EDSGN 100, Section 20, Group 5: JAMM

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Sustainable Campus Project Report

Summary: Penn State's CATA bus system currently transports students across campus and from local apartment complexes. Using survey questions, personal experiences, and information gathered from other college campuses, we determined that Penn State has an inefficient transportation system which could be made more sustainable. Our proposed solution involves developing an affordable bike rental system to provide bikes to students for use around campus. Initially, the bike system will cost $1.7 million, but with the investment return from a $50 student rental fee, we would have a payback period of 13 years. This solution also reduces campus vehicle emissions providing a more sustainable Penn State campus. We will reduce the total distance traveled by bus by 198 miles per day and reduce the CO_2 emissions by 396 kilograms per day.

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Introduction

We believe that the current CATA bus and vehicle system for transportation at Penn State is inefficient due to traffic jams and bus overuse on temperate days. We think that people over use cars and buses on days when they are not necessary. Our definition of sustainability after working for a few weeks on the project, is maintaining the environment and our resources for future generations while still living fulfilling and technologically advanced lives.

We thought that bus and commuter traffic was a problem at Penn State so we wanted to develop a solution to reduce the amount of traffic. Initially we thought that creating a tunnel system for vehicles to travel through would be a good solution. This would allow all of traffic to be underground and eliminate a majority of the vehicle noise and emission pollution and create a more sustainable campus. The tunnels would also allow for pedestrian traffic to move much more quickly whereas pedestrians often had to wait for vehicles at specific intersections. After some thought, we determined that a tunnel system would be much too costly and would have such a long payback period that it was not a viable solution for Penn State.

Then we examined a new way to cut down on the amount of vehicles on the road. We came up with a bike rental system. This would allow people to use bikes as opposed to using a bus or car. We wanted to get a feel for what other students felt about using bikes on campus. We researched other campuses to see if any other campuses had instituted a bike rental system. Once we found that a system similar to ours had been done at other campuses, we created a survey to ask Penn State students what they would think of a bike rental system at Penn State.

Concept Development

We began our concept development by creating a survey to find out if students would be interested in a bike rental service. Approximately one third of the people who took our survey said they currently use a bike on campus. Over one half of the people surveyed said they would use a bike if a bike rental service was provided by Penn State. So there is an interest in a bike rental service here at Penn State.

	Easily Accessible	Multiple Locations	Locking System	Helmets	Bike Lanes	Students Actually Use	Low Cost to Students	Easily Maintained Bikes	Total	Weights
Easily Accessible	1.00	1.00	3.00	4.00	5.00	0.50	0.66	1.00	16.16	14%
Multiple Locations	1.00	1.00	2.00	4.00	5.00	0.33	0.50	1.00	14.83	13%
Locking System	0.33	0.50	1.00	2.00	3.00	0.20	0.25	0.33	7.61	6%
Helmets	0.25	0.25	0.50	1.00	2.00	0.14	0.20	0.30	4.64	4%
Bike Lanes	0.20	0.20	0.33	0.50	1.00	0.10	0.13	0.17	2.62	2%
Students Actually Use	2.00	3.00	5.00	7.00	10.00	1.00	1.33	2.00	31.33	27%
Low Cost to Students	1.50	2.00	4.00	5.00	8.00	0.75	1.00	2.00	24.25	21%
Easily Maintained Bikes	1.00	1.00	3.00	3.00	6.00	0.50	0.50	1.00	16.00	14%
									117.44	

Table 1

Before we collected the data from our survey, we created an Analytical Hierarchy Matrix (Table 1). From our AHP, we determined that our most important priority was that students would actually use a bike rental service. From the survey results, we believe that students will in fact use this service. Secondly, we want this service to be inexpensive for students. If the service is too expensive, we believe that students would not use the service. This assumption was reflected by the survey where the majority of people said that they would like the price to be less than fifty dollars. In order to help keep costs low, we want the bikes to be durable and easily maintained. Therefore extra money would not have to be used to purchase new bikes.

We also included that our bike system is easily accessible and at multiple locations around campus. We believe that people will not utilize our bike system if they cannot ride their bike directly up to the building to which they are going. We had to determine a locking and

unlocking system that would be both efficient and securely lock the bikes. We determined that the best strategy would be to modify the current bike racks on campus (Figure 1). This model

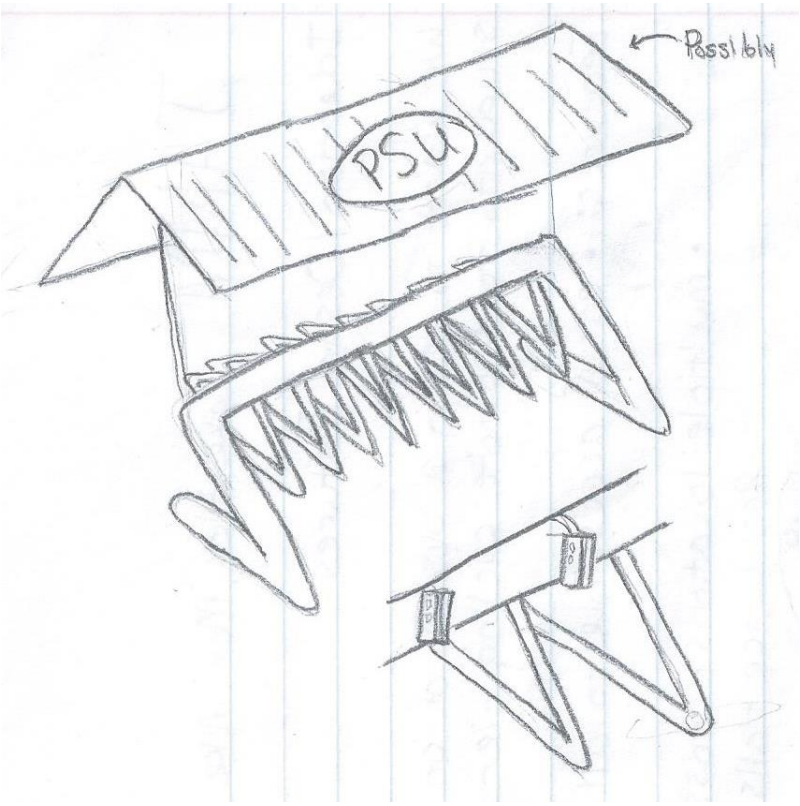
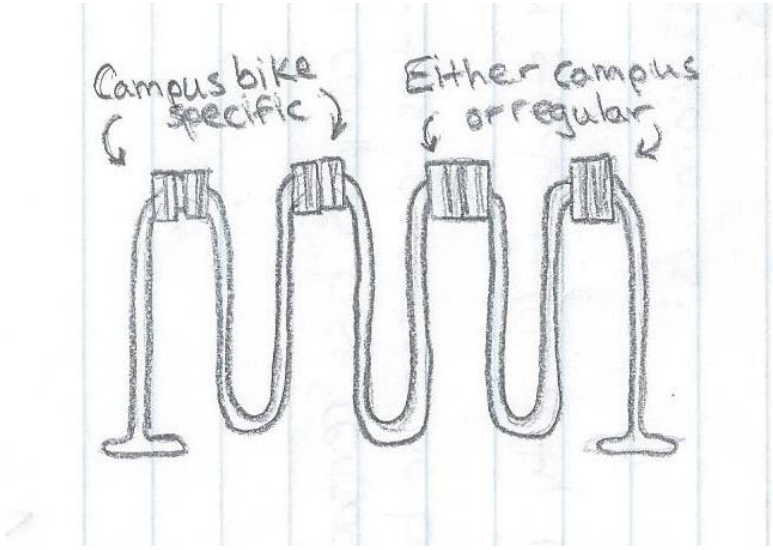


Figure 1

adds an overhang over the current bike rack to help protect the electronic locking system from the weather. The locking system will operate using an ID card reader. Students who pay the fee to use the University provided bikes can use the electronic locks. Several slots will be left available for students who use their own bikes. Unfortunately all of the bike racks on campus are the same (Figure 2) so we had to develop a different type of lock for these racks (Figure 3). This



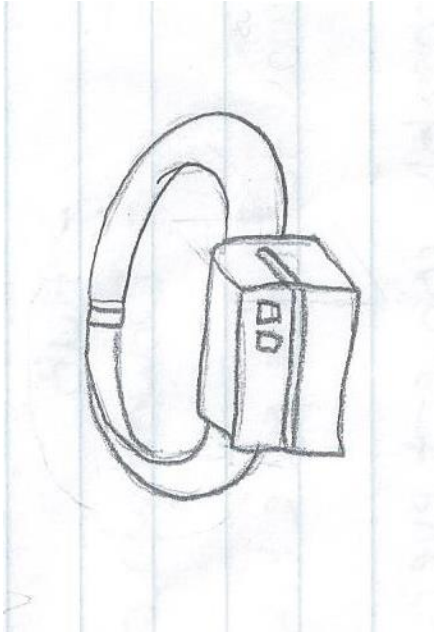


Figure 2 Figure 3

new lock will be a circular design which opens at the bottom and then clips onto to the bicycle.

Detailed Concept Development

After we had determined that our plan to make Penn State more sustainable was to implement a bike rental system, we researched to see if other campuses had used a similar system. We found that a bike rental system had been used at other universities such as Ripon College, Duke University, and Northern Illinois University. These campuses purchased enough bikes for approximately one third of their students. We used this information when deciding how many bikes to purchase for Penn State.

Penn State has 38,954 undergraduate students. From research, we found that thirty-seven percent of undergraduate students live on campus which is 14,413 students. Using the information from research, Penn State will have to purchase one bike for every three students which is approximately 4,800 bikes.

When we looked at what type of bike Penn State should purchase, we again looked to our survey. Over half of the people surveyed said they would like Penn State to offer mountain bikes.

We believe that a simpler bike is also better. Simple bikes will be easy to maintain and are less susceptible to malfunctioning. We searched online and found a bike (Figure 4) for $120.00.

Figure 4

When we converted that to a wholesale price, the bike became $80.00, which is the price Penn State would pay. Penn State will also be able to purchase locks to give to students along with the bikes for a wholesale price of $5.00.

We determined that providing a lock with each bike was much more economical than modifying the existing bike racks to include electronic locks. The other universities who have used a bike system also simply provided students with a lock. This will be much less expensive than adding card readers and locks to bike racks like we had initially planned on doing.

We also had to determine where we could store all of the bikes over the summer when they are not being used. There may be somewhere already in existence on campus where we could store the bikes, but in case there was not, we assumed that we would have to build a warehouse. This way the payback will not be an underestimate. We estimated that building a warehouse (Figure 5) large enough to hold all of the bikes would cost $1.3 million (4).

Figure 5

Purchasing 4,800 bikes and locks at a cost of $85.00 will be an upfront cost of $408,000. Along with the cost of the warehouse, this will require an upfront fee of $1.7 million by Penn State. It will also cost approximately $74,000 per year to maintain the warehouse (5). We understand that this is a lot of money for Penn State to pay upfront, but it will pay for itself in a reasonable amount of time, depending on the amount of money charged for the use fee, and then will be a source of revenue for Penn State.

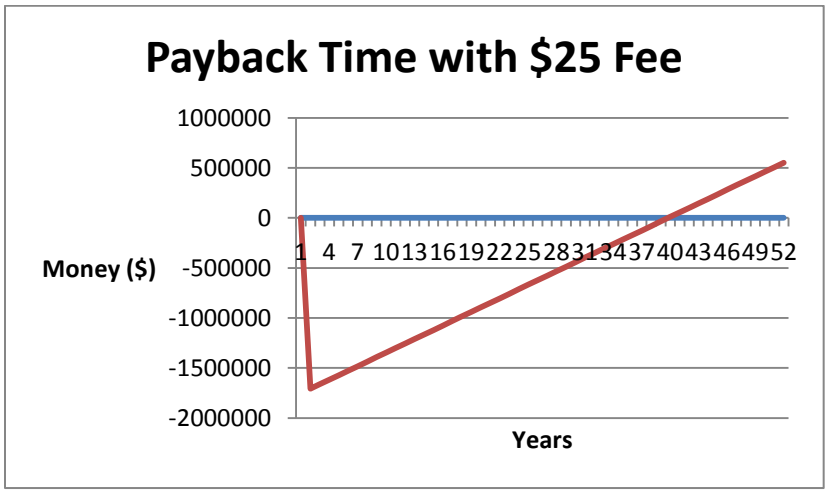


Figure 6

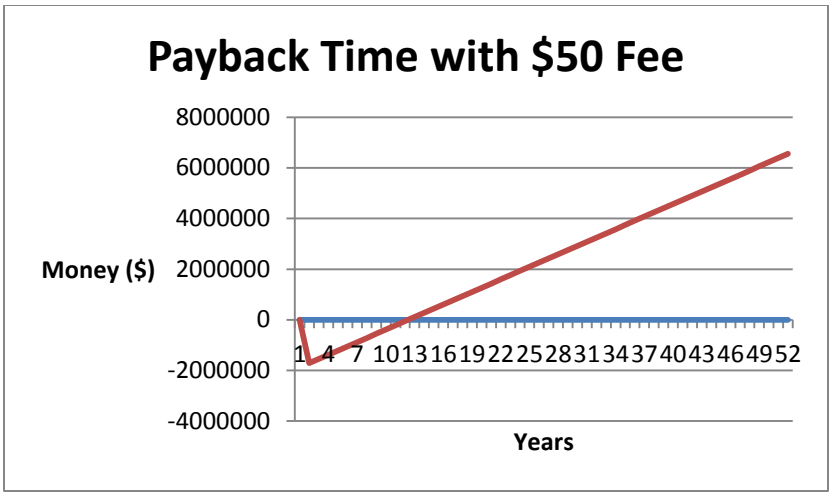


Figure 7

We considered charging a price of either $25 (Figure 6), $50 (Figure 7), or $75 (Figure 8). The payback time with $25 yearly use fee is thirty-eight years. This is rather unreasonable, so we also determined the payback time with two other use fees. With a $50 and $75 use fee, the payback times are eleven and six years respectively. Penn State would be able to decide which use fee they would charge. The $75 fee has a smaller payback time, but fewer students would also use the service. We believe that students would be more willing to use the service with a $50 use as opposed to $75, and our two most desired features were that students actually use the service and that the service is a low cost to students.

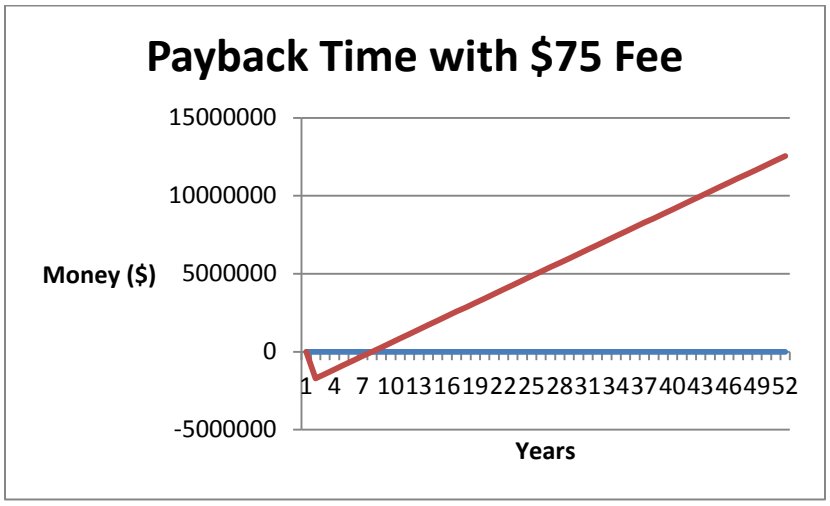


Figure 8

The payback time is strictly monetary. It does not include the reduced amount of pollution from fewer cars and buses on the roads. We were not able to monetize a reduced amount of pollution, so we could not include that in our payback time.

We tried to at least quantify the amount of pollution that would be kept out of the atmosphere by reducing the number of buses. We were specifically attempting to reduce the number of loops and links running on campus. We assumed that we could reduce the number of loops by four buses, two white loops and two blue loops, and reduce the number of links by two, one red link and one green link. This would reduce the total number of buses by six.

We are assuming that the buses are running from 6:00 A.M. to midnight, which is eighteen hours per day. But we would only reduce the number of buses running during the day from approximately 7:00 A.M. to 6:00 P.M., which is still eleven hours. If six compressed natural gas buses were only running for eleven hours, they would still produce a considerable amount of pollution. The information we found for the emissions was given in parts per mile. We are estimating that one loop and one link three miles. We are also assuming that each bus will complete three loops or three links in one hour. This gives a total of thirty three miles by each bus and a total of 198 miles traveled by all of the buses in one day.

If total bus travel was reduced by 198 miles per day there would be 4.158 grams of particulate matter, 2.97 grams of organic carbon, 2,970 grams of NO_x, and 396 kilograms of CO_2 kept out of the atmosphere per day. There would also be 1980 grams of methane, 15.84 grams of aldehydes, and 297 milligrams of benzene not released into the atmosphere every day (2). Some of these gases can be very harmful for both people and the environment.

Fine particulate matter is most harmful for children and the elderly. I can also aggravate heart and lung disease and damage lung tissue. CO_2 is very damaging for the environment. It is one of the leading greenhouse gases that contribute to global warming. Methane is also a greenhouse gas and has similar effects to CO_2. Both NO_x and organic carbon are major contributors to the formation of ozone near the surface of the earth. Ozone has been known to cause asthma, eye irritation, and nasal congestion among other things. On its own, NO_x can cause pneumonia, bronchitis, and irritate the lungs (3).

Conclusion

This unique, feasible, and certainly attainable design of a bike rental system should be utilized on campus. This will give students another option of getting class instead of simply walking or taking the bus. If fewer students are taking the bus, CATA will be able to use fewer buses and in turn will reduce harmful emissions from buses and cars. This system will sustain itself and eventually make money for Penn State. The system promotes a healthy lifestyle. The system will work by having students pay a yearly use fee. With this fee, each student will receive a bike and a lock to use all year long, and then they will return it at the end of the year.

We believe that Penn State should implement this design. Excluding the large upfront cost, this system is very economical. Depending on the size of the fee charged to students, the bike system will begin to generate revenue for Penn State between seven and eleven years after it is initially implemented.

Currently we are not sure if Penn State will choose to implement this system on campus. Penn State may want us to conduct more research to see if students would be interested in using such a system. Our survey size was rather small compared to the number of students we would expect to use the system. With more research we would be able to provide a more accurate number of projected students that would use the system. Also, Penn State may want us to find somewhere already on campus where we could store the bicycles. If we could avoid having to build a warehouse, which makes up the majority of our upfront cost, we believe Penn State will definitely implement this system.

We learned many new things while attempting to make Penn State a sustainable campus. First off, we found out that a bike system would be utilized by students if one was available. We also learned that even though CATA uses compressed natural gas buses which are cleaner than standard diesel buses, they still produce a large amount of pollution. Most importantly, we learned how important sustainability is. We have to preserve our resources and environment while still continuing our current lives in a fulfilling and advanced manner.

Sources

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Appendix A (6)

Bike Specifications

Features

Durable steel frame with Limited Lifetime Warranty
15-speed Index shifters are easy to shift
Front and rear linear pull brakes provide sure control
26" x 1.95" all-terrain tires designed for a great experience on the trail or road
Padded saddle for a comfortable ride

Color: Warm Silver Metallic
Recommended Age: 12 to Adult
Model Number Shown: 26201
Amazon Price: $120
Wholesale Price: $80