

**Survey Study on Accessing and Evaluating the public opinion
on the usage of UC Berkeley Campus Bus Shuttles**

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ABSTRACT

Public transportation systems provide many benefits to the general public; however, declining use of urban public transportation in developed countries is a major problem for many transit agencies. Identifying psychological factors associated with customer satisfaction in public transportation systems can inform policies designed to increase ridership. While the UC Berkeley campus bus shuttles are a convenient and free means of travel around campus, many students, staff, and faculty do not use them. To identify the factors behind the willingness to ride Berkeley campus shuttles, I assessed the opinions of frequent and non-frequent student, staff, and faculty riders and non-riders on their use of UC Berkeley campus bus shuttles using surveys. I found that improvement in bus service reliability was the most important factor influencing the willingness to ride for both frequent and non-frequent users. I also found that non-frequent value the off-bus services 17 percent more than the frequent bus users. Moreover, many non-riders do not use the campus bus shuttles because they that it is feel convenient enough to walk or bike to school. I conclude that campus bus shuttles should schedule and publicize bus schedules more effectively, in order to increase bus ridership at UC Berkeley. Livetrack technology and bus traffic priority light can be adopted to improve the overall ridership of campus bus shuttles. This study serves as a starting point for further studies.

KEYWORDS

Public transportation, service quality, bus policies, transit ridership, customer satisfaction.

INTRODUCTION

Public transportation systems provide mobility options for urban travelers, reduce global greenhouse gas emissions, air and noise pollution, mitigate traffic, and improve energy efficiency (American Public Transportation Association 2007). They can also play a key role in increasing urban population density, allowing for reduced travel distances, fossil fuel consumption, and per capita energy consumption (Barletta et al. 2009). But declining use of urban public transportation in developed countries (Hensher 1998) is a major problem for many transit agencies such as the San Francisco Municipal Transportation Agency (Taylor et al. 1998). Due to declining state and local funding, more than sixty percent of public transportation systems in the U.S. have cut services, while nearly two-thirds have eliminated some off-peak services and almost half have reduced geographic coverage (American Public Transportation Association 2009). In response to concerns that declining public transportation quality and service might decrease customer satisfaction and transit ridership, transit companies recently have focused on service quality to increase customer satisfaction and attract riders (Eboli and Mazulla 2007).

Identifying psychological factors associated with customer satisfactions in public transportation systems can inform policies designed to increase ridership. Perceived bus quality influences customer satisfaction (Eboli and Mazulla 2007), and passengers' willingness to reuse buses depends on their previous ridership experience (Jen and Hu 2003). Studies examining transit ridership during the 1990s showed that service quality and amenity improvements, such as adding bus stop shelters and increasing bus frequencies, enhanced user experience and increased ridership for 25 percent of U.S. transit systems (Hess et al. 2002). Transit managers perceive that service improvements and information availability programs increase ridership, while their opinions on other factors affecting changes in ridership patterns vary widely (Hess et al. 2002). A recent study of private transportation users concerning the psychological determinants of decisions to use public buses in Ho Chi Ming City, Vietnam concludes that potential riders would be more inclined to use buses if there were more frequent bus service and fewer negative rider experiences (Fujii and Van 2009). Thus, study of the psychological factors associated with ridership preferences is a valuable means of determining how to increase use of public transit.

Understanding riders' view on bus reliability (e.g., bus punctuality), on-bus service quality (e.g., driver attitude and behavior), off-bus service quality (e.g., information at bus stop), and

safety and security measures (e.g., bus driving safety) can be useful in developing policies intended to improve rider experience and increase ridership. Countries such as Australia have raised ridership significantly through bus service reliability improvements and frequency enhancements (Currie and Wallis 2008). ‘Soft’ bus vehicle improvements focusing on security, comfort, and amenities, on-bus safety, and on-bus service also influence bus ridership (Currie and Wallis 2008), while frequency and reliability improvements have been the top two priorities in efforts to increase ridership in Europe (Currie and Wallis 2008). Thus, service reliability is key to high bus patronage growth, while on-bus service quality such as exterior and interior cleanliness, off-bus services such as marketing and advertising, and safety measures are also valuable in developing policies that can increase ridership. No studies have considered all four factors in the same place. Moreover, many past studies focused on several factors affecting ridership, but none consider the factors that motivate the non-frequent users to ride the bus more.

While the University of California, Berkeley campus bus shuttles are a convenient and free means of travel around campus, many students, staff, and faculty do not use them. In Fall 2005, only 7.2 percent of undergraduate and graduate students used campus bus shuttles, and they used AC transit buses 6.4 percent more often than the UC Berkeley campus bus shuttles (UC Berkeley's Parking & Transportation Services 2005). No studies have been conducted to identify the definitive reasons for such low percentage ridership on the UC Berkeley campus bus shuttles. This provides an opportunity to conduct a comprehensive study of all four key factors effecting bus ridership at University of California, Berkeley.

To identify the key factors affecting decisions to ride Berkeley campus shuttles, I assessed the opinions of frequent, less-frequent, and non-frequent student, staff, and faculty riders on their use of UC Berkeley campus bus shuttles (Perimeter, Reverse, H-Line, C-Line). I hypothesized that bus service reliability is the most important factor influencing ridership decisions of frequent riders. Second, I hypothesized the non-riders of the UC Berkeley campus bus shuttles value the off-bus services as the most important factor.

METHODS

To access the factors affecting ridership on UC Berkeley campus shuttles, I surveyed University of California, Berkeley undergraduates, graduates, staff, and faculty at various campus bus stops and major entrances to campus (Appendix). I collected survey data both by hardcopy and online. I distributed around 700 surveys from Monday to Friday except on holidays at around 10 am, 1 pm, and 4pm to ensure coverage of different time periods, and I have 597 hardcopy surveys, and the 47 surveys were taken online. Since I divided the sections between different frequencies of ridership, I did not have to do stratify random sampling to prove my hypothesis. For the online surveys, I uploaded my survey to www.surveymonkey.com and distributed the survey link on facebook, limited only to UC Berkeley facebook networks.

In order to assess key factors influencing ridership decisions, I asked several riders to rank their concerns on service reliability, off-bus services, on-bus services, and safety and security measures. To compare preferences between frequent and non-frequent users of the campus bus shuttles, I asked about the usage times of campus bus shuttles. And I asked respondents to rate service quality measures from 1 to 5 to determine which bus service quality factors riders think need the most improvement. Then, I ask respondents to rank their top and second concerns on bus service qualities. At the end of the survey, respondents commented on the possible problems with my study design, confounding factors, and ideas for future studies.

I used Excel to collect and store my final data sets, and used regression models of different frequencies of bus use for each bus service quality factor to identify the most important factors affecting non-frequent and frequent user ridership decisions. I used statistical software Microsoft Excel to conduct Chi-Square and ANOVA tests to determine which services areas UC Berkeley students thought needed most improvement.

RESULTS

Cumulative Bus Service Improvement Priority Scores

Surveys of 644 mostly undergraduate students revealed that improvement in bus service reliability was the top priority and better off-bus service was the second priority affecting cumulative ridership decisions of frequent users, non-frequent users and non-users ($P = 6.679E-$

129, $P = 9.35E-35$). About 64.3% of respondents choose bus service reliability as their top priority and 40.2% of respondents choose bus reliability as their second priority. While 24.5% of respondents chose improvement of off-bus services as their top priority, and 34.4% considered this factor as secondary. Chi-Square Tests (Table.1) of top and second priority counts of bus service quality improvement, both with p-values less than 0.01, showed significant differences between the four groups of factors at 99 percent confidence levels.

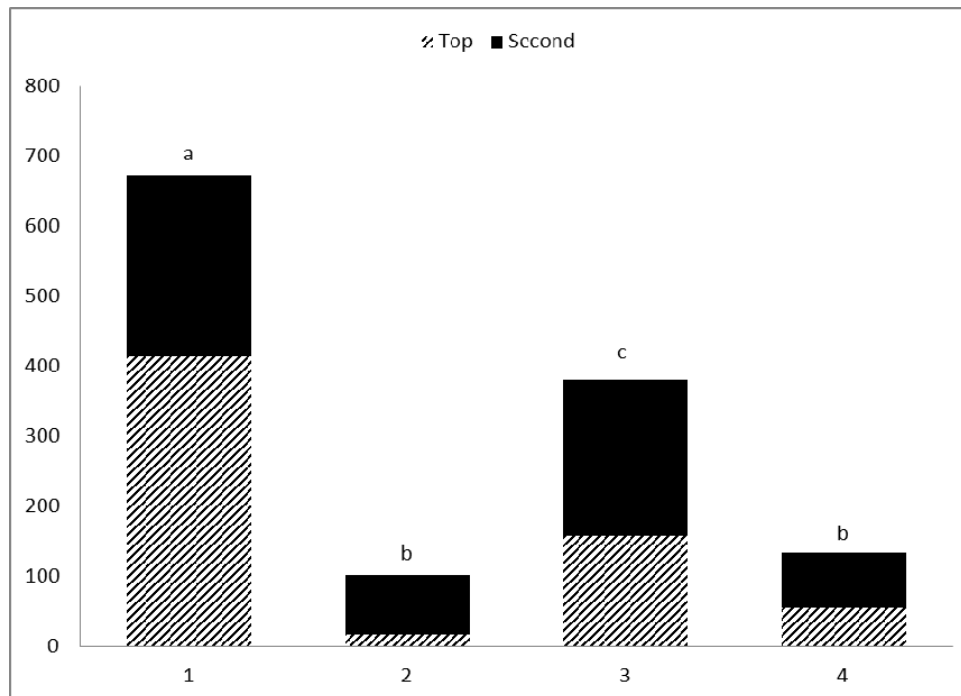


Figure.1 Total Top and Second Priority Count on Improvement of Bus Service Quality (1 = bus service reliability, 2 = on-bus services, 3 = off-bus services, 4 = safety and security measures) – Groups denoted by different letters ($p = 6.679E-129$, $p = 9.35E-35$)

Table.1 Chi-Square Test of top priority scores of bus service improvements

Chi Square Test – Top Priority	Bus Reliability	On-Bus Services	Off-Bus Services	Safety and Security	Total
Actual	414	17	158	55	644
Expected	161	161	161	161	644
P-value =	6.6797E-129				

Chi Square Test – Second	Bus Reliability	On-Bus Services	Off-Bus Services	Safety and Security	Total
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Priority					
Actual	259	84	222	79	644
Expected	161	161	161	161	644
P-value =	9.35218E-35				

Categorical Bus Service Improvement Priority Scores

I divided respondents into non-bus users, less frequent bus users (1-5 times/month), and frequent bus users (5+ times/month) to test if there were different opinions between these groups. Chi-Square tests were performed for the four factors affecting ridership decisions (Table.2 and Table.3). Frequent users listed improving bus service reliability as their top priority about 18 percent more than non-bus users (Table 2). And non-users preferred to improve off bus services 17 percent more than the frequent bus users. The Chi-Square Test for both top and second priority improvement counts shows significance differences between frequent, less frequent and non frequent users for both bus service reliability and off bus services.

Table.2 Chi-Square test between different ridership frequency and top priority improvement counts

Observed Values	Bus Reliability	On Bus Service	Off Bus Service	Safety and Security	Grand Total
Frequent	127	4	18	13	162
Less Frequent	144	5	50	22	221
None Frequent	143	8	90	20	261
Grand Total	414	17	158	55	644

Expected Values	Bus Reliability	On Bus Service	Off Bus Service	Safety and Security
Frequent	104.1428571	4.276397516	39.74534161	13.83540373
Less Frequent	142.0714286	5.833850932	54.22049689	18.8742236
None Frequent	167.7857143	6.889751553	64.03416149	22.29037267

	Bus Reliability	On Bus Service	Off Bus Service	Safety and Security
P-value =	0.012879462	0.853866713	1.14508E-05	0.669166378

Table.3 Chi-Square test between different ridership frequency and second priority improvement count

Observed Values	Bus Reliability	On Bus Service	Off Bus Service	Safety and Security	Grand Total
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Frequent	99	25	51	25	200
Less Frequent	92	29	83	28	232
None Frequent	68	30	88	26	212
Grand Total	259	84	222	79	644

Expected Values	Bus Reliability	On Bus Service	Off Bus Service	Safety and Security
Frequent	80.43478261	26.08695652	68.94409938	24.53416149
Less Frequent	93.30434783	30.26086957	79.97515528	28.45962733
None Frequent	85.26086957	27.65217391	73.08074534	26.00621118

	Bus Reliability	On Bus Service	Off Bus Service	Safety and Security
P-value =	0.020265093	0.861926822	0.019936049	0.991898213

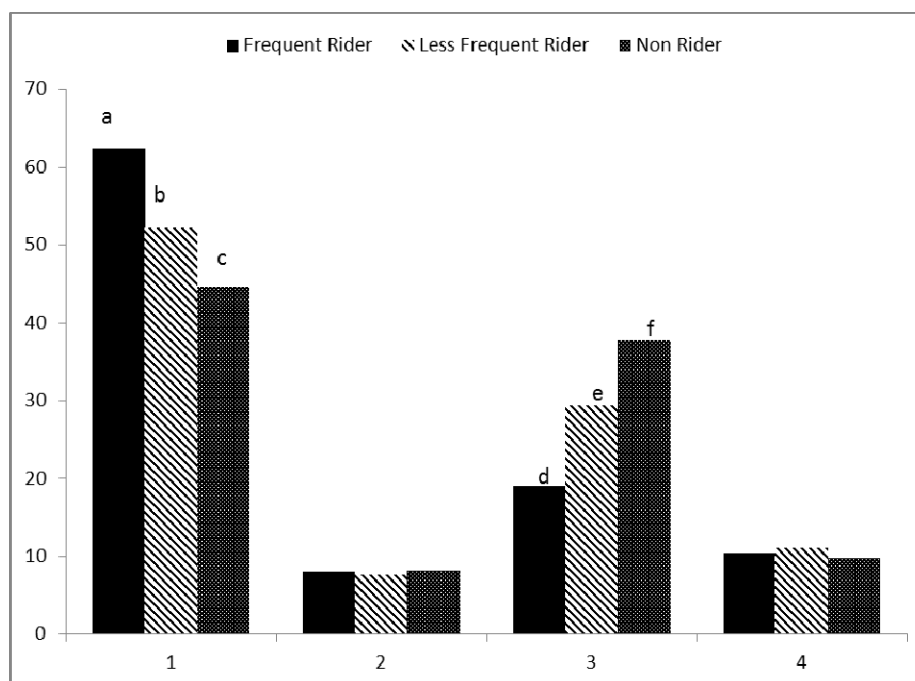


Figure.2 Percentage of different frequent riders versus the four different bus quality factors (1 = bus service reliability, 2 = on-bus services, 3 = off-bus services, 4 = safety and security measures) - Groups denoted by different letters (Top Priority - P = 0.042, P = 0.013, Second Priority)

Cumulative Bus Service Mean Quality Scores

In order to test the significance of different opinions of all respondents between the four bus quality factors, I recorded average bus quality scores. Mean quality scores showed similar

results to the ANOVA test, with a very small p-value revealing that there were significant difference within the groups ($F_{3,1564} = 2.610$, $P = 0.000$). The Tukey's Test shows that both bus reliability services and off-bus services quality scores were smaller than mean quality scores of the other two factors, and off-bus services quality scores were even smaller than bus service reliability quality scores (Figure.3).

Table.4 One-way ANOVA on bus mean quality scores

SUMMARY						
<i>Groups</i>	<i>Count</i>	<i>Sum</i>	<i>Average</i>	<i>Variance</i>		
Bus Reliability	392	1186	3.02551	0.991675		
On-Bus	392	1439	3.670918	1.01419		
Off-Bus	392	1082	2.760204	1.492223		
Safety	392	1509	3.84949	0.900562		

ANOVA						
<i>Source of Variation</i>	<i>SS</i>	<i>Df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
Between Groups	314.9439	3	104.9813	95.46681	9.7E-57	2.61059193
Within Groups	1719.872	1564	1.099663			
Total	2034.816	1567				

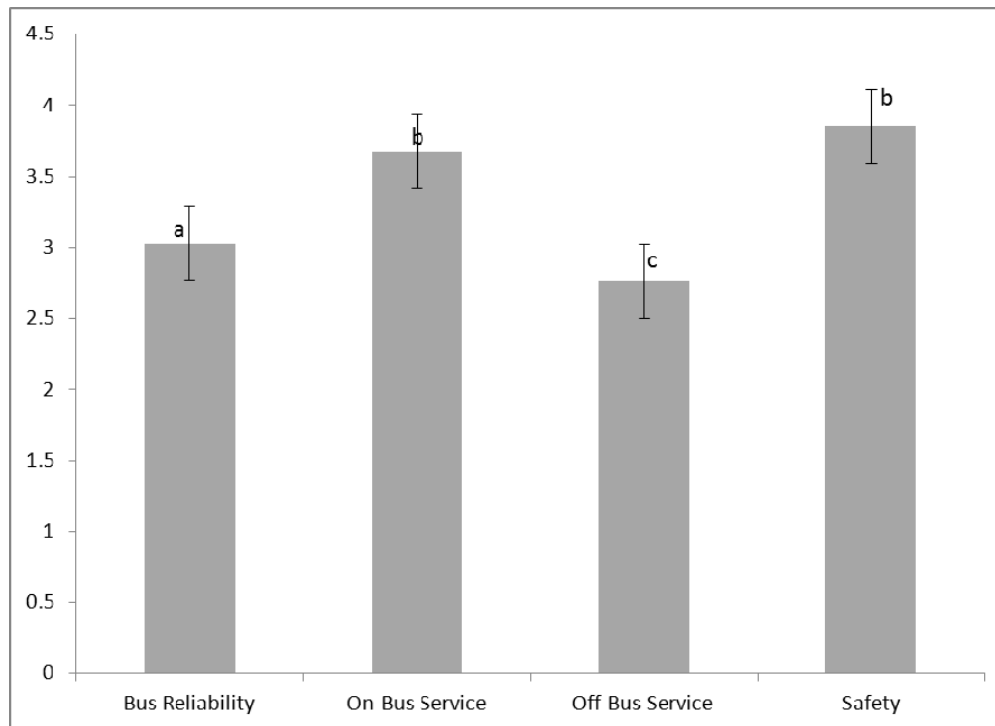


Figure.3 Mean Bus Quality Scores - Groups denoted by different letters ($P = 9.7E-57$)

Categorical Mean Quality Scores

To test whether the less frequent riders consider off-bus services as a more important factor influencing the willingness to ride, I divided mean quality scores between less frequent and frequent users and performed a T-test. The results show that frequent riders had significantly lower mean quality scores on bus service reliability than the less frequent riders (Table.5). However, the T-test results show no significant difference in prioritization of off bus services between these groups.

Table.5 T-test on bus service reliability and off-bus services between less frequent and frequent users.

Bus Service Reliability

t-Test: Two-Sample Assuming Unequal Variances

	<i>Less F</i>	<i>F</i>
Mean	3.131915	2.866242
Variance	0.892781	1.103789
Observations	235	157
Df	310	
t Stat	2.552946	
P(T<=t) one-tail	0.00558	

t Critical one-tail	1.649784
P(T<=t) two-tail	0.01116
t Critical two-tail	1.967646

Off Bus Services

t-Test: Two-Sample Assuming Unequal Variances

	Less F	F
Mean	2.731915	2.802548
Variance	1.43637	1.582558
Observations	235	157
Df	323	
t Stat	-0.55508	
P(T<=t) one-tail	0.289613	
t Critical one-tail	1.649585	
P(T<=t) two-tail	0.579226	
t Critical two-tail	1.967336	

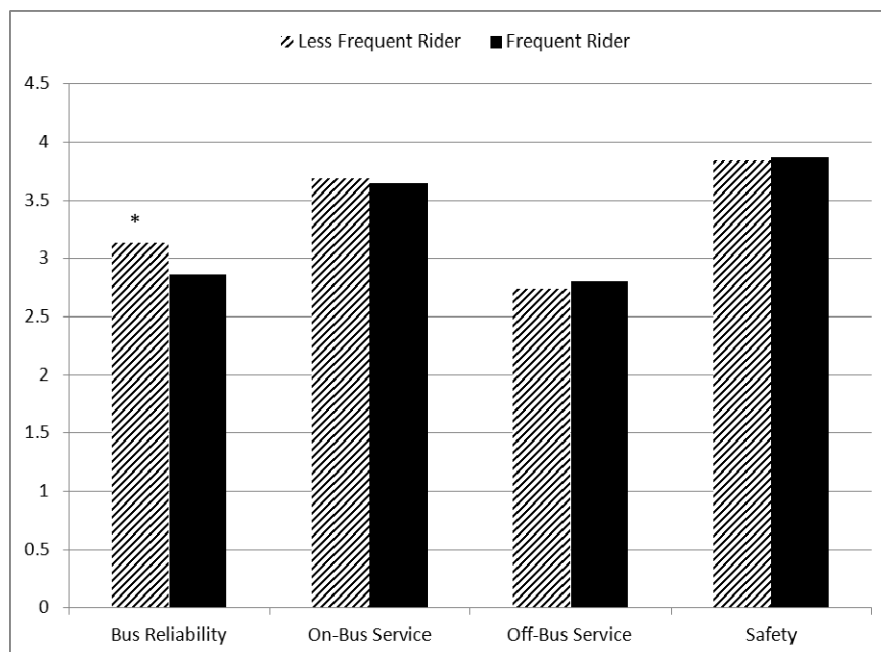


Figure.4 Comparison of bus mean quality scores between less frequent and frequent riders (* on the graph denotes that the differences are significant by T-test).

Qualitative Analysis:

Qualitative results shows similar feed backs between non-rider, less-frequent riders, and frequent riders. Most non-riders choose to not take bus because waiting time is too long and they think it is faster to walk to their destinations. Many respondents from all groups noted that publicizing bus schedules more on campus would increase bus ridership, the campus is not big enough to warrant a shuttle, and. synchronizing class schedules with bus schedules and improving service unreliability could shorten wait times and increase ridership. Less frequent riders seldom uses the bus unless the weather is bad, and they think the bus schedules are confusing and hard to access. There are some people that have safety and cleanliness concerns. Frequent riders mostly addresses the problem of punctuality and speed of the bus ,and wanted to reduce waiting time. Many thought that buses are usually late and not reliable.

DISCUSSION

My finding demonstrate the validity of both study hypotheses. Data showing that improvement in bus service reliability is the most important factor influencing willingness to ride proves the first hypothesis that the top factor influencing frequent user willingness to ride is bus service reliability, while off-bus services, on-bus services, and safety and security measures influenced ridership less factors. However, the mean quality scores of the four bus quality factors, which did not take into account the non-riders opinions, reveal that rider perceptions of bus reliability and off-bus services are both significantly lower than the other two factors. This shows that there are differences between the perceived quality of bus shuttles and the improvement that riders actually want to increase their willingness to ride. Moreover, Chen's study on public transits in Washington D.C. shows that bus service reliability factors such as transit travel speed, travel time would be first priorities above other transit quality characteristics under transit rider's considerations to take the transit system. Therefore, bus service reliability is the most important factor affecting bus ridership.

Finding that non-frequent and less frequent users value off-bus services as the most important factor proves my second hypothesis. I compared the percentage of bus factor priority scores between non-riders, less frequent riders, and frequent riders (Figure.2). Non-users

preferred to improve off bus services 17 percent more than frequent bus users, and the Chi-Square test shows that there were significant differences between the non-users and the frequent users. However, the t-test of mean quality scores of off-bus services did not show significant differences between less frequent riders and frequent riders, but there are still significant differences between the non-riders and the frequent riders. Therefore, non-riders value off-bus services as a more important factor influencing increased bus ridership decisions.

Non-riders and less frequent bus riders suggested several improvements in off-bus services that would increase their willingness to ride, including posting “clear and concise maps and schedules” at popular places such as Sproul Halls. Moreover, most survey respondents were not aware of where the campus bus shuttles stops are due to a lack of maps and schedules publication, clear bus stop sign, etc. A U.S. transit systems survey showed that transit managers think a good transit stop provides clear maps, schedules, and infrastructure that ensure the trust and safety for passengers, while they saw ease of transferring, cost-effectiveness, comfort, and aesthetic factors as less important (Smart et al. 2009). Other studies show that improving bus stop infrastructure would make riders feel safer waiting for buses, and thus increase ridership (Pulugurtha 2008). These studies support the conclusion that improving off-bus services qualities could drastically improve bus ridership numbers for the UC Berkeley campus shuttles.

The interrelationship of bus quality factors explains the conflict between perceived quality of current bus services and ideas concerning future improvement of bus qualities that could improve ridership. In Washington D.C., a study showed that travel time is a natural measure of the effectiveness of bus services and that the purpose of bus service is to transport people to their destination with safety and convenience, offering easy access and providing service information (Chen 2003). Bus schedule delays affect the perception of off-bus service and the safety and security measures of bus quality. This accounts for differences between the perceived bus quality scores and the future improvement of bus qualities, since people consider multiple factors when they are rating bus service reliability. Therefore, this is a confounding factor in this study that affects findings concerning current perceived bus quality and future bus quality improvement as means of increasing ridership.

Many people suggested improving the quality of bus stops by adding the ‘live stat’ information on buses such as nextBus.com to improve ridership. Many municipal bus rapid

transit services have adapted to this using ITS technology, which drastically improves customer satisfaction on bus transit because they feel certain that they will not be late to work or meetings by knowing the exact time the bus is going to come (Galicia 2009). Many Australasian BRT (Bus Rapid Transit) systems use real-time information displays at bus stops (Currie 2006). Active traffic light priority for buses is a major improvement for bus systems (Currie 2006), and many AC Transit, a Bus Rapid Transit system that runs between Alameda and Contra Costa County, bus stops have already adopted this kind of information technology. These types of real-time services will not only improve the quality of off-bus services, but will also make people trust the bus service because they will think the bus is more reliable. This kind of technology should drastically improve the ridership of campus bus shuttles.

Many non riders reported that why they did not use the campus bus shuttles at all because they feel that it is convenient to walk or bike to their destinations. Most of the survey respondents think that it takes much more time to get to a location by taking buses than by walking or biking because of the unreliable bus service and long wait time for the bus.

I prefer to walk. I am a proponent of public transportation, but I think the perimeter shuttle is a waste. The campus isn't really that big to warrant a shuttle, I think walking or biking should be more encouraged.

This quote is taken from one of the respondents who never took the campus bus shuttles. He talks about size of UC Berkeley and how it is not big enough to have an efficient bus shuttle service. He also talked about how his friends at UC Davis always take the campus shuttles to class since their campus is much larger than the UC Berkeley campus. The University TravelSmart initiative, a suggests that smaller campuses should encourage more walking and biking, since it is more energy efficient and environmental friendly (Rose 2008). Ryan and Frank's study of pedestrian environments (2008) considers how human behaviors affect travel options. They suggest that people would like to walk in a smaller traveling environment because it is more convenient and promotes healthier behavior. Compared to many other campuses, UC Berkeley campus size is fairly small, and many respondents think that walking or biking is a better option than taking the campus bus shuttles. This points to the need for future studies of the comparative efficiency between walking and taking public transportation at UC Berkeley.

Further future studies can be conducted based on the four service quality factors on other public transportation systems in regions other than campuses. From Currie and Wallis' study

(2008) shows the service quality factors would service great importance to increase transit ridership in Europe. Furthermore, Currie and Wallis's study (2008) states that even though improving service quality factors has a positive effect on growing the urban bus markets, there is no data showing which specific service factor would help urban bus ridership growth. Therefore, future studies can extend outside of the campus level and can have a comparative study on all the different urban region transit systems to discover if there are more underlying factors affecting transit ridership.

Public transportation certainly has a positive impact on our environment, but low ridership of public transit systems is wasteful. Even though public transportation systems provide mobility options for urban travelers, and they can reduce global greenhouse gas emissions, air and noise pollution, mitigate traffic, and improve energy efficiency (American Public Transportation Association 2007); only bus services that attract sufficient riders can realize those benefits to the environment. Therefore, improving service quality and ridership today should be a priority for policy makers. My findings show that improving bus service reliability would contribute to increase in ridership. Most importantly, improving off-bus service quality would be the most important means of making non and less frequent bus riders take the bus more. Hopefully this study will be a starting point for more and comprehensive studies about improving public transportation ridership based on the four service quality factors on different urban city areas.

ACKNOWLEDGMENTS

Thank you to Kurt Spreyer, Patina Mendez, Gabrielle Wond-Parodi, Lucy Diekman for assistance in all aspects of the research. I also thank all the people who took my survey.

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APPENDIX A

Hi. My name is Kehsun Lin. I am a senior majoring in Environmental Science at UC Berkeley. I am conducting research on public opinions about the use of UC Berkeley campus shuttles. Please help me by completing the survey! Thank You!

Survey – Form A

1. You Are a(n):

- ☐ Undergraduate
 ☐ Graduate
 ☐ Staff
 ☐ Faculty
☐ Other(Postdoc, etc.): _____

2. How many times per month do you use Berkeley campus shuttles?

- ☐ None
☐ 1 - 5
☐ 5 - 10
☐ 10 - 20
☐ 20 - 30
☐ 30 +

3. Rate the quality of UC Berkeley Campus Bus Shuttles in terms of the following:

	1	2	3	4	5
Punctuality of buses arriving at bus stops (Not on Time – Punctual)					
Time spent waiting for the bus (Long- Short)					
Attitude of the driver (Rude – Friendly)					
Information (timetable and map) at the bus stop (None available – Available)					
Safety of bus driving (Unsafe – Smooth)					

4. Based on the above measures of quality please indicate the two most important considerations that would encourage you to take the UC Berkeley campus shuttles more:

Top Priority: _____

Second Priority: _____

5. Please indicate any reasons that might make you NOT take the campus bus shuttles:

APPENDIX B

Hi. My name is Kehsun Lin. I am a senior majoring in Environmental Science at UC Berkeley. I am conducting research on public opinions about the use of UC Berkeley campus shuttles. Please help me by completing the survey! Thank You!

Survey – Form B

1. You Are a(n):

- ☐ Undergraduate
 ☐ Graduate
 ☐ Staff
 ☐ Faculty
☐ Other(Postdoc, etc.): _____

2. How many times per month do you use Berkeley campus shuttles?

- ☐ None
☐ 1 - 5
☐ 5 - 10
☐ 10 - 20
☐ 20 - 30
☐ 30 +

3. Rate the quality of UC Berkeley Campus Bus Shuttles in terms of the following:

	1	2	3	4	5
Speed and travel time of the bus service (Slow – Fast)					
Cleanliness of the bus (Dirty – Clean)					
Frequency of rude passengers on the bus (Less often – Frequent)					
Availability of Bus Schedules (Hard to Access – Easy to Access)					
Security on the bus (Unsafe – Safe)					

4. Based on the above measures of quality please indicate the two most important considerations that would encourage you to take the UC Berkeley campus shuttles more:

Top Priority: _____

Second Priority: _____

5. Please indicate any reasons that might make you NOT take the campus bus shuttles:

APPENDIX C

Hi. My name is Kehsun Lin. I am a senior majoring in Environmental Science at UC Berkeley. I am conducting research on public opinions about the use of UC Berkeley campus shuttles. Please help me by completing the survey! Thank You!

Survey – Form C**1. You Are a(n):**

- ☐ Undergraduate ☐ Graduate ☐ Staff ☐ Faculty
☐ Other(Postdoc, etc.): _____

2. How many times per month do you use Berkeley campus shuttles?

- ☐ None
☐ 1 - 5
☐ 5 - 10
☐ 10 - 20
☐ 20 - 30
☐ 30 +

3. Rate the quality of UC Berkeley Campus Bus Shuttles in terms of the following:

	1	2	3	4	5
Convenience of bus service for your needs (Inconvenient – Convenient)					
Comfort on the bus (Uncomfortable – Very comfortable)					
Comfort of shelter or Seats at the Bus stop (No Shelter or Seats – Shelter and Seats)					
Safety while waiting at bus stop (Unsafe – Safe)					

4. Based on the above measures of quality please indicate the two most important considerations that would encourage you to take the UC Berkeley campus shuttles more:

Top Priority: _____
 Second Priority: _____

5. Please indicate any reasons that might make you NOT take the campus bus shuttles:
