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# Developing a Sustainable Transportation Plan for Worcester Polytechnic Institute

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# DEVELOPING A SUSTAINABLE TRANSPORTATION PLAN FOR WORCESTER POLYTECHNIC INSTITUTE

An Interactive Qualifying Project

Submitted to the Faculty of

WORCESTER POLYTECHNIC INSTITUTE

In partial fulfillment of the requirements for the degree of Bachelor of Science

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This report represents the work of WPI undergraduate students submitted to the faculty as evidence of completion of a degree requirement. WPI routinely publishes these reports on its website without editorial or peer review. For more information about the projects program at WPI, please see <https://www.wpi.edu/academics/undergraduate/project-based-learning>

## **ABSTRACT**

This project focused on developing a plan to promote and provide more sustainable transportation options for the WPI community. We conducted a survey to determine the primary methods of transportation used by the WPI community to get to and from campus, conducted focus groups to understand why they used those specific methods and interviewed other colleges and universities to see what worked well on other campuses. Based on our findings, we developed recommendations to increase access to and promote sustainable transportation on the WPI campus.

## **ACKNOWLEDGEMENTS**

We would like to express our gratitude to our advisor, Professor Corey Dehner, and our sponsor, Elizabeth Tomaszewski, who advised us throughout this project, and provided us with the guidance we needed in order to make this project a success. We would also like to thank the Assistant Vice President of Facilities Alfredo DiMauro and the Director of Sustainability John Orr for providing us with their time and information to help make a successful project. We would also like to thank Erza Small, Jenny Isler, Stacey King, and Brandon Smith for taking time out of their busy schedules to discuss transportation plans at their respective Universities.

# **EXECUTIVE SUMMARY**

## **Project Goal**

The goal of this project was to develop a transportation plan with the intent to encourage people to use more sustainable modes of transportation. We worked with our sponsor, Elizabeth Tomaszewski, the associate director of sustainability at WPI, to research the WPI community's choice of transportation. From there we analyzed the data to extract findings and create recommendations based on the findings.

## **Methodology**

In order to achieve our project goal, we developed the following five objectives.

1. Understand the variety of current transportation systems used and available at WPI
2. Explore stakeholder's motives for using the certain modes of transportation and opinions about transportation options at WPI
3. Identify and evaluate current transportation plans at other colleges
4. Determine what makes a successful transportation plan
5. Create template/proposals for changes and seek feedback from stakeholders

In order to complete these objectives, we distributed a survey to the WPI community (Students, staff, and faculty), conducted interviews with members of the WPI office of sustainability and other university sustainability representatives, and conducted focus groups with the WPI community.

## **Findings and Recommendations**

Using the data from our surveys, interviews, and focus groups, we discovered a set of findings which fit into three main categories: Transportation, Motivation, etc. Using our findings

we were able to develop recommendations for WPI. We elaborate on our findings and recommendations below.

1. Finding 1: WPI provides a variety of sustainable transportation options which are SNAP (Student Night Assistance Patrol), Gateway Shuttle, WPI-UMass Shuttle, and Gompei's Gears. However many WPI community members do not know how to find information about these options. Twelve participants from our student body, faculty, and staff focus groups had difficulty finding all transportation options available to them using the WPI website. We also found that on other universities' websites, the *Transportation* tab was visible on their Homepages.
2. **We recommend the WPI webmasters provide a centralized location on the website for transportation options for campus**, which lists most of available transportation options at WPI. We recommend the location for *Transportation* page be under the drop-down menu on WPI Homepage.
3. **We recommend the Office of Sustainability sponsor a project for the development of a smartphone application that provides transportation information.** At a glance, many members of WPI's faculty and staff use their smartphones to quickly access information. Only to remedy this and other functionalities brought up during our focus groups, we believe an app would be the best solution.
4. Finding 2: The WPI community would be more willing to use public transportation if there was easy access between campus and the train station. We found that 27.3% (113 out of 414) of the survey responses stated that if there was frequent bus services or better transportation between WPI and Union Station, they would be more inclined to use public transportation.

5. **We recommend WPI facilities department implement a dedicated shuttle service for faculty, staff, and students for pickup and drop-off at Union Station.**
6. Finding 3: Students are concerned with their safety when walking. 6.5% (26 out of 414) of the survey responses were concerned about their safety in Worcester at night. In our student focus group, 2 students out of 4 indicated that they primarily used their cars to reach the food markets in Worcester that were reachable by walking. As of February 6th 2017, 5 of the last 10 safety incidents on WPI *Safety and Security* page involved either an attack on the streets or a suspicious person on the streets (WPI website, 2017).
7. **We recommend that the WPI campus police attempt to increase lighting around the areas just off campus which have a high number of students' apartments.**
8. Finding 4: Bike lights need to be replaced. In a survey of the available bikes at Salisbury Labs, three of the six bikes were equipped with lights, but only one had a working light.
9. **We recommend that WPI develops a priority parking area near to the entrance of the Park Avenue parking garage for hybrid vehicles.**
10. Finding 5: People would be more inclined to using more sustainable modes of transportation if there were incentives/disincentives to motivate them. Interviews with representatives from WPI and other universities: Clark University, UMass Amherst, University of Colorado Boulder, Boston University, and Harvard University and focus groups showed that incentives and disincentives would motivate people to use sustainable modes of transportation.
11. **We recommend that WPI develops a priority parking area near to the entrance of the Park Avenue parking garage for hybrid vehicles.**
12. **We recommend providing a limited number of subsidized transit passes.**

13. Finding 6: The use of telecommuting and condensed work week at other universities helps enhance sustainability of the campus. Through a plan that reduces the number of days the average employee commutes to WPI by one a week, we could reduce CO2 emissions by 17 thousand pounds a week for the 85% of WPI faculty and staff who use single passenger vehicles as their primary mode of transportation.

**14. We recommend that WPI institute a telecommuting plan for its faculty and staff who work desk jobs and for whom a large portion of time is spent in meetings.**

**15. We recommend that WPI institute a condensed work-week plan for its faculty and staff who do not need to be on campus all days of the week.**

16. In conclusion we have determined a suitable plan to empower our stakeholders to accomplish their goal of making the WPI campus a more sustainable one through supporting a more sustainable transportation system.



## AUTHORSHIP PAGE

All members of the team contributed in the writing of this paper. Each section was edited by the team. The following shows the main authors for each section:

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2.2 Transportation in the United States	Jia Cheng Zhou
2.3 Sustainable Transportation in College Campuses	Ryan Killea
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## Chapter 1: INTRODUCTION

Emissions from vehicles are a significant contributor to global warming, pollution, and waste. Each single passenger vehicle produces on average 5.1 metric tons of carbon dioxide per year which destroys our environment through damage to the ozone layer (USDOT, 2013). In addition, the trend of registered single passenger vehicles in the United States has increased from 61 million in 1960, to 135 million in 2006 (USDOT, 2016). One way to reduce the emission volume is to reduce the number of vehicles on the road and change people's transportation habits. CJL Balsas, a professor from the University of Albany who researches sustainable transportation, found that an effective university transportation plan would impact transportation habits of students in long term because these students become leaders in government, private companies or other organizations (Balsas, 2002).

If you walk through the streets of Worcester, Massachusetts surrounding Worcester Polytechnic Institute (WPI), you will find rows of vehicles parked along the side of the road. Members of the WPI community struggle to find on-campus parking when they arrive to campus at the start of their work or school day. As the parking lots on the WPI campus become overcrowded, the need for a sustainable transportation plan becomes a more pressing issue.

Worcester is not built to support the use of sustainable alternative methods of transportation. Though there is a public bus system, the roads and walkways do not provide accommodations for bicycles or pedestrians and were designed more for vehicle use. Walk Score, a company that assesses how well optimized a city's infrastructure is for walking, biking, public transit, and driving, gave Worcester, Massachusetts a Walk Score of 56/100, which they deemed as "Somewhat Walkable." The community around WPI scored a Walk Score of 82/100,



which they deemed “Very Walkable.” Worcester received a Transit Score of 35/100, due to few nearby public transportation options, and no Bike Score, meaning the city is not at all optimized for biking (Walk Score, 2017). For people traveling outside of walking distance, Worcester provides limited options.

WPI does provide transportation options for traveling around the surrounding city of Worcester. The Student Night Assistance Patrol (SNAP) allows students to request free rides to anywhere in Worcester up to one mile from campus. The Gateway Shuttle allows the WPI community to travel between the two campus locations during the day while the Evening Shuttle (theShuttle) allows students to travel around campus to get to their dorms and to the local supermarket (WPI, 2017). CarpoolWorld, a service that allows people to coordinate carpool rides to and from work, is a service that is barely used by the WPI community, if at all. WPI does well with sustainable transportation across campus, but does not do well promoting or providing services for the use of sustainable transportation outside of campus.

Elizabeth Tomaszewski, the Associate Director of Sustainability at WPI, wants to reduce the number of single occupancy vehicles on the WPI campus. This project focused on finding ways to encourage the WPI community to use more sustainable methods of transportation. In order to do this, we assessed how and why members of the WPI community used certain methods of transportation. We explored sustainable transportation solutions implemented by other universities. According to the Sustainability Tracking, Assessment and Rating System (STARS), 15% of students and 81% of employees use single-passenger vehicles regularly to get to and from WPI. This does not include categories such as traveling around the city, and navigating to different subsections of the campus.

The goal of this project was to determine the modes of transportation used in the year 2016 and propose a transportation plan for WPI to use based on the findings and recommendations. This project filled in the gaps by determining what the WPI community uses for modes of transportation, why they use them, and analyzed stakeholder opinions.

This report includes four chapters, this introduction, a background chapter, a methodology chapter, and finally, a findings and recommendations chapter. The background chapter provides information on global impact of pollution, the dynamics and roles of universities with sustainability, and WPI's history with transportation. The methodology chapter describes the methods we used to gather data. Finally, in the findings and recommendations chapter we discuss our project findings and evidence backed recommendations.

## **Chapter 2: Background**

To fully understand the current state of sustainable practices at higher education institutions, we studied sustainable transportation in the United States, at college campuses, and finally at Worcester Polytechnic Institute (WPI). From this information we derived the challenges we face as a society as well as WPI's place in solving those challenges. In section one, we attempt to define sustainability, and understand its importance globally. Then, in section two, we provide an overview of transportation in the United States including both public transportation and non-motorized means of transportation. In section three, we discuss the unique environment of the college campus and how it makes sustainable transportation different from the broader society. Finally, in section four, we outline the sustainability programs in place at WPI.

### **2.1 Sustainability and its influence**

According to the Brundtland Commission Report (1987), the goal of sustainability is “to ensure that humanity meets the needs of the present without compromising the ability of future generations to meet their own needs.” The process of progress in industry and urban lifestyles has caused an increase in waste and disrupted the environment we live in and this does not seem likely to change in the near future. Therefore, if we continue to improve our lifestyles, we will need to move towards sustainable practices that have positive effects on our environment, society and economy, which match with the three main aspects of sustainability: environmental, social and economic sustainability (Barnaby, 1987). In the following subsections, we discuss the three aspects in more detail.

### 2.1.1 Environmental Sustainability:

Due to heavy exploitation from human production activities: coal mining, oil extraction, wood cutting and more, the environment has gradually lost natural resources such as coal, oil, gas, wood, land, and water. Dr. Robert Goodland is a Social and Environmental Assessment Specialist in Sustainable Development, and is an authority on Environmental Sustainability. He was the environmental adviser of the World Bank Group, the largest and most famous development bank in the world which promotes equity and aims to end poverty. Dr. Goodland (1995) advocates for environmentally sustainable practices to be applied as soon as possible since doing so preserves non-renewable resources in his experience and keeps a moderate pace of harvesting the renewable ones.

#### 2.1.1.1 Decrease in resources

In 2016, Drs. Ortiz-Ospina and Roser, economists at University of Oxford, reported that the population of the world surpassed 7 billion people and the population of the world was only approximately 1.6 billion in 1900 (Ortiz-Ospina, Roser, 2016). In the past, Dr. Ortiz-Ospina served as an advisor to the National Planning Department in Colombia. Dr. Roser has been working on sustainable growth and in collaboration with Dr. Ortiz-Ospina, published “Our World In Data”, a web publication on social, economic, and environmental history of the world as of 2016. Alex Evans is an experienced researcher in international development, climate change, and global risks at Center on International Cooperation, a research center housed at New York University which aims to enhance international responses on the countries and issues most important to conflict prevention through direct and regular engagement with multilateral institutions. Evans predicts (Evans, 2010) that food demand will rise to 50% of the world’s total available resources by 2030 and water demand will rise to 32% of the world’s total available water by 2025 due to an increase in world population.

In addition to food and water demand, other resources such as oil, coal, and forests have been heavily used by both developed and developing countries which will lead to scarcity in the near future (Evans, 2010). To compound this issue, Evans (Evans, 2010) also identified that recent trends have indicated the growth rate of total supply chain production has decreased between 1990 and 2007. He forecasts that the food production growth rate will decrease from 2.0% to 1.1% in 2007 and estimates in 2025, two thirds of the world population will live in water-stressed conditions - either due to water shortages or to polluted water sources (Evans, 2010). These problems are compounded by the fact that a significant other world crisis - climate change - poses a threat to these resources as well.

#### 2.1.1.2 Climate change

The use of unsustainable practices has made an impact on climate change. In Allen et al. 2010 article, “A global overview of drought and heat-induced tree mortality reveals emerging climate change risks for forests”, published in *Forest Ecology and Management Journal* and Evans’ 2010 article, “Resource scarcity, climate change and the risk of violent conflict”, they illustrate how global temperatures have increased since pre-industrial times of from about 0.5 to about 0.7 degrees Celsius. The main greenhouse gases identified by Allen et al. are carbon dioxide (mostly emitted from automobiles, and industrial activities), methane (emitted from fuel production and livestock), nitrous oxide (emitted from industrial processes and wastewater management), and fluorinated gases (emitted from refrigeration and air-conditioning).

According to Rogelj (Rogelj, 2013), the change in global temperature is varied among different regions on the Earth. Dr. Joeri Rogelj is a lead author on several policy synthesis reports by the United Nations Environment Programme and a contributing author to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. As of 2016, Dr. Rogelj

was a research scholar at the Energy Program of the International Institute for Applied Systems Analysis. He has published papers on emission scenarios, carbon budgets, climate change uncertainty, implications of near-term policy choices, and on trade-offs and synergies between air-pollution and climate policies. Dr. Rogelj stated that the temperature change inland will be 1.4 – 1.7 times higher than the temperature change in ocean regions. According to a report published in the journal *Nature*, the effects of this difference in temperature could cause a drop in crop production (Asseng et al., 2015) which would have a negative effect on the increasing demand for food that Evans mentioned in his article (2010).

The conclusion we can derive from the issues of climate change is that if we continue to use non-sustainable practices we will face a significant natural resource shortage. This shortage would affect not only ourselves but also have a broader impact on all ecosystems on the planet.

#### 2.1.1.3 Diminishing habitats

At the time of this report, the increase in land use by industrial organizations has become a threat to natural habitats. In a report published in the journal *Science*, there has been a net loss of 7 to 11 million kilometers squared of forest area worldwide in the past 300 years from 2005 due to timber extraction and agricultural exploitation (Foley et al., 2005). Land exploitation for housing and industrial production also contributes to loss in forest ecosystems. Aquatic habitats are also endangered because of the consumptive use of water (the water that cannot return to water resource system due to chemicals and waste in water) (Foley et al., 2005).

The above state of environment will result in several health problems and concerns among the society. To address these health issues and current affairs concerns, researchers consider social sustainability as a solution, which we discuss in the following section.

### 2.1.2 Social Sustainability

Social sustainability aims to reduce the concerns of people by fulfilling their basic needs such as healthcare, education, and housing and complex needs such as community engagement, and cultural values (Kuhlman, Farrington, 2010). Tom Kuhlman, a senior regional economist at Wageningen University & Research, and Professor John Farrington, Emeritus Chair of Transport and Environment at University of Aberdeen, suggest that there are two aspects that both basic and complex needs must be fulfilled for a community to be socially sustainable.

#### 2.1.2.1 Ways of Life

Dr. Nicola Dempsey, a senior lecturer at Oxford Institute for Sustainable Development, Oxford Brookes University describes the fulfilment of the basic and complex needs described by Kuhlman and Farrington as an “equitable society”, which is an important factor contributing to sustainable development. Dr. Dempsey states that an aspect of “equitable society” is social networks, which range from familiar faces in the neighborhood to friends and family (Dempsey et al., 2011). If most people in the community know each other, members may help each other if one has a problem, creating, according to Dempsey et al. (2011), a community that is “sustaining itself at an acceptable level of functioning.” According to Dr. Dempsey, another aspect of an equitable society that should be considered is community engagement. If there are not many people in the community who take part in its activities, the community will likely reduce the activities in the future.

To help people fulfil their needs, researchers also take economic sustainability into consideration to ensure people are saving and consuming properly.

### 2.1.3 Economic Sustainability

The economic aspect of sustainability can be described as “the process of allocating and protecting scarce resources, while ensuring positive social and environmental outcomes.” (Doane et al., 2001). Deborah Doane is a consultant on international development and sustainability. Tahvonen (2000), works at University of Helsinki, Finland, also states that a lack of natural resources can lead to the market mechanism not work properly and result in profit loss. Therefore, to prevent markets from consuming too many natural resources such as air, water, gas, and oil, Anand and Sen (2000), from St. Catherine’s College, Oxford, UK and from Trinity College, Cambridge, UK respectively, state that the government has established policies such as taxes and regulation. Professor Acemoglu, an economics professor at Massachusetts Institute of Technology (Acemoglu et al., 2015), describes air consumption as air pollution. In the example, an industry produces air pollution by producing a lot of electricity. Then the government places a tax upon the limit of electricity that the industry can produce therefore preventing the industry from producing more air pollution.

In short, it is not possible to change our practices toward more sustainable ones immediately. However, it is possible for us to change little by little in each of our daily practices. In this project, we focus on the most frequent practice that most people do everyday: traveling from one place to another. In the following section, we discuss how people in United States travel.

## **2.2 Transportation in the United States**

Transportation is the way individuals get from one place to another. According to the United States Census Bureau, personal vehicles, public transportation, ride-sharing services and walking are the most frequently used modes of transportation in the United States (United States



Census, 2015). Most of a person's daily transportation need is going to and from work. With the amount of gasses a vehicle can release, sustainable transportation is integral to ensure a better future for the environment.

### 2.2.1 Trends in the Use of Vehicles in Transportation

A 2010 report of the United States Census showed that from the 1960s to the 2010s, the number of people in the United States who relied on vehicles as their main mode of transportation to and from work has more than doubled (McKenzie, Rapino, 2011). With such a large increase in the number of vehicles on the road, the environment is taking a toll. One gallon of non-ethanol gasoline produces about 19.64 pounds of carbon dioxide and one gallon of diesel produces about 22.38 pounds of carbon dioxide. In 2015 the United States Energy Information Administration reported about 83% of the United States transportation sector carbon dioxide emissions came from motor gasoline and diesel engines (United States EIA, 2016). Data from the 2015 United States Census reveals that over three-quarters of vehicles on the road are single-passenger vehicles (United States Census, 2015).

If the number of people using public transportation, carpools, or walking to work increased, there would be fewer personal vehicles on the road. Unfortunately, the data reveals an opposite trend. The 2015 United States Census showed that there was a drop in the percentage of people who carpoled to work, from about 10.7% in 2005 to 8.9% in 2015. The data also revealed that there was no increase in the percentage of single-passenger vehicle usage, from 2005 to 2015, but the number of vehicles on the road rose from about 102 million to about 113 million due to the increase in the United States population (United States Census 2005-2015).

### 2.2.2 Public Transportation Trends

Public transportation is the use of any publicly accessible transit systems, like city buses and trains, to get from one place to another. Only a small percentage of people in the United States, 5%, who travel to work use public transportation and that number has decreased significantly from 12.1% from the 1960 Census to the 2010 Census (McKenzie, Rapino, 2011). Though public transportation's *percentage* of riders is decreasing, the sheer number of riders are increasing. The American Public Transportation Association reported that transit systems have started to evaluate ways to increase ridership even more as public transportation is one of the best ways to get single-passenger vehicles off the road (APTA, 2015). Improvements and expansions made to public transportation infrastructure and service would encourage more people to start utilizing public transportation and increase ridership. The Massachusetts Bay Transportation Authority (MBTA) increased their ridership numbers through improvements to their infrastructure and schedule optimization and hit a record high of 400.8 million rides for 2014 (MBTA, 2015).

An analysis of the United States Census data showed that people and workers who live in cities with expansive public transportation systems are more likely to take public transportation than driving alone. A report on the United States Census revealed that from 2006-2013, there was about a 3% decline in the number of people driving alone in those cities (McKenzie, 2015). Public transportation plays a bigger role in the commutes of minorities and foreign-born than in native born people. With about 10.8% of minorities who commute relying on public transportation and 4.1% native-born commuters, public transportation has room to grow in both the minorities, foreign-born, and native born people (United States Census, 2015). With public transportation ridership on the decline, the usage of ride-sharing services has increased from the early 2010s to the mid-2010s.

### 2.2.3 Current Ride-Sharing Services and Its Growth

A ride-sharing service is any company that allows people and customers to pay to take or share a ride. At their core, ride-sharing services act like taxi services that do not have time restrictions and work whenever they want (Uber, 2016). With new ride-sharing companies like Uber and Lyft, taxi companies have taken a hit. Taxi & Limousine Services' yearly report detailed that from 2010-2016, both Uber and Lyft have been taxi services' largest competitor, resulting in a drop in the taxi companies' annual revenue (Taxi & Limousine Services, 2016). Between 2010 and 2015, people in the United States have been hailing significantly less taxis and calling more Uber or Lyft rides. This effect can be seen in Los Angeles, California, where the Los Angeles Department of Transportation reported an approximate 28% drop in the number of taxi trips from 2012-2015 (LA DOT, 2016). The benefits of Uber and Lyft, do outweigh the benefits of taxi services, both for their workers and for their riders. Uber allows their drivers to set their own schedule, use their own cars, earn more money per hour on average, and have less requirements for employment (Uber, 2016). Uber and Lyft are not the only companies with an increase in the number of users, but the company ZipCar increased their number of users as well.

ZipCar has left an impact on the east coast of the United States, especially in Baltimore, Maryland. Data from a 2010 Baltimore survey revealed that 18% of respondents have sold their cars to use Zipcars, 26% have been driving less, and 46% avoid buying a car in the future. Twenty-one percent of respondents now walk more, 14% ride a bike, and 11% take public transportation more often to get to a Zipcar comparative to the years before (Business Insights: Essentials, 2011). This data shows that ride-sharing services, like Uber, are making an impact on people's preferred mode of transportation.

#### 2.2.4 Non-Motorized Modes of Transportation

Non-motorized modes of transportation are ways of getting to and from one place to another, without using any motor or energy sources. This includes modes such as walking, cycling, skateboarding, roller-skating and other small wheel transport (Rosca, et al, 2010). Non-motorized modes of transportation are more sustainable, as they do not release any emissions nor do they consume non-sustainable sources of energy. People in the United States are now walking and biking more than before. A study that used data from the most recent National Household Travel Surveys, as of 2016, showed that people in 2009 walked nine more miles per year and cycled five more miles per year than in 2001 (Pucher, et. al., 2011). Non-motorized means of transportation produce no greenhouse gases into the atmosphere, as they consume no gasoline. Biking and walking are also healthier for the human body because you are more physically active than when you are sitting and driving a car (Lee, Buchner, 2008). Sustainable transportation is especially important on college campuses, as there are a large number of students, faculty, and staff who travel to and from campus daily.

### **2.3 Sustainable Transportation in College Campuses**

There are nearly 2000 college campuses in the United States as of 2006 (National Center for Education Statistics, *Digest of Education Statistics, 2006.*). Therefore the sustainability of the transportation systems employed by campuses contributes to the overall sustainability of the United States. In research done by the US Department of Transportation, Miller (Miller, 2001) found that all 30 of the colleges and universities considered by their research had a transportation system.

According to Balsas (2003), a professor at the University of Albany, universities often have a dense network of destinations that are easily navigable by bicycle and relegate parking to

their periphery (Balsas, 2003). This causes students, faculty, and staff to park on the fringes of campus and spend a large portion of the day commuting by foot to the classrooms and campus destinations they need to reach (Balsas, 2003). Add to that the working environment of the campus being more conducive to sustainable modes of transportation than the single-passenger car.

In the following section, we discuss the uniqueness of the college environment, as well as the contribution from known demographics.

### 2.3.1 College Campuses

College campuses are uniquely well-suited to support sustainable transportation. According to Balsas (2003), it is potentially easier to encourage change in a university setting. A 2003 survey conducted by C.J.L. Balsas of college campuses which have a focus on sustainable transportation found that these campuses have successfully encouraged a “modal split” from single-passenger automobile to pedestrian or bike transportation (Balsas, 2003). Balsas conducted this survey by determining the eight most bicycle-friendly campuses as determined through snowball sampling his peers in sustainable campus research. From there he gathered data from a survey of students, faculty, and staff with questions based upon the National Bicycling and Walking Study's chapter on Actions Plans and Programs at the local level (USDOT, 1994), a previously successful department of transportation study on use and accessibility. The survey was indicative of the success of liberal policies and planning taken on by these campuses on their undergraduate populations.

A study conducted by professors at Alabama State, and Tuskegee University of two US universities found that the knowledge gap for the importance of sustainability on college campuses is nearly nonexistent, but the “commitment gap” (how willing the knowledgeable

student is to put their knowledge into action) is a real problem (Adams and Emmanuel, 2011). The study used survey data from 406 university students across three universities in Hawaii and Alabama. The fact that the students were knowledgeable yet would not commit is both encouraging news, as it seems that the student body is well aware of the problem, but at the same time disheartening because even armed with this knowledge, students are unable to pursue action for whatever reason.

Faculty, staff, and students are all demographics that have different modes of choice. Targeting these groups is crucial for the sustainability of college campuses because they are much more common visitors to the campus than other groups. When deciding upon a transportation plan, the target group is also important when deciding how the transportation plan should be funded or monetized.

In a survey by Daggett, et al., 16% of students lived greater than 5 miles away from campus, a negligible fraction compared to faculty and staff (Daggett, et. al., 2003). Students' proximity to campus contributes to their willingness to use more sustainable transportation as whatever discomfort they experience is minimized by the short distance they typically travel (Balsas, 2003).

Faculty and staff are more likely to pay for regular use of a wide variety of transportation options, in comparison to students (Daggett, et. al., 2003). The interpretation that Daggett provides is that while more expensive options for transportation like a van service with a fare or daily use of a public train system may make sense for faculty, students will likely not be able to afford to pay for these systems.

While colleges are unique in that they are defined in part by their group identity of student, faculty, and staff, there is not a completely homogenous landscape of features.

Specifically, a college's transportation needs are not defined only by its quantities of each group, but additionally by other factors such as the distinctions between urban and rural (Miller, 2001).

All urban college campuses are more likely to have a transit network which operates entirely off of fees than those in more rural areas (Lewis, et. al., 1999). This could impact the decision to charge a fee for usage of the transportation system if it is controlled by the college, as it was in around half of the colleges considered in Miller's research (Miller, 2001). It could also impact the estimated budget for a sustainable transportation plan which ranged from below \$1 million to over \$16 million for colleges in Miller's research (Miller, 2001). Additionally, in a comparative study of colleges in Los Angeles and in less car-dominant cities conducted by researchers at Iowa University, the distinction between cities in which the majority of people use cars for transportation and other more pedestrian friendly cities is insignificant when used as the only distinguishing factor in the prediction of single-passenger usage of cars by college students (Zhou, 2012). This is somewhat counterintuitive, but was shown in the context of cities who used cars versus those that did not. In the context, it is surprising yet possible that students had everything within close enough reach that even in these car dominant cities they did not use single-passenger cars more frequently.

### 2.3.2. Sustainability Partners

There are organizations that help measure and compare colleges' sustainability records. The ones that are most popular to the location in which the project takes place (Worcester Polytechnic Institute) are AASHE, STARS, and GreenerU. AASHE the Association for the Advancement of Sustainability in Higher Education, is a non-profit organization that aims to be a resource for improving sustainable initiatives as well as provide resources for those seeking to innovate in the field of sustainability in higher education. The Sustainability Tracking,

Assessment & Rating System, or STARS, is a framework to measure the sustainability performance of AASHE college participants. In addition to AASHE and STARS, GreenerU help colleges and universities accelerate towards sustainable performance.

To better understand the differences of each college's sustainability performance, we have compiled a chart using data from the freely available AASHE STARS survey, as well as the websites associated with the universities surveyed (wpi.edu, umass.edu, bentley.edu, wesleyan.edu, bu.edu, 2016) which qualifies how sustainable any given college is. This survey can be found in the appendix (chart A). Notably, between the large urban college campuses (BU, UMass) there is a significant difference (87% vs 33%) of sustainable transportation usage. Sprawl difference is mirrored between the medium and small sized college campuses and the data also indicates that there is little difference between the urban and rural campuses at this scale (around 70-90% of students commute sustainably, along with around 20-50% of faculty and staff).

In his report on Urban Sprawl, Ewing, a researcher at the Metropolitan Research Center found that colleges in areas with a high amount of urban sprawl were surrounded by commuters who use cars to travel a significantly longer distance than those in areas without it (Ewing, et. al., 2003).

## **2.4 Worcester Polytechnic Institute (WPI)**

As a university in the northeastern United States, Worcester Polytechnic Institute (WPI) is looking to improve its sustainable transportation offerings. There are currently a few transportation initiatives in place, which have received a varying degree of success, but ultimately WPI is in a place where it needs to improve its sustainable transportation use.



WPI is a small private school that offers degrees mainly in engineering and business. In 2016, there were 4,256 full time degree seeking undergraduates and 1,325 full time graduates (wpi.edu). The University has around 1000 full time staff and faculty members (wpi.edu).

WPI is located in the center of the city of Worcester, Massachusetts, a city with a population of around 200,000 according to the 2010 US Census Data within a 38.61 square mile area (Google maps, 2016). WPI is one of nine universities within the city of Worcester. Figure 1 and figure 2 are an outline of the campus and the locations of the universities within the city. The WPI campus is also split into a main campus and a satellite campus called Gateway. Gateway is .7 miles away from the main campus (Google maps, 2016).

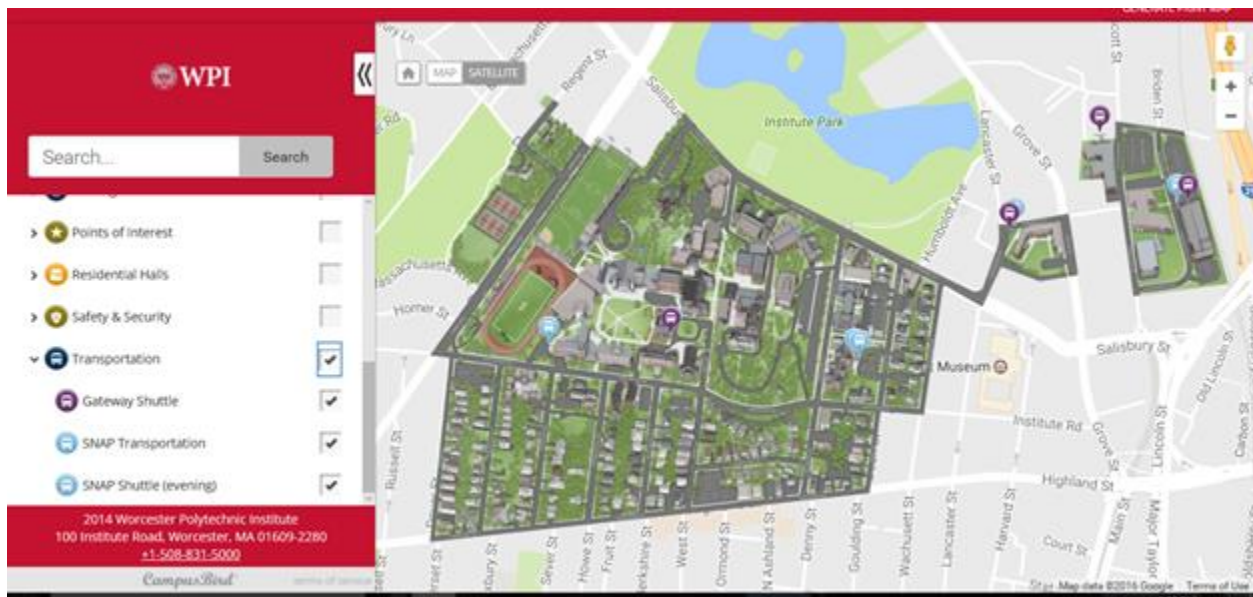


Figure 1. WPI Campus Outline (wpi.edu)

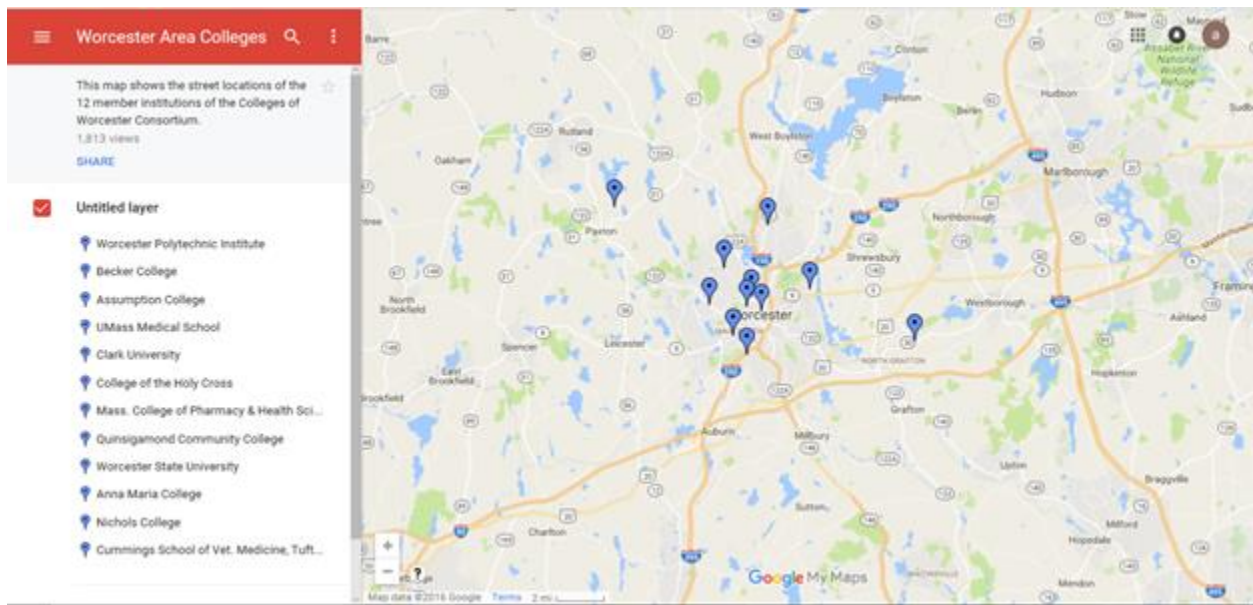


Figure 2. Colleges in the Worcester Area (Google Maps)

WPI has motorized and nonmotorized transportation programs while endorsing other modes of transportation in the 2016 year. The university provides Gompei’s Gears, Student Night Assistance Patrol (SNAP), and the Gateway shuttle service. Gompei’s gears is a bike share program created in 2016. Both SNAP and the Gateway Shuttle services are driven by students that take students and faculty to different parts of campus and housing. WPI endorses other programs as well such as Carpoolworld and CityRide. Carpoolworld is a carpool service that allows people in the city to organize carpools to get to where they need to go. City Ride is a shuttle service that runs on weekends from 5pm to 12am (wpi.edu).

The WPI community has access to all of the transportation programs such as SNAP, Gateway Shuttle, CityRide, Carpoolworld, etc. but they are used and known differently. In fact, according to the 2014 transportation IQP , as of year 2014, 52% of WPI students knew what Carpoolworld was and only 2% had ever used it (Cyr, 2014). When students traveled from campus to Gateway, only 13% of students used the Gateway shuttle service. Students complained that the shuttle is inconsistent with its timing (Cyr, 2014). The usage of Gompei’s

gears has been recorded by the Green Team who is in charge of maintaining the bikes. Carlos Barcelos, the vice president of the Green Team, provided the information that since the program's creation in D term (second half of second semester) of 2016, there have been 5554 bike checkouts which equates to 347 rides per bike as of November 8th, 2016 (C. Barcelos, personal communication, Nov 8, 2016).

In 2013, WPI established a sustainability plan that laid out goals and methods to accomplish the goals. The plan is split into four goals: 1) academics, 2) campus orientation, 3) research and scholarship, and 4) community engagement. Transportation was included in the community engagement goal. The task for transportation is to develop a plan for the WPI community to decrease reliance on single occupancy vehicles. Measures of progress are reduction in single occupancy vehicle miles and increased carpooling, walking, cycling, and public transportation use ("WPI Sustainability Plan," 2013). WPI also has an annual sustainability report with the latest being 2015. Between 2005 and 2015 there was a 9% reduction in campus emissions and a charging station for electric cars was installed ("Campus Sustainability Report," 2015). These numbers are not related to the plan because the plan was still being implemented.

The students of WPI travel using different methods of transportation. Each student has their primary method of transportation and use other means throughout their time on campus. In 2014, 15% of students who use a single occupancy vehicle say that their car is their primary mode of transportation, whereas 83% say they walk, bike, or use non-motorized options (Cyr, 2014). A student's form of transportation can change throughout the day depending on where the person needs to go on campus or around the city. The second part of campus, Gateway, is 0.7

miles away from the main campus (Google maps, 2016). Students use different methods to go from the main campus to Gateway. The distribution is labeled below in graph 1.

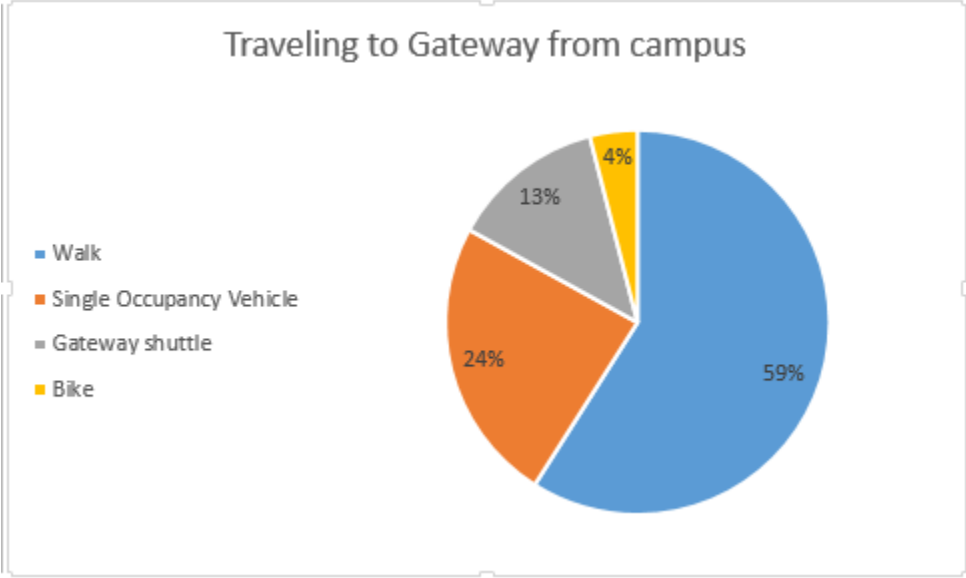


Figure 3. Distribution of methods used to travel to Gateway from campus (Cyr, 2014)

WPI releases a sustainability report annually and it is important to gather data on the current transportation methods being used in order to report the correct percentages. The Associate Director of Sustainability, Elizabeth Tomaszewski, has tasked this group with collecting data on the availability and usage of sustainable transportation methods at WPI in order to develop a sustainable transportation plan. The long-term goal of this sustainable transportation plan is to reduce single occupancy vehicle usage on-campus. We discuss our methodological approach to tackling this project in the next chapter.

## Chapter 3: METHODOLOGY

The main goal of this project was to determine what made a successful, sustainable transportation plan, and to develop a centralized resource for sustainable transportation at

Worcester Polytechnic Institute (WPI). To achieve this goal, we developed seven objectives:

Objective 1: Understand the variety of current transportation systems used and available at WPI.

Objective 2: Explore stakeholders' motives for using certain modes of transportation and opinions about transportation options at WPI.

Objective 3: Identify and evaluate current transportation plans at other colleges.

Objective 4: Determine what makes a successful transportation plan.

Objective 5: Create Templates/Proposals for changes and seek feedback from stakeholders.

We discuss the methods used to achieve each of the above objectives in the following sections.

### **OBJECTIVE 1: UNDERSTAND THE VARIETY OF CURRENT TRANSPORTATION SYSTEMS USED AND AVAILABLE AT WPI.**

Before creating any plan, we had to understand what modes of transportation the WPI community uses. In order to collect this data, we distributed a survey among the WPI community through Facebook groups, table-sitting, emails to aliases, and connecting with the faculty and staff. Through the responses to this survey, determined how the members of the WPI community travel. We chose a survey because we wanted at least 10% of the campus to get numbers that reflect the habits of WPI. Although we did not receive the gold standard of samples, we chose 10% as a goal because we knew that without a large enough sample, there was a high likelihood our survey would retain significant bias from our means of selection. A survey made sense because we were looking for a large amount of quantitative data.

#### 1.1 Designing and Administering the Survey

The survey contained questions about how members of the WPI community got to and from campus. We aimed to collect representative responses from a cross section of the WPI community. This meant from freshman through seniors, graduate students, on and off-campus

students, faculty, and staff. This gave us insight on who is using each mode of transportation, why and how we may encourage members of the campus community to use sustainable modes of transportation. (See Appendix A for our survey)

Administering a survey can pose a challenge to get the best return rate. To get the best return rate, we distributed the survey using Facebook, email, and an app called GroupMe. The WPI students have Facebook pages for every graduating class which provides easy access to most students who have a Facebook account. This made sense because out of all the 18-29 year olds that use the internet, 87% are Facebook users (Duggan et al, 2014). These accounts came in handy when we acquired samples from each class. We also administered the survey through table sitting at the WPI campus center on 4 days between 10 and 11am. Table sitting included going to the campus center with laptops and asking people to take the survey and in return offering them refreshments. Paper copies of the survey were available for anyone who preferred to fill out a paper copy.

Lastly, we reached out to clubs that team members are a part of. The team members are part of different clubs such as sports teams, and fraternities. Our membership in these groups gave us access to a number of email aliases to distribute the survey. However, the GroupMe app made reaching out to these sports and clubs more personal. GroupMe is an app available for computers and phones which allows instant messaging to whoever is in the created group, similar to a multi-person text. The team used both methods for more exposure and repetition.

We had to take a different approach to reaching out to faculty and staff. We asked our advisor and sponsor to send an email on our behalf because the team did not have access to the faculty's email alias. The advantages of a remote survey included that it was easier to reach out to a larger number of people in a shorter amount of time. We acknowledge that self-reporting

habits has its disadvantages including a potential responder bias because we cannot assume that our sample is representative of the greater WPI community if those who respond are self-selecting. We accounted for this by using an online Qualtrics survey in conjunction with our other methods of data acquisition.

### 1.2 Demographics of the survey

We deduced a majority of our findings using the student, faculty, and staff survey data. The team could not reach the whole population due to not having access to emails such as the all-student email. Figure 3.1 below demonstrates the population distribution of the survey respondents.

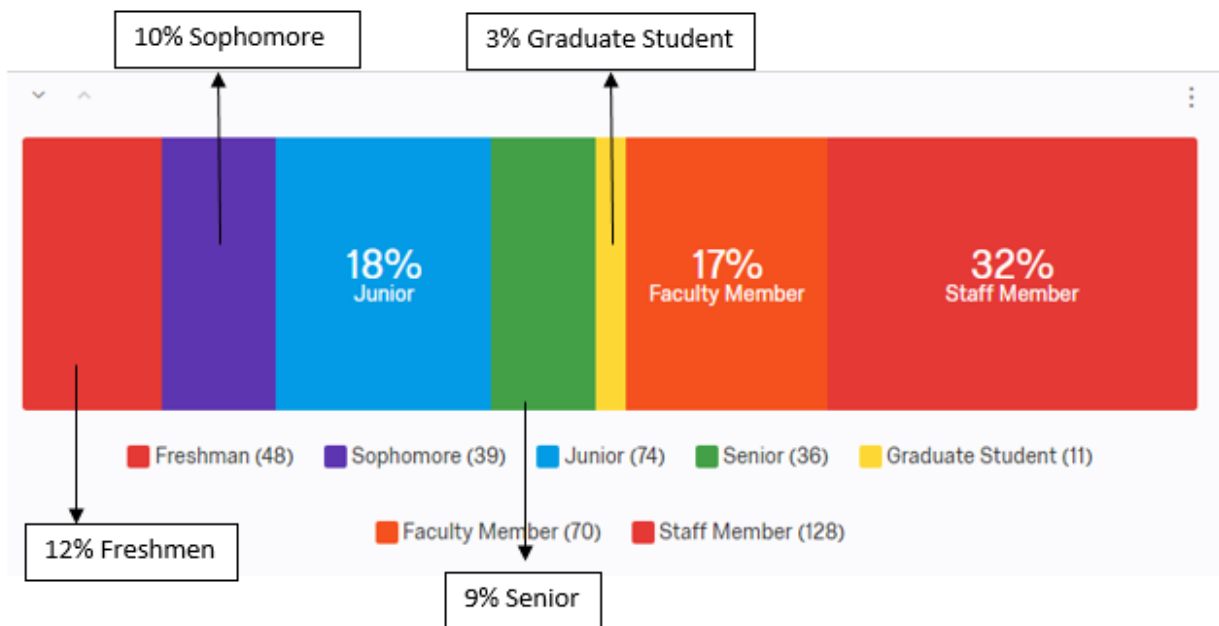


Figure 4. Demographic of the survey respondents

At the end of the project, we had received 414 responses to the survey. This represents about 10% of the WPI community, which we view as a moderately successful number of responses.

### **OBJECTIVE 2: EXPLORE STAKEHOLDERS' MOTIVES FOR USING CERTAIN MODES OF TRANSPORTATION AND OPINIONS ABOUT TRANSPORTATION OPTIONS AT WPI.**

To complete our goal, the team thought it was necessary to find out why the students and

faculty used their modes of transportation and what they expected for future transportation at WPI. To explore the qualitative side of transportation, the why questions, we facilitated two focus groups of faculty and staff. Berg (1998) defines focus group as “either guided or unguided discussions addressing a particular topic of interest or relevance to the group and the researcher.” The focus group helped us explore two problems. The first problem was beginning to understand why the WPI community uses the modes of transportation it does. The second was to understand what the WPI community wants for transportation options at WPI.

We conducted the focus groups with a convenience sample of a cross section of the WPI faculty and staff. We explained our project and the purpose of the focus group to all potential participants and obtained informed consent prior to facilitating any group discussion (see Appendix B for focus group questions and informed consent).

### 2.1 Designing the Focus Group

To triangulate our data from the survey discussed in Objective 1, the main participants for focus group were WPI students (including freshman, sophomore, junior, and senior), staff, and faculty members. We conducted two focus groups with six people total: one with one faculty and one staff, and the other with two faculty and two staff. According to Greenbaum (1998) and Berg (1998), each group should have from five to eight people. The duration of the group meetings should be 30-45 minutes. A team member facilitated the meeting with the focus groups. We rotated the role of facilitator among the team members for each focus group. All members of the team were present for the first meeting, and two members were present for the second. The ones who were not facilitating took notes. In addition, we provided food, such as pizza, cookies, and refreshments to help people feel more comfortable and open to the discussion. The facilitator asked the interview questions (see focus group questions in Appendix B) which were developed in such a way as to encourage discussion between the facilitator and the members of the focus group. In other words, the facilitator guided the group and stimulated discussion, not only between the facilitator and the group members but also among the group members. From this,



they brainstormed collectively and we obtained more thorough data from those meetings.

### **OBJECTIVE 3: IDENTIFY AND EVALUATE CURRENT TRANSPORTATION PLANS AT OTHER COLLEGES**

Before we determined what made a successful transportation plan, we conducted secondary research into what transportation plans were already in effect at other colleges. To do so, we analyzed the contents of the Association for the Advancement of Sustainability in Higher Education (AASHE) website and explored their Sustainability Tracking and Assessment Report System (STARS) reports on other colleges and universities. We chose to explore AASHE because it empowers institutions of higher education, along with their faculty and students, to move towards being more sustainable (AASHE, 2015). We analyzed the content of the AASHE STARS' reports because they are a centralized resource for multiple institutions of higher education and measure an institution's sustainability performance (AASHE, 2015). We chose several colleges and universities, and took note of their population and location. STARS reports score many aspects (academic, campus and public engagement, college operations, etc.) of a college or university to qualify how sustainable it is.

We focused mostly on the transportation plan ranking (campus fleet, student and employee commute modal split, and support for sustainable transportation) (AASHE, 2015), as our project was centered around the design of a transportation plan. By compiling this data, we looked for trends and also compared and contrasted the colleges we chose. To do so, we compared the compiled data of each subsection from the transportation section of the respective institution's STARS report. Aside from looking at the STARS reports of certain colleges and universities, we also analyzed the content of their websites, took notes of any similarities between colleges and looked for information pertaining sustainability and their transportation

plan (see Appendix C for sample rubric to compare colleges' sustainable performance).

#### **OBJECTIVE 4: DETERMINE WHAT MAKES A SUCCESSFUL TRANSPORTATION PLAN**

We compared our findings from the earlier objectives and determined what made a transportation plan successful. Comparative analysis is different from listing our findings in that it is concerned with explaining similarities and differences within the data and compares between two or more sources of data (Pickvance, 2005). We used comparative analysis to understand differences of opinions and facts between distinct interviews as well as between interviews, surveys, and focus groups as methods of data collection. We used the following considerations when contemplating which methodology to use:

- Surveys have a responder bias (Leedy and Ormod 2001)
- Our survey in particular may have less reliable data because it is not collected in person (Leedy and Ormod 2001)
- Our interviews and focus groups may be more reliable because they are conducted in person (Leedy and Ormod 2001)

We developed a rubric from the information gathered from survey, interviews, and focus groups that that informed us on which qualities a successful plan had to have. The rubric that scored transportation plans consisted of three areas: sustainability, feasibility, and usefulness. We chose these areas by adapting the criteria defined by Johnson and Scholes (*Johnson, Scholes* 1999) (suitability, feasibility, and acceptability) to the domain of sustainability plans. Each area included subsections that were based upon the requirements and qualities we defined up to the start of this objective and scored proposed plans from 1 to 5 (See Appendix D for rubric).

##### 4.1 Interviews

In order to understand what makes a successful plan we needed to hear from the representatives of Office of Sustainability at WPI, Facilities Office, and other universities. The

team conducted interviews with Professor and Director of Sustainability John Orr, Assistant Vice President of Facilities Office Alfredo DiMauro, and Associate Director of Sustainability Elizabeth Tomaszewski. We also interviewed representatives from other colleges and universities' sustainability office. The colleges and universities we interviewed were University of Colorado Boulder, Harvard University, University of Massachusetts Amherst and Clark University. The questions we asked the representatives are listed in Appendix C.

### **OBJECTIVE 5: CREATE TEMPLATES/PROPOSALS FOR CHANGES AND SEEK FEEDBACK FROM STAKEHOLDERS**

The current sustainable transportation plan for WPI is scattered across many areas of the WPI website. We drafted a template that detailed which changes we recommend the WPI webmaster make to the website in order to make information more accessible and user friendly. In order to assess the proposed sustainable transportation plan, we sought the insights of stakeholders and WPI staff and faculty who work on sustainability issues. We concluded that the plan is a “success” if it met or exceeded the expectations determined in the process of completing Objective 4. Potential members of this group were: people on the sustainability committee, Facilities Office, and the WPI police department. The reason that these groups would better understand whether our plan would succeed was that they were all connected and worked towards the efforts of sustainable transportation on WPI campus.

### **ETHICAL CONSIDERATIONS**

This project went through the Worcester Polytechnic Institution Institutional Review Board process and ensured that there was no risk to human subjects. We provided all project participants with sufficient information for them to give their informed consent. (See appendices for our statements of consent).

## Chapter 4: FINDINGS AND RECOMMENDATIONS

### Introduction

In this chapter, we discuss our project findings that arose from surveys, interviews, and focus groups we conducted. Following each finding we describe a relevant recommendation for the WPI community. We describe our long term recommendations at the end of the specific finding. We separated our findings into three main sections: I. Transportation Options, II. Motivating Factors, and III. Staff and Faculty Work Week Management.

### I. Transportation Options

This section focuses on the findings and recommendations that pertained to the topic of transportation options. We found that there was a significant need for improvements in terms of awareness of the different transportation options on campus, as well as providing better means to use those options. We recommend different possible solutions for each of the findings.

Finding 1: WPI provides a variety of sustainable transportation options, however many WPI community members do not know how to find information about these options.

We found that many WPI community members were lacking knowledge in their transportation options, which are: the Gateway Shuttle, the Shuttle, SNAP (Student Night Assistance Patrol), WPI-UMass Shuttle, and Gompei's Gears. Gateway Shuttle is a service for transportation between the main campus and Gateway Park. Gateway Shuttle runs from 7:30 am to 5:30 pm. After 5:30, the Shuttle offers transportation among on-campus buildings and WPI residence halls till midnight. WPI also provides SNAP (Student Night Assistance Patrol) to WPI community for transportation within one mile radius from the main campus (measured from 100 Institute Rd, Worcester, MA 01609). SNAP runs from 6:00 pm to 4:00 am during A-Term and D-Term, and 4:00 pm to 4:00 am during B-Term and C-Term. WPI also offers a service called WPI-UMass Shuttle that provides rides between WPI and UMass Medical School Lazare with a

limited schedule. There is also a free bike share program available to WPI community members, called Gompei's Gears. When asked to find information about the current transportation options provided by WPI, the 12 members of the student body, faculty, and staff that participated in the focus groups had difficulty finding all transportation options available to them using the WPI website.

Two participants in our first focus group with faculty and staff thought the transportation options would be available on the *Resources & Support* tab while the other two participants thought they could find the options on the *Directory* tab. None of the participants could find any transportation option in those tabs and had to navigate to other pages to find transportation options. For example, one of the participants found Gompei's Gears on the *Sustainability* page, another person found the Shuttle and SNAP information on the *Campus Transportation* page, which is currently placed under the *Safety and Security* section. Four students in the student focus group thought they could find transportation information on the *Campus Living* page but they could not find the transportation options and also had to navigate to other links to get to the *Campus Transportation* page.

We conducted our own research and also found it challenging to locate transportation information. Following are screenshots of WPI pages on which we found the transportation information. Figure 5 below is the screenshot of the drop-down menu on the WPI Homepage. As you can see, in this drop-down menu, there is only information about The WPI Plan, Academics, Admissions and Aid, The Student Experience, Research and News & Events. There is no information about transportation at WPI on the homepage. The transportation information at WPI and in Worcester are listed in the *Getting Around & Visiting* page (Figure 6), the *Sustainability* page (Figure 7), and the *Campus Transportation* page (Figure 8). On the *Campus*

*Transportation* page resides the information on the Shuttle, SNAP, Gateway Shuttle, and WPI - UMass Shuttle Service. On the *Sustainability* page, there is information about the Gompei's Gears bike share program. There is also transportation information in the *Getting Around & Visiting* page. The difficulty in finding this information may be their location on the WPI website. *Safety and Security*, *Sustainability*, and *Getting Around & Visiting* pages are not visible from WPI home page (as shown in Fig. 5). In order to navigate to these pages, visitors need to go through other pages. For example, in Fig. 6, to get to *Getting Around & Visiting* page, visitors need to navigate through *Home*, *About WPI*, *City of Worcester* then *Getting Around & Visiting* page.

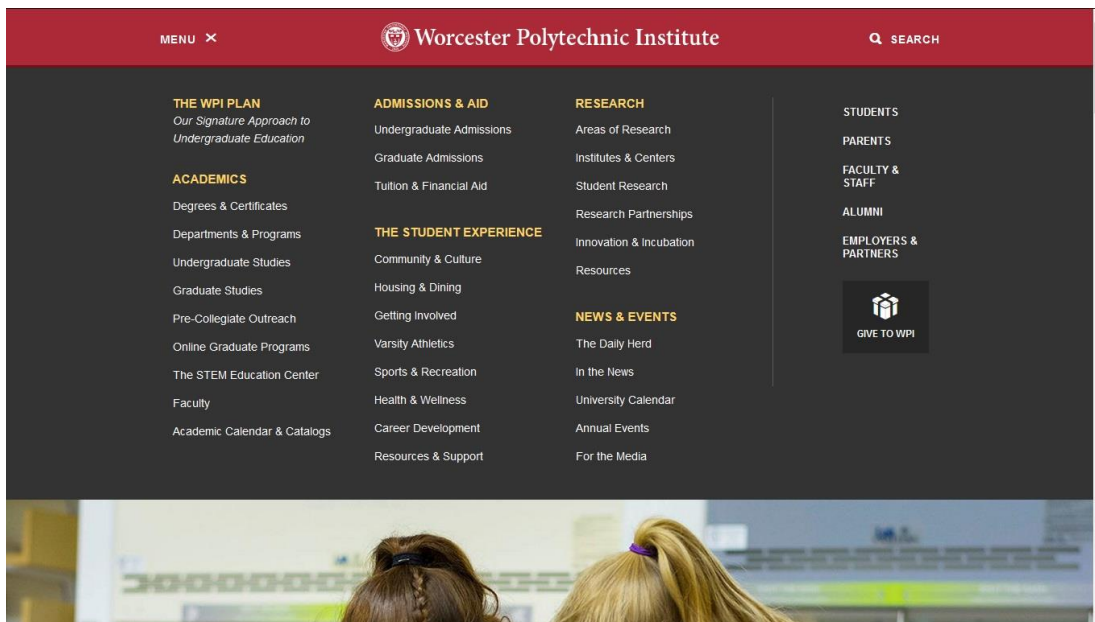


Figure 5. Screenshot of WPI Home Page

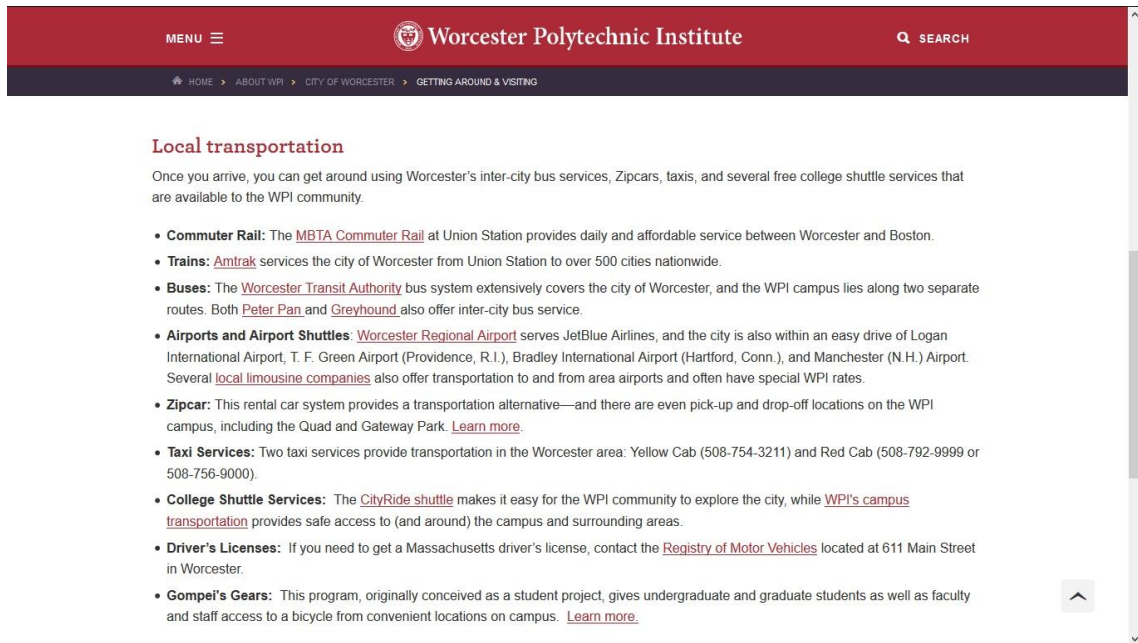


Figure 6. Screenshot of WPI Getting Around & Visiting Page

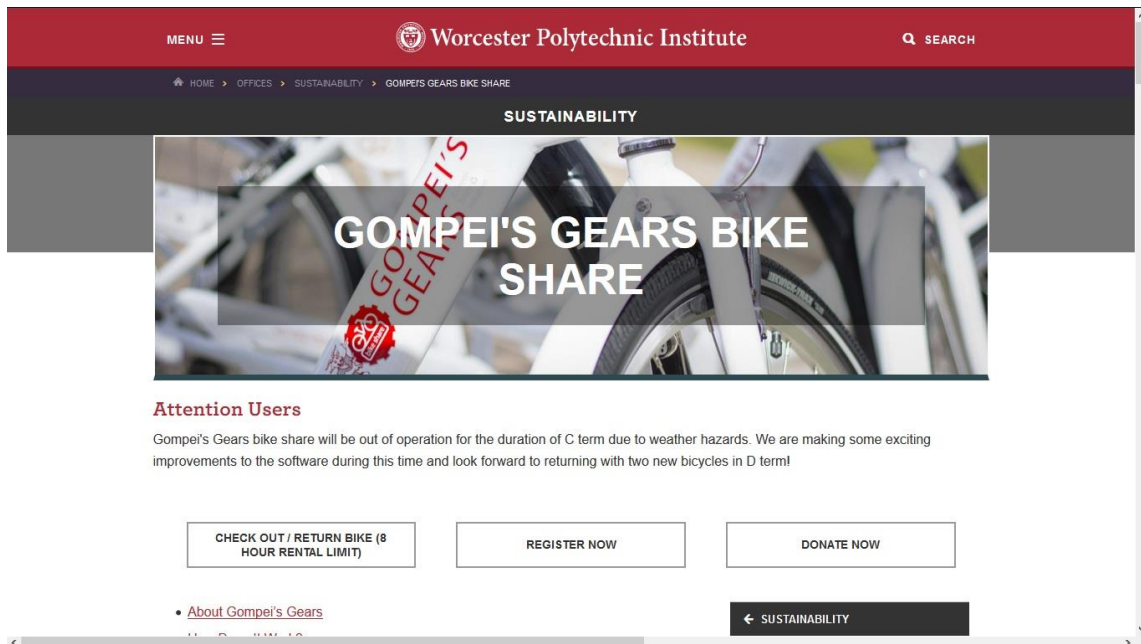


Figure 7. Screenshot of WPI Sustainability Page

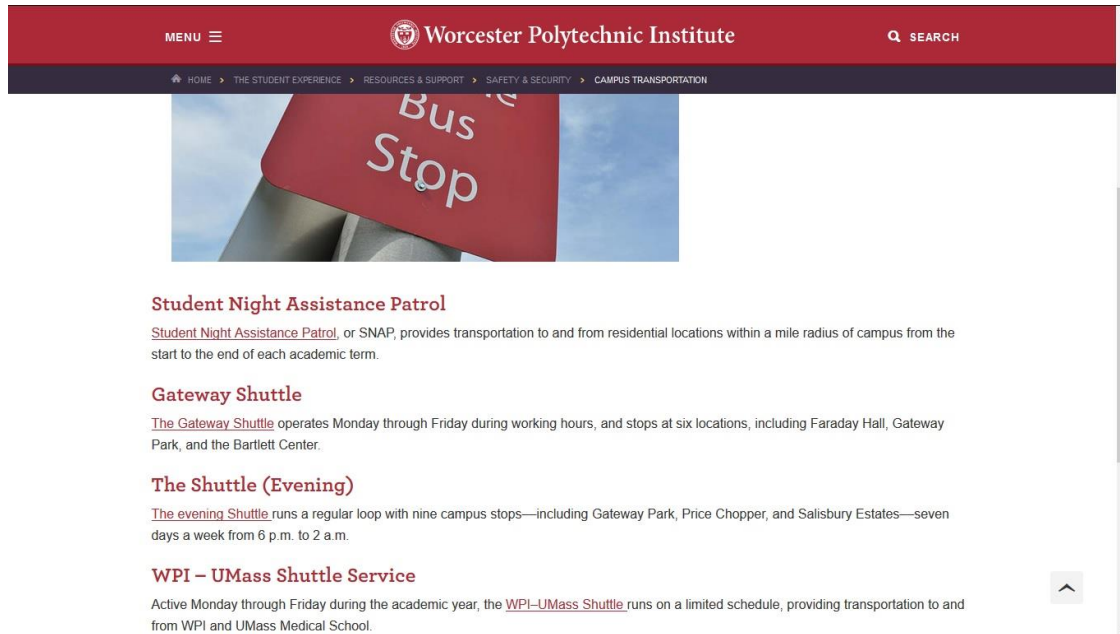


Figure 8. Screenshot of WPI Campus Transportation Page

There were 53 out of 307 responses in the survey indicated that people drove their cars to areas where the shuttle stopped, Gateway Park for example, since they did not know about where the shuttle stopped. In our first focus group with faculty and staff, we selected two participants to separately but simultaneously take part in the process of navigating through WPI websites to find transportation information. The first participant needed approximately five minutes only to find information about SNAP, the Shuttle, Gateway Shuttle, and WPI-UMass Shuttle Service and she could not find information about Gompei's Gears. The second participant also needed about five minutes only to find information about Gompei's Gears in *Sustainability* page. Four out of four in the second focus group with faculty and staff were surprised to see that there was no dedicated *Transportation* section on the WPI web site, as it was very useful information for the WPI community.

#### Finding 1.1: Organization of transportation options on other universities' websites

As illustrated in Table 1 below, we compared the ease of finding transportation information among other colleges' websites (UMass Amherst, University of Colorado Boulder,



Wesleyan University and Bentley University) and WPI. We chose the mentioned universities since they had a fairly high rating, that is Silver for Bentley University and Gold for the other universities, on the AASHE (Association for the Advancement of Sustainability in Higher Education) STARS (Sustainability Tracking, Assessment & Rating System) reports in the transportation section. AASHE STARS is a transparent, self-reporting framework for colleges and universities to measure their sustainability performance. The ratings on AASHE STARS are Reporter, Bronze, Silver, Gold, and Platinum (rating are from lowest to highest). We compared the ease of finding transportation information based on how many “mouse-clicks” to get to the information page. For example, one “mouse-click” is needed to go from WPI home page to *Faculty* page (as shown in Fig. 1). The screenshots of the other universities’ websites is in Appendix D and we marked the transportation information of these websites within the red rectangle.

<b>University</b>	<b>How to find transportation information</b>	<b>Number of “mouse-click”</b>
<b>Worcester Polytechnic Institute</b>	Homepage → Menu → Resources & Support → Sustainability Office → Gompei’s Gears	4
<b>UMass Amherst</b>	Homepage → UMass Transit (Visit Campus drop-down menu)	1
<b>University of Colorado Boulder</b>	Homepage → Parking & Transportation	1
<b>Wesleyan University</b>	Homepage → Area Transportation	1
<b>Bentley University</b>	Homepage → Safety & Transit (Campus Life drop-down menu)	1

Table 1. Comparative table of universities’ websites

**Recommendation 1: We recommend the WPI webmasters provide a centralized location on the website for transportation options for campus.**

We recommend the *Transportation* tab can be found in Figure 5 below. We recommend to put the *Transportation* tab under *The Student Experience* menu so students at WPI know what sustainable transportation options that WPI offers in order for them to use. In *Transportation* web page, there should be a list of available transportation options for WPI and the description of each option. Otherwise, we recommend the webmasters should include the list and the links for each transportation option such as SNAP, theShuttle, Gateway Shuttle, WPI-UMass Shuttle Service, Gompei’s Gears, MBTA Commuter Rail, Amtrak website, and WRTA website if all of these websites’ information is not fitted in one web page.

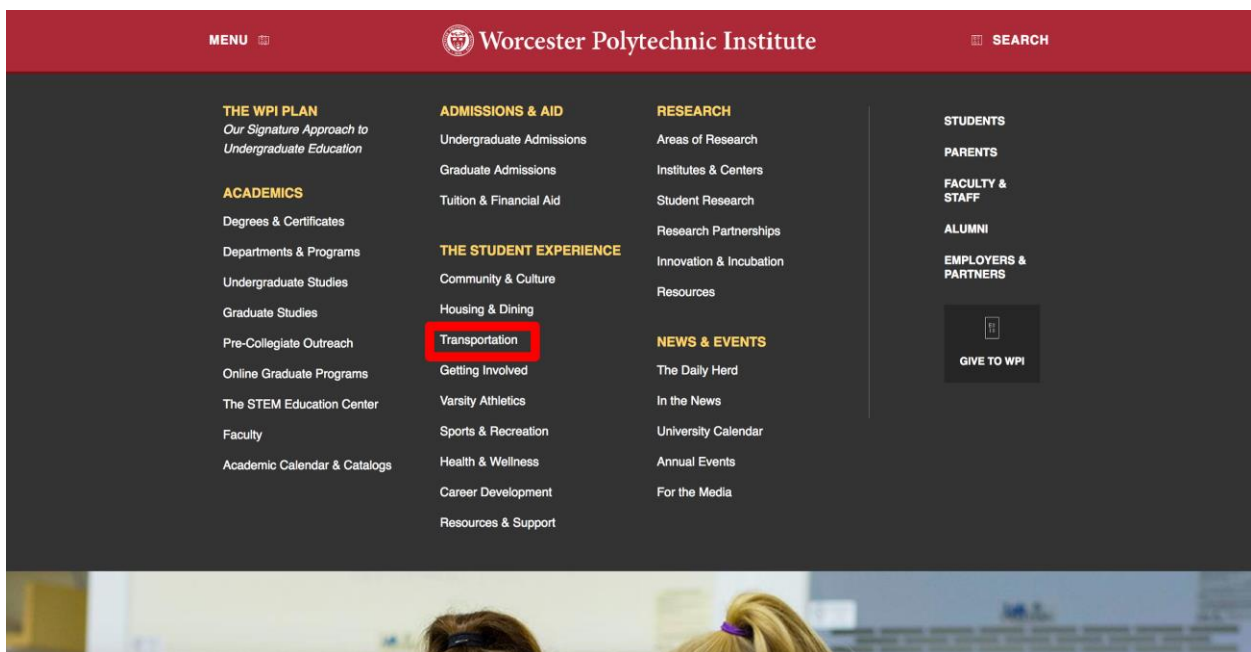


Figure 9. Screenshot of suggested location for Transportation page on WPI Home Page

Creating a dedicated tab on the main menu for *Transportation* would make it easier for visitors of the WPI website to find the transportation information that they are seeking. If there is a location on the homepage of WPI website for *Transportation*, website visitor can immediately find the information instead of spending five minutes or more.

**Recommendation 2: We recommend the Office of Sustainability sponsor a project for the development of a smartphone application that provides transportation information.**

Throughout our research, we saw the challenges students, faculty and staff faced when attempting to locate transportation information. Given the prevalence of smartphones consequently in the scope of the project, we did not have time to develop a smartphone application that provides transportation information but we recommend the Office of Sustainability sponsor a project to develop one with transportation information. This information would include Gateway Shuttle running times, SNAP's contact information, WRTA bus information for the bus routes that run through and around campus, and could even possibly be used to check out a bike from Gompei's Gears. The application could possibly even tell which bikes have been checked out and how many bikes are left on the bike racks. This would provide a detailed centralized place that houses all transportation information for WPI's campus.

**Finding 2: The WPI community would be more willing to use public transportation if there was easy access between campus and the train station.**

According to our survey, 27.3% (113 out of 414) of respondents stated that if there was frequent bus services or better transportation between WPI and Union Station, they would be more inclined to use public transportation. This was confirmed by our staff and faculty focus group participants. During the focus group, we asked participants to give their thoughts on a shuttle between WPI and Union station during the morning and afternoon hours (before and after work). Three out of four participants in the second focus group with faculty and staff acknowledged that there was a need for people who used the train regularly and that they would consider using the train if the shuttle was provided.

Both the survey data and focus group participants indicated that there was a lack of dedicated transportation between Union Station and WPI. Professor John Orr, Director of

Sustainability, agreed, explaining that WPI transportation services between WPI and Union Station would encourage members of the campus community to use trains and other modes of public transportation more frequently. He stated that there were some people at WPI who commuted to work by train. However, they encountered problems on the way to WPI. These problems included no taxi or ride-sharing services (Uber, cabs) available for immediate use (J. Orr, personal communication, Nov 14, 2016). Alfredo DiMauro, Vice President Assistant of Facilities, stated that he walked or used taxis from Union Station to travel to WPI. Mr. DiMauro shared that he would like to see more Uber rides available at Union Station, or a bus route with detailed times and a dedicated route that would travel to and from WPI and stops at locations along the way, including near areas where there are a large population of students, such as Subway, Honey Farms, and Price Chopper (A. DiMauro, personal communication, Nov 15, 2016). Such a shuttle service would also enable students to travel to these popular locations without driving in a single occupancy vehicle.

Jenny Isler, Director of Sustainability from Clark University, explained that in a 1 year survey of 40% of 3200 students on campus that 24% of survey respondents would be more inclined to use public transportation if there were a way to get to and from Union Station (J Isler, personal communication, Jan 24, 2017).

**Recommendation 3: We recommend WPI facilities department implement a dedicated shuttle service for faculty, staff, and students for pickup and drop-off at Union Station.**

A dedicated pickup shuttle would run in the morning, making three trips to WPI campus from Union Station: at 6:06AM, 7:07AM, 8:24AM, to run in tandem with the Worcester/Framingham Commuter Rail's arrival schedule (mbta.com, 2017). There would also be a dedicated drop-off shuttle service that would take people to Union Station from WPI, operating at 4:55PM, 5:40PM, and 6:50PM, to run in tandem with the 5:20 PM, 6:05 PM, and

7:15 PM commuter rail trains respectively (mbta.com, 2017). Because it takes approximately 10 minutes without traffic to travel to Union Station from WPI, these times would account for any traffic that might occur during travel. Having a dedicated shuttle running at those times would allow the faculty, staff, and students to better use the public transportation system.

This shuttle should be student run. The SNAP vans and shuttle vans are already driven by students. Most students live closer to campus than WPI staff and faculty, which means they do not have to travel as far to start their shift and can more easily stay on campus for longer. One possibility for funding this would be from Campus Police, as they are already in charge of running the campus shuttle and SNAP.

Another possibility would be to integrate this into the existing Gateway and Evening shuttle services on campus. These shuttle services are run by campus police and facilities. The Gateway Shuttle begins service at 7:30AM, if the Gateway Shuttle were to also service Union Station, it would only need to go into operation an hour earlier, and start their existing route at Union Station. For the evening trips to Union Station, the Evening Shuttle could take over, as they start their schedule at 5:30PM. The Evening Shuttle would only have to start service 10 minutes earlier to ensure that people get to Union Station on time. This would be feasible in terms of funding because WPI would not need to buy another shuttle or vehicle, and there is already approved funding for the Gateway Shuttle.

Some drawbacks to this include that the Gateway Shuttle has a 20 minute route already and adding another spot would reduce the amount of round trips throughout the day. Figure 10 below shows how pressed for time the shuttle already is.

GATEWAY HOURS OF OPERATIONS					
FARADAY HALL	GATEWAY PARK	85 PRESCOTT ST.	BARTLETT CENTER	FACILITY BUILDING-LEE STREET	SALISBURY ESTATES
7:30am	7:32am	7:35am	7:40am		7:45am
7:50am	7:52am	7:55am	8:00am		8:05am
8:10am	8:12am	8:15am	8:20am		8:25am

Figure 10. Gateway Shuttle schedule

## II. Motivating Factors

This section is dedicated to the findings pertaining to motivating the WPI community to use sustainable modes of transportation. Findings include safety concerns, replacing lights on the Gompei’s Gears bikes, and the use of incentives.

### Finding 3: Students are concerned with their safety when walking.

According to survey respondents, 6.5% (26 out of 414) of the respondents were concerned about their safety in Worcester at night. In our student focus group, 2 students out of 4 indicated that they primarily used their cars to reach food markets in Worcester that were reachable by walking because they did not feel safe traveling to the location alone no matter the time of day. WPI police records all incidents and notifies the WPI campus community of safety incidents. These reports can be found on the WPI website in the *Safety and Security* tab. The incidents are sporadic in occurrence and involve attacks on streets and break-ins. As of February 6th 2017, 5 of the last 10 incidents involved either an attack on the streets or a suspicious person on the streets (WPI website, 2017).

In response to our survey and student focus groups, students identified a lack of safety on areas off campus that the police do not patrol as a motivating reason to drive. Three student focus group participants indicated that they lived just off campus and it was dark enough that they did not feel safe walking the few blocks so they carpooled or drove alone to and from their

houses. This indicated a lack of proper lighting and thus, safety in the streets surrounding the WPI campus.

**Recommendation 1: We recommend that the WPI campus police attempt to increase lighting around the areas just off campus which have a high number of students' apartments.**

More adequate lighting would help students feel safer walking home at night, and may decrease driving. This would require reaching out to the necessary parties to assist us, including the Worcester City Council and WPI Police Department. We would propose specific locations as to where more static lighting would be added. Particularly, we recommend that lighting be added two blocks down on the streets perpendicular to Highland Street. We believe that with this recommendation, if implemented, would provide a safer atmosphere to walk to and from houses that the focus group indicated.

Finding 4: Bike lights need to be replaced.

In a survey of the available bikes at Salisbury Labs, three of the six bikes were equipped with lights, but only one had a working light. The working lights were dim and would not provide adequate lighting for safe travel. Additionally, the reflectors on the bikes could be made larger to improve visibility to cars and others traveling on the road at night. Elizabeth Tomaszewski, Associate Director of Sustainability at WPI, shared with the group that there was a need for lights to be permanently affixed or the lights would be stolen. Ms. Tomaszewski stated that brighter lights were used when the program was first launched but those lights were stolen.

**Recommendation 1: We recommend that bikes be outfitted with new working LED headlights and LED taillights, or that the lights be repaired**

The following is a comparative table of specifications of each type of bike lights from Amazon website. The last entry, the "Defender Anti-theft Bike Headlight" has already been

purchased for 8 bikes as a result of this recommendation, however it may be necessary to supplement these lights with higher lumen lighting for more visibility.

Product	Cost	Brightness	Durability	Duration	Detachable?
BV Bicycle Light Set	\$8.99	Over 1500 feet	Weather resistant	80 hours	Yes
Refun Bicycle Light - Silicone LED Bike Light Set	\$12.99	Over 1000 feet	Flexible material Water resistant	45 - 70 hours	Yes
Blitzu Gator Bike Light Set	\$23.97	320 Lumen	Waterproof	6 hours and rechargeable by USB	Yes
Defender Anti-Theft Bike Headlight	\$19.99	50 Lumen	Weatherproof	50 hours	Yes, with security device

Table 2. Comparative table of bike lights

To solve the theft issue, we tried to find the detachable lights so these lights can be rented through campus center and the lights are returned when the bike is checked in again. If the lights are not returned, there would be a charge to the student account who rented the bike. This can be done since everyone needs to register an account to check out the bike so if the lights are lost, Campus Police or Office of Sustainability can trace the account to charge for the lost lights. In addition to the new lights, we recommend Office of Sustainability add new reflectors to the spokes of both the wheels and the pedals. The reflectors would make the bikers visible to cars that are facing their side, making the driver of the vehicle more aware that there are bikers on the road at night. We believe that these recommendations will improve the student body’s perception of Gompei’s Gears as a safe mode of transportation to and from their houses that lie just off



campus.

Finding 5: People would be more inclined to using more sustainable modes of transportation of there were incentives/disincentives to motivate them.

Interviews with representatives from WPI and other universities: Clark University, UMass Amherst, University of Colorado Boulder, Boston University, and Harvard University and focus groups showed that incentives and disincentives would motivate people to use sustainable modes of transportation. In our interview with John Orr, he suggested that we disincentivize sustainable transportation. According to Mr. Orr, disincentives usually work better than incentives but have a lower chance of being well received (J. Orr, personal communication, Nov 14, 2016). However, the participants of our second focus group revealed otherwise.

Three out of the four participants in the second faculty and staff focus group revealed that they would be more inclined to use sustainable transportation if there were incentives in place. Disincentives are still likely to deter people from using non-sustainable modes of transportation because they would hate to pay or give up something to get what they have been getting in the past for free. Jenny Isler, the Director of Sustainability at Clark University, suggested that the disincentives would need to be enforced, otherwise they would not be effective (J Isler, personal communication, Jan 24, 2017). Stacey King, former Boston University Transportation Demand Manager, and current Harvard University Commuter Choice Coordinator, stated that when there were designated parking slots for carpool vehicles (with 50% discount for parking fee), there were more people (married couples and roommates specifically) carpooling instead of driving alone (S. King, personal communication, Feb 7, 2017). Jenny Isler explained that in a survey of Clark's campus, 28% (358) of their respondents were likely to use public transportation if provided a free or subsidized transit pass as an incentive. In addition, only 8.4% (35 out of 414) of the respondents in our survey would still use single occupancy vehicles if there was a parking

fee of \$25 per month.

Other campuses surveyed by AASHE STARS have bike facilities positioned conveniently around the perimeter of their campuses that allow people to shower and store their bikes for the day. UMass Amherst and CU Boulder have 68.18 and 71.7 ratings respectively on the AASHE STARS reports overall and their bike programs have been working well in encouraging students to bike on campus more often. These ratings are gold rank which means their programs are successful in terms of encouraging people to develop more sustainable habits.

**Recommendation 1: We recommend that WPI develops a priority parking area near to the entrance of the Park Avenue parking garage for hybrid vehicles.**

This would encourage those who are thinking of buying a new car to go hybrid. Providing priority parking is a great incentive, as employees do not have to spend minutes circling the parking lot to find a parking spot.

**Recommendation 2: We recommend providing a limited number of subsidized transit passes.**

This would encourage people to take public transportation, as it costs less money or would be free. With the limited number of passes, people either who really want or need the passes will come forward first, as they will be under pressure to get the passes before they run out. This means that the transit passes will be put to good use and would take more cars off the road.

### **III. Staff and Faculty Work Week Management:**

This section is dedicated to findings relating to staff and faculty work weeks. Findings include the use of telecommuting at other universities and the potential benefits of a condensed work week.

Finding 6: The use of telecommuting and condensed work week at other universities help enhance sustainability of the campus.

Other colleges, including the University of New Hampshire (UNH), have telecommuting options and shortened work weeks (with longer hours per day). In the interviews with University of Colorado Boulder, Clark University, Boston University, and Harvard University, we learned that there are telecommuting options in all the universities we explored, but that the specific options depend on departments and job types. WPI and Clark University also offer nine-month positions. Telecommuting options would take more cars off the road, as employees would not have to drive to campus to do their work. Shortened work weeks would also take single-passenger vehicles off the road because the employees would be working less days, but the same number of hours. Table 3 below compares the amount of cars on the road per week and the amount of fuel used per week by WPI staff and faculty.

<b>Work Week (40 hours)</b>	<b>Fuel Used</b>	<b>Vehicles on the road per week</b>	<b>Total CO2 Emissions</b>
4 Days	3.39 Gallons	3,400	69,190 pounds
5 Days	4.23 Gallons	4,250	86,488 pounds

Table 3. Comparison of a normal work week and a condensed work week

The fuel numbers are based off the average commute to and from work being 30 miles and the average miles per gallon being 25.4 (US Department of Transportation 2016). The estimated number of vehicles on the road numbers are based off 1000 staff and faculty (WPI.edu 2016) at WPI and our survey data which showed 85% of staff and faculty, or roughly 850 people when extrapolated to all faculty and staff, use a single occupancy vehicle. We acquired the CO2 emissions data from fueleconomy.gov.

In our focus groups, a common point of discussion was the amount of time that faculty and staff spend in meetings. Focus group participants at the very minimum were required to meet in person with others for these meetings and in some cases commuted to various points on campus using their single passenger vehicle. They agreed unanimously that this was a wasteful practice. They identified telecommuting and a condensed work-week as ways to reduce waste. One focus group participant noted WPI had recently purchased technology to support the integration of telecommuting.

In addition to this, zip code data we acquired from the Human Resources Department at WPI revealed that 45 of the total 1,010 WPI faculty and staff lived out of state. Of those faculty and staff who live out of state, 24 live in Connecticut, 9 live in Rhode Island, 5 live in New Hampshire, and the remaining 7 live in a mix of Wisconsin, Pennsylvania, New York, New Jersey, Michigan, and Maine. For the purpose of this research, we consider a long commute to be over 45 minutes. The national average commute time in 2015 was 45 minutes (Citi ThankYou premier commuter index, 2015) so we considered commutes over 45 minutes to be long commutes. By this definition, about 340 faculty and staff who live in Massachusetts were still able to have a long commute as determined by their zip code's predicted driving time to WPI.

**Recommendation 1: We recommend that WPI institute a telecommuting plan for its faculty and staff who work desk jobs and for whom a large portion of time is spent in meetings.**

WPI's tele-conferencing software, Skype for Business™, is supported by the Information Technology (IT) department and can be accessed from many computer labs and lecture halls on campus as well as on personal computers outside of campus. This would allow faculty and staff to schedule days where they work from home. These days may allow faculty and staff to be more efficient as it will remove time spent commuting.

Telecommuting has been shown to reduce costs both for employers and employees, and when given the specific location of Worcester, MA, a popular online calculator for the total financial impact of telecommuting was able to estimate a case for WPI (Global Workplace Analytics). The calculator reports that the average employee would save around \$4,836 a year, and WPI would save around \$9,666 a year per employee if they were to telework 2-3 times a week on average based on the latest statistics on telecommuting.

**Recommendation 2: We recommend that WPI institute a condensed work-week plan for its faculty and staff who do not need to be on campus all days of the week.**

According to the WPI Employee Benefits and Policies Manual (2017-2018 edition), faculty need to work from 8am to 5pm and staff need to work either from 8am to 4:30pm or 8:30am - 5pm with two fifteen-minute breaks and one-hour lunch. This plan would function similarly to our other recommendation to add telecommuting but would instead condense the normal work-week hours into a smaller number of days of the week for departments that could allow this to function. An advantage of this plan is that it could include faculty who teach classes as we have many classes that only meet two days a week and teleconferencing for the meetings that faculty schedule on other days of the week.

Lori Thompson and Kimberly Aspinwall, research professors at North Carolina State University and RIT International, conducted an online survey of 125 potential job applicants in the Southeastern United States with fictional job descriptions with various benefits (Thompson et. al., 2007). They found that 33% of the respondents viewed a compressed work-week as a significant motivating perk for potential employees and argued that this meant that offering a compressed work-week can improve recruitment performance (Thompson et. al., 2007).

## **Conclusion**

Sustainable transportation involves reducing single-passenger vehicle usage in exchange for using more environmentally and economically friendly forms of transportation. For WPI, this means creating a more centralized website with all outlined modes of transportation, creating a safer environment for bicyclists, and creating incentives that would entice members of the WPI community to use sustainable transportation. The alternative methods of transportation are known to the students and faculty as evidenced by our survey. The move towards sustainable transportation starts with providing people options, successfully promoting these options, and changing people's mindset about driving single-occupancy vehicles as their main mode of transportation. We believe that our research contributes to WPI's movement to become more sustainable.

## BIBLIOGRAPHY

*A Bicycle Share Plan for Worcester Polytechnic Institute*. from [https://www.wpi.edu/sites/default/files/docs/Offices/Sustainability/A\\_Bicycle\\_Share\\_Plan\\_for\\_Worcester\\_Polytechnic\\_Institute\(1\).pdf](https://www.wpi.edu/sites/default/files/docs/Offices/Sustainability/A_Bicycle_Share_Plan_for_Worcester_Polytechnic_Institute(1).pdf)

Anand, S., & Sen, A. (2000). Human development and economic sustainability. *World development*.

Anderson, K., & McKibbin, W. J. (2000). Reducing coal subsidies and trade barriers: their contribution to greenhouse gas abatement. *Environment and Development Economics*, 5(04), 457-481.

Asseng, S., Ewert, F., Martre, P., Rotter, R. P., Lobell, D. B., Cammarano, D., et al. (2015). Rising temperatures reduce global wheat production. *Nature Clim. Change*, 5(2), 143-147. Retrieved 02//print, from Letter database.

Balsas, C. J. L. (2003). Sustainable transportation planning on college campuses. *Transport Policy*, 10(1), 35-49.

Balsas, C. J. L. (2006). Transportation and sustainable campus communities: Issues, examples, solutions. Vol. 72, pp. 369-370). CHICAGO:(AMER PLANNING ASSOC).

Bentley Web Site. Retrieved November 5, 2016, from <https://bentley.edu>

Boston University Web Site. Retrieved November 5, 2016, from <https://bu.edu>

Bopp, M., Sims, D., Matthews, S. A., Rovniak, L. S., Poole, E., & Colgan, J. (2015). There's an app for that: Development of a smartphone app to promote active travel to a college campus. *Journal of Transport and Health*.

Bruce Berg, (1998). *Qualitative Research Methods for the Social Sciences*

Brundtland, G., Khalid, M., Agnelli, S., Al-Athel, S., Chidzero, B., Fadika, L., et al. (1987). *Our Common Future ('Brundtland report')*: Oxford University Press, USA.

Caiazzo, F., Ashok, A., Waitz, I. A., Yim, S. H. L., & Barrett, S. R. H. (2013). Air pollution and early deaths in the United States. Part I: Quantifying the impact of major sectors in 2005. *Atmospheric Environment*, 79, 198-208.

C. D. Allen, A.K. Macalady, H. Chenchouni, D. Bachelet, N. McDowell, et al.. A global overview of drought and heat-induced tree mortality reveals emerging climate change risks for forests. *Forest Ecology and Management*, Elsevier, 2010, 259 (4), p. 660 - p. 684. <10.1016/j.foreco.2009.09.001>.

Cyr, D., Hannoush, A., Josephs, M., & Mike Ionis, A. (2014). Promoting Alternative Transportation for the WPI Community. (Undergraduate Interactive Qualifying Project No. E-project-031914-1451117). Retrieved from Worcester Polytechnic Institute Electronic Projects Collection: [https://www.wpi.edu/Pubs/E-project/Available/E-project-031914-145117/unrestricted/Final\\_Report\\_3.pdf](https://www.wpi.edu/Pubs/E-project/Available/E-project-031914-145117/unrestricted/Final_Report_3.pdf)

Dempsey, N., Bramley, G., & Power, S. (2011). The social dimension of sustainable development: Defining urban social sustainability. *Sustainable ...*

Evans, A. (2010). Resource scarcity, climate change and the risk of violent conflict. *Resource scarcity, climate change and the risk of violent conflict*.

Foley, J. A., DeFries, R., Asner, G. P., Barford, C., Bonan, G., Carpenter, S. R., et al. (2005). Global Consequences of Land Use. *Science*, 309(5734), 570-574.

Goodland, R. (1995). The concept of environmental sustainability. *Annual review of ecology and systematics*.

Google. *Google Maps*. Google, 2017, from <http://maps.google.com>

Greenbaum, T. L. (1998). *The handbook for focus group research*. Sage.

Grimmond, C. S. B., Roth, M., Oke, T. R., Au, Y. C., Best, M., Betts, R., et al. (2010). Climate and More Sustainable Cities: Climate Information for Improved Planning and Management of Cities (Producers/Capabilities Perspective). *Procedia Environmental Sciences*, 1(1), 247-274.

Hansen, J., Sato, M., Hearty, P., Ruedy, R., Kelley, M., Masson-Delmotte, V., et al. (2016). Ice melt, sea level rise and superstorms: evidence from paleoclimate data, climate modeling, and modern observations that 2 °C global warming could be dangerous. *Atmospheric Chemistry and Physics*, 16(6), 3761-3812.

Horacek, T. M., White, A. A., Greene, G. W., Reznar, M. M., Quick, V. M., Morrell, J. S., et al. (2012). Sneakers and spokes: An assessment of the walkability and bikeability of U.S. postsecondary institutions. *Journal of Environmental Health*, 74(7), 8-15.

Institute, W. P. (2017). Retrieved February 16, 2017, from <http://www.wpi.edu>



Johnson, G., & Scholes, K. (1999). *Exploring corporate strategy*. London: Prentice Hall Europe.

Johnson, Scholes & Whittington (2005). "Exploring Corporate Strategy", 7th edition.

Kalb, R. (2010). Feasibility of Biodiesel and Waste Vegetable Oil at Williams College.

Kaplan, D. H. (2015a). Transportation sustainability on a university campus. *International Journal of Sustainability in Higher Education*, 16(2), 173-186.

Kaplan, D. H. (2015b). Transportation sustainability on a university campus. *International Journal of Sustainability in Higher Education*, 16(2), 173-186.

Kuhlman, T., & Farrington, J. (2010). What is Sustainability? *Sustainability*, 2(11), 3436-3448.

LA Department of Transportation. 2017, from <http://ladot.lacity.org/>

Mikelonis, A., Josephs, M. G., Hannoush, A. S., Cyr, D., Vaz, R. F., & Boudreau, K. (2014). Promoting Alternative Transportation for the WPI Community. In *Urban and Environmental Planning* [Text (pdf)]. pp. leaves col. ill. 28 cm.). Worcester, MA:(Worcester Polytechnic Institute,).

Miller, J. (2001). *Transportation on college and university campuses : a synthesis of transit practice*. Washington, D.C: National Academy Press.

Oxford English Dictionary(2008-01-01). focus group. In . : . Retrieved 3 Oct. 2016, from <http://www.oxfordreference.com/view/10.1093/oi/authority.20110803095825954>.

Public transportation. (2015). Retrieved November 06, 2016, from <http://www.apta.com/resources/statistics/Pages/RidershipArchives.aspx>

Promoting Alternative Transportation for the WPI Community. In *Urban and Environmental Planning* [Text (pdf)]. pp. leaves col. ill. 28 cm.). Worcester, MA:(Worcester Polytechnic Institute,).

Pucher, J., Buehler, R., Merom, D., & Bauman, A. (2011). Walking and cycling in the United States, 2001-2009: Evidence from the National Household Travel Surveys. *American Journal of Public Health*, 101(1), S310-S317.

Rosca, E., Rusca, A., Ilie, A., & Rusca, F. (2010). Non-motorized transportation--an educational challenge for urban communities. *Theoretical and Empirical Researches in Urban Management*(17), 5.

Skinner, B. J. (1979). Earth resources. *Proceedings of the national Academy of Sciences*, 76(9), 4212-4217.

Stoecker, Randy (1959). *Research methods for community change: A project-based approach*

STARS Technical Manual - Version 2.1. (n.d.). Retrieved October 31, 2016, from [http://www.aashe.org/files/documents/STARS/stars\\_2.1\\_technical\\_manual\\_-\\_administrative\\_update\\_one.pdf](http://www.aashe.org/files/documents/STARS/stars_2.1_technical_manual_-_administrative_update_one.pdf)

*Sustainable transportation IQP*. from <https://web.wpi.edu/Pubs/E-project/Available/E-project-050809-111714/unrestricted/FullFinalReport.pdf>

Tahvonen, O. (2000). Economic sustainability and scarcity of natural resources: a brief historical review. *Economic sustainability and scarcity of natural resources: a brief historical review*.

*Taxi & Limousine Services - Quarterly Update 7/11/2016*. (2016). Austin: Hoover's Inc.

Too, L., & Bajracharya, B. (2015). Sustainable campus: engaging the community in sustainability. *International Journal of Sustainability in Higher Education*, 16(1), 57-71.

Transportation, M. D. o. *MBTA*. Retrieved February 16, 2017, from <http://www.mbtta.com>

*U.S. Department of Energy*. 2017, from <http://www.eia.gov/>

*U.S. Department of Transportation*. 2016, from <https://www.transportation.gov/>

*Uber* (2017). Uber, from <http://uber.com>

UMass Amherst Web Site. Retrieved November 5, 2016, from <https://umass.edu>

*United States Census*. 2016, from <https://www.census.gov/>

*Walk Score* (2017). Retrieved February 16, 2017, from <https://www.walkscore.com/>

Wesleyan Web Site. Retrieved November 5, 2016, from <https://wesleyan.edu>

WPI Web Site. Retrieved November 5, 2016, from <https://wpi.edu>

Zhou, J. (2012). Sustainable commute in a car-dominant city: Factors affecting alternative mode choices among university students. *Transportation Research Part A: Policy and Practice*, 46(7), 1013-1029.

Zhou, J. P. (2014). From better understandings to proactive actions: Housing location and commuting mode choices among university students. *TRANSPORT POLICY*, 33, 166-175.

Zipcar Changing the Landscape of Transportation in Baltimore. (2011). *Entertainment Close-up*

## APPENDICES

### Appendix A: Transportation Survey

#### Transportation Survey

*We are a group of students from Worcester Polytechnic Institute in Massachusetts. We are conducting a survey of transportation methods to learn more about the modes of transportation used at WPI. We strongly believe this kind of research will ultimately assist the team in creating a sustainable transportation plan for WPI. Your participation in this survey is completely voluntary and you may withdraw at any time. Please remember that your answers will remain anonymous. No names or identifying information will appear on the questionnaires or in any of the project reports or publications. Your participation is greatly appreciated. If interested, a copy of our results can be provided at the conclusion of the study.*

#### Year (Circle one) **FR SP JR SR Staff Graduate Student Faculty**

1. How do you travel to and from campus from home? (select all that apply)
  - a. Drive (single passenger car)
  - b. Bike (Gompei's Gears)
  - c. Bike (Your own)
  - d. Walk
  - e. Carpool
  - f. Bus
  - g. Other \_\_\_\_\_ (Please specify)
  
2. How far away from campus do you live?  
Provide an estimate \_\_\_\_\_ (in miles)      Zip Code \_\_\_\_\_
  
3. How do you travel from main campus to Gateway, if applicable? (select all that apply)
  - a. Drive (single passenger car)
  - b. Walk
  - c. Bike (Gompei's Gears)
  - d. Bike (Your own)
  - e. Gateway shuttle service
  - f. Other \_\_\_\_\_ (Please specify)
  
4. How do you travel around campus? (select all that apply)
  - a. Bike (Gompei's Gears)
  - b. Bike (Your own)

- c. Walk
  - d. Drive (single passenger)
  - e. Other \_\_\_\_\_ (Please specify)
5. How do you travel in the city of Worcester? (select all that apply)
- a. Drive (single passenger)
  - b. Bike (Gompei's Gears)
  - c. Bike (your own)
  - d. Train
  - e. Bus
  - f. Carpool
  - g. Walk
  - h. Other \_\_\_\_\_ (Please specify)
6. How do you travel out of the city? (select all that apply)
- a. Drive (single passenger)
  - b. Bike (Gompei's Gears)
  - c. Bike (Your own)
  - d. Train
  - e. Bus
  - f. Carpool
  - g. Other \_\_\_\_\_ (Please specify)
7. Have you used SNAP (Student Night Assistance Patrol)?
- a. Yes
  - b. No
  - c. Never heard of it
8. Have you used the Gateway Shuttle?
- a. Yes
  - b. No
  - c. Never heard of it
9. Have you used Gompei's Gears?
- a. Yes
  - b. No
  - c. Never heard of it
10. Have you used Carpool world?
- a. Yes
  - b. No

c. Never heard of it

11. How important is it to you that WPI becomes more sustainable and environmentally friendly?

Very Important

Neutral

Unimportant

12. What programs or incentives would encourage you to carpool, bus, bike, or walk more often?

- a. More bike availability
- b. A bus pass
- c. A carpool system
- d. Prizes or awards
- e. A parking fee for single occupancy vehicles
- f. Other \_\_\_\_\_ (Please specify)

## Appendix B: Focus Group Questions

First, let's get to know each other. Since we will discuss transportation today, how about sharing what we use to get to work? For me, I walk to WPI everyday and walk/ Uber to get around in Worcester such as Union Station, supermarket. How about you?

1. I would like to ask you what comes to your mind first when I say "Sustainable Transportation?"  
  
What are some factors that affect your transportation choice?
2. If cost is a factor, how it would influence you?
3. Which of these have you used and why have you used methods of sustainable transportation in the past?
4. What is your mode of transportation now to travel in general (to train station, to supermarket, etc)? Why did you change?
5. How do you get to WPI? Can you tell me why?
6. How many transportation options which WPI offers do you know? Have you used any of them before?
7. (Write down if there is van/shuttle to Union Station, subsidized transit passes, carpooling, working from home, app on a white board and briefly explain all of them)  
  
Which of these options seem appealing, why or why not? I will tally how many are interested for each option.
8. What would convince you to change your mode of transportation?
9. How we incorporate one these things to WPI to make WPI better?

## Appendix C: Interview Questions

### John Orr:

1. (Talk a little about our IQP) What would you like to see happen as a result of this IQP?
2. What is your opinion on the current transportation plan at WPI?
3. What do you think could be improved about it?
4. In your experience, what do you see as the biggest obstacles to the WPI community embracing sustainable modes of transportation?
5. Can you recommend any resources for us to look into that we may not have already?
6. Is there anyone else that you recommend we speak with about our project on-campus or off?

### Alfredo DiMauro:

1. What are your thoughts on the current sustainability plan at WPI?
2. What are your thoughts on sustainable transportation?
3. What do you think could be improved about it?
4. Would you like to see WPI move towards a more sustainable transportation plan? Why?
5. Would you be open to making changes to the current transportation methods that facilities currently use?
6. Is there anyone else that you recommend we speak with about our project on-campus or off?
7. If we have additional questions, may we contact you again?



Elizabeth Tomaszewski:

1. What does the Office of Sustainability wish to have included in a sustainable transportation plan?
2. What are the colleges/ universities that you have seen to have a gold standard transportation plan?
3. Which colleges/ universities would you suggest us to speak with about their transportation plan?
4. What kind of marketing did the Office of Sustainability do for Gompei's Gears?

Ezra Small:

1. What do you feel is the biggest contributor to having people, whether faculty, staff or students, utilize more sustainable transportation methods (at UMass Amherst)?
2. What programs/services have you seen work well in the past or present to successfully help move towards using more sustainable methods of transportation? Why do you think they worked so well?
3. Do you think campus size and location has a great affect on people's transportation habits? Say if UMass Amherst spanned a smaller area and had a much lower number of students attending classes, do you think that the students would be utilizing the same sustainable methods that they do now (like the shuttle, bus, train, or carpooling) or would nothing change if the geography changed?
4. Do the staff and faculty at UMass Amherst have to pay for a parking pass for parking their vehicle on campus? Do you think that this disincentive works well in deterring people from driving a single-occupancy vehicle? If parking was free for staff and faculty, do you think that the number of vehicles coming into UMass Amherst would go up?

5. Does UMass Amherst provide free/subsidized bus/transit passes? If so, about what percentage would you say utilize these passes regularly? If you didn't offer these passes at a free/discounted rate, do you think that less people would be using public transportation as their primary methods to get around?
6. Does UMass Amherst offer telecommuting services, a condensed work week, or any other service that would allow people to either work from home, or shorten their work week so they would not have to come to campus every day during the workweek?

Jenny Isler:

1. What do you feel is the biggest contributor/motivator to having people, whether faculty, staff, or students, utilize more sustainable transportation methods (at Clark)?
2. What programs have you seen work in the past or present to successfully help move towards more sustainable methods of transportation?
3. Do you think the campus size and location greatly affect people's transportation habits? Say if Clark's campus spanned a greater area and there were a greater number of students, do you think that students would be more open to sustainable transportation methods for travel (like public transportation, shuttles, carpooling, etc) or would it have the opposite effect?
4. Do the staff and faculty at Clark have to pay for parking passes for their vehicles? Do you think disincentives like these encourage people to utilize other types of transportation other than a single-occupancy vehicle?
5. Does Clark provide free/subsidized transit passes? If so, about what percentage of people would you say utilize these passes regularly? If you didn't offer these, do you think less people would be using public transportation right now?

6. Does Clark University offer telecommuting services, a condensed work week, or any other options that allow someone to work from home or shorten their work week? If so, about how many people would you say utilized this? Do you think it is an effective way to encourage people to work from home more often? Why or why not?
7. Do many people at Clark use the sustainable transportation options at Clark?
8. Do you think a shuttle service between the colleges in Worcester would be utilized enough to make it work while for implementation? I know there are a number of people who do commute between colleges, whether to visit, take classes, or for other reasons.

Stacey King:

1. What do you feel is the biggest contributor to having people, whether faculty, staff or students, utilize more sustainable transportation methods at Boston University?
2. There are some transportation options that I found on Boston University Transportation website and Sustainability website such as The BUS, MBTA Commuting Options for students, faculty & staff, carpooling, vanpooling, and biking.
3. Regarding the BUS, I want to ask if the stops are from campus to campus or there are stops at other places such as train station.
4. I've read the MBTA Commuting Options at Boston University and I saw that Boston University offers subsidized passes for employees and MBTA Student Semester Pass. I wonder if the MBTA Student Semester Pass also includes commuter rail or only includes local bus and subway.
5. What percentage would you say utilize these passes regularly? If you didn't offer these passes at a free/discounted rate, do you think that less people would be using public transportation as their primary methods to get around?

6. How about carpooling and vanpooling? Would you please share some information about this method?
7. In terms of biking, what methods does BU use to improve safety for biking?
8. Are there any protected bike lane/ cycle tracks near BU? I saw on BU Biking Safety website that there would be cycle tracks coming to Commonwealth Avenue in 2017.
9. Does BU offer bike-share program for BU community?
10. Among the programs mentioned above, are there any other programs that BU offers?  
What programs/services have you seen work well in the past or present to successfully help move towards using more sustainable methods of transportation? Why do you think they worked so well?
11. Do you think campus size and location has a great effect on people's transportation habits? Say if Boston University spanned a smaller area and had a much lower number of students attending classes, do you think that the students would be utilizing the same sustainable methods that they do now (like the shuttle, bus, train, or carpooling) or would nothing change if the geography changed?
12. Do the staff and faculty at Boston University have to pay for a parking pass for parking their vehicle on campus? Is there any privilege for carpooling in terms of parking lot?
13. Do you think that this disincentive works well in deterring people from driving a single-occupancy vehicle? If parking was free for staff and faculty, do you think that the number of vehicles coming into Boston University would go up?
14. Does Boston University offer telecommuting services, a condensed work week, or any other service that would allow people to either work from home, or shorten their work week so they would not have to come to campus every day during the workweek?

Brandon Smith:

1. Was there a difference in sustainable transportation use after the website update?
2. Do you have anything you'd like to add for useful information?
3. What do you feel is the biggest contributor to having people, whether faculty, staff or students, utilize more sustainable transportation methods at CU Boulder?
4. Do you think campus size and location has a great effect on people's transportation habits?
5. Does CU Boulder offer telecommuting services, a condensed work week, or any other service that would allow people to either work from home, or shorten their work week so they would not have to come to campus every day during the workweek?
6. Do the staff and faculty at UMass Amherst have to pay for a parking pass for parking their vehicle on campus?
7. Do you think the student body has played a role in encouraging sustainable transportation?

## Appendix D: Screenshots of other universities' websites

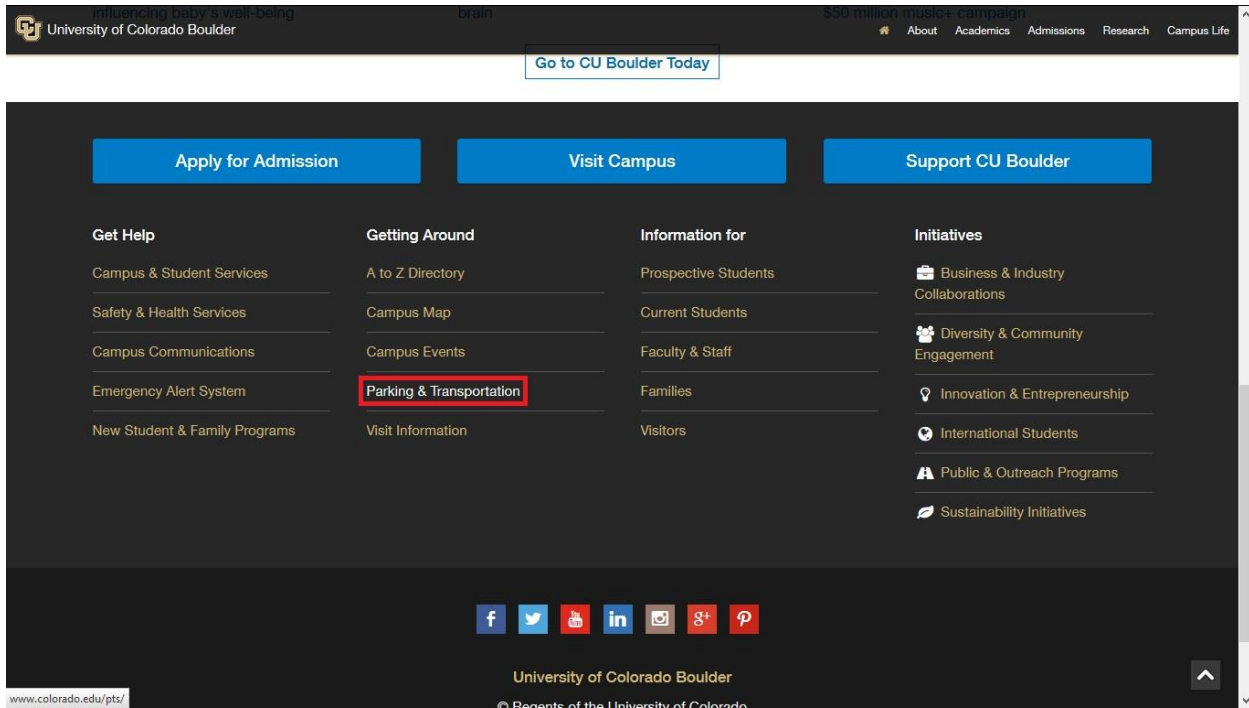


Figure 11. Screenshot of University of Colorado Boulder Home Page

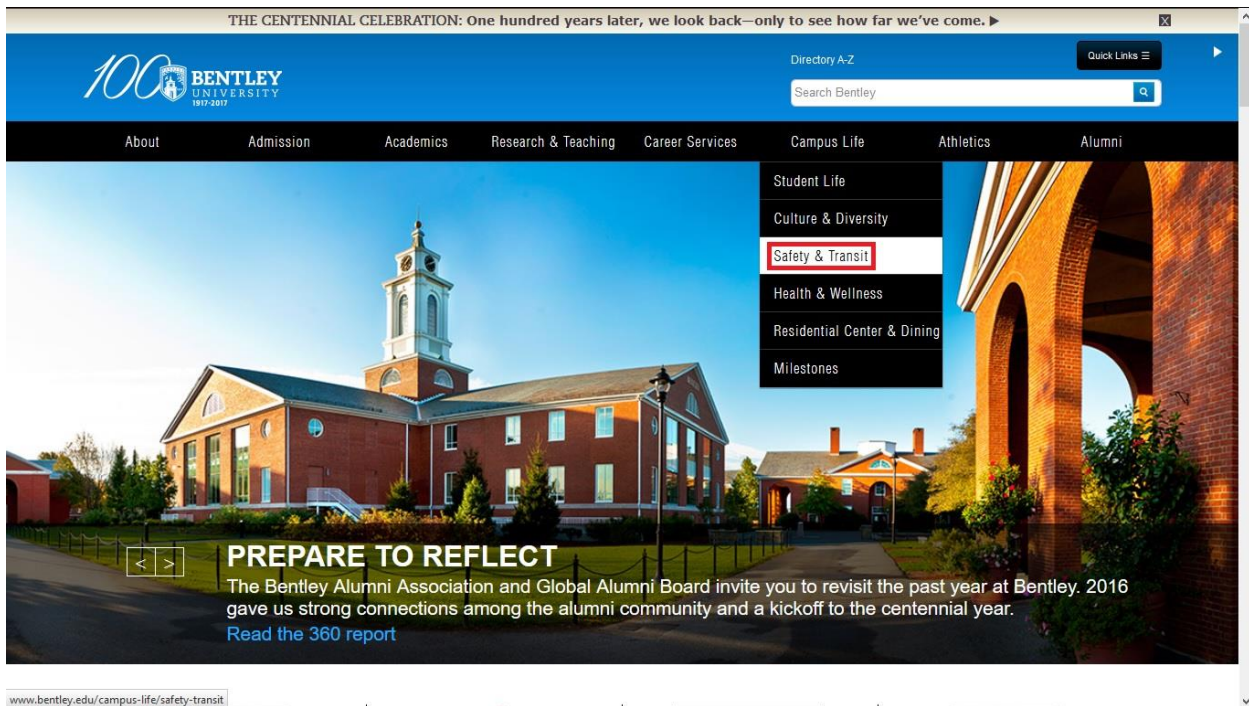


Figure 12. Screenshot of Bentley University Home Page

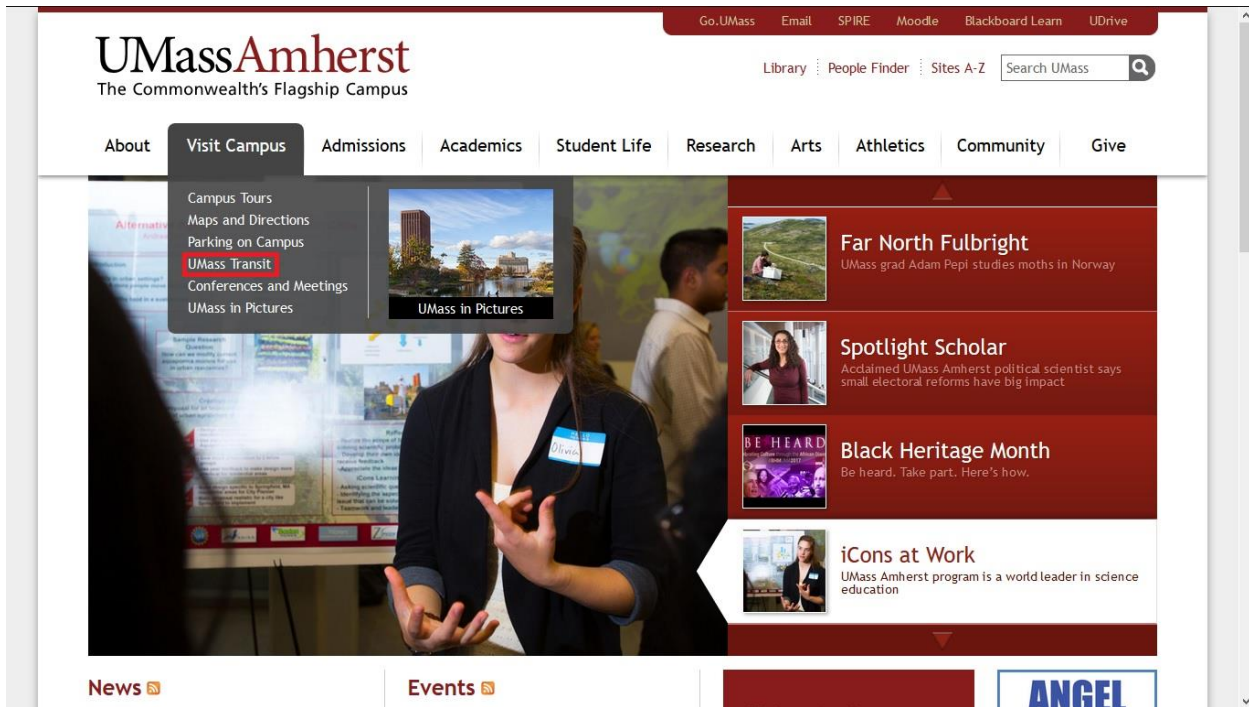


Figure 13. Screenshot of UMass Amherst Home Page

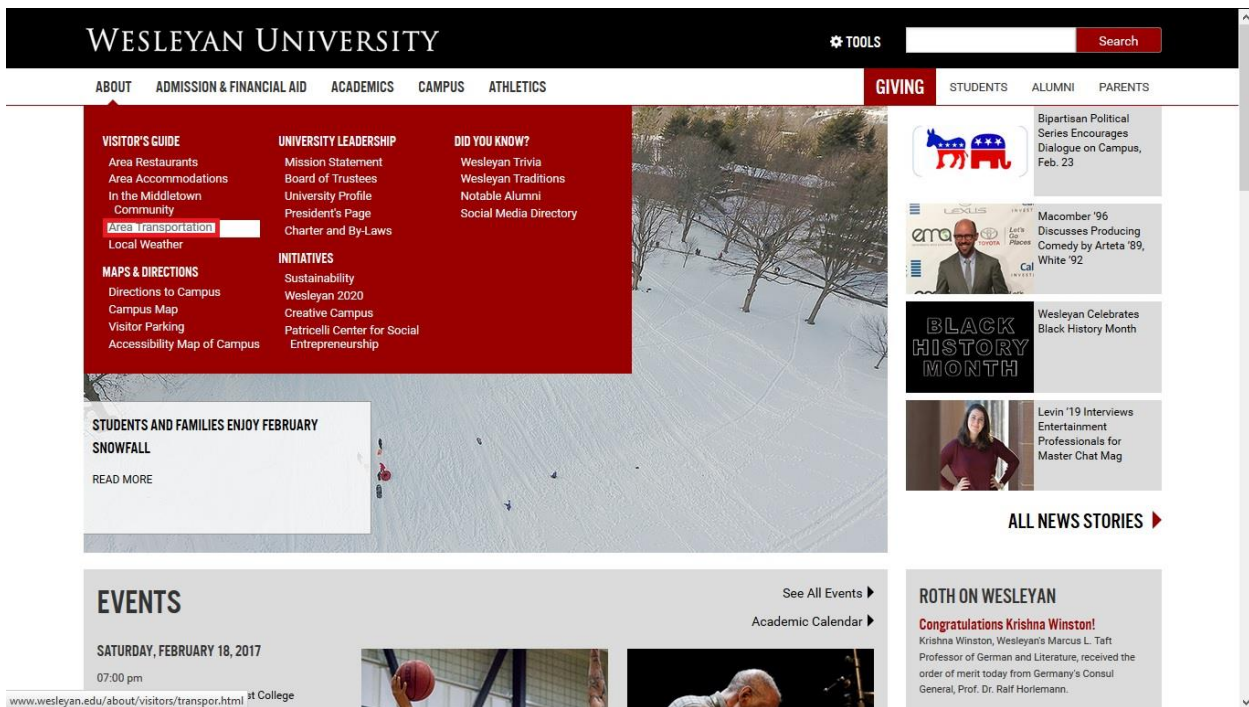


Figure 14. Screenshot of Wesleyan University Home Page