Implementation of a Campus Bike Sharing Program for Washington University’s Danforth Campus

Hitherto, bike sharing programs have not focused on the college campus where students seek flexible biking options. A bike sharing program with 13 stations would cost approximately $425,000-$475,000 over the first three years. The operating costs would be covered by the revenue. Benefits include reaching a wide population of students, providing faster on-campus travel, requiring fewer bikes on campus, offering more part-time on-campus jobs, and taking a visible and tangible step towards a greener and healthier campus. These benefits outweigh the costs. It is recommended that Washington University implement a bike sharing program.

By: Ashish Heda, Engineering Consultant at GBA Architects Engineers
For: Washington University Parking and Transportation Services
12/7/2012
Note that this report was made for learning purposes on how to write formal reports. Many of the sources, numbers, and graphs were simulated and this report should not be used in real consideration of a bike sharing program on the Washington University Danforth Campus.
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TO:     Washington University Parking and Transportation Services

DATE:    December 7, 2012

CC:       Jim Ballard, M.A.
Director of Engineering Communications
Washington University, Urbauer Hall, Room 104
St. Louis, MO

SUBJECT:  Implementation of a Bike Sharing Program for Washington University's Danforth Campus

FOR:       [ X ] Action        [ ] Decision        [ ] Information

Enclosed is a detailed cost-benefit analysis for implementing and operating a bike sharing program on the Washington University Danforth Campus. A bike sharing program is very similar to the WeCar car rental program, but utilizes bikes instead of cars. According to the Washington University Residential Life office, nearly 60% of students who do not ride bikes would ride a bike if the costs reflected their desired usage, and if concerns over safety and maintenance were reduced. Bike sharing programs would meet these requests but have not focused on the university or college campus.

This analysis covers the costs involved in implementing a bike sharing program, and discusses what features can be modified or removed for a university campus. These changes were made based on student survey data, acquired with the help of the Residential Life office. This data was used to determine the number and location of bike stations and the number of bikes required. It was found that the 13 bike stations and 350-400 bikes needed for Washington University Danforth Campus would cost $425,000-$475,000 over a span of three years. After three years, the program would be self-sustaining.

It is recommended that Washington University invest in this program due to the many benefits, which include reaching a wider population of students (as opposed to current on-campus bike rental programs), providing faster on-campus travel, requiring fewer bikes on campus, offering more part-time on-campus jobs, and taking a visible and tangible step towards a greener and healthier campus.

Please contact me at (314) 231-0100 or via email at aheda@gba.com for further inquiries.

Ashish Heda

Engineering Consultant
Transportation Division
GBA Architects Engineers
St. Louis, MO
Executive Summary

According to the Washington University Residential Life office, nearly 60% of students who do not ride bikes would ride a bike if the costs met their expected usage, and if concerns over safety and maintenance were removed (Harres). A bike sharing program is similar to the WeCar car rental program, but utilizes bikes instead of cars. It is a non-motorized transportation service, usually meant for short trips (0.5-3 miles). It uses a flexible pay system to serve a variety of users, takes care of the safety and maintenance of the bikes, and has bike stations where bikes can be picked up or dropped off. Bike sharing programs have not focused on the university or college campus. In this report, the feasibility of implementing a bike sharing program on the Washington University Danforth Campus is assessed.

The report is intended for Washington University’s Parking and Transportation Services administration, as well as any others who may be involved in the implementation process, such as the Residential Life office. Other interested universities may also find the report useful. This report was written with the assistance of the Washington University Residential Life office, which provided student opinions on the current status of on-campus biking, and helped conduct many of the student surveys used in this paper.

This study found that a total of 13 bike stations would best serve student travel on campus along with a total of 350-400 bikes. The operating cost of $140,000 per year would match the estimated $140,000 in revenue per year. Thus, the major costs involve the initial equipment and installation fees, which are estimated to be between $425,000 and $475,000 over the first three years. However, the benefits include reaching a wider population of students (as opposed to current on-campus bike rental programs), providing faster on-campus travel,
requiring fewer bikes on campus, offering more part-time on-campus jobs, and taking a visible and tangible step towards a greener and healthier campus.

It is recommended that Washington University begin by building 11 of the 13 bike stations, and then add another station each year for the next two years. A total of 250 bikes for the first year can be expanded to 350-400 bikes with the additional stations. A pricing structure similar to that of meal plans should be implemented whereby gold members get the first 60 minutes free each day and silver members get the first 30 minutes free each day. Otherwise, both members and nonmembers pay $1 for each additional 30 minute segment. 24 hour service should be provided. The program should use a radio frequency identification (RFID) docking system, build two-sided docking stations, install magnetic strip card readers for campus card access, design a light system to inform the user if the bike is locked or if it requires maintenance, provide users with a one minute testing period to check bike condition, and provide baskets and adjustable bike seats. The program should not purchase costly kiosks that allow riders to request a 15 minute extension if a bike station is full, purchase bike redistribution trucks to balance the bikes among stations each day, be held liable for any injury done to the user while riding, or provide helmets or bike locks. See Appendix A for a glossary of bike sharing terminology.

Introduction

Imagine a utopia where people travel by bike and share bikes. No one steals bikes! Thus, bikes are left out on the street free for anyone to use. Someone may travel to work and leave the bike out on the street. Someone else then uses that same bike to travel wherever they desire. This one bike may serve ten people over the course of the day.

This idea of a bike sharing program was implemented in the Netherlands in 1965 where a fleet of free bikes or “white” bikes was left in the city streets for public use. While the system...
failed due to theft and vandalism, the idea of bike sharing evolved into successful bike sharing programs, albeit the bikes are not free to use.

**What is a bike sharing program?**

A bike sharing program is essentially a WeCar car rental program that utilizes bikes instead of cars. It is a non-motorized transportation service, usually meant for short trips (0.5-3 miles). The modern bike sharing program provides users with secured bike pick-up at a number of docking stations and the ability to return the bike at any of the docking stations. Additionally, the user does not need to worry about bike maintenance. See Appendix A for a glossary of bike sharing terminology used in this report.

Currently, nearly all bike sharing programs have been implemented in city localities, as listed in Appendix B. Bike sharing programs have not focused primarily on the university or college campus. Bike sharing would reduce average student travel time and reduce the total number of bikes on campus. There are two major populations of students who currently do not ride bikes.

1. Students who do not want to deal with the hassle of maintenance and safety for their bike.
2. Students who bike occasionally (once a week or once a month) and cannot justify purchasing or renting a bike for the full year.

According to the Washington University Residential Life office, nearly 60% of students who do not ride bikes would ride a bike if the cost met their desired usage and if concerns of maintenance and safety were removed (Harres). While Bears Bikes offers on-campus rental bikes and covers most maintenance costs, the lowest rental price is $189.99 per year (Bears Bikes). This price is too high for many students. Additionally, those who are active bike riders prefer purchasing their own bike for $150-$500 in order to avoid paying yearly rental fees.
Purpose and background

In this report, the feasibility of implementing a bike sharing program on the Washington University Danforth Campus will be assessed and recommendations for implementation will be provided. This report does not detail the specific software programming involved nor does it go into any of the details on how to build the bike stations or bikes.

This report is written with regards to Washington University, though other interested universities may find it useful. It is intended for the Parking and Transportation Services administration, as well as any others who may be involved in the implementation process, such as the Residential Life office.

This report was written with the assistance of the Washington University Residential Life office, which provided student opinions on the current status of on-campus biking and helped conduct many of the student surveys used in this paper. Two meta-analyses of U.S. bike sharing programs provided much of the numerical information used to assess the costs involved in implementing a bike sharing program. One was written by the Toole Design Group and the Pedestrian and Bicycle Information Center. The other was published by Mineta Transportation Institute. Additional numerical information comes directly from product websites.

Plan of discussion

This report is divided into five chapters along with a conclusions and recommendations section. It begins by discussing the structure and cost of current bike sharing programs using information provided from the two meta-analyses. The report then assesses current bike sharing programs with regards to implementation on the Washington University Danforth Campus. Student surveys provide much of the information used in this analysis and can be found in Appendix C. First, pricing and hours of service are discussed. Second, the implementation of a
Implementation of a Campus Bike Sharing Program for Washington University’s Danforth Campus

bikesharingprogramisanalyzedwithregardstothenumbertofpotentialusersandstations. This is followed by a discussion on how to reduce costs. Third, the benefits of a bikesharingprogram are outlined in terms of revenue and the school’s image. Finally, concluding arguments and recommendations are provided along with a discussion on future expansion of the program.

Chapter 1: Structure of Modern Bike Sharing Programs

Most modern bike sharing programs are driven by the use of information technology (IT). They use automated self-serve kiosks and card swipe access as shown in Figures 1 and 2 below.

Each bike station contains a dock pad where the bikes are locked into docks via the docking probe shown in Figure 3. Bikes have radio frequency identification (RFID) tags allowing the kiosk to read which docks are full or empty. Each dock has three lights (red, yellow, green) to indicate if the bike is properly locked (green), if the bike is still in the initial 30-60 seconds testing period (yellow), or if it needs maintenance (red). This advanced technology is costly, but limits vandalism and theft.
Implementation of a Campus Bike Sharing Program for Washington University’s Danforth Campus

Users are divided into two general categories: annual members and casual riders. Annual members pay a membership fee in the range of $30-$85 and are given an access card. Casual riders may pay for a month, week, or day pass. For each day, users have a free period that ranges from 30 to 60 minutes. Additional charges apply after the free period as seen in Figure 4. While casual riders must always check-out a bike via the kiosk, annual members can bypass the kiosk and just swipe their card at each individual dock.

Most bike sharing programs maintain a one-mile radius rule whereby stations are never more than a mile away from another station. They use customized bikes, which makes the bikes easily identifiable and, thus, harder to steal.

Problems can still occur when using modern bike sharing programs. These problems along with solutions to some of them are listed below:

- What if a user checks out a damaged or unusable bike? A small testing period (30-60 seconds) is provided for the user to return the bike if it requires maintenance and then get a bike from another dock. Most modern bike sharing stations allow users to press a button that turns on a red light, indicating the bike needs maintenance, as seen in Figure 2.
- What if a user arrives at a station but there are no docks available to return the bike? Using the kiosk, users can request an additional 15 minutes to find another station.
• What if a user arrives at a station and there are no bikes available? This is currently the hardest problem to solve because it is difficult to ensure the bikes stay properly distributed. Some programs have implemented bike redistribution programs, but this does not always solve the problem. Some have begun implementing GPS tracking of bikes. This allows for real time data acquisition and the development of a website or phone application so that users can check for bike availability online. However, this is relatively new and costly feature.

• Do the bikes fit all? The customized bikes have adjustable seats so that both the height and angle of the bike seat can be adjusted.

• What happens if the bike is stolen or if an accident occurs? The user is expected to immediately report the occurrence to the company. In the case of theft, the user will likely be charged for recovery or replacement of the bike. In the case of an accident, the user is responsible for the bike until it is returned. If it is too damaged to dock then the user must wait for a company representative to get the bike from them. Depending on the severity of the damage and who is at fault in the accident, the user may be charged for bike repair or replacement (Capital Bikeshare).

Chapter 2: Costs Involved in Implementing a Modern Bike Sharing Program

In this section, the costs of implementing a modern bike sharing program are discussed in order of increasing significance. Theft and vandalism are not major concerns due to the advent of modern technology, specifically radio frequency identification (RFID), and the additional security of campus police. The major obstacles are equipment, installation, and maintenance
Implementation of a Campus Bike Sharing Program for Washington University’s Danforth Campus

2012

Costs, which range from $50,000-$85,000 per station ($35,000-$58,000 for equipment and installation; $12,000-$28,000 for maintenance).

2.1 Theft and Vandalism

As indicated in Table 1, theft and vandalism are not major issues in existing U.S. bike sharing programs due to very secure locking systems that use RFID (Susan). Additionally, the specialized shape and branding of bikes makes them easily identifiable and thus harder to steal. Many programs use unique parts in the bike design that cannot be transferred to other bikes.

The Washington University Annual Crime Report for the Danforth Campus indicates a total of 13 incidents of robbery over the past 3 years (Washington University Police Department). Don Strom, Chief of Police for Washington University, reported that only two or three of the incidents involved bike theft. He argues that in these cases bikes may have been stolen because students failed to lock bikes (Strom).

2.2 Equipment, Installation, and Maintenance

Equipment, installation, and maintenance of a single docking station range from $50,000-$85,000, as indicated in Table 2. Equipment includes redistribution trucks, bikes, kiosks, docking pads, and card readers. Installation includes the RFID system, the card-swipe system, and the lock-and-maintenance system. The operation costs include bike repair, redistribution, and customer service (Toole). The numbers in Table 2 are average prices that largely depend on

<table>
<thead>
<tr>
<th>Station Size (Docks)</th>
<th>Bikes</th>
<th>Equipment and Installation Costs (Includes Bikes)</th>
<th>Approximate Annual Operating Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>6</td>
<td>$35,000 - $40,000</td>
<td>$12,000 - $15,000</td>
</tr>
<tr>
<td>15</td>
<td>8</td>
<td>$45,000 - $48,000</td>
<td>$18,000 - $21,000</td>
</tr>
<tr>
<td>19</td>
<td>10</td>
<td>$53,000 - $58,000</td>
<td>$24,000 - $28,000</td>
</tr>
</tbody>
</table>
the type of power supply employed. Currently, there are two types – alternating current (AC) and solar power. Alternating current is significantly less costly to install though it has greater operation costs (Toole). Estimates indicate that it takes 10-20 years before solar power can cover the additional costs of installation and largely depends on location.

**Chapter 3: Pricing and Hours of Service**

Most bike sharing programs serve larger populations than Washington University. Users have varying reasons to use a bike sharing program that range from daily commute to one-day recreational use. Thus, most bike sharing programs provide options for annual, one month, one week, or one day passes as seen in Figure 5. For a university campus, this general model can be altered along the lines of the meal plan system. For example, students could “register” for a membership just as they register for a meal plan. Each student chooses a membership based on their individual interests as outlined in Figure 5 or pays a regular fee of $1 for every 30 minutes of use. Student surveys found in appendix C helped determine the cost of each membership.

**General Model**
- **Annual Members:** $30-$95
  - First 30-60 minutes free every day
  - $2-$4 for each addition 30 minute segment
- **Casual Riders**
  - 1 Day Pass: $5-$10
  - 1 Week Pass: $10-$25
  - 1 Month Pass: $15-$40

18-24 Hours Service

**Proposed Campus Model**
- **Gold Member:** $40
  - First 60 minutes free
  - $1 for each additional 30 minute segment
- **Silver Member:** $25
  - First 30 minutes free
  - $1 for each additional 30 minute segment
- **Casual Riders**
  - $1 per 30 minutes

24 Hour Service

Figure 5 – Pricing and hours of service of the general model used in current U.S. bike sharing programs (left) and a proposed model for the Washington University Danforth Campus (right)
The proposed model has two types of membership along with general usage fees. One week and one month passes are not applicable for students. Note that minutes cannot be saved for another day and only the time when the bike is not docked will be considered for usage fees. For example, a user may bike for 15 minutes and then dock the bike; pick up a bike two hours later and bike for 10 minutes; then not bike the rest of the day. If not a member, the user would be charged $1 and the extra five minutes would not carry over to the next day.

**Chapter 4: Costs with Regards to Washington University**

As noted in Chapter 2, equipment, installation, and maintenance are the major costs involved in setting up a bike sharing program. The combined cost ranges from $50,000-$85,000 per station. In this section, the number of bike stations and bikes required for Washington University is assessed. Using student data, it was found that 13 bike stations and 350-400 bikes would be needed. With regards to a university campus, the equipment, installation, and maintenance costs were reduced to an average of $36,000 per station ($25,000 for equipment and installation; $11,000 for maintenance).

**4.1 Implementation of a bike sharing program on the Danforth Campus**

According to Washington University student surveys found in Appendix C, 78% of the students living on the Danforth campus would use the bike sharing program - nearly 20% indicated daily use and approximately 30% indicated weekly use (assuming bike stations were available to meet their travel needs). Thus, approximately 2,500 of the 5,000 students living on campus would be interested in becoming an annual member. On average, current bike sharing programs use a 1:7 ratio of bikes to the number of annual users, as seen in Appendix B. Thus, Washington University will be looking for a total of 350-400 bikes.
The student survey results indicate that in addition to locations near dorms on the South Forty, there are eight other locations that would best serve student on-campus travel. Based on these results, a map of recommended bike station locations was developed. There are a total of 13 bike stations, as shown in Figure 6. Appendix D shows images of current bike stand areas that could be converted to bike stations.

During the transition period to the bike sharing program, some stations will not be necessary because many students will already have personal bikes. These upperclassmen joined Washington University when a bike sharing program did not exist. They live in the Village and
South Forty. Additionally, only one freshman course takes place in the northeast sector of campus. These bike stations should be built during the second and third years of the program, as indicated in Figure 6.

Current docking stations have a maximum of 19 docks, but for universities where locations near dorms and large lecture halls are likely to get crowded, larger docking stations are preferable. The dimensions of current docking stations are shown in Table 3 and a schematic can be seen in Appendix E. Also shown in Appendix E, is a schematic for a two-sided station, which doubles the number of docks in nearly the same width, but increases the total depth to 16 ft. The two-sided stations have only begun to be employed, but would be ideal for Washington University. They do not require major additional equipment or installation costs except for the additional bikes (Toole).

Two-sided docking stations with 30 docks should be installed in most locations. Stations near the Danforth University Center, Lab Sciences Building, Olin Library, and dorms were given the highest predicted usage ratings. Thus, 38-dock bike stations are recommended. On the other hand, the stations near the village and athletic campus were given the lowest ratings and a 22-dock bike station would suffice.

**4.2 Reducing the costs of bike stations**

In this section, the cost of the 15-dock bike station is analyzed. For a university where the size of the bike sharing program will range from ten to fifteen stations, the cost per station will lie on the lower end for both the installation and maintenance costs listed in Table 2. There are two major reasons for this. One, the university will likely use AC powered stations due to their lower installation costs and St. Louis’s highly fluctuating sunlight patterns (Bing). Two, the

<table>
<thead>
<tr>
<th>Docks</th>
<th>Width (ft)</th>
<th>Total Depth (ft)</th>
<th>Weight (lbs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>31-32</td>
<td>10-12</td>
<td>3000-5000</td>
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<td>40-42</td>
<td>10-12</td>
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</tr>
<tr>
<td>19</td>
<td>50-52</td>
<td>10-12</td>
<td>5500-6500</td>
</tr>
</tbody>
</table>
Implementation of a Campus Bike Sharing Program for Washington University’s Danforth Campus

university does not have to go through the same property rights process as city programs do because the stations will be on university property and not on city property. In fact, most of the programs listed in Appendix B, serve cities and are significantly larger in size. Boulder B-cycle, which has 15 stations, cost approximately $45,000 to install and around $13,000 to maintain per station (Toole). For the university, the costs would be lower, but since two-sided 15-dock bike stations are being implemented, the total price is around $60,000 per station ($47,000 equipment and maintenance and $13,000 maintenance).

4.2.1 Equipment and Installation

A basic interactive kiosk ranges from $3,000 – $8,000, with customized software costing an additional $3,500- $10,000 (BuyerZone). The total cost of implementing a kiosk system at each station costs nearly $8,000-$10,000. For a university campus where students carry magnetic strip ID cards, the stations only need to have card-swipe systems. By not installing kiosks, the cost per station drops by approximately $8,000. However, requesting 15 additional minutes to return a bike if a station is full will not be possible. Additionally, the program will be confined to students and faculty who have magnetic strip identification cards.

Currently, bikes cost $1000 each because of their specialized design, use of unique parts, and branding (Susan). For a university, the specialized design can be simplified to reduce costs. Students are agile enough to get their foot over the second support bar that many bike sharing programs have eliminated, as seen earlier in Figure 3. Additionally, students are less likely to try and steal bike parts while living among peers. Universities should purchase bikes with a locked bike seat, but can avoid other specialized parts like unique tire designs and handlebars. Branding of the bikes with the Washington University logo is the least expensive feature and is very useful
in preventing theft. This should not be scrapped. By doing the above, the cost per bike will drop to $600 and save approximately $6000 per station.

Additionally, the simple university pricing structure will save approximately $5,000 per station. The programs necessary to implement the pricing structure mentioned in Chapter 3 and the card swipe system are already developed for meal plans.

4.2.2 Maintenance

In the survey taken by Washington University students (see Appendix C), many students indicated that they would both pick up and return the bike to locations near their dorms. Thus, purchasing a $50,000 truck for a redistribution program is not necessary. Instead, redistribution can be covered manually. This will save $2,000 in operating costs per station.

Thus, the final cost per station will average around $36,000 ($25,000 for equipment and installation; $11,000 for maintenance). For a total of 13 stations, the cost will be approximately $468,000 for the first year. The yearly operating cost will be approximately $143,000. This may seem like a large amount of money for Washington University, but some of the costs will be covered by membership and usage fees, and there are other benefits.

Chapter 5: Benefits of a Campus Bike Sharing Program

As noted in Chapter 4, there are significant costs involved in implementing a bike sharing program even when simplified for a university campus. In this section, the revenue generated by implementing a bike sharing program will be discussed along with the benefits of improving student life and the school image. It was found that total revenue generation will match yearly operation costs of $140,000. Thus, the only cost of a bike sharing program will be the initial equipment and installation costs of $425,000-$475,000. A bike sharing program is a visible and tangible step towards a greener and healthier campus. It could lead to more interaction with the
surrounding community and a possible partnership with the city of St. Louis to implement a city wide bike sharing program.

5.1 Revenue

There are an estimated 1,000 daily bike users along with a total of 1,500 weekly bike users. Assuming they become either gold or silver members, the program would generate approximately $90,000 in membership fees. Based on other results found in the survey, general usage fees would provide an additional $40,000-$60,000. Thus, total revenue would be around $140,000. This estimate does not taken into account the potential revenue generated from the 1,200 undergraduate and the 5,200 graduate students who live off campus. During the first year many potential users will not join the program because they already own bikes, and it will take two to three years before the numbers above can be realized. Since the total per year operation cost for 13 stations is approximately $140,000, this program will nearly cover its operation costs. Note that Washington University subsidizes the WeCar program by 37.5%. On the other hand, a bike sharing program would be self-sustaining once installed. The initial equipment and installation costs are predicted to range between $425,000 and $475,000 over the first three years. These costs should be considered in light of the program’s other benefits.

5.2 Student life and school image

According to Curt Harres, assistant director of Residential Life, a campus bike sharing program would greatly improve student life. Students would be able to get to classes faster and many commented that they would use it to make trips to Schnucks as well as for recreation on the Forest Park biking lanes. According to one student, “a bike sharing program will make it easy for me and my friends to quickly go places. Otherwise, there is always someone who does not have a bike.”
Bike sharing programs reduce the total number of bikes on campus by allowing users with varying schedules to essentially use the same bike. For example, one student may have class at 9:00 am and 2:30 pm; another student may have class at 11:00 am and 4:30 pm; a third student may have only one class at 6:00 pm. These three students could all be served by a single bike for that day rather than having three individual bikes.

The campus bike sharing program would provide 10-15 part-time, on-campus jobs. Positions would be available for customer service as well as bike repair and maintenance.

A bike sharing program is a visible and tangible step towards a greener campus. It shows a long term commitment to healthy living and adds to Washington University’s commitment to better transportation in the St. Louis area (see Appendix F for a list of past initiatives). If successful, the program could strengthen Washington University’s relationship with the surrounding neighborhood. Schnucks, for example, may want a nearby station for students. The city of St. Louis may team up with Washington University to implement a citywide program.

**Conclusions**

Bike travel on the Washington University Danforth Campus would be enhanced by the implementation of a bike sharing program. A bike sharing program

- reaches a wider population of students (as opposed to current on-campus bike rental programs);
- provides faster on-campus travel;
- requires fewer total number of bikes on campus;
- offers more part-time, on-campus jobs;
- and takes a visible and tangible step towards a greener and healthier campus.
The major drawback is the initial implementation costs, which are estimated to be between $425,000 and $475,000 over the first three years. However, the benefits and longevity of a bike sharing program outweigh these costs. The program is self-sustaining given the initial implementation costs.

**Recommendations**

In the initial implementation of a bike sharing program only 11 stations should be built as indicated in Figure 6. A total of 250 bikes will suffice for the first year. The main features of these bikes include the docking probe, adjustable seat, and basket. The bikes should be branded with the Washington University logo. A prototype of the bikes is shown in Figure 7.

A pricing structure with two types of memberships should be implemented, as indicated in Figure 8.
The WU Bike Sharing Program

<table>
<thead>
<tr>
<th>Should</th>
<th>should not</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Implement RFID docking technology</td>
<td>• Have costly kiosks which allow riders to get a 15 minute extension if a bike station is full</td>
</tr>
<tr>
<td>• Build two-sided docking stations</td>
<td>• Employ the use of bike redistribution trucks</td>
</tr>
<tr>
<td>• Install magnetic strip card readers for each dock</td>
<td>• Carry any liability for any injury done to the user while riding</td>
</tr>
<tr>
<td>• Design a light system to inform user if the bike is locked or if it requires maintenance</td>
<td></td>
</tr>
<tr>
<td>• Provide users with a one minute testing period to check bike condition</td>
<td></td>
</tr>
<tr>
<td>• Provide baskets and adjustable bike seats on all bikes</td>
<td></td>
</tr>
</tbody>
</table>

Over the next two years, the two other bike stations indicated in Figure 6 should be built and an additional 100 bikes should be added to the program. Appendix G provides an outline of these recommendations.

**Going Forward**

GPS tracking allows for real time data acquisition, but is prohibitively expensive (Susan). It allows for the development of websites and phone applications that provide users with real-time information about bike availability at nearby locations. This new technology should be kept in mind. As the program progresses, it may become feasible and would assist students in their campus travels.

According to the Residential Life Office, approximately 38% of off-campus students bike to school (Harres). These students are currently not being reached by the program and future efforts may involve expansion in to surrounding areas such as further east on Forsyth Blvd., the path to the Loop, and along Waterman Blvd. However, this is city property, which requires more paperwork and fees. Additionally, in order to maintain the lower costs, only Washington University students and faculty can use the bikes. If the program expands outside of the Danforth Campus, the city may expect them to open the stations to the public, which would require kiosks
and other expenses. A logical expansion of the program includes the medical campus, which is 2.5 miles away from northeast campus. Additional analysis could help identify whether this expansion would be beneficial.

Works Cited

Appendices

Appendix A: Glossary of Terms .......................................................... A1
Appendix B: List of Current U.S. Bike Sharing Programs ......................... B1
Appendix C: Washington University Student Survey and Survey Results ... C1-C5
Appendix D: Images for Potential Locations of Docking Stations on the Danforth Campus .......... D1
Appendix E: Schematics of Docking Stations ........................................ E1
Appendix F: List of Community Initiatives Pertaining to Travel .................... F1
Appendix G: Outline of Recommendations .......................................... G1-G2
Appendix A: Glossary of Terms

**Bike Sharing**
A non-motorized transportation service, usually meant for short point-to-point trips (0.5-3 miles), that provides bike security and maintenance. It offers bike pick-up at a number of docking stations and the ability to return the bike at any of the docking stations (including the origin).

**Bicycle Redistribution**
Refers to any service that moves bikes within the service area to adjust for uneven distribution of bikes.

**Docking Station or Bike Station**
Used interchangeably to refer to the structure where bikes are either picked up or returned and contains a dock pad with docks.

**Dock Pad**
The total area over which the individual bike docks are located.

**Dock**
Located on the dock pad and includes the mechanism to keep bikes upright and secured, until released by user.

**Free Period**
The time immediately after picking up a bike during which no additional charges are incurred by the user. It usually ranges from 30-60 minutes.

**Membership Fees**
Charge to become an annual member. For current programs, this means the ability to have swipe card access to bikes.

**“One Mile Radius” Rule**
Refers to the relative region over which the bike sharing service is provided to users by a single bike station. Each station covers a one mile radius.

**Service Area**
The geographical area over which the bike sharing program offers service based on the “one mile radius” rule.

**Testing Period**
Time immediately after undocking the bike during which the user can return the bike if the user finds it unsatisfactory. It usually ranges from 30-60 seconds.

**Usage Fees**
Additional charge that take place after the free period.
## Appendix B: List of Current U.S. Bike Sharing Programs

Table B1 - Basic statistics of current U.S. bike sharing programs (Toole)

<table>
<thead>
<tr>
<th>U.S. Bike-Sharing Programs</th>
<th>Users</th>
<th>Number of Bikes</th>
<th>Number of Stations</th>
<th>Annual Membership Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital Bikeshare (Washington DC and Arlington Area)</td>
<td>Annual: 19,200 Casual: 105,644</td>
<td>1200</td>
<td>140</td>
<td>$75</td>
</tr>
<tr>
<td>Hubway (Boston, Massachusetts)</td>
<td>Annual: 3,600 Casual: 30,000</td>
<td>600</td>
<td>62</td>
<td>$85</td>
</tr>
<tr>
<td>Boulder B-Cycle (Colorado)</td>
<td>Annual: 1,171 Casual: 6,200</td>
<td>110</td>
<td>15</td>
<td>$50</td>
</tr>
<tr>
<td>Denver B-Cycle (Colorado)</td>
<td>Annual: 2,659 Casual:40,600</td>
<td>520</td>
<td>52</td>
<td>$65</td>
</tr>
<tr>
<td>Nice Ride (St. Paul, Minnesota)</td>
<td>Annual: 3,521 Casual:37,103</td>
<td>1300</td>
<td>145</td>
<td>$65</td>
</tr>
<tr>
<td>B-Cycle (San Antonio, Texas)</td>
<td>Annual: 1,000 Casual: 2,800</td>
<td>200</td>
<td>23</td>
<td>$60</td>
</tr>
<tr>
<td>Spartanburg B-Cycle (South Carolina)</td>
<td>Annual: 127 Casual: 828</td>
<td>14</td>
<td>2</td>
<td>$30</td>
</tr>
<tr>
<td>Deco Bike (Miami, Florida)</td>
<td>Annual: 2,500 Casual: 338,828</td>
<td>800</td>
<td>91</td>
<td>---</td>
</tr>
</tbody>
</table>
Appendix C: Washington University Student Survey and Survey Results

Below is a copy of the survey completed by 500 Washington University Students who all lived on the South Forty. This was conducted with the help of the Washington University Residential Life office.

Washington University Bike Sharing Program
A bike sharing program is similar to the We Car program except for bikes instead of cars. Stations would be located around campus where bikes can be picked up or dropped off. For this survey assume that bikes are always in good condition and there are plenty of bike stations to meet your needs.

Do you currently own a bike on campus?
- Yes
- No

If yes to the above, then how often do you use your bike to travel on campus?
- Daily
- 2-3 Times a Week
- Once a Week
- 2-3 Times a Month
- Once a Month
- Less than Once a Month
- Never

Would you use a bike sharing program if it met all of your needs, in terms of location and bicycle specs (i.e. assuming stations were located perfectly for you to go to and from classes and that the bike suits your height)?
Note: Say yes even if you plan on only using occasionally.
- Yes
- No

If yes to the above, how often would you use such a program?
- Daily
- 2-3 Times a Week
- Once a Week
- 2-3 Times a Month
- Once a Month
- Less than Once a Month
Most modern bike sharing programs charge $30-$35 for annual membership which provides between 30-60 minutes of free bike riding each day. How much would you be willing to pay for the following options? (Note the third option is to not become a member in which case it costs $1 per 30 minutes)

<table>
<thead>
<tr>
<th>Dollars</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
</tr>
<tr>
<td>10</td>
</tr>
<tr>
<td>20</td>
</tr>
<tr>
<td>30</td>
</tr>
<tr>
<td>40</td>
</tr>
<tr>
<td>50</td>
</tr>
<tr>
<td>60</td>
</tr>
<tr>
<td>70</td>
</tr>
<tr>
<td>80</td>
</tr>
<tr>
<td>90</td>
</tr>
<tr>
<td>100</td>
</tr>
</tbody>
</table>

Gold Member: 60 minutes free for each day of the semester, $1 fee for every additional 30 minutes

Silver Member: 30 minutes free for each day of the semester, $1 fee for every additional 30 minutes

Where is it going to be most convenient to first pick up a bike?

- Near your dorm
- Near Business School
- Near Danforth University Center
- Near Olin Library
- Near Lab Sciences
- Near Lopata Hall
- Near Brown Hall
- Near Architecture School
- Near Whitaker Hall
- Near Seligie Hall
- Near the Village
- Near the Athletic Complex

Where is it going to be most convenient to finally drop off a bike (i.e. you will no longer use it for the rest of the day after dropping it off)?

- Near your dorm
- Near Business School
- Near Danforth University Center
- Near Olin Library
- Near Lab Sciences
- Near Lopata Hall
- Near Brown Hall
- Near Architecture School
- Near Whitaker Hall
- Near Seligie Hall
- Near the Village
- Near the Athletic Complex
During the day which locations are you most likely going to use? Rank them in terms of how much you will use them per week.

<table>
<thead>
<tr>
<th>Location</th>
<th>Never</th>
<th>Rarely</th>
<th>Sometimes</th>
<th>Often</th>
<th>All of the Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Near your dorm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Near Business School</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Near Danforth University Center</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Near Olin Library</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Near Lab Sciences</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Near Lopata Hall</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Near Brown Hall</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Near Art/Architecture School</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Near Whitaker Hall</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Near Seigle Hall</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Near the Village</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Near the Athletic Complex</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

What are reasons you would use a bike besides going to classes?


Survey Results

General Questions

<table>
<thead>
<tr>
<th>Percent</th>
<th>Do you own a bike?</th>
<th>Would you join a bike sharing program?</th>
<th>How often would you use the bike sharing program?</th>
</tr>
</thead>
<tbody>
<tr>
<td>20%</td>
<td>Yes</td>
<td>78% Yes</td>
<td>22.81%</td>
</tr>
<tr>
<td>20%</td>
<td>Yes</td>
<td>78% Yes</td>
<td>22.81%</td>
</tr>
<tr>
<td>22.81%</td>
<td>Daily</td>
<td>78% Yes</td>
<td>22.81%</td>
</tr>
<tr>
<td>14.32%</td>
<td>2-3 times a week</td>
<td>78% Yes</td>
<td>22.81%</td>
</tr>
<tr>
<td>16.35%</td>
<td>Once a week</td>
<td>78% Yes</td>
<td>22.81%</td>
</tr>
<tr>
<td>23.09%</td>
<td>Once a month</td>
<td>78% Yes</td>
<td>22.81%</td>
</tr>
<tr>
<td>3.42%</td>
<td>Less than once a month</td>
<td>78% Yes</td>
<td>22.81%</td>
</tr>
<tr>
<td>20%</td>
<td>Never</td>
<td>78% Yes</td>
<td>22.81%</td>
</tr>
</tbody>
</table>

Figure C1 - General survey questions. Do you own a bike? Would you join a bike sharing program? How often would you use the bike sharing program?

Pricing: How much would you be willing to pay for:

<table>
<thead>
<tr>
<th>Average Amount ($)</th>
<th>Gold Member: Annual membership with first 60 minutes free</th>
<th>Silver Member: Annual member with first 30 minutes free</th>
</tr>
</thead>
<tbody>
<tr>
<td>45</td>
<td>$42.5</td>
<td>$24.4</td>
</tr>
<tr>
<td>40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td></td>
<td></td>
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<tr>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td></td>
<td></td>
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<tr>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure C2 - Survey question on pricing. How much would you be willing to pay for gold membership or silver membership?
Most common reasons to ride bike other than for classes:

- Trip to Schnucks
- Recreation – around Forest Park
- Exercise
Appendix D: Images of Potential Locations for Docking Stations on the Danforth Campus

Figure D1 – Potential locations for the 13 docking stations on campus. Note that each location has the desired space to build the designated sized docking station.
Appendix E: Schematics of Bike Dock Stations

One-Sided

Figure E1 - Schematic of 11 dock bike station. The K stands for kiosk and is not needed for a campus bike station.

Two-Sided

Figure E2 - Schematic of a two-sided 11-dock bike station. Note the width is halved and the depth increases to 16 feet.
Appendix F: List of Community Initiatives Pertaining to Travel

1. Washington University Partnership with Metrolink (Metrolink)
   - Washington University has been supporting the Greater St. Louis Transit Alliance. In the 1990s, Washington University helped implement the construction of two new Metrolink Stations close to the Danforth Campus, which resulted in the blue line metro path.

2. Washington University Partnership with Greenway Rivers Greenway
   - Washington University assisted in developing Centennial Greenway bike path through Washington University. It is part of the Great Rivers Greenway District’s River Ring, an interconnected system of greenways, parks and trails that, when completed, will encircle the St. Louis region (Daues). It has improved bike paths on the Danforth Campus.

3. Washington University Underpass
   - This path fell along Forsyth Boulevard. The school recently remodeled it such that it provides better bike paths from the South Forty to main campus.
Appendix G: Outline of Recommendations
Implementation of a WU Bike Sharing Program

⇒ Stations

⇒ Bikes
  ➨ First Year: 250 bikes
  ➨ Second-Third Year: Add 100 bikes
Implementation of a Bike Sharing Program for Washington University’s Danforth Campus

Pricing and Hours of Service

Gold Member
$40
First 60 minutes free

Silver Member
$25
First 30 minutes free

Usage Fees
$1
Each additional 30 minutes

24 Hour Service
Call (314) ####-#### for Assistance

Helmets and bike locks are not provided. Bike locks are only needed for non-station locations. To see our policy on stolen or damaged bikes, visit www.------.wustl.edu or call our customer service agent.

The WU Bike Sharing Program

Should
- Implement RFID docking technology
- Build two-sided docking stations
- Install magnetic strip card readers for each dock
- Design a light system to inform user if the bike is locked or if it requires maintenance
- Provide users with a one minute testing period to check bike condition
- Provide baskets and adjustable bike seats on all bikes

should not
- Have costly kiosks which allow riders to get a 15 minute extension if a bike station is full
- Employ the use of bike redistribution trucks
- Carry any liability for any injury done to the user while riding