BIKE SHARE BUSINESS MODEL

FOR CAL POLY – SAN LUIS OBISPO

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Abstract

With the increasing admittance of students into colleges and universities across the nation, the need for alternate modes of transportation is becoming more pressing. College and university campuses, as well as small cities, in which there is a college or university, are being overloaded with student cars. In San Luis Obispo specifically, parking on campus as well as downtown can be extremely difficult to find. Traffic is also getting progressively worse, especially at the hour when class begins/ends and student arrive to or leave campus. Financial reasons are yet another deterrent for students at Cal Poly. Parking permits, gas, and costs associated with owning a car make it even more difficult for students to be able to afford driving. City busses have attempted to resolve this issue, but with their set schedules, routes, and capacity, they only provide a band-aid solution. BikeShare seeks to solve this problem by offering students an affordable means of transportation, which they will have access to at all times. San Luis Obispo is the town to start this new sustainable movement in, and when proven successful, others will follow in its wake.

SLO is constantly seeking to make the town a better place to live as seen through its implementation of a no plastic bag policy in grocery stores, elimination of drive-thrus, limiting outdoor smoking, and hosting a weekly farmers market. These are just a few of the successful policies and events that have been brought to SLO and have become part of its culture. As not only an innovative green idea, but also a practical means of transportation, the implementation of a BikeShare system in SLO will further this image that it is creating for itself. BikeSharing will give students and residents of SLO an alternate mode of transportation in the sharing of these communal bikes. After implementation and expansion of this program, financial success is expected as well. Through the acquisition of membership fees, payment from advertisements, government grants, and donations, BikeShare is believed to be a self-sustaining, if not profitable business.

After developing and analyzing various BikeShare models, the model in which the remote bike locking system which uses existing bike racks around San Luis Obispo to lock the bike up at was decided upon. This was due to its low start up cost paired with the relative security of the bikes and preferences over other models by both users as well as from the business' point of view.

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Introduction

This project seeks to analyze the most effective BikeShare models and use the information found as a basis for providing an inexpensive alternate solution for getting students on the Cal Poly - SLO campus in a safe and sustainable way. Research showed that there were around nineteen thousand students on campus in the fall of 2011 and that number continues to rise as the years go on.

While various versions of BikeShare models are discussed in this report, they all share the same basic characteristics. All seek to offer an alternate mode of transportation to users in which they are not required to own a bicycle of their own. Four different models will be analyzed in this project in order to find the most effective one which will be used as the blueprint for our proposed BikeShare. Our project is made significant due to the fact that there is an obvious need for improved transportation methods, made apparent by traffic, outrageous parking permit fees, full parking structures/lots, permitted parking in residential neighborhoods, and planned parking expansion construction, just to list a few. We foresee BikeShare will be primarily used by students, however, in a town where students make up approximately half the population, this will only increase usership. With students as our target market, our methods in reaching them will be made easier due to the confinements inherent within that segment.

Owning one’s own means of transportation can prove difficult, especially as a student. Vehicles are a very expensive initial investment, and seeing as students generally do not have the funds necessary to buy a new vehicle, older ones are the only which are affordable, and those either come with problems already, or are more likely to develop them sooner. Therefore, maintenance costs, along with insurance, registration, and gas are all payments inherent when owning a vehicle. Students also must pay an additional fee for a parking permit in order to drive to school. City busses are an alternative, however, they have limited capacity, set schedules and routes, and can take much longer than other modes of transportation. Besides these reasons, time has proven that most students do not prefer this mode of transportation regardless. Bicycling is another popular transportation method, however, besides the initial cost of buying a bicycle,

bikes require a fair amount of maintenance, whether it be pumping up the tires, keeping the chain oiled, adjusting the brakes, etc. Also, many times people are looking for one way transportation which is not an option when they cannot leave their vehicle/bike at their destination, or are somewhere without access to them. The final popular mode of transportation available is walking. This is very time consuming, and although there are no monetary costs associated with it, can be seen as wasteful in terms of time spent.

Due to these expensive and inefficient current methods in use today, we believe now is the time to implement a BikeShare which will reach an audience already exasperated by the current state of affairs. From our survey which we conducted, 74% of students replied that they would use a BikeShare if available.

Background

San Luis Obispo is a small community that is trying to move forward on having less and less cars within the city. San Luis Obispo has made steps towards the end goal by having a well-run public transportation system, short distances between major vicinities, and the elimination of drive-thrus throughout the city. With the amount of cars used in the city being reduced, there will be a need for a cheaper alternative source of transportation that must be made available to the public.

Recently there has been a popular movement towards bike sharing systems in big cities around the world. A BikeShare system is a service that provides a quick and convenient way for people to get from place to place for a cheap price. Cities that have implemented a BikeShare system have hubs or stations where there are bike available for rent. A customer would simply walk up to a station, pay a certain amount of money, and have use of the bike until he/she is done. The beauty of the service is that since there are multiple hubs around the city, the customer does not have to return the bike to the same location. If there is another station or hub nearby, the customer could simply return the bike there and not be charged with any other fee.

BikeShare programs are a clean and fun alternative way to get from one point within the city to another. There are many existing BikeShare programs that are successful and booming that this model can be based off of. There are many concerns that are a big issue with BikeShares, but they can be easily countered if planned correctly. With the idea of a BikeShare and how successful it is in many cities, the implementation of a service that is similar to the city of San Luis Obispo could bring the city closer to the end goal. There are many types of theoretical models that could be used by a BikeShare program. Consequently, even though the model which uses hubs/stations is the most common form of bike sharing it is not necessarily the most efficient one.

With the ideas of many of bike sharing programs and the way the city is formatted, there is a good possibility for a BikeShare program to be implemented within the city of San Luis Obispo. In order to accomplish the goal of a bike sharing system to be

implemented in the city, much data must be collected, statistical analysis performed, and simulation models created. A simulation model will help create the best scenario of which alternative to use as a basis. Some of the main points that will be observed are the individual bike utilization, the interarrival rate of bikes to certain areas, and how many bikes should be put in the system. This simulation will act as a proposal to the city to take into consideration of implementing an actual service which will be available to the public.

Within the time allotted for this project, the scope of planning and simulating a BikeShare program for the whole city would be too large of a scope. After deciding and narrowing it down, the decision was made to plan a BikeShare program for students at Cal Poly. This service will be available for students at the apartment complexes within a two mile radius of campus. This scope is much more plausible and can also help out students for their benefit.

The objectives for how to implement a BikeShare system will be done as a business model, or way to show financially how to implement the system. The decision to choose which alternative will be the best will be selected with fully allocated costs, an analytical hierarchical process model, a Simio model, and statistical analysis. This report will go over much background research into the positives and negatives of various BikeShare systems, how the scope of the project was narrowed down, which alternative BikeShare solution was selected, and the simulation modeling. It concludes with statistics drawn from the Simio model and a further financial analysis into how much it would cost to maintain this alternative.

Literature Review

One of the main concerns with BikeShare systems is safety. The article, “Bike-Share Safety Issues” by Natalie Lukas, talks about some of the many safety concerns that are involved with various BikeShare programs. One concern that Lukas has is, how are the users of the BikeShare program being protected or insured? Lukas points out that the elderly are some of the main users of the BikeShare programs and their bodies are

more prone to injury than someone younger. Another concern that Lukas addresses is the education (or lack thereof) about how bicyclists are supposed to be treated on the road. With an influx of users that don't know how a bike should act on the road adds more to the worry of more civilians being hurt with many BikeShare programs (Lukas, 2013).

Even though the elderly aren't going to be using the BikeShare program on campus, there is still a need to teach students how to properly use a bicycle in public areas. Since there can be a lot of traffic with pedestrians and other bikes going around campus, the probability of a customer getting hurt can go up by a lot.

Daniel Beekman writes about how a customer of the CitiBike program in New York City got severely injured while using one of their products. Ronald Corwin, the customer in question, got hurt when there was a low barrier that was out of sight. After the injury Corwin and his wife sued the city for $15 million (Beekman, 2014).

The possibility of having this type of event happen is high on campus. Cal Poly is always under construction and there could be obstructions in the road which are difficult to see. Another factor that can apply to the project is if the user will use a helmet or not. This is another liability issue that must be taken into account and to ensure that anyone using the BikeShare program will be safe.

One way to take care of liability is to treat the BikeShare the same way that Cal Poly takes care of liability at the recreational center. If a student wants to have access to the rec center, the student must agree that the associated students incorporated will not be held liable for any mistreatment or misuse of equipment that could result in injury or harm. This concept can be taken into consideration when creating the BikeShare. If a student wants to have access to a bike, the student must go on their student portal and agree to the same rules that they do for the rec center. Once a student agrees, then the bike will be able for use to the student.

Lenny Bernstein from the Washington Post talks about how many BikeShare programs don't provide any safety for the customers/users. In the past, there have been several cases of hit-and-run accidents with no resolution to how the crime was committed. Some of the BikeShare programs are resolving this issue by asking the local police department to start issuing tickets to those who are using a BikeShare bicycle and not wearing a helmet (Bernstein, 2014).

One way to ensure that bikers will use a helmet is do ask UPD to enforce BikeShare users to wear a helmet so that they will be safe and there will be no lawsuits involved. This could be a part of their agreement when buying a subscription to the BikeShare programs by asking the customers to agree to use a helmet at all times.

After further research, there has been good and bad reviews about many of the BikeShare implementations. Some of the main focuses were about the program's finances. Colin Daileda talks about how CitiBike is so successful in some of its starts, but fails to keep up the revenue throughout many years. One of the main concerns is how expensive a membership is ($100 for a year and $10 for a day). This cost analysis has no middle ground. A potential customer might only use the bike for a day, but may have no idea if they might need to ever use it again. If a customer uses a day pass ten times in a year, then the person could have just bought a year pass and would have been satisfied. However if someone pays for the year pass and uses the bike once a day or multiple times a day, it will not be in favor of the company and they will lose money in maintenance and upkeep (Daileda, 2014).

One way that can resolve this problem is to have a trial run on campus (for free) to see who is willing to use the bikes. Once there is a good estimate on who will actually use it, pricing can then be calculated and used. One alternative is to just have the BikeShare be added to the student's tuition and treat it like how the free bus pass is treated for the students.

In an interview between Andy Riga of the Montreal Gazette and Renee Montagne from the NPR. Riga talks about how Bixi, one of the largest BikeShare programs in the world, is now filing for bankruptcy even though there was major talk of success. Riga states that much of the problem was with the amount of funding that Bixi received and yet did not produce the ideal revenue for them to maintain business (Montagne, 2014).

This could be a problem with the project because it will be hard to sell to people about subscribing and using the bikes regularly. With a large initial cost, it will be hard to pay back for those funds in a certain time frame if there are not as many customers as expected.

Eben Weiss of the New York Times talks about how many of the BikeShare programs have reached several bumps on their path to success. In the beginning there was worry about biker safety, stolen bicycles, and how much it actually costs for the program to run. Citi bikes looked towards tourists for funding since there, the government did not supply enough financial aid. In the end it turned out to be a fail because the tourists still ended up taking taxis or other means of transportation to fulfill their needs of getting from one place to the next (Weiss, 2014).

Again, the BikeShare programs are going to be hard to sell to the students/customers due to the lack of advertising. Since it is mainly going to be focused on the students, it will be somewhat cheaper since the window of where the BikeShare program can be implemented/used. If the window is kept within a reasonable range, the price will be relatively cheap for any student across campus.

Perry Burnap wrote an article in The Denver Post that introduces B-Cycle. The company will be opening a new branch in Denver. Even though B-Cycle has informed the public and publicized as much as it could, the revenue or usage of the actual BikeShare was not up to what they projected it to be. However, after showing what the program can do for the public and how beneficial it could be, the usage started to climb and still continues to do so (Burnap, 2012).

This could be a problem for the possible program due to lack of student knowledge. Many students don't pay attention to their emails or PolyPortal to know if there was an actual BikeShare program being implemented on campus and if there is a lack of participation, then the project will fail.

There are even some cases where some of the programs have filed for bankruptcy. Luz Lazo writes about a BikeShare program, Alta, in Montreal which was corrupted earlier in the year due to lack of profit. This was caused by a trickledown effect that made the company perform poorly. The first event that started this decline was from the bicycles being damaged and mistreated. Because the bikes were mistreated, the customers did not want to use the bicycles because they were afraid that they would get hurt while using the item. This roll over effect kept going and because the bikes were getting more damaged and there wasn't enough funds to repair them all (Lazo, 2014).

This is one thing that is a concern for this project. Since college students are going to be the main focus for this program, there is a concern for them treating the bike/products correctly. One possible usage that students might use the BikeShare for, is getting to class when they are running late. Because of them rushing to get to class, there is a chance that they could mistreat the bikes or not even lock them up properly. Another situation to worry about is the weather. The early morning mist that comes in to San Luis Obispo could damage the bikes and chains if they are not taken care of properly. With this, there has to be a person that must be hired in order to maintain and repair the bikes if there is any such damage done to them.

Since one of the main focuses is to cut down the cost, one decision that was agreed upon was to abandon the use of the hubs/bike stations. One way to get around this was to adapt the use of individual locks that are on the bikes and that can be unlocked through an app, card, or some other device.

One other alternative that was looked at was a product that is being designed by a new start up. Bill Chappell writes how his solar powered u-lock can supply the best type of prevention when having the bikes being stolen. With this u-lock, there is an accelerometer attached as well as a GPS device. With both of these sensors in play, it can detect if a bike/u-lock is being stolen or if it is in the middle of an attempt to be stolen (Chappell, 2014).

This is a valuable tool for a potential BikeShare program on campus because it will help save a lot of money. Normally BikeShare programs have a hub that can store all the bicycles, but since we are abandoning the idea and implementing a lock that can be located through GPS, this type of lock will be amazing for the program as it already has many of the needs already built in.

Luz Lazo talks about the philosophy of how BikeShare bicycles are stolen often and why they are. Some of the BikeShare programs are enforcing a heavy and expensive policy if a bike is stolen. Some programs charge up to one thousand dollars if a bike is claimed as missing or not returned on time. With this set, it will be very hard to enforce it since so many bikes are stolen on a regular basis and is hard to keep track of where the bike is and how to keep a good track on it (Lazo, 2014).

One way to resolve this with the Cal Poly program is to install RFID chips on the bicycles so that they are being tracked at all times. With a RFID club on campus, there could be possible collaboration in the future to keep track of the bikes to make sure that nothing goes wrong or missing. Another way to make sure that the bicycles are only being used for their original purpose is to enforce a strict policy of not losing track of a bike by charging the last user with a missing or stolen bicycle price. With this being enforced, it will make the customer keep track and check in the bicycles at all times.

With the discussion on what makes a BikeShare successful, a business model is an excellent way to spread awareness and a great way to have possible clients purchase or have a stake in the company. Don Debelak talks about how a business model is a

way to get potential clients who can have high stakes and invest in a company. A business model is a way to show why this is a unique solution and explain the plan of how it could be manufactured (Debelak, 2007)

This project is essentially a business model that could be proposed to the city of San Luis Obispo, Cal Poly, or any other cities around the area. This project and report entails what is necessary to have this BikeShare program be successful and make profit within a small window from the initial start. Customer satisfaction is a main key to get anything to start; without it, the pitch will end and the whole thing has to be started over again. With a business model, it can be proposed to any customer and show why the customer or client should be a part of this and potentially invest in the company.

From initial research and basic knowledge, the BikeShare program will cost a lot to fund regardless of which alternative is selected. The State Energy Program is a new program through the government that helps fund any program that helps provide a clean and alternative solution to the world. Their main focus is the reduction of fuel dependency and anything to help provide a greener world (Energy.gov 2012).

Reaching out towards the SEP would help fund the project and would be a great way to help kick start this is if it were to be actually implemented to the campus. The SEP would also help give advice on what to do since they have a lot of experience working with alternative solutions and could help provide guidance to where this project would go.

Design

Project Scope

The scope of this project is to develop a business plan for possible ways to provide transportation to students on campus. This plan will analyze the possible costs of the vehicles, any devices that will be involved, and/or any fees that will be charged to the user.

Objectives:

1. Develop several BikeShare models that would appeal to our target market and are cost effective.
2. Develop a Business Plan.
3. Predict performance through the use of Simio using research and data collected.
4. Report statistical analysis of findings.
5. Give recommendation based on which model proves best.

Alternative Solutions

From the literature reviews and further research, the tools necessary to be able to determine what was necessary to run a successful BikeShare program were drawn and stated. From this research, four alternative models for a BikeShare program in SLO were thought out. All of them share the same fundamental concept that the default BikeShare program has, however, pricing, accessibility, and usership differ from model to model.

One of the alternatives that was discussed was having a default BikeShare program implemented at Cal Poly. The initial cost for a default BikeShare program would be large due to the amount of parking hubs and space that is needed for the default model to be fully functioning.

An example of how the default BikeShare systems payback their costs would be to charge the customers a yearly fee of $100 and to charge one-time users $10 per day.

The yearly fee would go towards usage of the bikes at any time. It would be convenient for any customer because of the initial payment, and if the customer is an active bike user, it would pay for itself within ten uses. Having this model would be very convenient to base this project off of, but it would be very difficult due to the price and the possibility of having the bikes be unidirectional. A reason why the bikes might be unidirectional is because a majority of residents of SLO would be using the bikes to get to work and use some other mode of transportation to get back instead of taking the original bike to go back. Since the hubs only have so much capacity, the hubs would overflow and there wouldn't be enough space to store the bikes.

The cost to buy a stock BikeShare hub would be expensive. For an initial payment, it would cost about $47,500 per station. With an average hub only holding around twenty bikes, it would be very expensive to provide for twenty thousand students this form of BikeShare. This isn't the only amount of money that would go into it as well. There are more variables to be worried about to make sure that they are always being maintained and operating at one hundred percent at all times. One of these worries, is the payment hub. The payment hub will always have to be working under any weather condition just so the customer can have easy access to a bike. The weather in San Luis is not as brutal as other places in the world, but there is still a chance of rain and possibly shorting out the hub. The costs to maintain the hub is unknown since it depends on how often the hub breaks down but it is still something to consider.

Other costs that would have to be considered in the default BikeShare system are:

Operational Costs

- Program Administration Salaries and Benefits
- Insurance
- Internet and Phone Service
- Postage and Printing for New Subscriber Packages and Annual Mailing
- Ongoing Promotions Annual Budget
- Software License and Back-End Operation

- Customer Service Help Desk
- Credit Card Processing Fees
- Wireless Communication between Locking Stations
- Hosting Services
- System Operating Cards
- Misc. Supplies and Expenses

Maintenance Costs

- Full-Time Bike Mechanics
- Electronics Technician(s)
- Contractor Overhead, if applicable
- Bicycle Parts
- Locking Station Batteries
- Other Locking Station Parts
- Communications (Cellular)
- Vehicle Maintenance

Replacement Because of Theft and Major Vandalism (Requiring Replacement)

- Bicycle Theft and Major Vandalism Replacements
- Locking Station Replacements

These costs are used in our FAC calculations and the calculated price per bike. Since the other models do not require all of the costs listed above, the price per bike and calculated FAC is less for the other models.

Another alternative that has been in consideration is to have a BikeShare program but with a mobile lock. The mobile lock, will allow the bikes to be locked anywhere at any time. This kind of system would eliminate the need for hubs and would eliminate the overflow at one area. To keep track of where the bikes would be, an RFID chip would be implemented on the locks and the location would be accessed through a designed phone application that can locate any and all of the bikes. Since normal locks are

separate from the actual bike, there is a concern of having the bikes being stolen. A way to counter-act this is to have the locks be physically attached to the bikes so that there is no separation between the lock and bike.

A previous Cal Poly student, Nick Schmidt, also worked on a BikeShare alternative and created the remote bike locking system. After talking to him and looking at the remote bike lock, the costs to build a fully functioning lock would be $70.This locking system uses Arduino board technology and can be remotely unlocked through an app, which a paying BikeShare customer would have. With this alternative considered, it was included in the model.

After performing research, there is a new startup company that is producing bike locks which are connected to the user’s phone through an application. This company focuses on motion tracking and phone application. This type of lock will help accelerate the project as it will be able to track and lock all the bikes remotely. Due to the tracking capability of these new locks, a master computer will be able to locate all the bikes and locate them on an app that can be accessed by any paying user. The only take backs from this would be a high initial cost. Since this lock is from a start up company the costs would be very high. Also, there could be a major delay in lead time. Since it is only a concept and not fully developed, it is possible that the time needed to make the actual lock would take longer than expected and would not deliver on time.

One of the stakeholders, Billy Riggs, suggested implementing an honesty system with bikes. The honesty system is essentially a free-for-all with any of the bikes within the system with no available tracking of any of them. This goes off of the theory that if something is free and available for use, the object will not be stolen compared to something that is locked down and secured. The honesty system would be unreliable as there is no for-sure way to keep track of the bikes. Many of the bikes might be stolen and many purchases might need to be made in order to keep the number of bikes in circulation constant. This would increase the cost to keep the customers satisfied with

bikes being available for use, however, this could be an alternative since it could reduce the amount needed for initial investment.

To see which would be the best alternative to use, an analytic hierarchy process was used to analyze the best alternative. There were two approaches to the AHP, one from a customer standpoint and one from a business point of view. Within a survey, people were asked to rank three topics with their view on the importance of the topics. The topics were reliability, costs, and convince. The AHP for the customer can be seen in appendix D. From the results, the customer valued the stock BikeShare system and both locking mechanisms fairly closely. With this close ranking, this alone cannot be used in determining which alternative to use. However, from a business point of view and how it would be received in the market, the results turned out differently. In Appendix E, it shows that the second alternative (the mobile electronic lock) ranked the highest by a considerable amount from the business' point of view. Some of the factors that were different in the business AHP than the customer AHP was the amount of cost and how reliable the system was compared to the other two. With the AHP results, the second alternative was taken into consideration and modeled into the program.

Business Model

Basing this project as a business model, the key partners are Cal Poly students, San Luis Obispo cycleries, and university police department. The key suppliers are bike suppliers, RFID supplies, and anyone providing the bike locks. From the key partners, some of the things that are needed are financial support, maintenance, advertising, bikes, support, and decision making.

There are many key activities needed in the theoretical model so that the model can be actually implemented. One of the main concerns is the redistribution of the bikes. Some of the original concerns with other BikeShare programs are that the bikes are always distributed unevenly throughout the city. A way to solve for this would be to hire a redistributor to drive around the city of San Luis Obispo, locate the bikes, and redistribute the bikes into all the living areas and campus. An example of this would be

to have each destination have fifteen bikes so that everyone has an equal chance at any location to use them.

Some of the main resources to acquire partners would be financial support, maintenance, advising, and bikes to help propel the project. The key activities and ways to make sure that there will always be income are to develop subscriptions for yearly, weekly, and daily use. Another thing to keep in mind is the price of advertising BikeShare and make sure that everyone has knowledge of what BikeShare is and how it can help them.

The values that will be provided for the customer will be a use of an alternative mode of transportation that is inexpensive and easy to use. This would save the customer money on gas, parking permits, and would help maintain the value of their car or vehicle. It will also help the city of San Luis Obispo as it would help lower the bottleneck that occurs on their busses as many of their busses are over packed or some students are forced to take a separate bus as an alternative.

Some of the costs that need to be considered are the initial payments, maintenance costs of both the electronics and bikes, possible repurchase of bikes if they are too damaged to repair, the development of the app that the user will use, the locks needed to keep the bike safe, and any possible employees to redistribute the bikes if they are all located in one spot.

The bullets below show how much other BikeShares pay for their system and how to maintain it:

- Bay Area Bike Share
    - $9 per day
    - $22 for three days
    - $88 per year
- B-Cycle

    - $8 for day use
    - $20 for one week
    - $30 for one month
    - $80 per year
- Capital BikeShare
    - $7 per day
    - $15 for three days
    - $25 per month
    - $75 per year

These costs are relatively the same and do not differ much from other BikeShares researched. This data can be a base for what this project can be modelled after.

Methods

A survey was conducted to obtain the data necessary to add to the Simio models. The results for the survey can be seen within appendix G. In the survey, the question was asked of how much a user was willing to pay for a BikeShare system. On average, students were willing to pay $5 per year for the use of a BikeShare. This number was used as the cap in calculating how many bikes should be added. A simulation was used to model the current state of the system and then a second model was used to model the proposed implementation of BikeShare. From the models, experiments were run to obtain data from the sample taken and statistical analysis performed on the data.

Simio Model

The logical model that was designed had a much broader scope than the final model built on Simio. It encompassed seven of the main student apartments (on and off campus) and the Cal Poly campus itself. Each apartment and Cal Poly's campus was represented by a server.

There were no sources or sinks used in the model since the model being analyzed cycles students in between apartments and campus continually rather than processing them only once and then the students leaving the system. The system itself was the apartments and Cal Poly with students traveling back and forth from one to the other and then back again. The student was thus represented by an entity which was placed in the system as the simulation run was initialized. Three transporters represented bikes, cars, and busses. Each transporter was assigned to its own node which was also the parking station for the transporters assigned to that node. The output nodes at each server contained the routing logic specifying which outbound link to take. The logic used in determining which link to take was determined from the data collected shown in appendix G and appendix I. An initial model was created as the system currently is, and a proposed model was created as the system would be with a BikeShare system. Once the logical model was completed, the information was then inputted into Simio. After trying to complete the model with all the apartments listed in the logical model, it was decided that the Simio model should be scaled back to represent a single apartment

and Cal Poly's campus. This one apartment was a representation of a certain percentage of Cal Poly's student population and could then be extrapolated to represent other apartment complexes. Once the model was thus simplified, more variables were added in order to add more depth to the simulation.

From the data collected, probabilities and percentages were calculated for how many transporters were needed, and how often each mode of transportation was used. These were used in the processing logic for which paths were taken in between nodes. For instance, 53% of students responded that they walked in the survey conducted. Therefore, there was a probability of .53 that the entity choose the path corresponding to walking in the output node in the initial model. Some of the differences between the initial model and the proposed model were that in the proposed model, a student did not necessarily have to bike back to their apartment if they biked to campus, and there was an increase in the amount of students who chose to bike over other modes of transportation. The paths in between nodes represent how long it takes for a student to travel from one node to the next. Similarly, the time students spent on campus or at their apartment was modeled by the time in the server. This is calculated by inputting the distribution which best fit the data for that path or server. One mode of transportation was the public bus system. In the city of San Luis Obispo, the bus comes in thirty minute intervals between the hours of 6:30am and 8:00pm. The bus stop was modeled as a node and had a queue of students that would wait for the bus to take them to campus. The path that the bus travelled on was a TimePath and the time it took for the bus to arrive on campus was measured from the data collected. For example, times that students rode on a bus for to get to campus followed an exponential distribution with a mean of 6.3 minutes. Likewise, times that students were at their houses/apartments for followed a normal distribution with a mean of 4.2 hours with a standard deviation of 0.9 hours. All of these times inputted into the servers and paths between servers produced a fairly accurate representation of processing times at Cal Poly and home, travel times for various modes of transportation, and the utilization of these various modes of transportation.

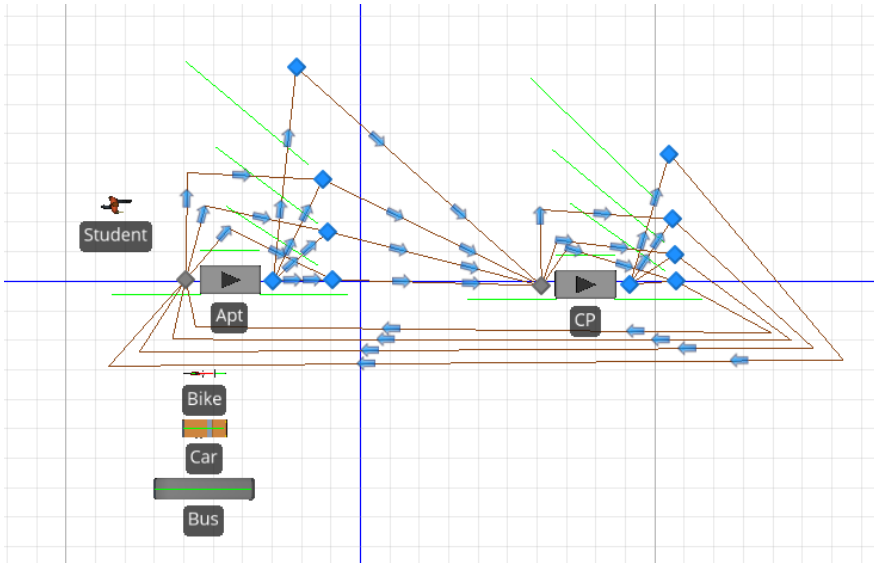

Figure 1 – First Simio Model

From the models, experiments were conducted in order to find the optimal number of bikes that should be added to the system. These experiments were also used to justify the investment required for the BikeShare system. One experiment ran the simulation for 30 replications with the amount of bikes in the system starting at two and increasing by one up to eight. The other experiment ran the simulation for 30 replications with the amount of bikes in the system starting at 100 and increasing by 100 up to 600. The purpose of the first run was to show that the number of bikes proposed would be utilized more than any of the options for bikes lower than that number. In other words, the utilization kept increasing from three bikes, to four bikes, to five bikes, and so on. The purpose of the second run was to show that on a larger scale, the utilization would keep increasing as well up to in between 300 and 400 bikes. This makes sense since the probability that a user choose to use a bike is 74%, which with a simulation of 500 students is 370. This shows that the optimal number of bikes to add to the system in order to maximize utilization is between 300 and 400 bikes for a sample of 500 students. Because of the cost limitations, the initial amount of bikes to be added to the system should be restrained to 5 bikes for 500 students. The sample of 500 students represents approximately 2.5% of the student population at Cal Poly, assuming there are about 20,000 students. Because of the complexity of the system, the decision made

to model only one apartment complex, and the limitations of Simio, the number of 500 students was chosen to represent the entire student population. Therefore, extrapolated out, the results indicate that 200 bikes should be put in the system for 20,000 students.

Figure 2 – Final Simio model

Results

From the experiment, the mean and confidence intervals for the seven different situations were found and put up against each other in Simio. Figure 3 below shows the data for small incremental changes between the bikes put within the system. A difference of means test was implemented between a set of two situations to see if there would be a significant difference if there were more bikes added to the system. To see if there was any significance between adding the different populations of bikes, there had to be a crossover between the confidence intervals of the different situations. A null hypothesis was inferred saying that there would be no difference between the two populations; the alternative hypothesis said otherwise.

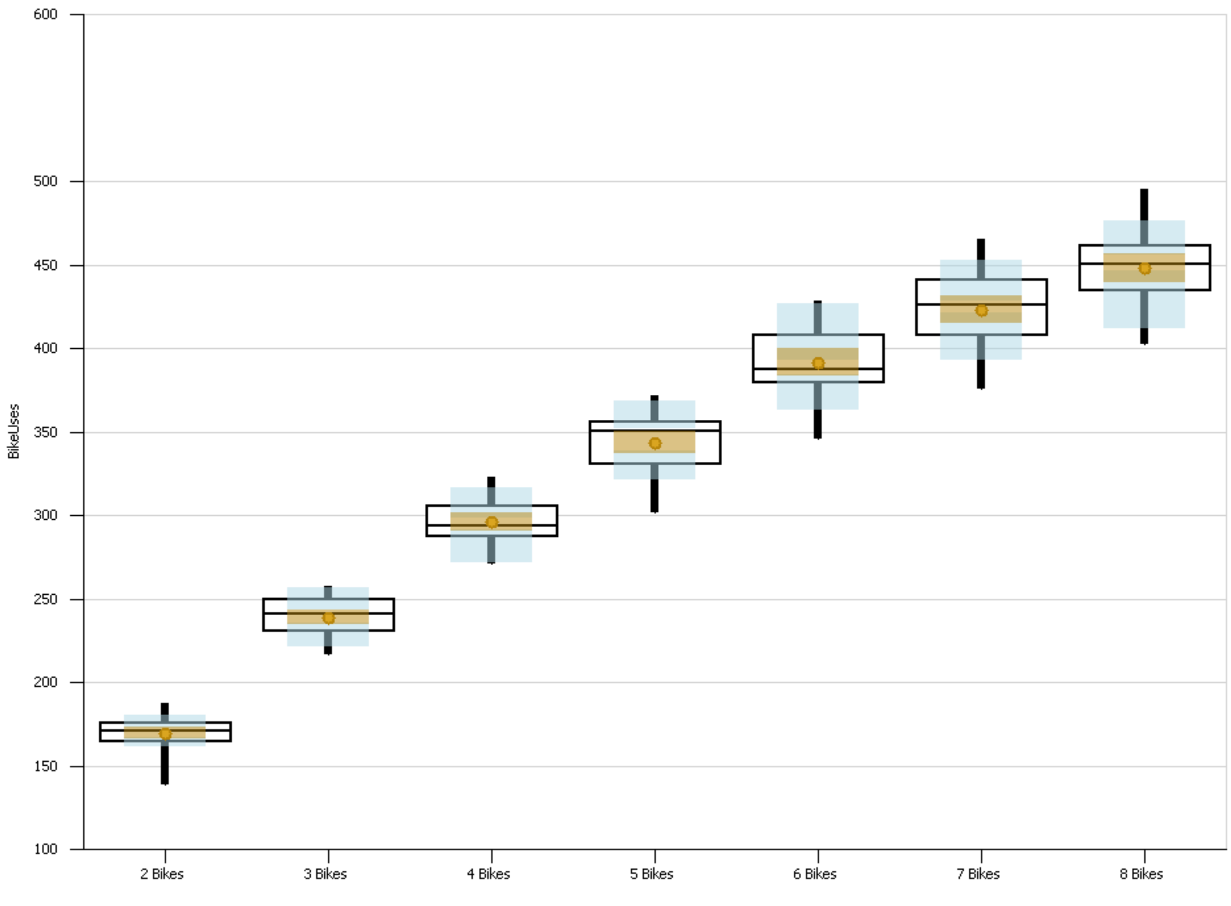

Figure 3 – Simio Measure of Risk & Error Plot for initial bikes

The first two situations to be analyzed were “3 bikes” and “4 bikes.” The confidence intervals for “3 bikes” was from 234.73 bike uses to 243.74 uses with ninety-five percent

confidence. For “4 bikes” yielded a ninety-five percent confidence interval between 290.81 and 301.79 bike uses.

H_0: $\mu_{3\text{ bikes}} = \mu_{4\text{ bikes}}$

H_a: $\mu_{3\text{ bikes}}$ <> $\mu_{4\text{ bikes}}$

x_1= 239.23

x_2= 296.3

Half-Width - $Z * (\frac{s}{\sqrt{n}})$ = 4.50

$\mu_{3\text{ bikes}}$ CI at 95% confidence = (234.73, 243.74)

$\mu_{4\text{ bikes}}$ CI at 95% confidence = (290.81, 301.79)

Since the upper bound of $\mu_{3\text{ bikes}}$ is less than the lower bound of $\mu_{4\text{ bikes}}$, it can be concluded that there is a significant statistical difference between the means, therefore, the null hypothesis should be rejected.

This test was used in a similar fashion by increments of one and the confidence intervals of each were compared with each other to see whether or not to reject or fail to reject the null hypothesis. Like the comparison beforehand, there was no crossover between the confidence intervals of any two. When “4 bikes” was compared to “5 bikes,” the upper confidence interval of “4 bikes” was 301.79 and the lower confidence interval for “5 bikes” was 350.60 uses. This situation also happened when the lower confidence interval for “6 bikes” and the upper interval for “5 bikes” did not cross as well. This trend continued for each scenario that was tested and the null hypothesis was rejected each time. This shows that there is a significant statistical difference when adding more bikes to the system. The number of bikes needed to be within the system in order to fail to reject the null hypothesis was unknown. In order to see how many bikes are needed to be implemented in order for this to happen, another experiment was done in Simio. Figure 4 below shows where the number of times a bike is used in the system to a greater extent than the previous model. Like before, a difference of means tests was created to see if there is any statistical significance between two compared situations.

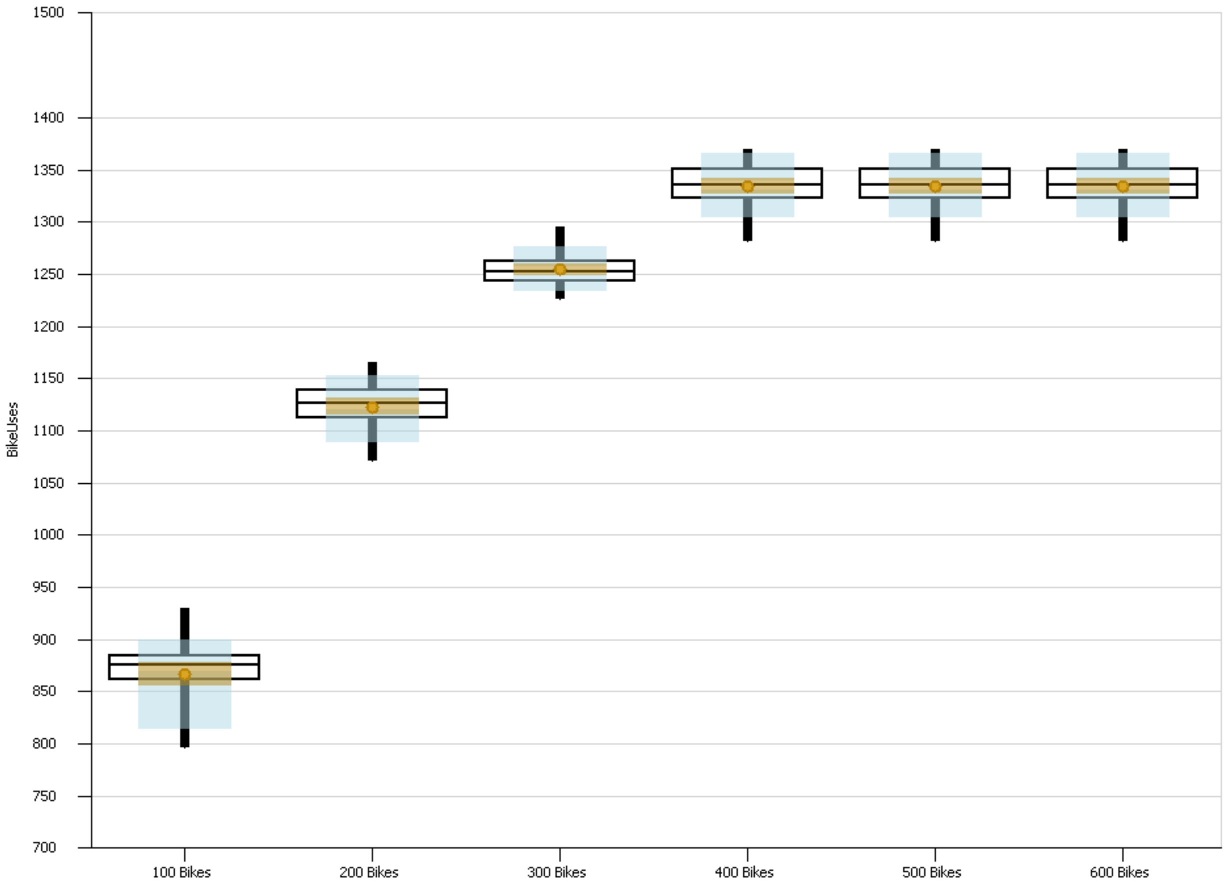

Figure 4 - Simio Measure of Risk & Error Plot for greater number of bikes

From figure 4, it can be implied that the confidence intervals for “100 bikes,” “200 bikes,” and “300 bikes” show no crossover at all. From this, the null hypothesis can be rejected on all accounts of comparison between all three situations. Even though there are drastic changes between the first three scenarios, it changes drastically when four hundred or any more bikes are put into the simulation. Like the previous model and differences of means tests, the means for two compared models must be equal in order for there to be a failure to reject the null hypothesis and a rejection if otherwise. When comparing “400 bikes” to “500 bikes” the means for both scenarios showed a value of 1,334.4 uses with confidence intervals of 1326.63 and 1342.17 uses. This means that there is not enough evidence to reject the null hypothesis.

Conclusion

From what the students are willing to pay for a BikeShare system and from what could be purchased with that cost, two hundred bikes is the amount that can be purchased and that could help maintain sustainability. The cost of the remote BikeShare system is $478. $95,600 would be needed to afford the initial costs for the bikes and this would be covered by the students within their tuition payments.

Figure 4 shows that two hundred bikes isn't the most efficient alternative out of the number of combinations of bikes to have in the system. For an initial run, two hundred bikes will be able to satisfy the student population but there is always room for improvement. If the BikeShare system does continue on, then more bikes could be purchased to help satisfy the rest of the student population that still want to participate in using the BikeShare system. However, there is a limit to how many bikes would be needed to be purchased. The second experiment mentioned in the "Results" section shows that between 12,000 and 16,000 would be optimal to satisfy the students who would use the BikeShare system out of the twenty thousand students.

There are many ways to decrease the initial costs of this remote BikeShare system. One obvious way to lower the initial costs is to ask for donations from the students or Cal Poly alumni. With simple donations it could lower the cost by a small amount, but if the outcome can be presented to them showing why and how a BikeShare program would greatly benefit Cal Poly, then the possibility of raising the donation amount or amount of donations would go up. Another way to raise money would be through government grants. The State Energy Program provides grants to any school or program that endorses clean and alternative solutions that would provide a better good for the world. Talking to the SEP and asking for grants to help fund this project would greatly reduce the initial costs and could possibly help fund the program later on in the project wants to expand.

This is, however, just an estimation of how many students would actually use the program. In the actual implementation, there could be discrepancies that could occur.

The Simio model shows the perfect conditions for every time, every day. Of course, that is not how events occur in the real world, but in order to prevent possible bankruptcy like other BikeShare systems, it would be best if a small number of bikes were put into the student population and then slowly increase the numbers once real life data has been taken and analyzed.

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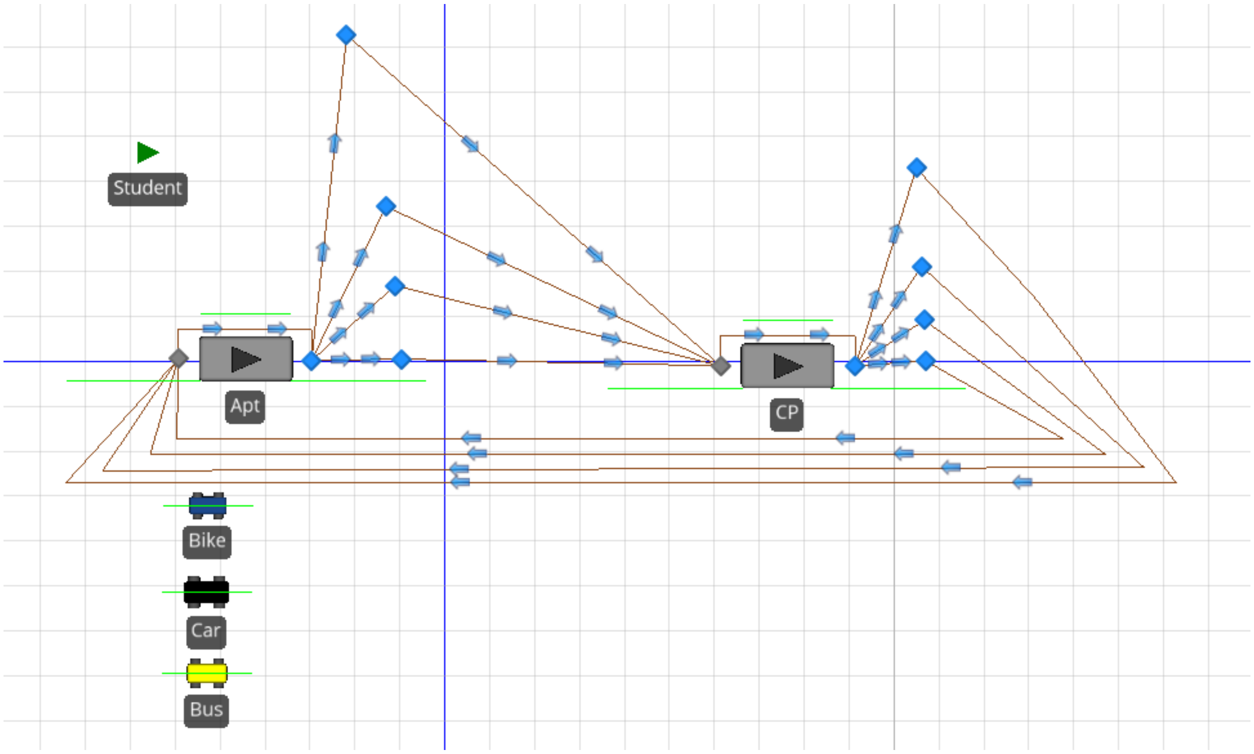
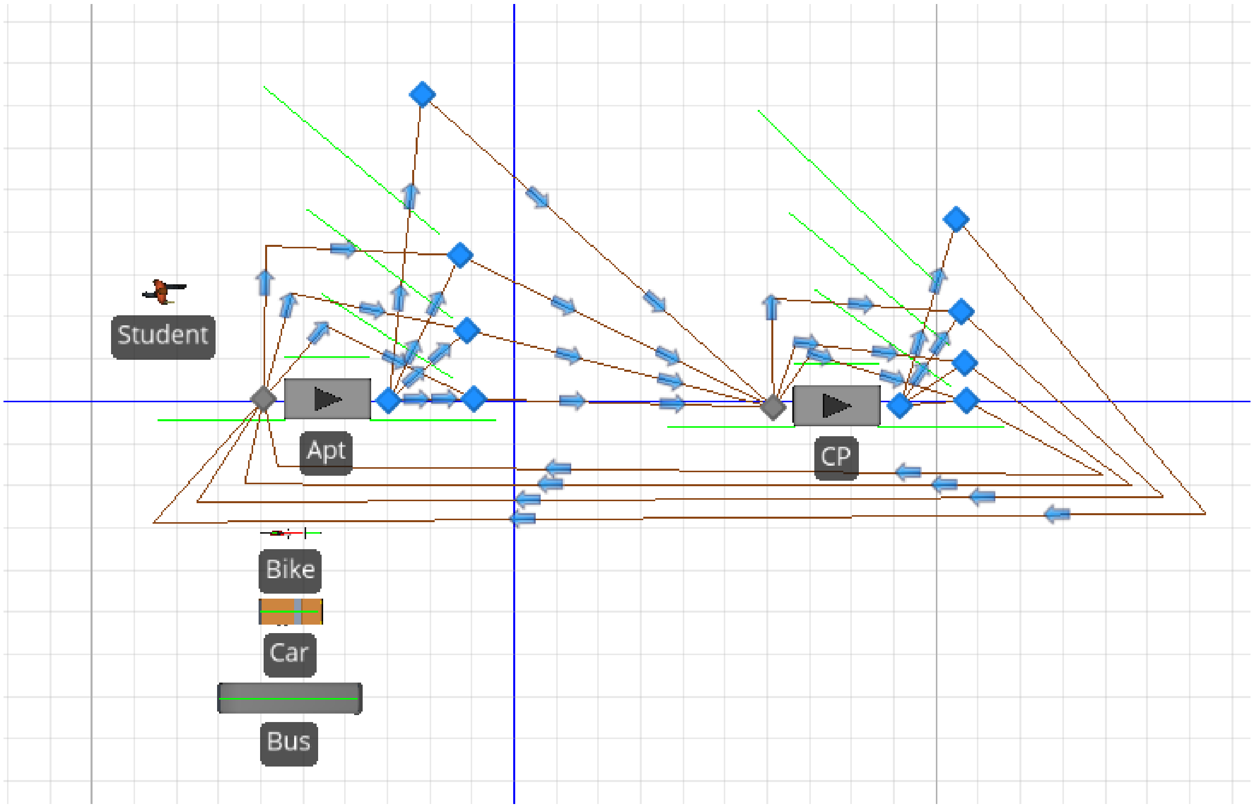
<u>Appendix</u>

Appendix A: Logical Model



Appendix B: Simple Simio Model No Bike Share



Appendix C: City vs Campus

City

Pros	Cons
• Wider audience • Work with public instead of student • Higher income rate • Reducing public gas emissions • Increase knowledge in bike safety/awareness	• High probability of stolen bicycles • Too many units to keep track off • High recycle turnover • Larger initial payment • High probability of users being injured or hurt due to age or misusage

Campus

Pros	Cons
• Free to students (covered in tuition) • More freedom for students to leave campus • Possibility of higher class attendance • Higher usage within students • Increase knowledge in bike safety/awareness	• Limited area • No possibility of income • Possibility of user injury due to lack of knowledge of bike safety • High chance of "one-way" usage • High possibility of unsustainability

Appendix D: AHP for Bike Share (Customers)

Cost	1	2	3	4
1	1.000	0.333	0.500	4.000
2	3.000	1.000	3.000	2.000
3	2.000	0.333	1.000	3.000
4	0.250	0.500	0.333	1.000
	6.250	2.167	4.833	10.000

Cost	1	2	3	4	
1	0.160	0.154	0.103	0.400	0.204
2	0.480	0.462	0.621	0.200	0.441
3	0.320	0.154	0.207	0.300	0.245
4	0.040	0.231	0.069	0.100	0.110
					1

Convenience	1	2	3	4
1	1.000	2.000	0.500	4.000
2	0.500	1.000	0.250	2.000
3	2.000	4.000	1.000	3.000
4	0.250	0.500	0.333	1.000
	3.750	7.500	2.083	10.000

Convenience	1	2	3	4	
1	0.267	0.267	0.240	0.400	0.293
2	0.133	0.133	0.120	0.200	0.147
3	0.533	0.533	0.480	0.300	0.462
4	0.067	0.067	0.160	0.100	0.098
					1

Reliability	1	2	3	4
1	1.000	0.500	3.000	0.250
2	2.000	1.000	2.000	3.000
3	0.333	0.500	1.000	5.000
4	4.000	0.333	0.200	1.000
	7.333	2.333	6.200	9.250

Reliability	1	2	3	4	
1	0.136	0.214	0.484	0.027	0.215
2	0.273	0.429	0.323	0.324	0.337
3	0.045	0.214	0.161	0.541	0.240
4	0.545	0.143	0.032	0.108	0.207
					1

Alternatives	Cost	Conv	Reliab
1	0.204	0.293	0.215
2	0.441	0.147	0.337
3	0.245	0.462	0.240
4	0.110	0.098	0.207

Criteria	Cost	Conv	Reliab
Cost	1.000	2.000	3.000
Conv	0.500	1.000	2.000
Reliab	0.333	0.500	1.000
	1.833	3.500	6.000

Criteria	Cost	Conv	Reliab	
Cost	0.545	0.571	0.500	0.539
Conv	0.273	0.286	0.333	0.297
Reliab	0.182	0.143	0.167	0.164
	1	1	1	1

Ranks	
1	0.233
2	0.336
3	0.309
4	0.122
	1

Appendix E: AHP for BikeShare (Business)

Cost	1	2	3	4
1	1.000	0.500	0.250	4.000
2	2.000	1.000	4.000	3.000
3	4.000	0.250	1.000	3.000
4	0.250	0.333	0.333	1.000
	7.250	2.083	5.583	11.000

Cost	1	2	3	4	
1	0.138	0.240	0.045	0.364	0.197
2	0.276	0.480	0.716	0.273	0.436
3	0.552	0.120	0.179	0.273	0.281
4	0.034	0.160	0.060	0.091	0.086
					1

Convenience	1	2	3	4
1	1.000	0.500	0.333	4.000
2	2.000	1.000	3.000	4.000
3	3.000	0.333	1.000	4.000
4	0.250	0.250	0.250	1.000
	6.250	2.083	4.583	13.000

Convenience	1	2	3	4	
1	0.160	0.240	0.073	0.308	0.195
2	0.320	0.480	0.655	0.308	0.441
3	0.480	0.160	0.218	0.308	0.291
4	0.040	0.120	0.055	0.077	0.073
					1

Reliability	1	2	3	4
1	1.000	0.333	4.000	2.000
2	3.000	1.000	2.000	4.000
3	0.250	0.500	1.000	3.000
4	0.500	0.250	0.333	1.000
	4.750	2.083	7.333	10.000

Reliability	1	2	3	4	
1	0.211	0.160	0.545	0.200	0.279
2	0.632	0.480	0.273	0.400	0.446
3	0.053	0.240	0.136	0.300	0.182
4	0.105	0.120	0.045	0.100	0.093
					1

Alternatives	Cost	Conv	Reliab
1	0.197	0.195	0.279
2	0.436	0.441	0.446
3	0.281	0.291	0.182
4	0.086	0.073	0.093

Criteria	Cost	Conv	Reliab
Cost	1.000	9.000	4.000
Conv	0.111	1.000	7.000
Reliab	0.250	0.143	1.000
	1.361	10.143	12.000

Criteria	Cost	Conv	Reliab	
Cost	0.735	0.887	0.333	0.652
Conv	0.082	0.099	0.583	0.255
Reliab	0.184	0.014	0.083	0.094
	1	1	1	1

Ranks	
1	0.204
2	0.438
3	0.274
4	0.083
	1

Appendix F: FAC for All BikeShare Alternatives

Alt # 1
Defaul BikeShare

Item	Cost	Quantity	Total Cost
Bike	$408	60	$24,480
Stations	$45,460	12	$545,520
			$570,000

Alt #2
Remote Lock

Item	Cost	Quantity	Total Cost
Bike	$408	200	$81,600
Ardiuno	$30	200	$6,000
Body	$20	200	$4,000
Labor	$20	200	$4,000
			$95,600

Alt #2.1
BitLock Alt

Item	Cost	Quantity	Total Cost
Bike	$408	200	$81,600
BitLock	$119	200	$23,800
			$105,400

Alt #3
Combo Lock

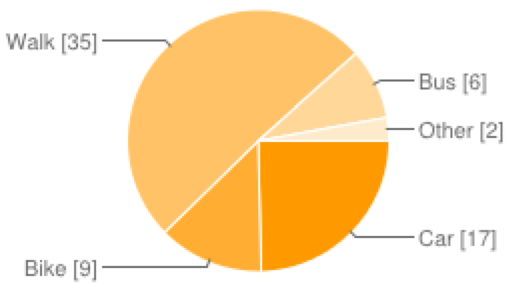
Item	Cost	Quantity	Total Cost
Bike	$408	200	$81,600
Lock	$20	200	$4,000
			$85,600

Alt #4
Honesty System

Item	Cost	Quantity	Total Cost
Bike	$408	200	$81,600
			$81,600

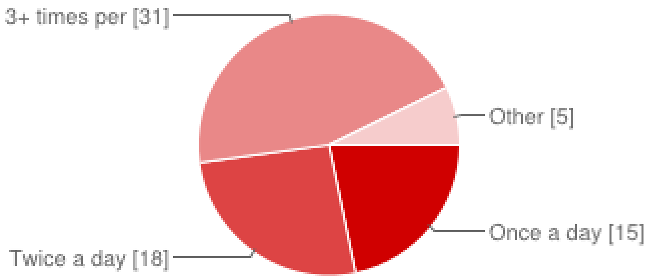
Appendix G: Survey Results from Students

How Do You Get To Campus



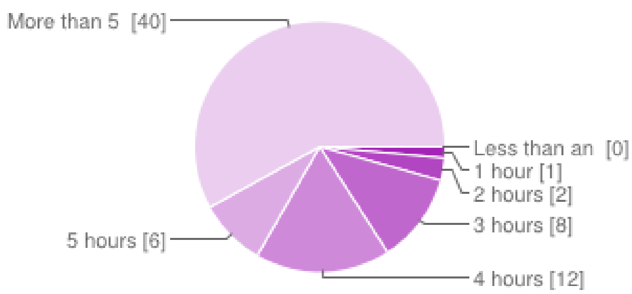
Car	**17**	25%
Bike	**9**	13%
Walk	**35**	51%
Bus	**6**	9%
Other	**2**	3%

How many times a day do you use this mode of transportation to get to campus?



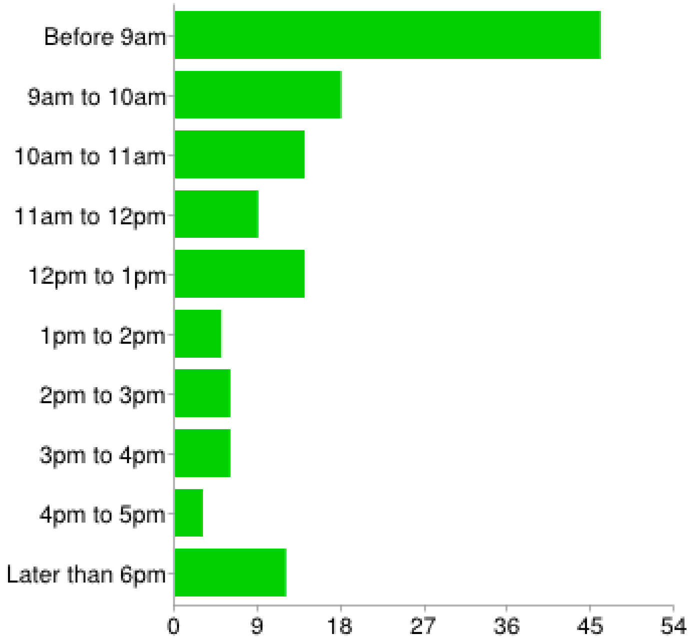
Once a day	**15**	22%
Twice a day	**18**	26%
3+ times per day	**31**	45%
Other	**5**	7%

How long do you stay on campus for?



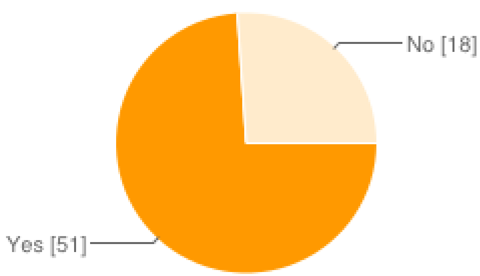
Less than an hour	**0**	0%
1 hour	**1**	1%
2 hours	**2**	3%
3 hours	**8**	12%
4 hours	**12**	17%
5 hours	**6**	9%
More than 5 hours	**40**	58%

What time do you get to campus?



Before 9am	**46**	67%
9am to 10am	**18**	26%
10am to 11am	**14**	20%
11am to 12pm	**9**	13%
12pm to 1pm	**14**	20%
1pm to 2pm	**5**	7%
2pm to 3pm	**6**	9%
3pm to 4pm	**6**	9%
4pm to 5pm	**3**	4%
Later than 6pm	**12**	17%

If you had the option to use a bike, would you use it to get to campus/home?



Yes	**51**	74%
No	**18**	26%

Appendix H: Full Business Model Canvas

The Business Model Canvas

Key Partners

Who are our Key Partners?

- Cal Poly students
- SLO residents
- SLO cycleries
- Downtown businesses
- Cal Poly
- SLO PD

Who are our key suppliers?

- Bike suppliers
- RFID suppliers
- Bike lock suppliers

Which Key Resources are we acquiring from partners?

- Financial support
- Maintenance
- Advertising
- Bikes

Which Key Activities do partners perform?

- Use of the bikeshare system
- Advertisements on the bikes
- Maintenance of the bikes

Key Activities

What Key Activities do our Value Propositions require?

- Redistribution of bikes

Our Distribution Channels?

- Paid employee truck driver

Customer Relationships?

-

Revenue streams?

- Subscriptions
- One time use
- Late fees
- Advertising
- Events

Key Resources

What Key Resources do our Value Propositions require?

- Start-up funding

- Grants
- Venture capitalists
- Donations

Customer Relationships?

- Interface with the app

Value Propositions

What value do we deliver to the customer?

- An alternative mode of transportation
- A sustainable alternative to driving or riding the bus

Which one of our customer's problems are we helping to solve?

- A mode of transportation for people who do not own or have access to a vehicle
- A mode of transportation for people who cannot afford a parking permit

What bundles of products and services are we offering to each Customer Segment?

- A bike and lock to those looking for transportation

Which customer needs are we satisfying?

- Quick transportation by eliminating having to wait in traffic and look for parking
- Convenience by not having to rely on the bus' schedule or other people for a ride

Customer Relationships

What type of relationship does each of our Customer Segments expect us to establish and maintain with them?

- Ease of use with the app
- Ease of use locking and unlocking the bike

Customer Segments

For whom are we creating value?

- Students
- People who are environmentally conscious and want a sustainable mode of transportation

Who are our most important customers?

- Cal Poly students

Channels

Through which Channels do our Customer Segments want to be reached?

- Technological means (phone/computer)

How are we reaching them now?

- app on phone

Which ones are most cost-efficient?

- app is free

Cost Structure

What are the most important costs inherent in our business model?

- Cost of the bikes
- Cost of the locks
- Wages paid to employees

Which Key Resources are most expensive?
- Bikes

Which Key Activities are most expensive?
- Redistribution of the bikes

Revenue Streams

For what value are our customers really willing to pay?
- (survey students and ask)

For what do they currently pay?
- Car
- Gas
- Bus (in tuition)
- Bike

How are they currently paying?
- Parental financial support
- Loans
- Salary from job

How would they prefer to pay?
- (survey, presumably through their phone)

BikeShare Costs
- Average cost = $200 per bike if purchased online
  - Auctioned bike
- Locking System
  - Arduino Board = $30
  - Body = $20
- Maintenance cost = $130 per year
- Bay Area Bike Share
  - $9 per day
  - $22 for three days
  - $88 per year
- B-Cycle
  - $8 for day use
  - $20 for one week
  - $30 for one month
  - $80 per year
- Capital BikeShare
  - $7 per day
  - $15 for three days
  - $25 per month
  - $75 per year

Appendix I: Chi Square Test for All Distributions

Auto::Fit of Distributions

distribution	rank	acceptance
Exponential(2., 3.)	0.	reject
Lognormal(2., 0.287, 1.28)	0.	reject
Triangular(2., 14.2, 2.31)	0.	reject
Uniform(2., 12.5)	0.	reject

Auto::Fit of Distributions

distribution	rank	acceptance
Exponential(7., 6.33)	100	do not reject
Triangular(7., 26.4, 7.)	24.2	reject
Lognormal(7., 1.19, 1.38)	12.3	reject
Uniform(7., 22.5)	0.	reject

Auto::Fit of Distributions

distribution	rank	acceptance
Lognormal(2., 1.55, 0.957)	0.	reject
Triangular(2., 17., 2.36)	0.	reject
Uniform(2., 12.5)	0.	reject

Auto::Fit of Distributions

distribution	rank	acceptance
Lognormal(1., 1.33, 0.418)	0.	reject
Triangular(0., 6.3, 5.77)	0.	reject
Uniform(1., 6.)	0.	reject

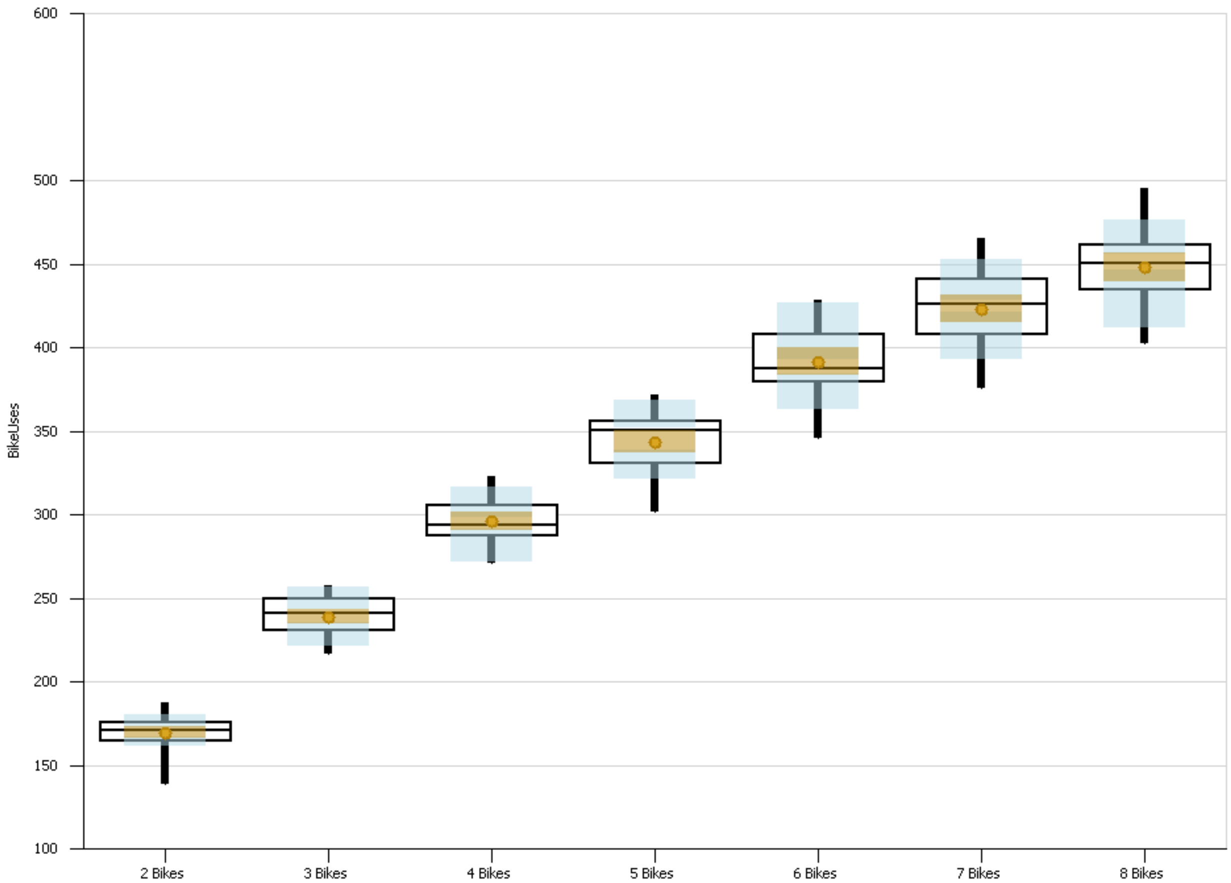
Auto::Fit of Distributions

distribution	rank	acceptance
Lognormal(2., 0.989, 1.42)	100	reject
Exponential(2., 5.66)	17.	reject
Triangular(2., 20.2, 2.)	0.965	reject
Uniform(2., 17.5)	0.	reject

Appendix J: Simio Results for Small Increments

Design | Response Results | Pivot Grid | Reports | Input Sensitivity

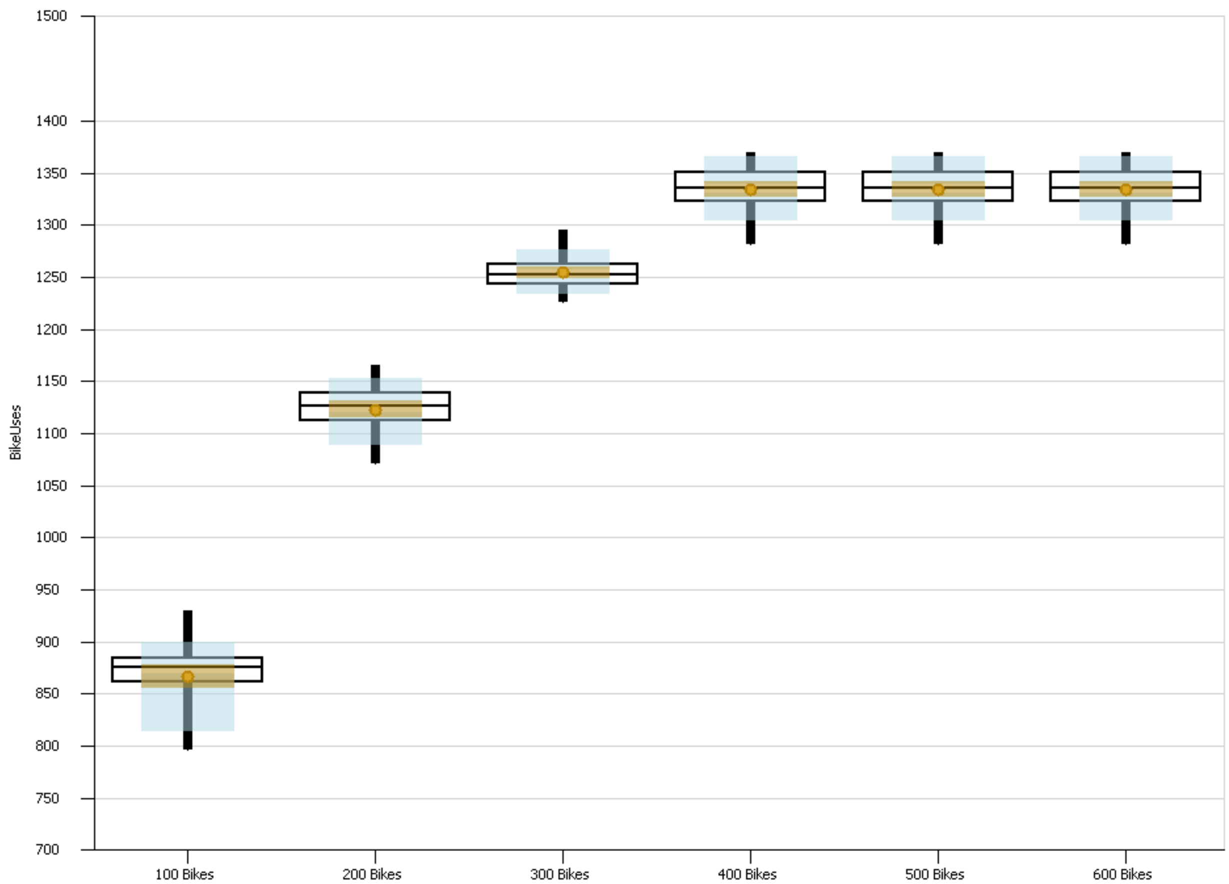
Scenario			Replications		Controls	Responses
☑	Name	Status	Required	Completed	InitialNumberBikeInSystem	BikeUses
☑	2 Bikes	Compl...	30	30 of 30	2	170.033
☑	3 Bikes	Compl...	30	30 of 30	3	239.233
☑	4 Bikes	Compl...	30	30 of 30	4	296.3
☑	5 Bikes	Compl...	30	30 of 30	5	343.9
☑	6 Bikes	Compl...	30	30 of 30	6	392.067
☑	7 Bikes	Compl...	30	30 of 30	7	423.5
☑	8 Bikes	Compl...	30	30 of 30	8	448.467



Appendix K: Simio Results for Large Increments

Design | Response Results | Pivot Grid | Reports | Input Sensitivity

Scenario			Replications		Controls	Responses
☑	Name	Status	Required	Completed	InitialNumberBikeInSystem	BikeUses
☑	100 Bikes	Idle	30	30 of 30	100	867.1
☑	200 Bikes	Idle	30	30 of 30	200	1123.17
☑	300 Bikes	Idle	30	30 of 30	300	1254.43
☑	400 Bikes	Idle	30	30 of 30	400	1334.4
☑	500 Bikes	Idle	30	30 of 30	500	1334.4
☑	600 Bikes	Idle	30	30 of 30	600	1334.4

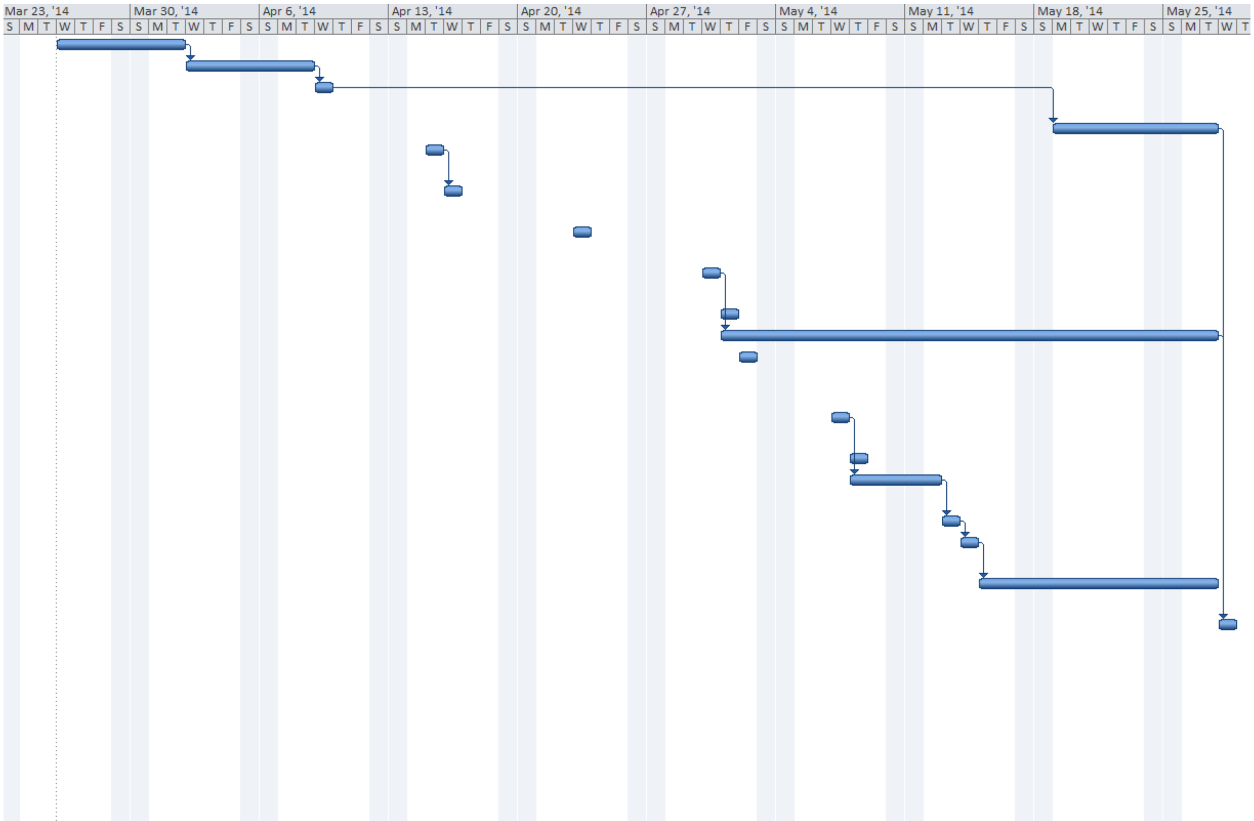


Appendix L: Final Simio Model

Appendix M: Work Breakdown Structure of IME 481 and IME 482

		Task Mode	Task Name	Duration	Start	Finish	Predecessors
1			Initial Research	5 days	Wed 3/26/14	Tue 4/1/14	
2			Project Proposal	5 days	Wed 4/2/14	Tue 4/8/14	1
3			Check In with Karen on Project	1 day	Wed 4/9/14	Wed 4/9/14	2
4			Lit Review	7 days	Mon 5/19/14	Tue 5/27/14	3
5			Meet with Kurt and Liz to switch classes	1 day	Tue 4/15/14	Tue 4/15/14	
6			Meet with Karen to switch classes	1 day	Wed 4/16/14	Wed 4/16/14	5
7			Present Project Proposal to Kurt and Liz	1 day	Wed 4/23/14	Wed 4/23/14	
8			Present Current Research to Kurt and Liz	1 day	Wed 4/30/14	Wed 4/30/14	
9			Contact Billy Riggs	1 day	Thu 5/1/14	Thu 5/1/14	
10			Start Business Model	19 days	Thu 5/1/14	Tue 5/27/14	8
11			Meet With Eric Burgus To Talk About Bike Share Model	1 day	Fri 5/2/14	Fri 5/2/14	
12			Present Possible BikeSharing Systems	1 day	Wed 5/7/14	Wed 5/7/14	
13			Meet With Billy Riggs	1 day	Thu 5/8/14	Thu 5/8/14	
14			Narrow Down Possible Choices	3 days	Thu 5/8/14	Mon 5/12/14	12
15			Select One Alternative	1 day	Tue 5/13/14	Tue 5/13/14	14
16			Present Model to Kurt and Liz	1 day	Wed 5/14/14	Wed 5/14/14	15
17			Work On Final 481 Report	9 days	Thu 5/15/14	Tue 5/27/14	16
18			Turn In IME 481 to Kurt and Liz	1 day?	Wed 5/28/14	Wed 5/28/14	4,10
19			Research Over Basic Bike Models	73 days	Mon 6/16/14	Wed 9/24/14	
20			Meet With Roya on 482	1 day	Wed 9/24/14	Wed 9/24/14	
21			Email Kurt And Liz to Switch Classes	1 day	Thu 9/25/14	Thu 9/25/14	20
22			Attend Kurt and Liz's 471 Class and Present Proposal	1 day	Wed 10/1/14	Wed 10/1/14	

22			Attend Kurt and Liz's 471 Class and Present Proposal	1 day	Wed 10/1/14	Wed 10/1/14	
23			Continue Lit Review and Create Cost Breakdown Structure	1 day	Wed 10/8/14	Wed 10/8/14	22
24			Present Findings To Kurt	1 day	Thu 10/9/14	Thu 10/9/14	23
25			Research Liability Waivers	5 days	Fri 10/10/14	Thu 10/16/14	24
26			Contact UPD	5 days	Fri 10/10/14	Thu 10/16/14	24
27			Present Research To Kurt	1 day	Fri 10/17/14	Fri 10/17/14	26,25
28			Start Rough Draft of Final Report	10 days	Mon 10/20/14	Fri 10/31/14	27
29			Start Logical Model	9 days	Mon 10/27/14	Thu 11/6/14	
30			Take Exit Exam	1 day	Wed 11/5/14	Wed 11/5/14	
31			Submit Logical Model	1 day	Fri 11/7/14	Fri 11/7/14	29
32			Start Simio Model	17 days	Mon 11/10/14	Tue 12/2/14	31
33			Finish Final Draft of Report	22 days	Mon 11/3/14	Tue 12/2/14	28
34			Submit Rough Draft To Kurt	1 day	Fri 11/21/14	Fri 11/21/14	
35			Submit Video To IAB	1 day?	Fri 11/21/14	Fri 11/21/14	
36			Submit Final Report	1 day	Wed 12/3/14	Wed 12/3/14	29,31
37			Present To IAB	1 day	Thu 12/4/14	Thu 12/4/14	36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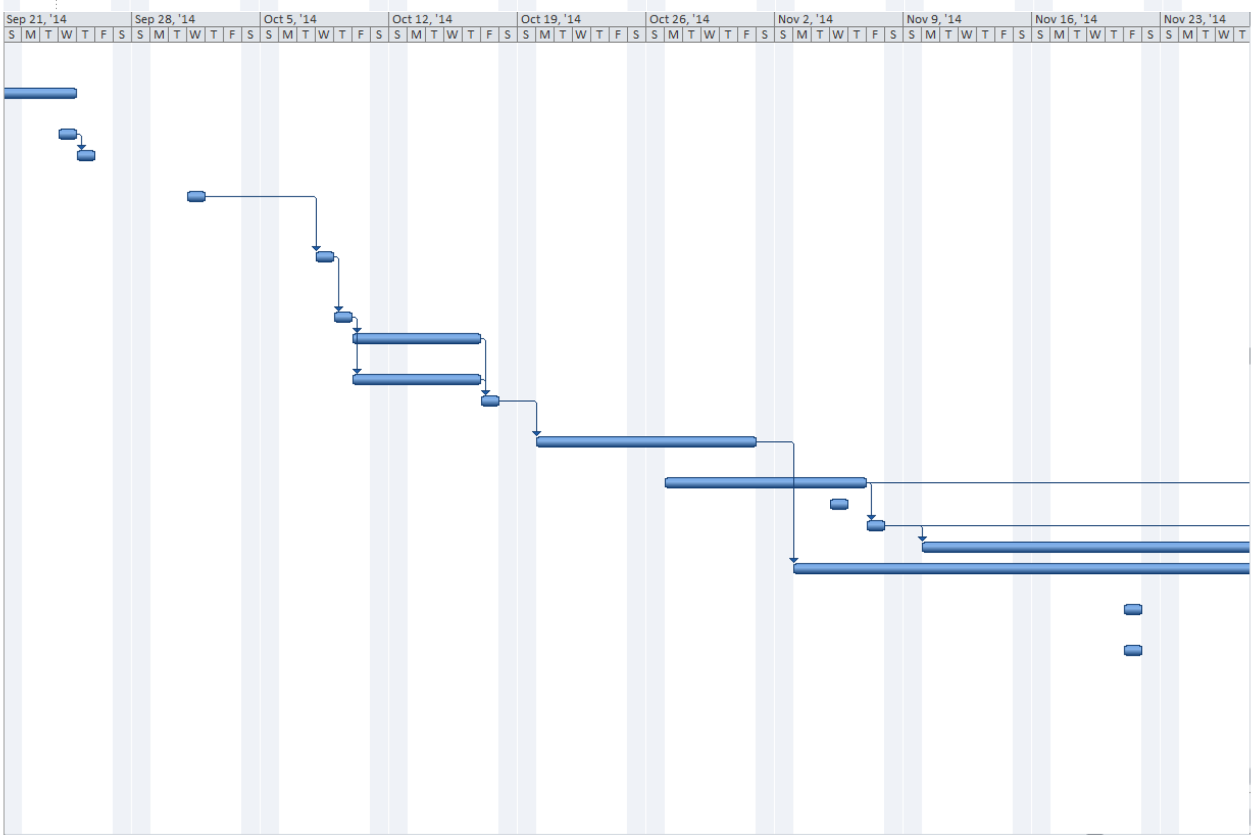
May 25, '14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Nov 2, '14
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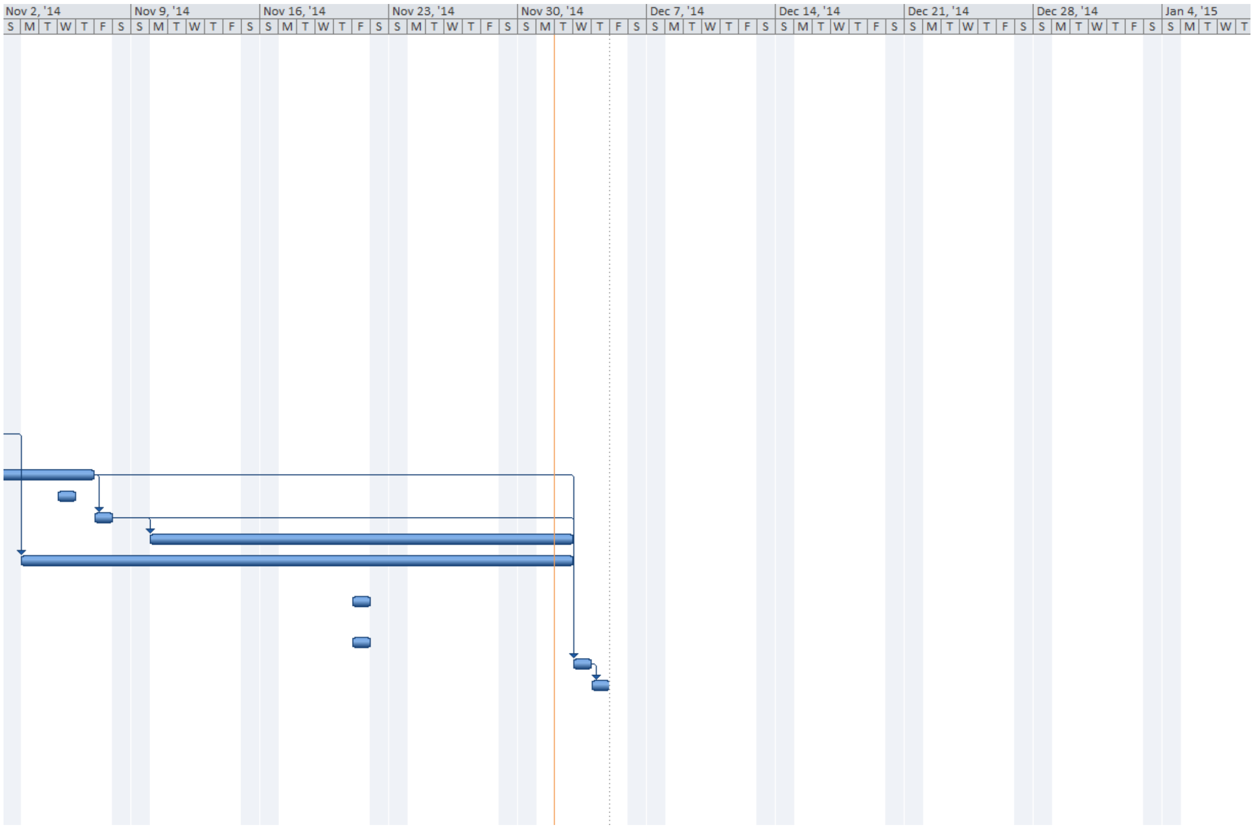
Nov 23, '14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Jan 4, '15