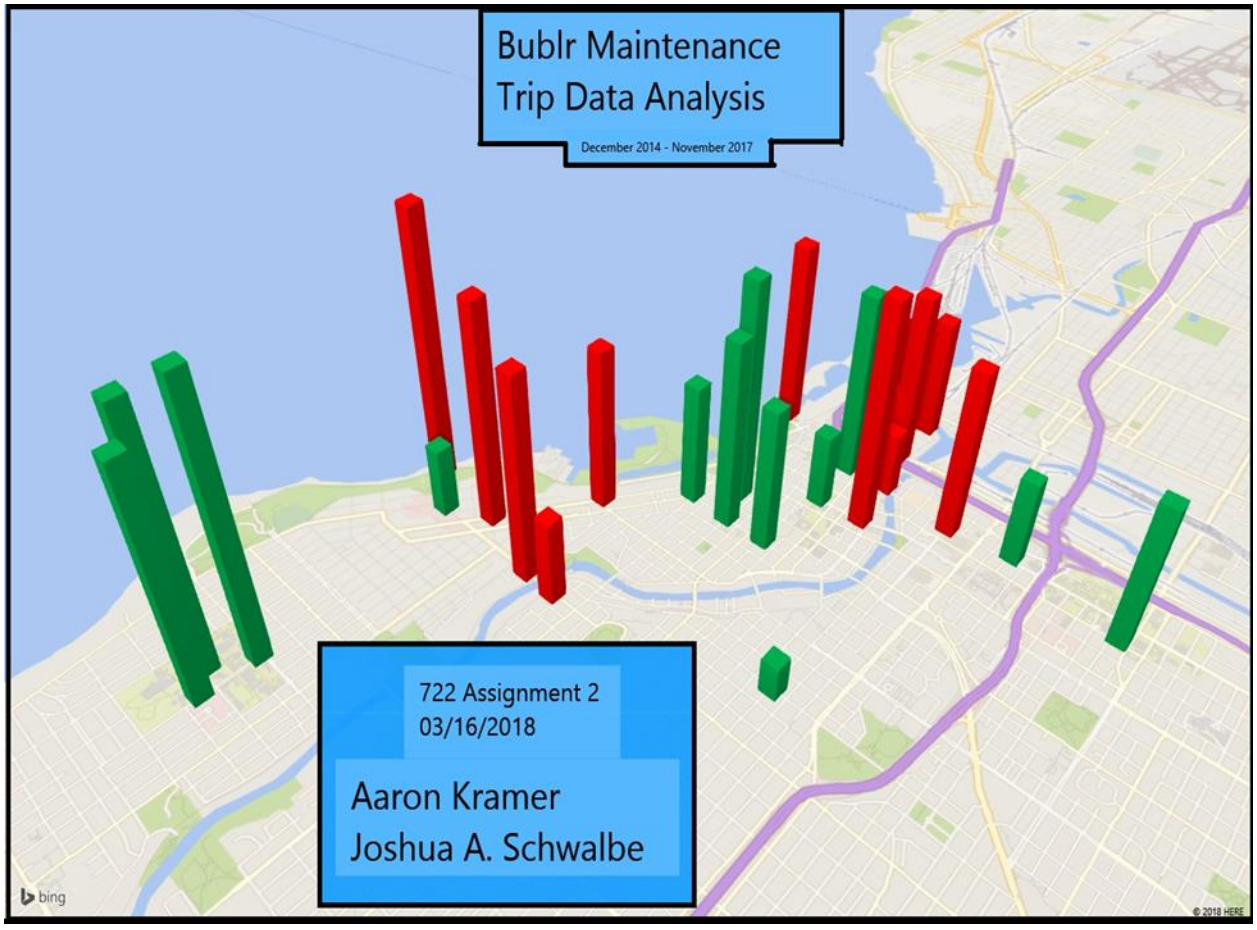
Bublr Maintenance
Trip Data Analysis
December 2014 - November 2017
722 Assignment 2
03/16/2018
Aaron Kramer
Joshua A. Schwalbe
bing
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Introduction

Cities and communities moving towards alternative modes of transportation. The need to meet increasing transportation needs along with a desire for greener transportation modes has many looking towards shared biking as a piece to the solution[i]. A bike share system makes renting bicycles accessible to people at kiosk stations across a municipality. Milwaukee's bike share can be considered a 3rd generation[ii] system operated by the non-profit organization Midwest Bike Share doing business as Bublr Bike Share. Bublr manages the day to day operations, planning, outreach, and other tasks related to the operation of the bike share system. The top two tasks that require the most time and resources are physically maintaining the bikes and balancing the system. Balancing the system is when bikes are manually transported by van from stations that are full of bikes to stations that are empty. The purpose of this report is to explore Bublr trip data generated from riders and staff with the goal of making the system more efficient.

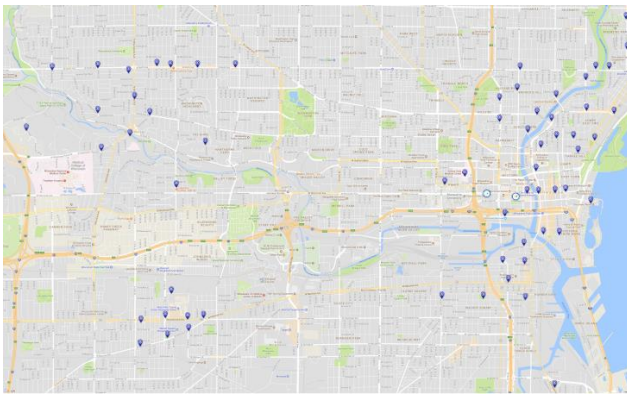
The future economic and environmental sustainability of Bublr must improve to avoid challenges with current and future expansion of the bike share system. As the number of stations/bikes/users increases with expansion, minimizing expenses through more efficient maintenance will be key to the success of the bike share. "Distribution of bikes must improve to make the bike-sharing service more efficient and environmentally friendly. Staff moving bikes from areas of high supply/low demand to areas of low supply/high demand is time consuming, expensive, and polluting[ii] ."

Background Information

The history of Bike Share in Milwaukee starts with a one-year funding approval process lasting from the summer of 2013 until fall of 2014. A pilot program of 10 stations was first installed in strategic locations throughout the city in August 2014. Over the next several years the system has

shown steady expansion and growth. The system has expanded to 49 stations in Milwaukee and 56 stations regionally including Wauwatosa (Appendix A).

List of 10 pilot program stations:



- Cathedral Square Park
- Chase Plaza
- Discovery World
- 411 East Wisconsin Center
- Intermodal Station
- Public Market
- Red Arrow Park
- Schlitz Park
- U.S. Bank Building
- Wisconsin Center

The system operates with two types of users. Annual users pay an annual membership fee and are issued a coded key. Single pass users can access the system through a terminal attached to the bike station using their credit card. Annual user passes generate more detailed data due to the unique id associated with the user's key while single pass users may use different credit cards and be more difficult to track.

Users can locate kiosk stations by a map attached to the station or through a smartphone app. The app shows kiosk station location, how many docks are open/full, and real-time directions with a map. The user can checks-out a bike either with a credit card or a Bublr pass key and can use the bicycle for a set period of time. After the user has reached their destination they check-in the bike at any nearby station completing their trip.

Data Analysis

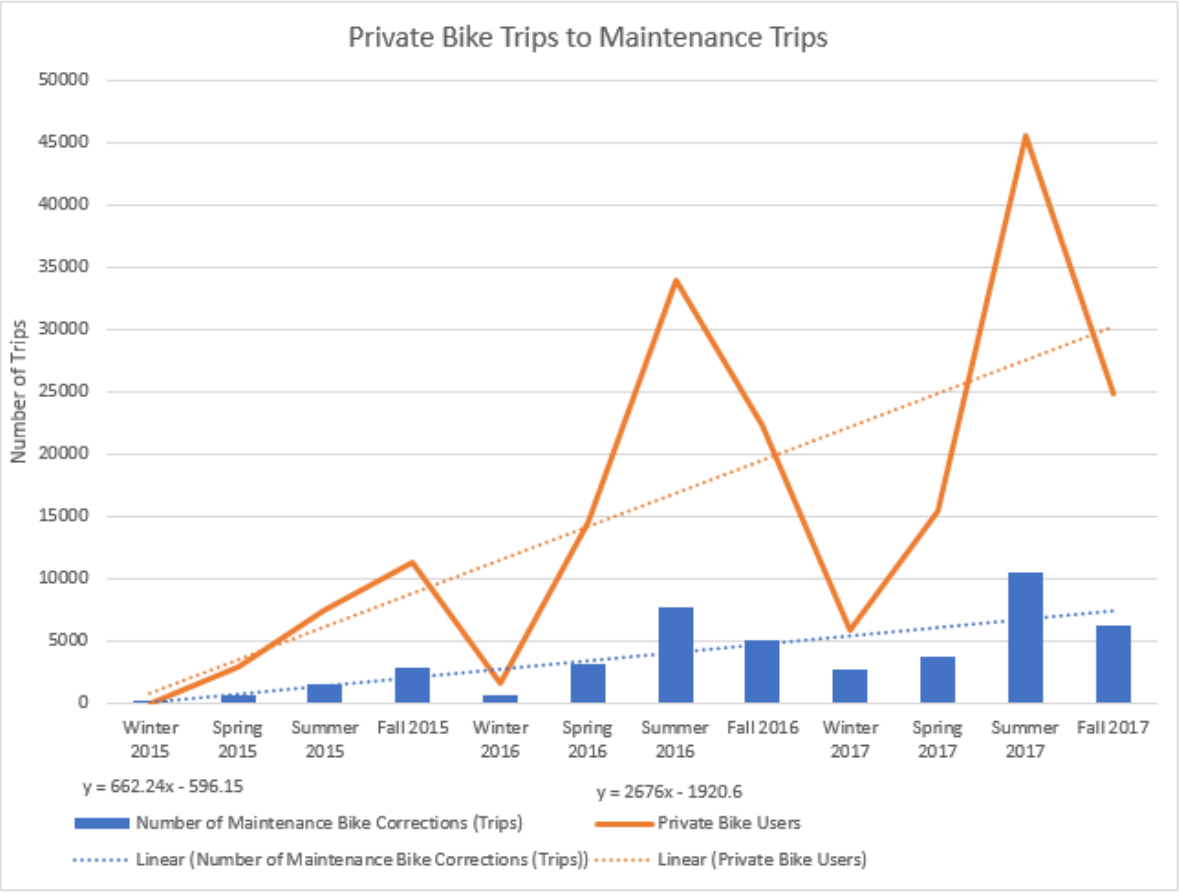
Trip data is generated within the Bublr Bike Share system every time a bike is checked-out or returned to a docking station. The data is managed in real-time through administrative software. Access to the data required downloading monthly data sets by year. Seasonal data sets were assembled manually. The scope of this report is seasonal and does not calculate on the day or time of day level. Datasets were available by month and were grouped by year and season as follows:

2015 – 2017[1]
Fall—September October November
Winter—December January February[2]
Spring--March April May
Summer—June July August

There were 233,296 total records in the compiled dataset, and 45,052 of those trips were generated by staff to maintain and balance the system. Data was collected from the Bublr database and cleaned by removing irrelevant fields without unique values. Maintenance trips were filtered from user trips. The data was then adjusted for trips generated for snow removal by comparing the check-in station with the check-out station. If the check-in station was the same as the check-out station, it was assumed that this was a snow removal event and was subtracted from the total frequency calculations for each station respectively. Scheduled maintenance check-out trips identified by the check-in destination "Garage" were also subtracted. Check-in trips identified by the check-out destination "Garage" were included as they are used to balance the system when they are checked-in to a station.

[1] December 2014 data was used for winter 2015 dataset.
[2] January and February 2015 the system was not operating, and no data was collected

Findings



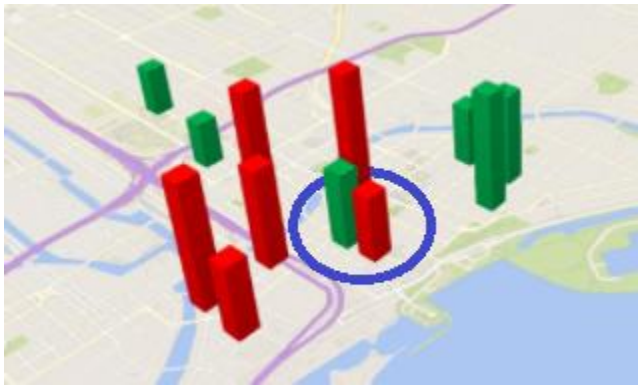
(Appendix B)

The graph above depicts the number of riders, in orange, and the number of maintenance trips, in blue, with corresponding trend lines. The overall ridership yearly has been increasing for the past three years of the program. Bublr has and plans to add more Bublr Bike stations and promote its brand and mode of transportation to the city of Milwaukee.

A T-Test was performed assuming unequal variances to test our hypothesis that an increase in either ridership or kiosks will have a positive causal impact on the number of maintenance trips. Both tests resulted in a rejection of the null hypothesis and allowing us to assume that there is a

strong correlation. Based on the data and the future plans of Bublr's leadership to expand their system. We can assume that the number of maintenance trips will increase going forward.

Using GPS coordinates, a histogram type location map was created for spring, summer, fall, winter, and all four seasons combined (Appendix C). These maps are useful for understanding how maintenance trips generated by balancing the system relate to each other spacially. Clear patterns can be seen in some stations throughout all four seasons such as the Golda Meir Library, Sandburg, and UWM Student Union stations on the University of Wisconsin Milwaukee campus in green. Also, complementary stations that require opposite balancing can easily be referenced by their proximity to each other on the map (Location Map Y).



(Map Y)

Table A shows the stations that have the highest positive maintenance check-in and the lowest negative maintenance check-out totals from December 2014 - November 2017. The locations in this table represent the strongest stressors and the stations that require the most resources to manage. These stations also represent the highest potential impact on the efficiency of balancing the system. Further analysis of the maintenance data for patterns at the day or time of day level could be useful for managing staff and predicting high demand stations. This information can also be used for future empirical testing. Comparing this data to future datasets can show the

effectiveness of changes made to balancing the system and the overall effects on balancing maintenance efficiency.

Top 10 Stations	TTotal Balancing	Bottom 10 Stations	BTotal Balancing
UWM Student Union	842	Water/Wisconsin	-273
Golda Meir Library	798	Broadway/St Paul	-307
Sandburg Hall	719	Riverview	-356
Astor/Juneau	694	Jefferson/Menomonee	-429
Ogden/Marshall	585	Erie/Menomonee	-528
411 East Wisconsin	580	Brady/Prospect	-691
Ogden/Jackson	449	Wisconsin Center	-720
Marquette University Student Union	447	Public Market	-742
Burns Commons	380	Discovery World	-797
Central Library	276	North/Cambridge	-873
Cathedral Square	236	Kenilworth Square	-959
North/Lake	220	Red Arrow Park	-973
MLK/Brown	105	Bradford Beach	-1151

(Table A)

Course of Action Parameters

Problem Statement

Our goal is to provide recommendations to improve the Bublr Bike sharing system. The Bublr organization will expand the number of Kiosks and continue to expand its overall ridership. Bike ridership across the nation is increasing[iii]. The issue we will be tackling is that as the system expands, so does the number of imbalances in the system. Bublr Bike has experience habitual overflows in some of its bike share stations and scarcity in other areas. These imbalances threaten to reduce the reliability of the system for its user base. To correct the system the Bublr staff intervenes to balance the system by physically driving out and moving bikes from one station to another. The goal is to draft a final recommendation to Bublr on how to promote user behavior to reduce the need for outside correction as the system expands.

Current Correction Method

The Bublr staff physically going out and moving bikes from one kiosk to another is the primary means of balancing the system. This system is ad hoc, reactive, and potentially inefficient as the system expands in ridership and number of stations. The Bublr staff tracks the status of all the Bublr station kiosks remotely through an administrative computer program. Basic station data is available on staff portable devices in the form of the interactive map on the mobile app. The staff looks at the system's network of kiosks and make a determination of when and where to go out and adjust the system when kiosks are potentially to full or near empty. The staff will then use one of Bublr's vehicles to go out and physically move bikes from one kiosk to another via three maintenance vehicles.

The current average number of maintenance trips is eight thousand per each three-month season in 2017[3]. In two years there will be four thousand additional maintenance corrections per each three-month season[3]. This projection conveys that there will be more imbalances in the system that threaten to degrade the Bublr quality of service. This projected increase will necessitate an increase in staff time and resources towards addressing the increased number of maintenance trips under the current ad hoc way of making corrections to the system.

Current Correction Method Cost

Without a change in operating procedures, we assume that Bublr will continue making manual correction is its current project method. We need to understand what this current method will cost to judge our alternative courses of action we will draft and propose. If we assume that Bublr brings on two part-time assistants to address this concern, we can approximate a rough cost

[3] Appendix B

projection would be. This cost projection can then be used to compare our potential alternative courses of action allowing us to evaluate and formulate a final recommendation.

In the lowest cost scenario for 2019, we will assume that two assistants are brought on at a wage of thirteen dollars an hour to work twenty hours a week[4]. The annual salary cost for this option would be approximately $27,000. If we included the true cost of an employee, this figure would jump to $35,100 when factoring insurance, payroll tax, administrative costs[4][iv]. The current Bublr maintenance fleet of vehicles is composed of three, variously sized, vehicles for transporting bikes. These three vehicles are tasked to cover their entire service area. A service area which is set to expand as it adds additional stations. It is reasonable that a new vehicle will have to be added to meet the increase in required maintenance trips. A new capital expenditure on renting and servicing a small truck will run approximately $8,400[v]. When we factor in insurance on a company vehicle operating in an urban setting this pushes the annual cost by $1,268[vi].

The total annual financial cost in this scenario is approximately $45,000 annually. While this figure displays the financial cost, it does not reflect the true cost. The current method reacts to imbalances in the system in a delayed manner which may affect the quality of service. Additionally, we know through talking with the director of Bublr, James Davies, that issues such as weather are a major factor. Furthermore, Bublr can be a competitor with the Milwaukee bus system for those using alternative means of transit.

Our goal in this report is to offer improvements to Bublr Bikes that improve their system. We know that there is an inconsistency in user round trip transportation choice. We know that weather has a huge impact on user choice. In the following pages we will explore several

[4] Based on current Bublr Bikes intern salary and hours.

potential options and offer our recommendation on how to promote user behavior to reduce the need for outside correction as the system expands.

Course of Action Development

We have focused on two areas of improvement. Changes to, or emplacement of, physical capital and other physical changes to address several trends born true by our data. The other area is in implementing digital initiatives that would encourage the clients or users themselves to balance the system using incentives. While complete self-sufficiency would be appreciated – the focus is on alleviating the need for corrections as the system expands and becomes increasing visible to the Milwaukee and broader communities.

Actions on Behavioral Choices

Bublr Bikes has an established mobile application accessible for both registered users and guests to the system. This Bublr app shows the location and current capacity of the kiosks in Milwaukee County. The application and the significant portion of Bublr registered users presents several opportunities that may be instrumental in improving the system.

One initiative would be to prompt regular registered users with a regular route to utilize another kiosk station. This message may be sent through an ‘end of year’ data review as a general thank you to the ridership email. Another method would be an automatic message pushed to the registered users phone or at the kiosk station they are docking their bike to. Should the docking kiosk be ninety percent full, it could automatically send a notification to any additional users questing that they consider docking at a nearby station.

Should it be determined that appealing to the user's altruism be unreliable in changing behavior, an incentive could be offered. This incentive could be anything from clear monetary rate of compensation or complete refund for your trip should you choose to dock at a less crowded station. Another incentive method may be to offer a fixed, or tiered, monetary compensation to users who willingly move a bike from a station that is at eighty percent capacity to another station currently at less than twenty percent capacity.

Physical alteration Improvements

To either facilitate user self-correction or user behavior that would make user usage consistent and more regular there are several, physical options to explore. A go to method would be a ask or incentive the current user population to balance the system themselves. The current facts on the ground limit the ability of a ready and willing user to actively correct imbalances in the system.

An important consideration are the bikes themselves. Bublr Bikers are built differently than normal bikes. A Bublr bike has a different frame and higher weight than the average street or normal bicycle. Because of the bicycles frame design – Bublr bikes are not currently compatible with Milwaukee City Bus racks. Milwaukee altering their city bus racks opens the opportunity for users themselves to Sheppard one to four bikes from station to station utilizing the city bus network.

Another possibility is to augment bublr bikes to facilitate one person to move two bikes at once. This could be done by changing the bikes themselves – which would be costly, or by offering a

small bundle of attachments. By setting up a second Bublr bike as a trailer or side-bike. You potentially make it worthwhile for a rider to move bikes within the system. The other advantage would be to have a grate container or basket attachment for the trailer or side-bike that allows for someone to move groceries more conveniently. The Bublr stations themselves offer possible areas of improvement. Weather influences a person's choice in transportation. Offering Bublr stations with a canopy or contained within a bike locker may reduce the adverse impact of weather on ridership patterns.

Course of Action Refinement

Physical changes to the system require upfront capital to implement. The best alternative scenario is adding people and another vehicle to the maintenance department to meet the rising demand for staff maintenance trips. This would increase the cost by approximately 45,000 according to our conservative estimation. This course of action stacks up well when compared to the ideas of options that require physical changes implemented. Changing the Bikes themselves would incur a cost well above the alternative. Milwaukee County is under tight budget constraints[vii]. The Milwaukee bus system is unlikely to take on altering this bus bike racks without financial compensation to offset the costs. There may be a demand from the riders to offer an accessory kit on require or order that would enable riders to trailer or connect two bublr bikes together. This option allows for Bublr to charge a small price to cover the price of the accessory kit that would allow the rider-less side or trailer bike to be used as storage.

The possibility exists with the digital mobile to prompt user behavior with a much lower cost to roll out the program. The question is how to motivate registered users of the system to alter their behavior to encourage user correction of the bike system. The instinct that may come to mind

would be to offer a financial incentive to prompt the desired user behavior to help self-correct the system.

There are two stories that demonstrate why moving to a financial incentive system may not be optimal in this situation. The first concerns a study at an Isreali daycare. The researchers observed the daycare's pick-up routines before implementing any changes to the organization. The parents of the child are asked to pick their children up by 4:00 pm to allow the staff to finish up their own work and go home for the day. The researchers then implemented a monetary disincentive, a fee, for parents who picked up their children late. The results were that more parents started picking up their children late from daycare. After the study it was found that altruism and social norms of respect were a greater motivation system than the financial reward. Once the daycare organization replaced the social norm, a taboo of wanting to do the right thing, with a financial disincentive – behavior worsened dramatically[viii].

The second story occurred during a highly controlled motivational study. Two groups were told to accomplish a task. The control group was informed that there would be no compensation. The experiment group was told that they would receive a trophy if their group completed the task in a better time than that of the control group. The result was that the group which was promised nothing worked harder than the group that was promised a trophy[ix].

The common theme from both accounts is one of unintended results when trying to correct for a problem. Both examples demonstrate that social norms and a person's internal motivation can dramatically out perform a straightforward financial incentive.

Course of Action Analysis and Recommendation

We recommend that Bublr implement an initiative aimed at influencing the behavior of its registered user base. This initiative would be rolled out through the Bublr mobile app. This 'Helping Bikes' initiative would be an automatic system of push notifications requesting a register rider parks at a nearby station when the station they are attempting to dock at is ninety percent full. The initial rollout could present an altruistic identity incentive that appeals to the registered users pride and character in supporting bike sharing in Milwaukee.

This program can automatically track data based on where the recipient of the push notification ultimately parks their bike. A different incentive may be implemented should an altruistic incentive yield insufficient result as deemed by leadership at Bublr. This alternative incentive should not be a direct monetary compensation to the rider. An option then would be to offer an award such as a refund for your bike trip that you just rode or if the user helps Bublr out so many times a year that they receive a thank you letter and or a free membership next year.

Appendix A

Timeline A: Bublr History from the City of Milwaukee website

July 24, 2012 - Common Council passed a Resolution "directing City departments to assist and support efforts to establish and maintain bicycle facilities including bike-sharing programs and installations".

July 2, 2013 - Common Council passed a Resolution authorizing a Grant Agreement with Midwest Bike Share for up to $50,000 from Tax Incremental Districts (TID) #68 and #75 in the 12th Aldermanic District.

July 23, 2013 - Common Council passed a Resolution authorizing a Grant Agreement with Midwest Bike Share and the City's Office of Environmental Sustainability for up to $38,000 of federal Energy Efficiency Block Grant (EECBG) funding.

Dec. 17, 2013 - Common Council passed a Resolution authorizing execution of a grant agreement for $1.6 million ($1,280,000 of federal Congestion Mitigation/Air Quality [CMAQ] funding, and $320,000 local City match) for the design, equipment purchase, and installation of additional public sharing equipment within the City of Milwaukee.

Spring/Summer 2014 - Department of Public Works staff worked closely with Midwest Bike Share staff to assess and select pilot bike share station locations, prepare these sites, and coordinate necessary permits and approvals. Ten stations were installed in August 2014.

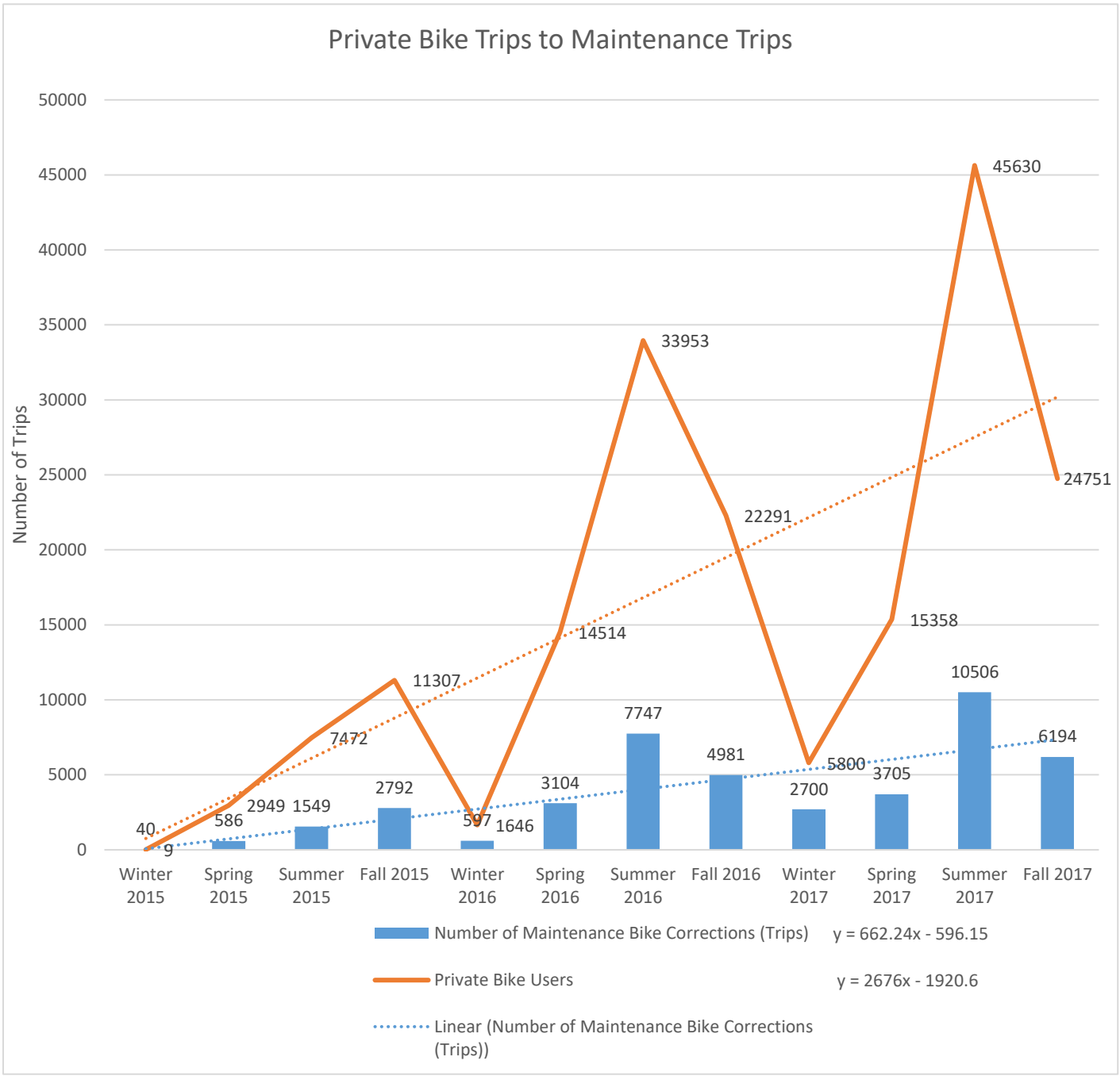
April 2015 - An eleventh station was installed on Brady Street at Humboldt Boulevard in partnership with the Brady Street Business Improvement District.

Fall 2015 - 17 new stations were installed, including six in partnership with the University of Wisconsin - Milwaukee.

Spring/Summer 2016 - 12 new stations were installed and 1 removed for a net gain of 11 stations.

Fall 2016 - 10 more stations were installed in Milwaukee, including one on South 5th St funded by TID 85. Those new stations brought the grand total to 49 stations in Milwaukee and 56 in the entire system, including the new stations in Wauwatosa.

Appendix B


Private Bike Trips to Maintenance Trips
Number of Trips
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
Winter 2015
Spring 2015
Summer 2015
Fall 2015
Winter 2016
Spring 2016
Summer 2016
Fall 2016
Winter 2017
Spring 2017
Summer 2017
Fall 2017
40
9
586
2949
1549
7472
2792
11307
597
1646
3104
14514
7747
33953
4981
22291
2700
5800
3705
15358
10506
45630
6194
24751
Number of Maintenance Bike Corrections (Trips)
y = 662.24x - 596.15
Private Bike Users
y = 2676x - 1920.6
Linear (Number of Maintenance Bike Corrections (Trips))

Two Sample T-Test assuming unequel variences

Comparing Increase in ridership to Increase in Maintenance Trips

Null: There is no strong correlation

Ho: There is a strong correlation

t-Test: Two-Sample Assuming Unequal Variances

Number of Maintenance Bike Cor		*Private Bike Users*
Mean	3483.416667	14990
Variance	11110513.9	208146543.8
Observations	12	12
Hypothesized Mea	0	
df	12	
t Stat	-2.691908037	
P(T<=t) one-tail	0.009800279	
t Critical one-tail	1.782287556	
P(T<=t) two-tail	0.019600558	
t Critical two-tail	2.17881283	

Alpa 0.05

Reject the null hypothesis if the alpha level in the output is smaller than your stated alpha level.

Compare the t-value with the t-critical value. If the t-value is smaller than the t-critical value, reject the null hypothesis.

t Stat		t - critical two-tail
2.69	>	2.17

absolute value of t-Stat is less than the t Critical two-tail test

Therefore, We can reject the Null Hypothesis

P(T<=t) two-tail		Alpa
0.020	<	0.05

absolute value of the p-value is less than the alpha

Therefore, We can reject the Null Hypothesis

Comparing an Increase in Kiosks to Increase In Maintenance Trips

Null: There is no strong correlation

Ho: There is a strong correlation

t-Test: Two-Sample Assuming Unequal Variances

Number of Maintenance Bike Cor		*mber of Active Kiosks*
Mean	3483.416667	37.25
Variance	11110513.9	660.0227273
Observations	12	12
Hypothesized Mea	0	
df	11	
t Stat	3.581351332	
P(T<=t) one-tail	0.00215422	
t Critical one-tail	1.795884819	
P(T<=t) two-tail	0.00430844	
t Critical two-tail	2.20098516	

Alpa 0.05

t Stat		t - critical two-tail
3.58	>	2.2

absolute value of t-Stat is less than the t Critical two-tail test

Therefore, We can reject the Null Hypothesis

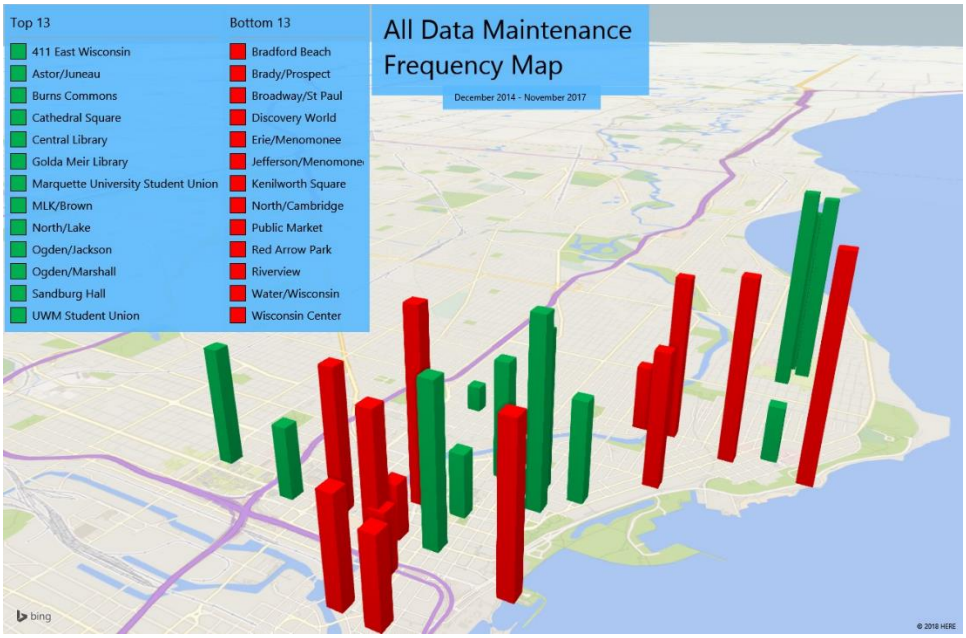
P(T<=t) two-tail		Alpa
0.00430844	<	0.05

absolute value of the p-value is less than the alpha

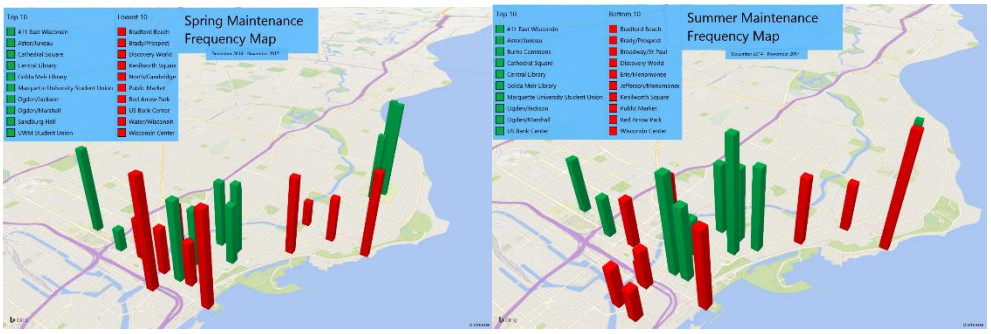
Therefore, We can reject the Null Hypothesis

Appendix C

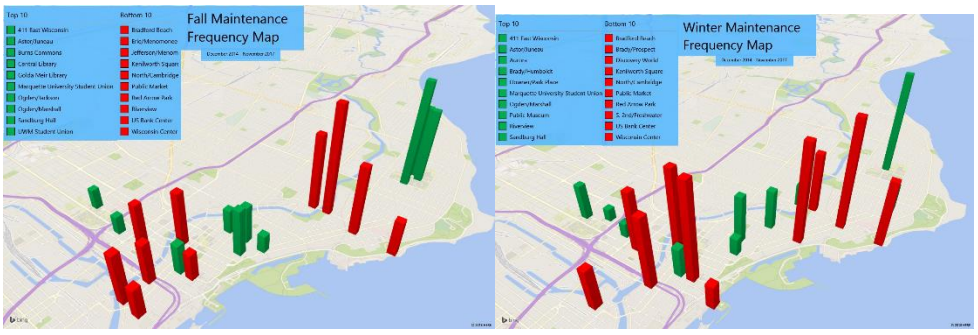
Map A



Map B - C



Map D - E



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