containers purchased for the Green-2-Go program, as well as any other reusable container, can be made compatible for use with the Ozzi-2-Go machines by affixing them with labels sold by Ozzi-2-Go. The OZZI implementation should mirror the current reusable container program and only use the large reusable entree containers as an alternative to

the large disposable food containers. Results have shown that this will still have a positive financial and ecological impact, and can serve as a pilot study.

Survey findings suggested that the Ozzi-2-Go machine should be placed somewhere in the Campus Center to better advertise the program, make emptying the machine and washing containers easier for Dining Services, and ensure consumers have a readily accessible location to return their containers. Looking to how well-adopted Clarkson's program was, the program should be free to enroll in, and place a $0.50 fee for anyone using a large disposable food container. This way there are fewer barriers to enter the reusables program while also financially incentivizing consumers to utilize the program. The money collected through this disposable fee could even be put into a fund for purchasing and replacing Ozzi-2-Go containers. In order to improve ease of use and keep consumers accountable, the machine should be upgraded with a card reader compatible with current WPI ID's. Also for sanitary reasons, Dining Services might want to set a limit on how long before the container is returned to the machine. The program would keep track of when consumers took or returned a container via a "credit" on the student's account. Such a system could then be used to charge consumers for taking out a container longer than a set amount of time. To do this, future curators of this project should contact IT Services.

4.5.2 OZZI-2-Go in the Future

If the OZZI program is initially implemented and becomes a success with only the large containers, the program can be expanded. If the program is found to be successful, WPI can move to expand the program to include replacements for other food containers, 16 oz beverage

containers, and even silverware. Replacing further disposables with reusables at WPI will only continue to have a positive financial and environmental impact. Additionally, the increased use of reusables and decreased use of disposables is positive for publicity and could even lead to further schools adopting similar reusable programs.

5.0 Washburn Labs Industrial Plastics

From the interview with Ian Anderson, the team learned that it would be ineffective and infeasible to bulk-recycle industrial plastics in Washburn Labs. Currently, Washburn Labs already internally recycles their industrial plastics. After a student has gotten use out of the material, it is placed on a shelf where other students can salvage the material for their own use. Once the material has been cut to a point where students can no longer use it, only then is it thrown into the waste bin, to which Ian stated "*There is probably about one trash can full of waste plastics and wood produced every term, most of which is wood."* Additionally, the teams interview with a Warehouse Plastics Co. Inc. representative found that post-industrial recycling plants require at least a gaylord (48"x40"x36" collection container) of material for them to pick it up. According to Ian there isn't any room in the lab for that large of a container. The following flowchart (**Figure 16**) explains the current industrial plastics collection process at WPI in blue. Additionally, the flowchart shows a possible solution to reduce industrial plastic waste at WPI in yellow where the plastics would be stored in gaylord containers until they are purchased and picked up by an industrial plastic recycling company, such as Warehouse Plastics Co, Inc.

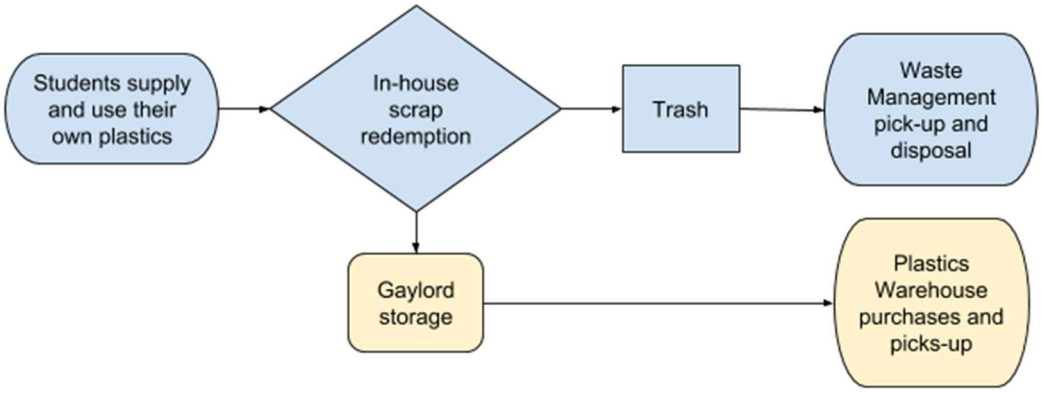

Figure 16: The blue bubbles shows how the bulk scrap plastic is currently disposed of. The yellow bubbles are how the plastics would be disposed of with a recycling program

At this time, there isn't enough waste produced or the space available to warrant the collection of scrap industrial plastics. However, Ian also mentioned that the Foisie Innovation Studio would be equipped with two additional laser cutters, potentially increasing the quantity of scrap plastic produced. "*...we would be happy to collect the plastics in a trash can and bring them to a collection area somewhere on campus...if that lab produces plastic waste we may be able to combine our plastic waste to have enough scrap for it to be worth recycling."*

5.1 Develop and Operate a Bulk Scrap Industrial Plastics Recycling Program for Campus Manufacturing Shops

There is currently no collection area specifically for scrap plastics from manufacturing labs on the WPI campus. After talking with the Washburn Labs senior technician, Ian Anderson, it was obvious that there wasn't enough industrial plastics produced at this moment to implement a recycling program. However, the new Foisie Innovation Studio will have two laser cutters that may produce enough plastic waste to warrant recycling. Due to this, our team recommends that

another IQP group investigates how much scrap plastics the Foisie labs produce when they are in use. Additionally, there is always space and capacity issues in buildings on campus, so building a collection area outside could be the best approach if there is enough plastics produced to implement a recycling program. If the campus produces roughly 1-2 gaylords or more of industrial plastic waste every semester, then a bulk scrap industrial plastics recycling program would be sensible. A trial of scrap plastics collection from the Washburn Shops and the new Foisie Innovation Studio Labs has potential as they will be in possession of two more laser-cutters.

6.0 Conclusion

After considering various ways to reduce waste on the WPI campus, our group found that the implementation of a new and improved reusable container program on campus would not only reduce waste, but also save WPI money. We found that the OZZI-2-Go program is the best reusable container program to implement at WPI, as it enhances consumer convenience and effectively holds consumers accountable. It also has the capacity to replace a variety of disposables with reusables. In the end, our project concludes with recommendations to implement the OZZI-2-Go on campus. It is our hope that future projects will address our recommendations and implement the OZZI-2-Go program at WPI.

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Appendices

Appendix A: Interview Questions

Who: Warehouse Plastics Co. Inc. Representative
When: 3/15 at 10 am
Where: Over the phone
Who was present: Shea Mooney, James Curtin, Stephen Peccerillo

Our team conducted this interview to gather some preliminary information on the industrial plastics. The questions asked were general but we got the necessary information needed to move forward with our project.

What does your job entail? How does it relate to sustainability?

We are looking to recycle the #7 industrial plastics, such as acrylic, at our school, from our understanding you guys buy back the plastics. What materials do you collect and how much would we need to collect for you to pay for it?

Would there be a set schedule every time for pickup? Or would we call when the containers are full?

If we don't produce enough plastic, how much is it for your company to recycle the #7?

Who: Kayleah Griffin (Sustainability Intern)
When: 9 o'clock 3/19
Where: IQP group meeting spot
Who was present: James Curtin, Shea Mooney, Stephen Peccerillo

As a sustainability intern, how do you feel WPI can effectively reduce waste on campus?

How do you think the the reusable programs on campus can be improved?

How do you feel about implementing a reusable bottle or cup program?

How do you feel about implementing “no-choice” initiatives on campus?

What is your role in the Green2Go program?

What have been the biggest issues or challenges with the Green2Go program?

Who are key people to talk to about the reusable program at WPI?

How has Green2Go been advertised?

How can Green2Go be improved?

Who: Ian Anderson (Senior Instructional Laboratory Technician)
When: 2:00 pm 3/19
Where: Washburn Manufacturing Lab
Who was present: James Curtin, Shea Mooney, Stephen Peccerillo

Meeting intended to be with Torbjorn Bergstrom, but he was running late and Ian Anderson had all relevant information needed

In your eyes, is there enough scrap plastics produced in Washburn to warrant bulk scrap plastic recycling?

How are the plastics in Washburn collected and disposed of currently?

How much scrap plastic do you think is produced in the Lab?

Do you believe bulk scrap plastic recycling is a viable way to reduce the waste stream in the Washburn Labs?

Do you have any other ideas in mind to reduce waste in Washburn, or on campus in general?

Who: Alex French (Sustainability Coordinator at Clarkson University)
When: Friday, 3/30 at 10am
Where: Over the phone
Who was present: Shea Mooney, James Curtin, Stephen Peccerillo

How long have you been the sustainability coordinator at Clarkson?

As the sustainability coordinator what is your role with individual projects and programs on campus?

Has Clarkson made any plans to eliminate plastic bags on campus?

Has Clarkson made any plans to eliminate plastic straws?

Have you had experience with any kind of on-campus reusable program before?

Did you predict any kind of cost savings when considering the OZZI-2-Go program?

Was there any reusable program at Clarkson before OZZI-2-Go was implemented ?

What was your role in the implementation of OZZI-2-Go?

What products does your OZZI-2-Go program utilize?

What steps were necessary to implement OZZI-2-Go?

What are the biggest factors that contributed to the programs failure?

You mentioned having some issues with the OZZI-2-Go machines in your email. What were the biggest issues you faced?

You also mentioned a problem with student accountability. How do you plan on fixing this problem when the program is relaunched?

****The remainder of the questions were not answered because Alex had another meeting****
How do you plan on slowing the transition to reusables when the program is relaunched?

Another issue brought up in the email was Clarkson's dishwashing capacity, what was the initial capacity when the program was initially launched? Now with the relaunch, what has been done to improve the dishwashing capacity to account for the reusable containers?

Do you have any other advice or problems to look out for as we try to implement an effective reusable program for the first time on the WPI campus?

What kind of benefits and/or challenges would you foresee if WPI implemented any kind of "disposable disincentives".

What kind of benefits and/or challenges would you foresee if WPI implemented any kind of "reusable incentives".

Who: Joe Kraskouskas (Director of Dining Services at WPI)
When: Tuesday, 4/3 at 1 pm
Where: Joe's Office in the Campus Center
Who was present: Shea Mooney, James Curtin, Stephen Peccerillo

The current goal of this IQP is to reduce waste production on campus by assessing current waste management practices, investigating new initiatives, and evaluating the viability of these practices. At this time, our team is interested in the amount of waste being produced on campus through disposable containers, cutlery, etc. We want to see if this waste can be mitigated through various initiatives, as well as evaluate and recommend effective ways in which WPI can implement these initiatives.

As part of the project, we are investigating the current Green2Go program on campus. Would you be able to tell us how many WPI students and faculty utilize the current Green2Go program?

Additionally, we were interested in gathering data on many of the disposables used in the Rubin Campus Center. If you have the information available, would it be possible to share the quantity purchased and amount spent on some of the following items?

From Dunkin' Donuts:

- Plastic cups and lids
- Foam cups
- Straws
- Paper bags

From the Campus Center Food Court:

- Coffee cups
- Fountain drink cups and lids
- Plastic bags
- Bottled drinks
- Straws
- Burrito bowl containers
- Plastic utensils
- Plastic candy containers
- Plastic "clamshell" containers
- Pizza "slice" boxes
- Paper food "boats"

How long have you been working in your current position?

As Director of Dining Services, is your position involved with running or promoting any of WPI's existing sustainability efforts?

Reusable Dishware

Can you quantify how much the reusable dishware is used in the CC?
Do you feel it is being over or under utilized in any way?

How is the current reusable dishware program in the CC doing?

What is the dishwashing capacity of the CC like?

What are some existing complications with the reusable dishware provided in the CC? (washing, theft, etc.)

Green2Go

What is your job's role in the Green2Go program?

Where is the G2G program advertised and how?
Do you in any way receive feedback about the G2G program?

Are there plans to expand the G2G program? (Advertising, Financial, etc.)

Beverage Containers

In researching this topic, we discovered two different types of reusable beverage container programs that have been implemented at other institutions.

One entails campus-provided reusable "to-go cups" that students and faculty use for their beverage. When the person is done with their cup, they return it and it is washed by dining services. The other entails students carrying their own reusable container which can be filled with the various beverages around campus. Washing the container would be the job of the student.

In either case, the use of a reusable container over a disposable one would carry some kind of incentive with it. Whether that be a perk for using the reusable, or a disincentive to using the disposable.

Do you have any experience with a reusable beverage container program for the CC? (reusable dishware, reusable to-go cups, etc.)

What would you say to an official campus-wide reusable cup or beverage container program?

What steps are necessary to implement a reusable cup or beverage container program?

Plastic Bags, Silverware, and Straws

Already in Massachusetts 61 cities and towns have legislation approved banning plastic bags. Worcester has considered a plastic Bag Ban but has not yet approved legislation.

Has WPI made any plans to eliminate plastic bags on campus?

A survey we have looked at concluded that WPI could save up to 3,000 straws a month if we switched to reusable straws.

Has WPI made any plans to eliminate plastic straws?

General Implementation/Financial Questions

What kind of benefits and/or challenges would you foresee if WPI implemented any kind of "disposable disincentives".

What kind of benefits and/or challenges would you foresee if WPI implemented any kind of "reusable incentives".

What kind of cost saving would need to be promised to consider any new initiative?

If we were to implement an incentive for a reusable program or disincentives for disposables, who should we talk to about it?

Who: Kayleah Griffen and Nicole Luiz
When: 9:00 am 4/9/18
Where: IQP Meeting Spot
Who was present: Shea Mooney, Stephen Peccerillo, James Curtin

Topics:
Financial Side of Green2Go
Advertising of Green2Go
OZZI-2-Go
Possible disincentives/incentives

Who finances the Green2Go program?

How was Green2Go advertised, and by who?

How do you feel about implementing OZZI-2-Go on the WPI campus?
OTHER TALKING POINTS:

Dishwashing Capacity:

- There are plans to expand the Campus Center Kitchen within the next two years.
- The plan is to get rid of the mailboxes, which gives room for a new dishwasher and more storage area.
- Although there currently isn't a pressing dishwashing capacity issue in the Campus Center, catering and the addition of more reusable containers could be a problem.
- Dining services are the people who would handle all processes related to dirty reusable containers.

Card Swipe Technology:

- Talk with Joe and someone from IT services about card swipe technology.
- Card swipe technology that can use Student ID's to monitor the program is very valuable and would improve WPI's reusable program significantly.

Reusable Beverage Program:

- Joe is the person to talk to about reusable beverage program.
- Personal bottles should not be a health or safety risk.
- Joe leans towards the Campus Center providing beverage containers, rather than students bringing their own.
- Weighing the cups or establishing a limit (24 fluid ounces) are possible ways to make sure the program isn't taken advantage of.

Green Team:

- Green Team could potentially have a new position to monitor and control the Green2Go program.
- Kyle Corry is the Green Team President, and may be a valuable person to speak with.
- Getting someone from the Green Team to help run Green2Go in the future would be beneficial. If the Green Team has an official relationship with Green2Go, SGA money will be more available.

General pieces of Advice from Kayleah and Nicole:

- With sustainability programs like these, change should always be focused more on behavior than anything else. Behavioral changes last longer than physical changes.
- Eventually, making the sustainable option free and putting a charge on the disposable option is the way to go. However, more sustainable options need to be introduced on campus before this can happen.
- Proof of concept is crucially important in programs like these. Green2Go was meant to introduce the WPI campus to an OZZI like program.

Who: Elizabeth Tomaszewski
When: Monday, 4/9 at 3 pm
Where: 37 Lee Street (Liz's office)
Who was present: James Curtin, Shea Mooney, Stephen Peccerillo

Do you have any recommendations to improve the Green2Go program?

If a disincentive was implemented, where would the money go?

To make sure containers are returned in a timely fashion, we are considering a late fee if the container is not returned within 3 days. How do you feel about implementing a late fee?

Could you explain the process facilities goes through when dealing with waste in the Campus Center?

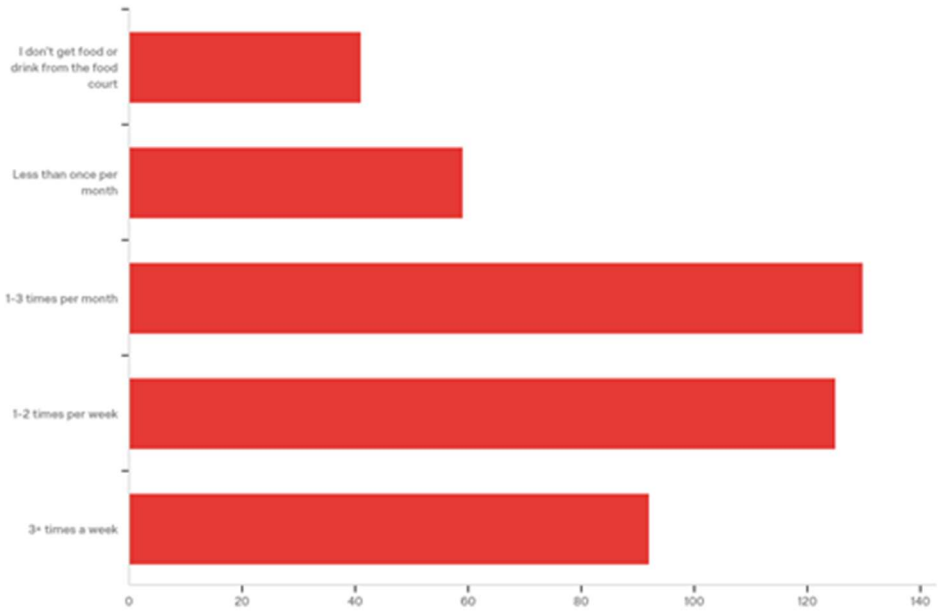
How much is WPI charged for waste removal by Waste Management?

In your eyes, how can OZZI-2-Go be financed and implemented?

Do you think the Green Revolving Fund would be something that we could look into for funding?

Appendix B: Survey Questionnaire

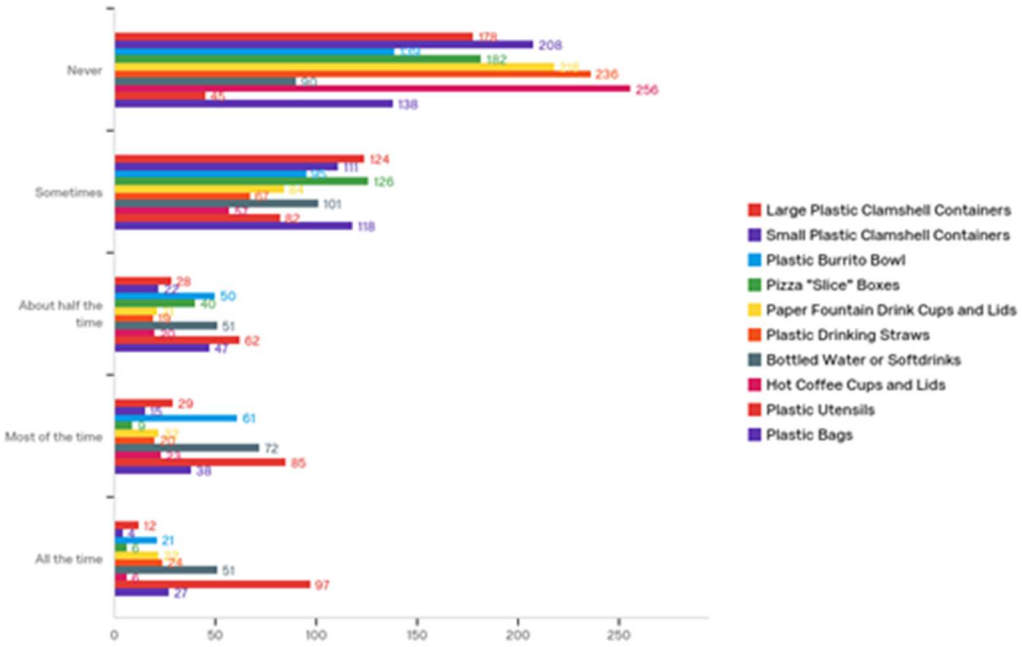
Q1 - On average, how often do you get food or drink from the Rubin Campus Center food court?



Q1 - On average, how often do you get food or drink from the Rubin Campus Center food court?

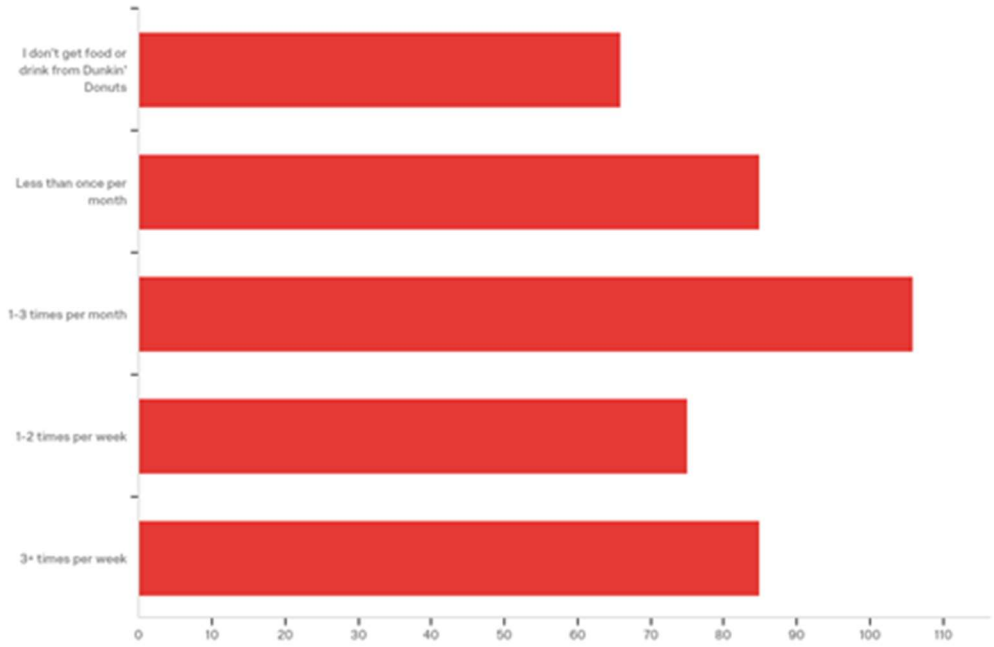
#	Answer	%	Count
1	I don't get food or drink from the food court	9.17%	41
2	Less than once per month	13.20%	59
3	1-3 times per month	29.08%	130
4	1-2 times per week	27.96%	125
5	3+ times a week	20.58%	92
	Total	100%	447

Q2 - How often do you use the following items when you get food at the Rubin Campus Center food court?



#	Field	Never	Sometimes	About half the time	Most of the time	All the time	Total
1	Large Plastic Clamshell Containers	47.98% 178	33.42% 124	7.55% 28	7.82% 29	3.23% 12	371
2	Small Plastic Clamshell Containers	57.78% 208	30.83% 111	6.11% 22	4.17% 15	1.11% 4	360
3	Plastic Burrito Bowl	37.98% 139	25.96% 95	13.66% 50	16.67% 61	5.74% 21	366
4	Pizza "Slice" Boxes	50.14% 182	34.71% 126	11.02% 40	2.48% 9	1.65% 6	363
5	Paper Fountain Drink Cups and Lids	59.40% 218	22.89% 84	5.72% 21	5.99% 22	5.99% 22	367
6	Plastic Drinking Straws	64.48% 236	18.31% 67	5.19% 19	5.46% 20	6.56% 24	366
7	Bottled Water or Softdrinks	24.66% 90	27.67% 101	13.97% 51	19.73% 72	13.97% 51	365
8	Hot Coffee Cups and Lids	70.72% 256	15.75% 57	5.52% 20	6.35% 23	1.66% 6	362
9	Plastic Utensils	12.13% 45	22.10% 82	16.71% 62	22.91% 85	26.15% 97	371
10	Plastic Bags	37.50% 138	32.07% 118	12.77% 47	10.33% 38	7.34% 27	368

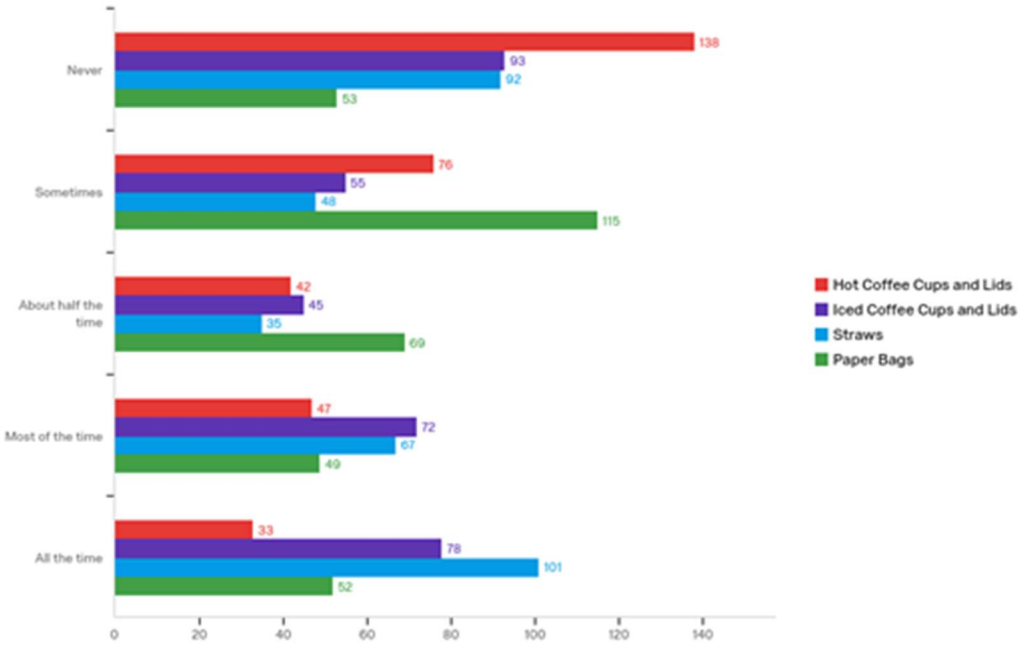
Q3 - On average, how often do you get food or drink from the Rubin Campus Center Dunkin' Donuts



Q3 - On average, how often do you get food or drink from the Rubin Campus Center Dunkin' Donuts

#	Answer	%	Count
1	I don't get food or drink from Dunkin' Donuts	15.83%	66
2	Less than once per month	20.38%	85
3	1-3 times per month	25.42%	106
4	1-2 times per week	17.99%	75
5	3+ times per week	20.38%	85
	Total	100%	417

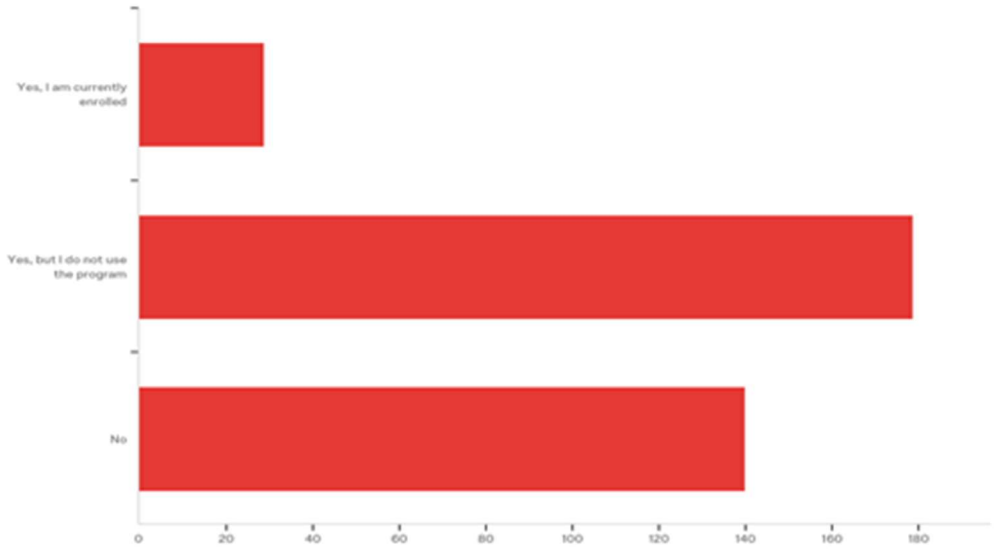
Q4 - How often do you use the following items when you get food or drink at the Rubin Campus Center Dunkin' Donuts?



#	Field	Never	Sometimes	About half the time	Most of the time	All the time	Total
1	Hot Coffee Cups and Lids	41.07% 138	22.62% 76	12.50% 42	13.99% 47	9.82% 33	336
2	Iced Coffee Cups and Lids	27.11% 93	16.03% 55	13.12% 45	20.99% 72	22.74% 78	343
3	Straws	26.82% 92	13.99% 48	10.20% 35	19.53% 67	29.45% 101	343
4	Paper Bags	15.68% 53	34.02% 115	20.41% 69	14.50% 49	15.38% 52	338

Showing Rows: 1 - 4 Of 4

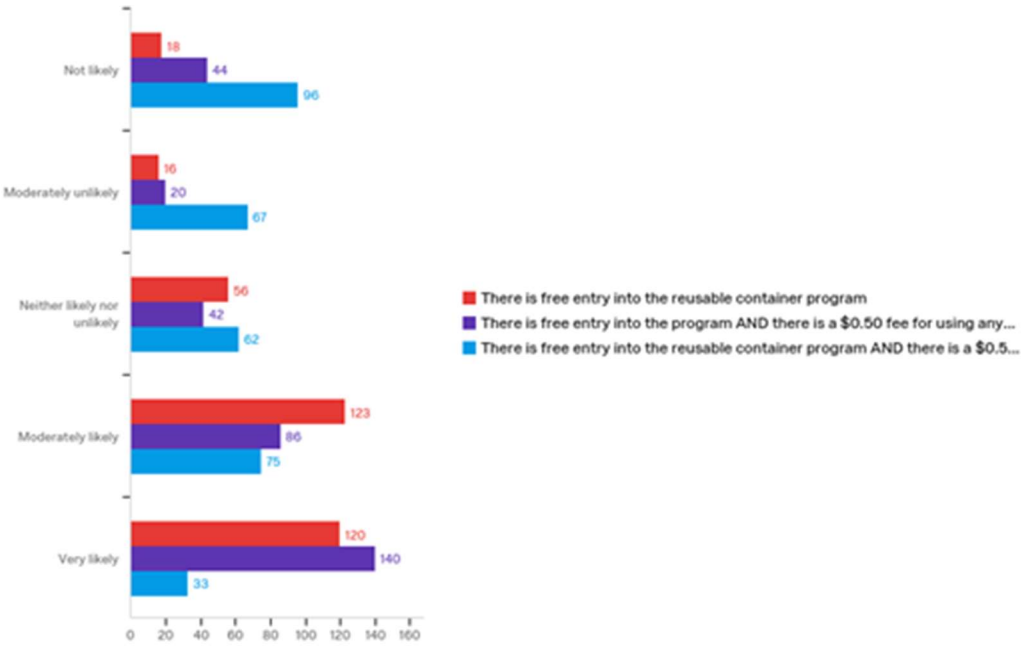
Q5 - On the WPI Campus, there is an option to use a reusable Green2Go container. As part of the Green2Go program, there is a $5 deposit to enter, with unlimited uses of the container. Dining services will clean the container for you after each use. Have you heard of this program before?



Q5 - On the WPI Campus, there is an option to use a reusable Green2Go container. As part of the Green2Go program, there is a $5 deposit to enter, with unlimited uses of the container. Dining services will clean the container for you after each use. Have you heard of this program before?

#	Answer	%	Count
1	Yes, I am currently enrolled	8.33%	29
2	Yes, but I do not use the program	51.44%	179
3	No	40.23%	140
	Total	100%	348

Q6 - Given the following sets of conditions, how likely would you be to use a reusable food or beverage container?



#	Field	Not likely	Moderately unlikely	Neither likely nor unlikely	Moderately likely	Very likely	Total
1	There is free entry into the reusable container program	5.41% 18	4.80% 16	16.82% 56	36.94% 123	36.04% 120	333
2	There is free entry into the program AND there is a $0.50 fee for using any disposable food or beverage container	13.25% 44	6.02% 20	12.65% 42	25.90% 86	42.17% 140	332
3	There is free entry into the reusable container program AND there is a $0.50 fee for using any disposable food or beverage container AND there is a small "late fee" for failing to return your container within 3 days.	28.83% 96	20.12% 67	18.62% 62	22.52% 75	9.91% 33	333

Appendix C: Ozzi-2-Go Pricing

Quote

Date	Estimate #
4/23/2018	2018-069

AGreenOzzi, LLC
P.O. Box 747
East Greenwich, RI 02818

Phone: 855-GRN-OZZI (855-476-6994)
Website: agreenozzi.com

"Changing the world from disposable to reusable one meal at a time."

Customer
Worcester Polytechnic Institute 100 Institute Road Worcester, MA 01609

Terms
Due on receipt

Description	Qty	Price	Total
OZZI System Rental, Annual Rental based on 5 Year Lease	1	5,988.00	5,988.00
CBORD Swipe System Technical Upgrade	1	2,900.00	2,900.00
Tokens per 1000	1	230.00	230.00
OZZI Plastic Liners, Box of 50	5	85.50	427.50
OZZI Cart	3	599.00	1,797.00
O2GO 9x9 Single Entree Container, Case of 50	10	205.00	2,050.00
OZZI Barcode Labels, Roll of 1,000	1	750.00	750.00
NOTE: Please note that the rental is invoiced annually and that rental payment includes on-line maintenance. This lease allows a purchase of the machines during the first 12 months of the lease. You would be credited $4,680.00 for each machine toward the purchase price of $13,999.00 for each machine. This Lease to Own option is only available during the first year of the lease. If you choose to, you may continue with your lease for the remaining 48 months at $5,988.00 per machine per year.			
NOTE: Machine requires 120 volt and data jack connection.			
Please contact Sue Mariani at 401-744-5213 or smariani@agreenozzi.com with any questions.		**Total**	$14,142.50

Quote

Date	Estimate #
4/13/2018	2018-062

AGreenOzzi, LLC
P.O. Box 747
East Greenwich, RI 02818

Phone: 855-GRN-OZZI (855-476-6994)
Website: agreenozzi.com

"Changing the world from disposable to reusable one meal at a time."

Customer
Worcester Polytechnic Institute 100 Institute Road Worcester, MA 01609

Terms
Due on receipt

Description	Qty	Price	Total
OZZI 480 System	1	13,999.00	13,999.00
Year One Maintenance Agreement	1	1,308.00	1,308.00
CBORD Swipe System Technical Upgrade	1	2,900.00	2,900.00
Tokens per 1000	1	230.00	230.00
OZZI Plastic Liners, Box of 50	10	77.00	770.00
OZZI Cart	2	599.00	1,198.00
O2GO 9x9 Single Entree Container, Case of 50	2	205.00	410.00
O2GO 5x5 Single Entree Container, Case of 100	4	235.00	940.00
O2GO Hot & Cold Drink Cup, Case of 50	7	199.50	1,396.50
OZZI Barcode Labels, Roll of 1,000	1	750.00	750.00
NOTE: Machine requires 120 volt and data jack connection.			
Please contact Sue Mariani at 401-744-5213 or smariani@agreenozzi.com with any questions.		**Total**	$23,901.50