Community Transit Service at the University of Nevada, Las Vegas

MNTRC Report 12-73

MINETA NATIONAL TRANSIT RESEARCH CONSORTIUM

UNIVERSITY OF NEVADA LAS VEGAS

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REPORT 12-73

COMMUNITY TRANSIT SERVICE AT THE UNIVERSITY OF NEVADA, LAS VEGAS

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16. Abstract

The University of Nevada, Las Vegas (UNLV) provides parking at various locations on campus. However, this parking is not enough to meet demand and is increasingly becoming congested with single-occupant vehicles. Many students have to park upwards of about two miles from their campus destinations, either at periphery campus parking structures or off campus entirely, and then walk to the campus.

The Regional Transportation Commission of Southern Nevada (RTC)–in coordination with the University of Nevada, Las Vegas (UNLV)–conducted the study described in this report in order to determine the impact of improved bus service for students, staff, faculty, and others. The primary objective of this study was to identify the origins and destinations of UNLV students, staff, and faculty; their travel behaviors; their willingness to take buses to travel to the campus; and the cost associated with improved bus service. This study identified the services that should be improved in order to encourage students, staff, and faculty to take the bus, and found that if public transportation services were improved, most of them who never or rarely take public buses would be willing to ride buses to UNLV.

A cost analysis based on improved bus service showed that the students would have to pay $47.17 per semester to use it. In addition, the survey data showed that 50% of the student respondents were against including bus fees in semester fees. Therefore, to maintain existing farebox recovery, the cost of a 30-day pass and U-Pass should be increased 700%.

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EXECUTIVE SUMMARY

The University of Nevada, Las Vegas is a growing suburban university. The university has 30,454 students (head counts) as well as 2,925 full-time and 1,985 part-time employees. Located in the heart of Las Vegas, just east of The Strip, the university has 370 acres of land only. There are no more undeveloped parcels adjacent to the UNLV campus. Between 2013 and 2016, enrollment grew by 2.6%, on average, per year. Therefore, to accommodate this future growth, the university may need to consider measures to mitigate the growth of single-occupant vehicle traffic; increase the use of alternative modes; and increase campus densities by repurposing parking for other academic, support, and housing uses. One of the growing problems at the university is adequate parking for students, staff, and faculty. At present, the parking available is not enough to meet the demand. Therefore, students often must park their cars outside the university and walk longer distances to their destinations. This parking situation is causing problems for both the students as well as administrators.

The Regional Transportation Commission of Southern Nevada (RTC) currently provides bus service around the university. UNLV is surrounded by four major arterials, namely:

- S. Maryland Parkway (Route 109 and the Centennial Express (CX)) at the eastern border of the campus;
- E. Flamingo Road (Route 202) north of the campus; and
- Swenson Street and Paradise Road (Route 108) on the western edge, and E. Tropicana Avenue (Route 201) on the southern edge.

Based on parking passes purchased by students in fiscal year (FY) 2015, it seems that not many students take the bus to come to the campus. Only 4,370 transit passes were purchased by UNLV students, staff, and faculty in 2015. Therefore, the research team conducted a study to determine the frequency of use of existing bus service, routes, timing, amenities, and the cost associated with riding the bus. This study also determined travel behavior; travel mode; preferences with regard to amenities; willingness to use bus service; and the cost that people are willing to pay if the RTC bus service is improved.

An online survey was conducted with students, staff, and faculty between August 2014 and May 2015, and the findings are as follows:

1. 1,329 people responded to the survey. Of the respondents, 63% were students, 18% were staff, and 10% were faculty, representing a response rate of about 5% of the campus population. This distribution is representative of the composition of UNLV's population. About 85% of the student respondents are from Nevada.
2. The survey showed that most respondents (74%) commute to UNLV more than three times a week, mostly during the spring and summer semesters. Most respondents come to campus between 7 a.m. to 12 p.m. during the weekdays and leave the campus between 5 p.m. to 10 p.m.

3. About 80% of the respondents use single-occupant vehicles to come to the campus, and only 28% use public bus service. About 62% of the respondents said that they never took RTC buses to travel to UNLV.

4. The preferred mode of transportation by the respondents was single-occupant vehicles, followed by car pooling and public buses.

5. The respondents stated that the main reasons for not taking public buses are inconvenience, inflexible bus schedules, and safety. However, about 48% of the respondents who said that they had never taken the bus also said that they would be willing to take the bus if the service improved. This is a very important finding, indicating that students are willing to take the bus, but due to quality-of-service problems, they currently are not.

6. Half of the respondents stated that they are against including the bus fees as part of semester fees. The other half (42%) are willing to pay between $10 to $15 per semester for bus fees.

Based on these findings the following recommendations are provided to improve and sustain UNLV bus service.

1. The existing four bus routes operated by RTC for UNLV's population should be rerouted based on the destination points stated by the respondents. Specifically, two bus routes–Route 209 and the Centennial Express (CX)–should be rerouted to go to Lied Library in the center of campus so that the students can reach their destinations more easily.

2. Another major recommendation is to add the new bus routes so that RTC can serve a greater number of UNLV students. Based on the survey data, there is no RTC bus service in areas that are densely populated by UNLV students. However, the research team recommends that more demand analyses be conducted before adding the new bus routes proposed in this study because, in order to add new bus routes, a significant amount of resources are needed. In addition, RTC suggested that the research team find ways to improve existing bus service rather than adding new bus routes.

3. The existing bus service should be improved. The research team calculated the headways required for each of the bus routes, and determined the costs associated with increasing bus service. The headway was set for 18 minutes from 7 a.m. to 8:30 p.m. Based on the cost analysis, the research team recommends adding one-time bus service fees into the semester fee. To sustain this improved bus service, the students would have to pay $47.17 per semester.

4. Half of the students were against this semester-based bus-fee approach. Therefore, another cost analysis was conducted to determine the cost of each pass. The analysis found that the cost of passes would need to be increased seven times the current cost in order to generate enough revenue for the bus service.

I. INTRODUCTION

The University of Nevada, Las Vegas (UNLV), established in 1957, currently is making an effort to become a Tier 1 research university.[1] At the same time, UNLV plans to add a medical school.[2] The number of students enrolled in fall 2015 was 28,600; in FY 2014, the number of full-time employees was 2,925 and the number of part-time employees was 1,785.[3] UNLV has limited student housing, namely:[4]

1. The Dayton Complex, with capacity for 440 persons;
2. The South Residential Complex, with capacity for 480 persons;
3. Tonopah Residential Complex, with capacity for 622 persons; and
4. UCC Residential Complex, with capacity for approximately 400 persons.

This data reveals that UNLV's in-house capacity for student accommodation is negligible when compared to the number of students, which is why most students commute to UNLV. UNLV has limited parking lots and garages. Also, UNLV students, staff, and faculty face difficulties in finding the closest parking space to their destinations. Either they have to park at the far corners of the school or outside the school, at their own risk, and then walk to the campus. UNLV parking lots and garages can accommodate about 13,000 vehicles.[5] However, the demand is higher than that and the UNLV master plan aims to provide 20,000 to 23,500 parking spaces for Phase 1 Mega Events Center and campus growth. The long-term goal of the UNLV master plan is to provide the possibility for up to 29,000 parking spaces.[6] To fulfill future needs, UNLV requires more parking spaces. However, space on campus is limited and no other extra space can be accrued. The only viable solution is to make the public transit system more safe and reliable.

The Regional Transportation Commission of Southern Nevada (RTC) provides transit service around the university. UNLV is surrounded by four major arterials, namely:

1. S. Maryland Parkway at the eastern border of the campus;
2. E. Flamingo Road north of the campus;
3. Swenson Street and Paradise Road on the western edge; and
4. E. Tropicana Avenue on the southern edge.

Currently RTC is providing the bus service–namely, Route 109 & Centennial (CX), Route 202, Route 108, and Route 201–along these roads, respectively. If safe and reliable bus service could be operated between UNLV and various locations around the Las Vegas Valley, it is possible that more UNLV students, staff, and faculty might be attracted to use public transportation.

A quick search of websites from a number of universities revealed that most reputed schools have their own university transit system and their own schedule for shuttle operations. A website maintained by the American Public Transportation Association lists the universities that have their own transit systems.[7] Appendix A lists some details about shuttle systems at several universities in the United States. These websites indicated that most of the schools allow university commuters to ride public transportation free of charge. In turn for providing a free-ride transportation system, either the university managed its funds by selling parking permits and citations, or else by charging a mandatory fee at a certain fixed amount to each student in the university. Additionally, these websites revealed that most of the universities had their shuttles in operation when the schools were open, but they did not operate the shuttle service when the schools were closed. However, if the university operated the shuttle service during weekends and public holidays, the transit service was for limited hours and the headway (bus arrival and interval time) was as long as one hour.

UNLV has a transit center on campus that is operated by RTC and was established in 2013.[8] The transit station (Figure 1) occupies approximately 600 square meters, and is located south of University Road and west of Maryland Parkway. This transit station was built with financial help from the Federal Transit Administration.[9] Currently, the transit service operates on the route for RTC's Centennial Express, which provides service from the Bonneville Transit Center in downtown Las Vegas all the way to McCarran Airport Terminal 3.

RTC offers a discounted U-Pass program, and currently the U-Pass is sold for $32.5 per month and $104 for a semester to UNLV students, staff, and faculty. If students do not buy the U-Pass, they have to pay the regular price for a single ride, for 24 hours, or for a three-day pass.

Figure 1. The Transit Center at UNLV

The RTC website showed that for the existing UNLV bus transit service, the longest headway was 87 minutes (off-peak time) and the shortest headway was 18 minutes (peak time) for the southbound trip on the CX route.[10] On the other hand, for the northbound route, the highest bus interval was 109 minutes (off-peak time) and the shortest headway was 26 minutes (peak time). On average, the headway for the CX was about 48 minutes during the weekdays and 60 minutes on the weekends. This long transit gap is creating unfavorable conditions for students, staff, and faculty to be willing to take the bus.

Regarding the bus pass sold to UNLV students, staff, and faculty, data provided by RTC is shown in Table 1. The data for the number of passes sold in FY 2014 and FY 2015 was available, and showed that more UNLV 30-day passes were sold compared to the U-Pass. However, the trend of data showed that there was an increase of about 29% in the sale of the passes to UNLV students, staff, and faculty from 2014 to 2015. This indicated that more students, staff, and faculty were buying bus passes in order to commute to campus.

Table 1. Sale Data of Bus Passes to UNLV Students, Staff, and Faculty

		Number of Sales		Revenue ($)	
Type of U-Pass	**Price ($)**	**FY 2014**	**FY 2015**	**FY 2014**	**FY 2015**
UNLV 30-day pass	32.5	2,760	3,550	89,700	115,375
UNLV Fall semester pass	104	235	300	24,440	31,200
UNLV Spring semester pass	104	400	520	41,600	54,080
Total		3,395	4,370	155,740	200,655

Compared to the number of passes sold and the population of UNLV, it could be determined that only about 12% of the UNLV population commuted to campus by using RTC bus service. Most students, staff, and faculty either traveled by bicycle, carpooled, or used their private cars to come to the campus. The cheapest fare for a U-Pass for a semester costs $104, and the annual parking permit for students per year is just $137.[11] This website also indicated that the cost for parking is very low compared to other universities.

The number of students enrolled at UNLV is growing every year. In 2010, the total student head count was 28,639 (UNLV, 2016). The student head count reached 30,454 by Fall 2010, which is an average increase of 1% per year. However, the increase was about 4% in 2016. Without an increase in campus housing, carpooling, public transit ridership, cycling, or other alternative modes, UNLV will require more parking spaces to accommodate future growth.

Due to limited land adjacent to the campus, future growth will require campus infill and densification supporting higher-quality transit service (e.g., more routes, reduced headways, more amenities, etc.). In order to study the existing transit conditions at UNLV, the origins and destinations of students, staff, and faculty were identified to determine their travel behaviors, preferences, and existing bus schedules. This study assessed the existing bus stations and their routes in order to recommend the number of bus stations needed so that more students, staff, and faculty can take the bus while commuting to UNLV. In addition, a cost analysis was conducted regarding improvements to current bus service, and to determine the new fee structures for the students, staff, and faculty.

Study Objective

The main objective of this study is to improve the transit system at UNLV so that more students, staff, and faculty will take a bus to the campus and relieve traffic congestion on campus. To accomplish this objective, the researchers performed the following tasks:

a. Conducted an origin and destination survey of UNLV students, staff, and faculty;

b. Identified locations for new bus stations and bus service headways;

c. Identified the amenities required in buses so students, staff, and faculty will ride them;

d. Performed a cost analysis to determine the fee structures of bus service based on the improved transit system; and

e. Provided recommendations to improve the bus service on UNLV's campus.

Literature Review

A literature review related to the university transit system and its funding models was conducted. First, academic research findings related to university transit systems were explored. Then, transit models of various universities were studied by visiting the universities' websites. In addition, funding models for their transit systems were analyzed. A summary of the findings of this main literature review are provided as follows. Appendix B shows the literature related to university transit systems.

University Transit Systems

A report published by the Transportation Research Board (TRB) in 2008, entitled *Transit Cooperative Research Program (TCRP) Synthesis 78*, was based on the survey responses provided by 94 educational institutions about transit systems at college and universities.[12] Most of the survey respondents were from four-year universities. All of the universities indicated that they operate the transit system themselves or contract these services via a third party to serve campus communities. Most respondents agreed that the headway was less than 10 minutes for college transit stations. The report showed that 29 transit systems charged no bus fare for students, and 26 transit systems charged $1.00 to $1.50 per local bus ride. However, most of the shuttle services for on-campus circulation were free to ride.

Approximately 60% of the universities utilized park-and-ride facilities off site that were owned/operated by the university. The report revealed that many institutions charged low parking fees to their staff and faculty. Nine institutions reported an annual parking fee that was less than $100. The study found that a reduced parking fee did not support the concept of reducing the number of single-occupant vehicles (SOVs). The report recommended conducting more research on safety systems, including late-night safety and emergencies regarding the transit system.

Another TRB report showed transit fees for the students covered 11% to 100% of the transit systems' total income.[13] The fee ranged from $8 to $59 per semester; some had a separate rate for summer terms, and some charged directly per year. This report revealed that most of the educational institutions involved in the survey were moving towards the unlimited transit access system (U-Pass) funded by student fees, parking fees, fine revenue, operating grants, and other university contributions.

Survey results obtained by Bryan Dorsey at Weber State University in Ogden, Utah, which has around 18,000 students, indicated that during the first year of operation of the Ed-Pass, operated by the Utah Transit Authority, student ridership on buses increased by 6%.[14] According to the author, the Ed-Pass offered "… unlimited access (UA) and was an outcome of partnerships between universities and public transit agencies in which universities purchase discounted transit passes." The author mentioned that most respondents suggested more direct travel routes, better bus scheduling, and better availability of bus information as desirable improvements for their transit system.

In 2006, Myers et al. conducted a survey that targeted students at the Western Washington University in Bellingham, Washington.[15] Most of the respondents favored a mandatory university bus pass with unlimited access at a cost range of $15 to $20 per quarter of an academic year. The respondents preferred the concept of having a mandatory pass system because of reasons such as night services, safety, reasonable pass prices, cost savings as compared to owning a car, and less environmental pollution. Respondents who did not prefer the mandatory fee mentioned that the system did not meet personal needs, and the pass should be made optional rather than mandatory. The authors claimed that the "willing to pay" (WTP) amount was less for people who drive than that for those who commute by bus or bicycle. While analyzing the data, they found that the mean WTP cost was $32.08 per semester, which was higher than the required cost of $20 per student per semester to run the transit system.

Wilbur Smith Associates conducted a feasibility study for a transit station inside UNLV, and pointed out the need for improving UNLV transit.[16] The report mentioned the necessity of improving signalization at Swenson Avenue and Harmon Road as well as at University Road and Maryland Parkway. It also pointed out the requirement of a real-time bus tracking system for UNLV transit services. The report concluded that bike access around the school could be improved as well. The feasibility study proposed connecting the UNLV Transit Center with Swenson Avenue through to the Thomas & Mack Center. The connection would have some bus rapid transit points within this road stretch.

Khattak et al. compared the travel characteristics of university students in Virginia to local residents. In this study, the authors considered any travel more than a 300-foot distance as a separate trip.[17] They compared the number of trips made by university students with the number of trips made by local residents. The t-test performed by these authors showed that university students made a significantly higher number of trips than the local residents on weekdays, around 20% more; this difference was not much greater on the weekends. The purposes of travel made by students were commuting to the university, workplaces, malls, and home as well as for meals, academic activities, shopping, and social and recreational activities. The study showed that university students participated in more

activities during the midday and the evening than did the local residents. Finally, these authors recommended that data of trip generations by university students be integrated in the regional travel-demand model.

Akar et al. conducted a web-based survey at Ohio State University to collect data on travel patterns of the campus community.[18] Most respondents indicated that shorter travel time and frequent service were the top factors that encouraged commuters to use the transit service. Their study on mode choice showed that travel time, flexibility in departure times, concern for the environment, and cost were the most important factors affecting the mode choice. The authors performed a principal component analysis to find the co-relation between the variables for factors affecting mode choice. Safety from crime and traffic were found to be the first component, and positively correlated with extreme weather conditions. The cost and concern for the environment were reported as highly important factors affecting mode choice, and positively correlated as the second component. From the study and the survey data analysis, the authors concluded that in order to encourage use of alternative transportation modes instead of SOVs, such factors as safety, flexibility for departure, and travel time should be improved to existing services.

Transportation Services at the University of Wisconsin-Madison conducted a survey to understand the transit-trip characteristics of the campus's bus riders during the academic semester.[19] The report stated that the bus service was free, and nobody had to show an identification card to get rides. The report covered survey data received from all the routes connecting the university, and noted that a particular route, Number 80, was more crowded than other routes. It further showed that 34.4% of the commuters travelled from between 10 a.m. to 3 p.m.

Considering the cost savings, Godavarthy et al. conducted a benefit-cost (B/C ratio) analysis for small urban and rural transit systems in the U.S. Based on their findings, the overall B/C ratio for a small urban area was 2.16 and for rural areas, 1.12.[20] The study found that for fixed-route buses in small urban cities in Nevada, the B/C ratio for a transit system was 2.39, which was greater than the national average. However, for rural areas in Nevada the B/C ratio for a transit system was 1.26. Similarly, a report prepared by Ferrell indicated that a reasonable investment in a transit system could generate substantial benefits.[21] The author found that B/C ratios for transit systems located in urban and rural areas were higher than the break-even value of 1.

Study on the University Transit Service Funding Mechanism

In order to understand the funding models for transit systems at U.S. universities, in this study correspondence was sent by email to the responsible administrative units of these transit systems. The responses received are provided below.

A response from Cliff Shuttle service, operated by Emory University (Atlanta, Georgia), revealed that a portion of its transportation budget was funded by a benefits pool for employees. In addition, various department/entities on campus paid for designated shuttle-service hours to be offered to their employees. The benefit of this model was that a shuttle system could be provided to the Emory University community free of cost.

Iowa Metro City has three transit systems, namely Iowa City Transit, Coralville Transit, and CAMBUS. CAMBUS operates at the University of Iowa (UI) and between UI facilities. The Coralville and Iowa City transit systems provide service to connect these campuses to the city's community. CAMBUS always has been a no-fare service, supported by other means. Any commuter could ride CAMBUS at no cost, and it has approximately 4.7 million riders per year. According to the CAMBUS management team, as communicated by email in March 2015, UI had funding support from three sources: the student service fee (40%), parking services at UI (30%), and the U-Pass system for the Iowa City transit and Coralville transit system (30%). A full-time student was charged $28.15/semester and $14.08 for the summer.

Arizona State University (ASU) does not charge any fees to students and staff for its transit service. ASU manages the funds for the transit service through sales of parking permits and citations. According to an email communication from a reliable source at ASU, this kind of funding is not sustainable and ASU is looking for another source of funding for future transportation.

Similarly, Florida State University charges a Transportation Access Fee of $8.90 per credit hour to all students. This income supports the entire parking and transit system, including the Seminole Express and the evening service known as Nite Nole. The citation revenue, parking fees paid by faculty/staff, and event revenue provide some portion of the funding for the transit system as well. However, the transit system relied heavily on revenues from the Transportation Access Fee.

An inquiry to Northern Arizona University (NAU) indicated that its Transportation Department does not receive any state or university funding. Currently, the department is supported by a fee of $50 per semester for each student. However, no charge is imposed on students who purchase a parking permit. Revenue from the parking permits also is used to support the transit service. However, this revenue is not sufficient to support the entire transit system. In the last six years, NAU had weekly ridership over 25,000; currently, this ridership has doubled to 50,000. To meet the increased demand, the semester fee to students became a necessity.

Summary

The literature review revealed that most universities studied have transit systems run by their administration or in partnership with the local transit agencies, similar to UNLV. To sustain these systems, some universities charge students within their semester fees, and some use bus-pass fees or revenues generated by parking fees and citation fees. Some universities have a certain dedicated budget for their transit system.

Some universities collected the students' travel behaviors and their preferences with regard to a university bus system. These studies showed that students made frequent trips to the universities during the weekdays, and between certain hours when on campus. The students mentioned that the frequency of the buses and the cost are the major factors for them to decide whether to use the university bus system. Many universities had prepared their bus systems based on their students' requirements.

A quick review of bus systems in various universities showed that they provide service to their students based on their requirements. Some universities also have prepared online GPS bus-tracking systems in their apps, so that the students could use the service effectively in their daily life. This literature review helped the research team in its preparation of the survey questionnaire so that relevant data could be collected to fulfill the research objectives. As mentioned earlier, the objective of this research was to determine how the UNLV transit system could be improved and financially sustained.

II. METHODOLOGY

For a systematic approach, this research followed the steps given in Figure 2. The research team met with RTC's director and staff to prepare the questionnaire. After the questionnaire had been approved by RTC, it was sent to the Institutional Review Board (IRB) to get approved. After the questionnaire approval, the survey was distributed to students, faculty, and staff. The data collected were analyzed to make recommendations for improved transit service on the UNLV campus.

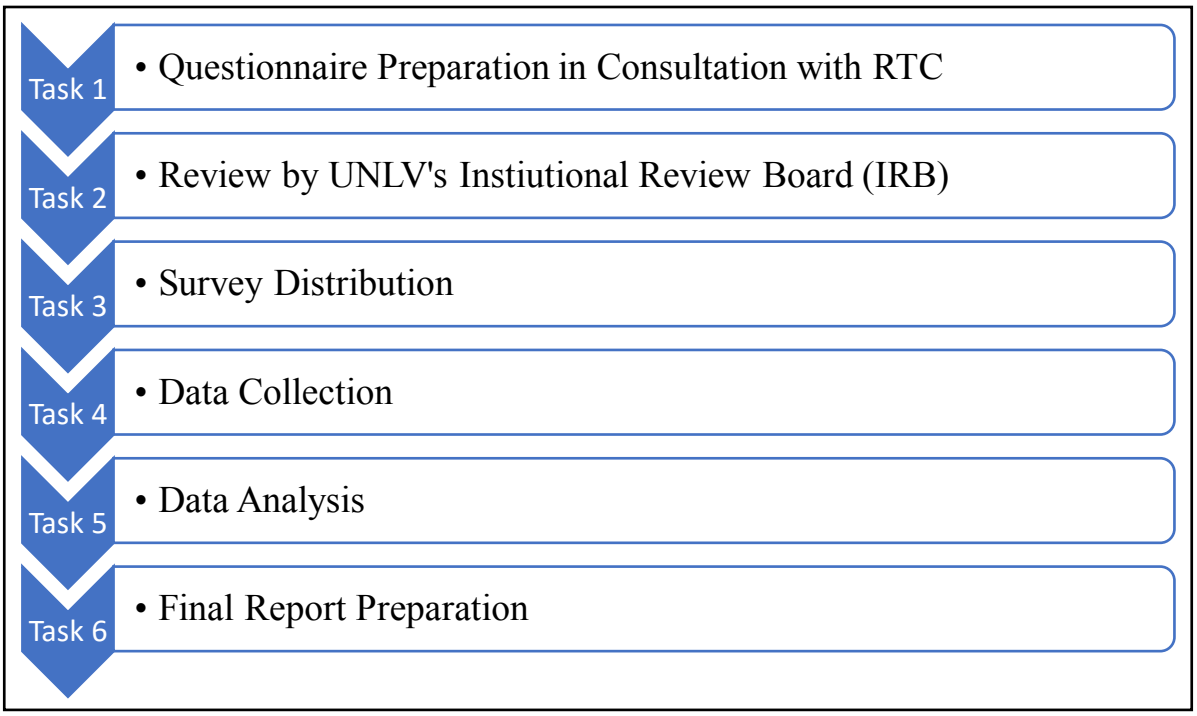

Figure 2. General Steps Adopted for the Research Methodology

Questionnaire Preparation

The first step of this research was to prepare a questionnaire in order to collect the data from target groups. The questionnaire was prepared based on the literature review as well as what was proposed in the original proposal. The main goals of the questionnaire were to collect origin-destination data and travel behavior of UNLV students, staff, and faculty; the cost of the transit system; and the amenities that respondents wanted in RTC buses.

After the researchers developed the questionnaire, the survey instrument was presented to RTC staff at a kickoff meeting on June 4, 2014. Then, the questionnaire was modified to incorporate feedback received at the meeting. After the questionnaire was approved by RTC, the survey instrument was sent to UNLV's IRB on August 15, 2014. The research team received IRB approval to commence data collection on September 5, 2014. The questionnaire is available in Appendix C.

Survey Distribution

After IRB approval, the questionnaire was designed using the Qualtrics survey tool.[22] Because the survey targeted three UNLV user groups, the link to the survey were distributed by three means. For the first method, the communications director of the Howard R. Hughes College of Engineering sent a mass email to all students, staff, and faculty at the college. There are 15 colleges and schools within UNLV, so the communications director at the engineering college also sent the survey link to the 14 other communications directors, who forwarded the email to their respective students, staff, and faculty. The second method involved sending the survey by email to students by means of their Rebel Mail accounts. The principal investigator (PI) of this project posted the survey link in RAVE (Rebel Announcements via E-mail), which was sent to all students by UNLV's Office of Information Technology (OIT). The third method involved posting the survey link in the daily online newsletter, UNLV Today, which is sent by email to all staff and faculty.

These three means were the major methods to contact students, staff, and faculty. The PI tried to get the database of email addresses for all students from OIT; however, due to privacy reasons, OIT refused to provide this list to the researchers or send our survey link to its email database of students, staff, and faculty. Therefore, the researchers used these three alternative ways to reach out to the UNLV population.

The emails and announcements of this survey were sent out every two weeks for two semesters, starting in Fall 2014 and ending in Spring 2015. There were no incentives offered to take the survey; however, a cover letter included with each announcement stated that the feedback from the survey would help UNLV to improve transit service for the university and the information gathered would be kept as confidential as possible. The invitation cover letter included in the survey is provided in the Appendix.

Data Collection

Progress in data collection using the survey was not satisfactory in the Fall 2014, with only 789 responses collected. The survey was extended for an additional semester to increase the response rate. In Spring 2015, the research team distributed the questionnaire once again to the students, staff, and faculty. By the time the survey process ended, 1,329 survey responses had been collected.

In Qualtrics, when the data is collected each has its own ID for each of the respondents. Once the respondents opened the survey link, the ID was created for that respondent based on their email address and IP address. If the respondents opened the survey by email, their ID was recorded. If the respondents did not complete the survey, and then opened the survey link once again, the responses started from the point where he/she left the survey. Therefore, there was no chance of duplication if the respondents opened the survey link by using their email address. However, if the survey link was opened from an announcement page in RAVE and UNLVToday, then there was a chance that the same respondents might have filled out the survey more than once. If the respondents opened the survey link from the same computer, the IP address was noted by Qualtrics; if required, it can be checked whether the respondents had used the same computer more than once.

However, to remove the responses from the same computer IP address would not make sense, because the students could go to the library, for instance, and log into the same computer to provide their responses. Therefore, data collected from Qualtrics were not screened for duplicate responses.

The emails and the announcement with survey links were sent during the two long semesters. The data was collected when the semesters started and ended at the end of the semesters. It can be seen that during the semester when the survey started, more responses were received; in the later semester, the responses decreased significantly. Therefore, data collection was stopped after the third semester because the responses were much fewer, and continuing the survey would not have helped to increase the sample size. The researchers kept track of the number of responses every month to see the progress of data collection.

Data Analysis

The data received from the survey was analyzed using descriptive statistics. In some cases, where required, statistical tests were conducted to validate the findings. A descriptive analysis was performed to count and categorize the responses based on whether they were students, staff, or faculty.

The questionnaire survey was designed to capture the origin and destination of students, staff, and faculty to UNLV. Based on the data received from the survey, maps for their origins and destinations were prepared. These maps helped to identify those areas in which the UNLV population resided more densely than other locations. A map that showed the most common destinations of respondents assisted to identify the most frequent destinations inside UNLV. For mapping using geographic information systems (GIS), shape files were obtained by Clark County, Nevada.

Various analysis tools were explored to help study the data obtained from the survey. For visualization purposes, QGIS (2.8 version) was used to prepare the map that assisted the origin-destination study as well as other maps relevant to this study. For data analysis, the R-programming (3.8.1 version) tool was used.

The survey results were analyzed in three major categories. First, a descriptive statistic of the respondents' demographics was developed. Then, data from the origin-destination surveys were analyzed. Based on this analysis, the geospatial distribution of respondents' origins and destinations were generated so that new bus station locations could be identified to improve bus service inside the campus. In addition, data related to the types of amenities the respondents preferred in the buses were analyzed. Finally, a cost analysis was conducted to determine the fees for the UNLV transit system in order to provide the improved bus service as suggested by the respondents. All responses were analyzed based on the number of responses received for specific questions. Not all of the respondents responded to each question provided in the questionnaire. Therefore, the total number of responses for each question is not equal to the total number of responses. The total number of responses received was 1,329, which is about 4.5% of the university's total population.

In this study, various maps presenting the spatial distribution of the respondents were prepared. Based on the spatial distribution of the respondents and the suitability of a new transit station, the location of the new transit station was identified. Finally, a cost analysis was performed to determine a mandatory transportation fee that should be charged to each student so that RTC could operate a fare-free transit system. The resulting sections present the final output of this research.

Improved Bus Service and Cost Analysis

Based on the survey results, the research team identified new bus routes that could be introduced so that the areas where students, staff, and faculty reside are covered by RTC bus routes. Based on this analysis, locations for new bus stations were identified as well. The bus headway required based on the survey data was calculated so that enough buses could run on these routes to serve UNLV students, staff, and faculty.

After the headway was calculated, an additional need for buses was determined. Based on the new headway and new bus stations, the total cost of providing improved service was calculated. Based on the literature review of funding models for other universities, the research team used the semester fee system for all students based on systems used at Florida State University, Northern Arizona State University and the University of Texas at Austin. In addition, the cost for a U-Pass and 30-day pass was also calculated based on the improved bus service.

Final Report Preparation

Based on the data analysis, the conclusions and recommendations are provided to improve the transit system at UNLV. The research team prepared a final report based on the tasks completed for this project.

III. SURVEY RESULTS

This section includes the descriptive statistics of the respondents' demographics; travel information and behavior; perception of public bus service; parking permit information; and recommendations to improve bus service at UNLV. The detailed findings are described below.

Descriptive Analysis of Respondents' Demographics

Out of 1,329 participants, most respondents (63%) were students, followed by administrative staff, then faculty members. About 9% of the respondents were categorized as "Others," which included guests and post-doctoral fellows as well as friends and family of the students, staff, and faculty (Table 2). This distribution shows that the sample size of each of these groups is representative of the UNLV population.

Table 2. Types of Respondents

S.N.	Types of Respondents	Proportion of Responses	Responses	%
1	Student		833	63%
2	Administrative staff		240	18%
3	Faculty member		135	10%
4	Others		121	9%
		Total	1,329	100%

Even though 833 students participated in this survey, only 791 students completed the questionnaire. Out of these students, 70% were undergraduates, 12% were graduate students (MS students), 6% were doctoral students, 2% were guests, and 10% were others (Table 3).

Table 3. Categorization of the Student Respondents

S.N.	Student Category	Proportion of Responses	Responses	%
1	Undergraduate		557	70%
2	Graduate (MS students)		92	12%
3	Doctoral		45	6%
4	Guest		16	2%
5	Others		81	10%
		Total	791	100%

At UNLV, most of the students are from Nevada. Therefore, the respondents were asked about their residency status. The data showed that 85% of the respondents were from Nevada, and only 15% of the respondents were from out of state (Table 4).

Table 4. Residency Status of the Respondents

S.N.	Residing in Nevada just for the study?	Response	%
1	Yes	191	15%
2	No	1,086	85%
	Total	1,277	100%

Travel Information for the Respondents

The questionnaire was designed to collect information about the respondents' residence locations; their origins and destinations while traveling to the campus; their frequency of travel to the campus; travel periods; modes of travel; and RTC bus routes used while coming to campus.

Most of the respondents live in the neighboring areas surrounding UNLV. Based on the zip codes of respondents' residences, a map was prepared to determine the distribution, as shown in Figure 3. For visualization purposes, QGIS (2.8 version) software was used to prepare the map. The map showed that the highest percentage of respondents (around 9.34%) who commute to UNLV was from zip code 89119, which surrounds the campus.

Most respondents for this survey were students, therefore, the highest percentage of respondents were residing nearby the UNLV campus. Fewer respondents had residences farther from UNLV, and RTC has existing bus service for the residents of this zip code. The second highest percentages of respondents commuting to UNLV came from zip codes 89074 and 89052, with 4% living in these areas. However, these zip codes do not have any existing RTC bus service. Hence, RTC may need to plan a new bus route from these areas to the UNLV Transit Center.

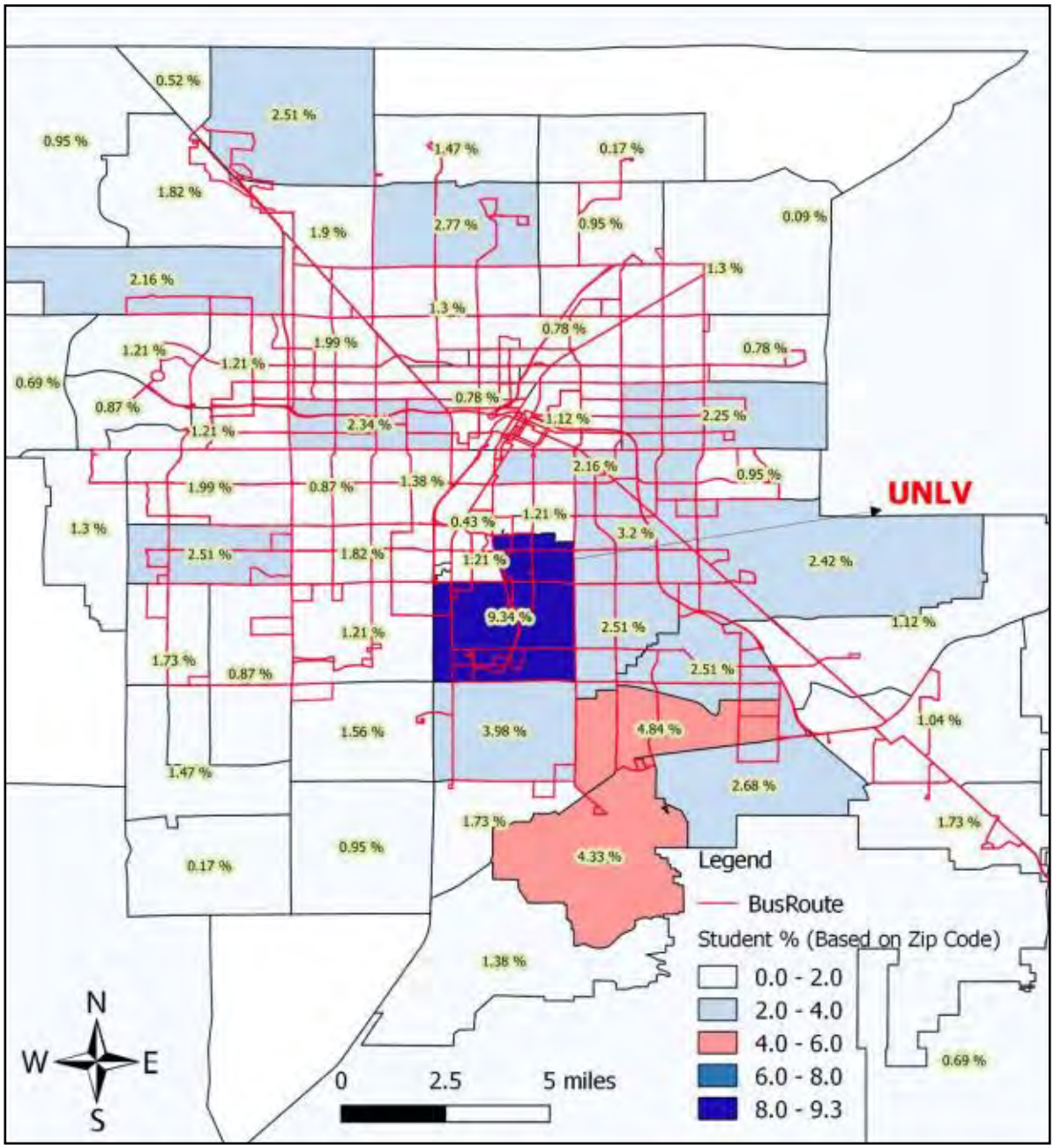

Figure 3. Spatial Distributions of Respondents Based on Their Residency Zip Codes

Distributions of the respondents based on zip codes are presented in Table 5. This table, as well as Figure 3, indicates that respondents are living in different area of the Las Vegas Valley, and a lot of respondents have to travel to UNLV.

Table 5. Distribution of Survey Participants Based on the Zip Codes of Residency

ZIP Code	Respondents' Percent (%)	ZIP Code	Respondents' Percent (%)	ZIP Code	Respondents' Percent (%)
89119	9.34	89148	1.73	89142	0.95
89074	4.84	89183	1.73	89166	0.95
89052	4.33	89139	1.56	89081	0.95
89123	3.98	89178	1.47	89113	0.87
89121	3.20	89084	1.47	89146	0.87
89031	2.77	89044	1.38	89144	0.87
89120	2.51	89102	1.38	89156	0.78
89131	2.51	89032	1.30	89106	0.78
89147	2.51	89135	1.30	89030	0.78
89122	2.42	89115	1.30	89138	0.69
89107	2.34	89145	1.21	89005	0.69
89110	2.25	89169	1.21	89143	0.52
89129	2.16	89128	1.21	89109	0.43
89104	2.16	89169	1.21	89004	0.26
89117	1.99	89134	1.21	89179	0.17
89108	1.99	89118	1.21	89086	0.17
89130	1.90	89101	1.12	89124	0.09
89103	1.82	89011	1.12	89019	0.09
89149	1.82	89141	0.95		

Most respondents mentioned that they visited mainly three buildings inside the UNLV campus. The most frequently visited buildings, marked by circles in Figure 4, were the Lied Library building (LLB, 29%), the Student Union (SU, 27%), and the Classroom Building Complex (CBC, 23%). These three buildings are essential for the students and, correspondingly, most respondents said that they visited these building regularly. LLB is the main library students and faculty visit frequently for conducting various academic activities. The SU has several student service offices and food services. The CBC building consists of classrooms for students of all majors.

All the building names can be found in the UNLV map provided at the university website (http://www.unlv.edu/maps/campus).

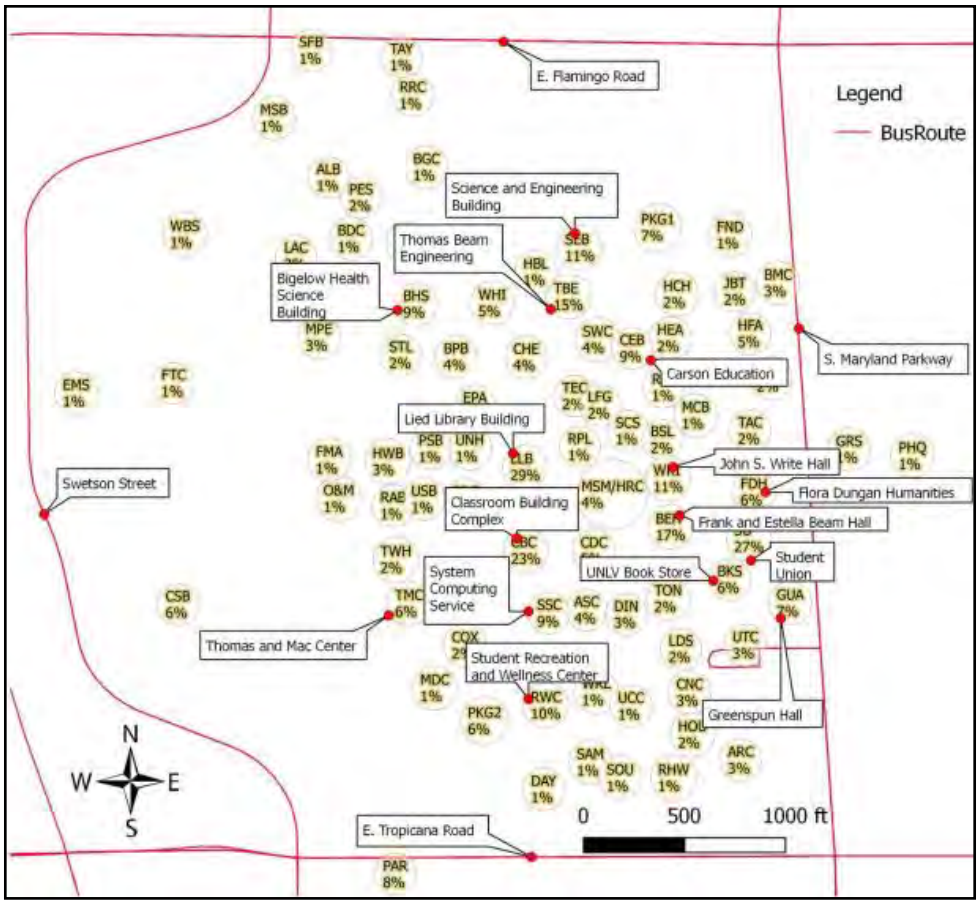

Figure 4. Distributions Based on Destinations of Respondents to UNLV

Travel Behaviors of the Respondents

The questionnaire asked about the frequency of travel to the UNLV campus. Most respondents (73.4%) traveled more than three times a week from their residence to campus (Table 6). As the survey respondents mostly were students, it is assumed that they regularly came to campus for their studies and to perform other related activities. Similar results were found for students at the University of Virginia, in that students made 20% more trips to the university than others did to their workplaces during weekdays and weekends.[17]

Table 6. Frequency of Travel

S.N.	Travel frequency	Proportion of Responses		Responses	%
1	More than three times a week			862	74%
2	Three times a week			96	8%
3	Twice a week			94	8%
4	Once a week			63	5%
5	None			59	5%
			Total	1,174	100%

When asked about their travel period to the UNLV campus, most of the respondents (79%) traveled throughout the entire year (Table 7). About 19% traveled during Spring and Fall semesters only. Very few participants traveled only in the Fall semester (2%) and in the Spring semester (1%). Few students took summer courses at UNLV; therefore, the number of respondents visiting campus during Summer semester was very negligible. The literature review revealed that most universities offered full bus service during the long semesters and reduced bus service during the Summer semester.

Table 7. Travel Period

S.N.	Travel time	Proportion of Responses		Responses	%
1	Throughout a whole year			911	79%
2	Spring/Fall semesters			217	19%
3	Fall semester only			16	2%
4	Spring semester only			8	1%
5	Summer semester only			5	0.5%
			Total	1,157	100%

The respondents were asked about their arrival time on campus. The data showed that most respondents (70%) arrived from 7 a.m. to 12 p.m.; only a few respondents (24%) arrived during the afternoon (Table 8); and 13% arrived during the evening. A review of bus schedules from other universities showed that most provided bus service in shorter intervals from 7 a.m. to 5:30 p.m.[23] During the survey, respondents were allowed multiple choices because their arrival times might be different based on their day of travel. Therefore, the total number of responses is not equal to the total respondents.

Table 8. Time of Arrival to Campus

S.N.	Arrival Time	Proportion of Responders		Response	%
1	Morning (7 a.m. to 12 p.m.)			986	86%
2	Afternoon (After 12 p.m. to 5 p.m.)			272	24%
3	Evening (After 5 p.m. to 10 p.m.)			148	13%
			Total number of responses	1,147	-

Note: Respondents could select multiple answers so totals may not sum to 100%.

Similarly, when asked about their departure time from campus, most respondents (68%) stated that they departed between 5 p.m. and 10 p.m. (Table 9). However, around 48% departed in the afternoon and 9% departed in the morning. On average, most respondents left campus after 5 p.m.

Table 9. Time of Departure from Campus

S.N.	Departure Time	Proportion of Responders	Response	%
1	Evening (After 5 p.m. to 10 p.m.)		778	68%
2	Afternoon (After 12 p.m. to 5 p.m.)		548	48%
3	Morning (7 a.m. to 12 p.m.)		99	9%
		Total number of responses	1,145	-

Note: Respondents could select multiple answers so totals may not sum to 100%.

The respondents were asked about the mode of transportation they used to come to campus and go back to their residences. Table 10 presents a list of transportation modes the respondents were using at the time the survey was conducted. It showed that most respondents (80%) traveled to and from campus by their own car.

Table 10. Modes of Transportation Used by Respondents

S.N.	Travel Mode	Proportion of Responses	Responses	%
1	Private car		932	80%
2	Public bus		329	28%
3	Carpool		157	14%
4	Walked		95	8%
5	Bicycle		68	7%
6	Motorcycle		19	2%
7	Others		15	1%
		Total number of responses	1,164	-

Note: Respondents could select multiple answers so totals may not sum to 100%.

Research conducted by Limanond et al. showed that if students owned a car, they preferred to come to campus by car and did not rely on public transportation.[24] As UNLV is an urban campus, and most of the students both work and own a car, most of the respondents used their cars to travel to campus. However, the data also showed that about one-quarter of respondents (28%) took public buses to come to the campus. About 14% stated that they carpooled, and 8% preferred to walk because their residences were very close to UNLV. When respondents were asked this question, they were allowed to give multiple answers because they might have used multiple modes of transportation while coming to the campus.

When asked about using public buses while traveling to campus, 62% of the respondents stated that they never used public bus service (Table 11). However, 16% said that they

used public bus service sometimes or all the time while coming to campus, and 13% said that they rarely used public transportation to commute to UNLV. This showed that fewer respondents used public bus service while coming to UNLV.

Table 11. Frequency of Using Public Buses

S.N.	Frequency	Proportion of Responses	Responses	%
1	Never		704	62%
2	Rarely		151	13%
3	All of the time		123	10%
4	Sometimes		65	6%
5	2-3 times a week		53	5%
6	Often		44	4%
		Total	1,140	100%

The respondents were asked that if they preferred to use the current RTC bus service, which route do they mostly likely use? The data showed that most respondents (47%) preferred to take 109-Maryland Parkway bus service, followed by 201-Tropicana (Table 12). Both of these bus routes run through Maryland Parkway, which runs along the eastern side of UNLV. In addition, 34% stated that they preferred to take the CX-Centennial Express to come to the campus. This bus service stops at the UNLV Transit Station and also travels to McCarran International Airport. Similarly, 27% and 9% of the respondents preferred to take the 202-Flamingo and 108-Paradise bus routes, respectively. Both of these routes run in the vicinity of the UNLV campus. The respondents were allowed multiple choices when choosing their preferred bus routes.

Table 12. Preferred RTC Bus Routes

S.N.	Bus Route	Proportion of Responses	Responses	%
1	109-Maryland Parkway		202	47%
2	201-Tropicana		151	35%
3	CX-Centennial Express (UNLV transit)		149	34%
4	202-Flamingo		118	27%
5	108-Paradise		41	9%
6	None of above		51	12%
		Total number of responses	430	-

Note: Respondents could select multiple answers so totals may not sum to 100%.

A question was asked regarding the distance between their residences and the nearest bus station. The response to this question determines whether the bus stations were located near their residences, and thus were easy to take. The data showed that 41% of the respondents lived about 10 minutes walking distance from the public bus stations (Table 13). However, 59% stated that the walking distance between their residences and

the nearest public bus station was more than 10 minutes. That may be one of the reasons the respondents were not taking public buses. In particular, the summers in Las Vegas are very hot, and no one would wish to walk that long a distance.

Table 13. Distance between the Respondents' Residences and the Nearest Bus Stop

S.N.	Time range	Proportion of Responders		Response	%
1	Less than 10 minutes			400	41%
2	10 to 20 minutes			335	35%
3	20 to 30 minutes			134	14%
4	Greater than 30 minutes			98	10%
			Total	967	100%

Responses from the question about bus stop locations revealed that most bus stops were within walking distance from respondents' residences (Table 14). However, 30% of the respondents stated that their bus station is not walking distance from their residences. Furthermore, 13% indicated that they did not have any idea about where the public bus stops were located.

Table 14. Location of Bus Stop

S.N.	Is a Public Bus Stop within Walking Distance?	Proportion of Responses		Responses	%
1	Yes			640	57%
2	No			341	30%
3	Do not know			139	13%
			Total	1,120	100%

A question was asked about their willingness to take a public bus if the bus station was within walking distance from their residences. Table 15 shows that about 50% stated they would take the bus if the stop was near their residences. This indicates that more bus stops should be located near respondents' residences so there might be a higher chance they would use the bus service. This question was only asked to the 341 respondents who stated that the nearest bus stop was not within walking distance. The data also showed that 8% were not ready to use public transportation, and 33% were undecided.

Table 15. Willingness to Take Bus Service if Bus Stop is Located Within Walking Distance

S.N.	Willingness to take Bus Service	Proportion of Responses	Responses	%
1	Yes		167	49%
2	No		60	18%
3	Undecided		114	33%
	Total		341	100%

Perception about Public Bus Service

The respondents were asked about the reasons they might not use public bus service, and the amenities they want to be present on the buses so that they would consider taking public transit while commuting to UNLV. The results of the survey are described below.

Reasons for Not Using Public Bus Service

One of the objectives of this survey was to determine the reasons for not using public bus service while commuting to the campus. Table 16 presents the responses to the question related to some of the reasons for not using public bus service. The complete reasons provided by the respondents are shown in Appendix D. Some respondents provided more than one reason.

This table shows that the main reason was "inconvenience," which caused 68% of the respondents to not travel on public buses. "Long intervals in the bus schedule" was the second reason for not using public transportation, followed by "Bus stop too far from home." Safety also played an important role in deterring UNLV students, staff, and faculty from using public transportation. A study conducted by Akar et al. showed that safety as well as flexibility of departure and travel times should be improved for existing bus services.[18] Another study conducted by Dorsey found that travel routes, flexible bus scheduling, and easy availability of bus-service information were critical for students when making the decision to take public buses to campus.[25]

Table 16. Reasons for Not Using Public Bus Service

S.N.	Reasons	Proportion of Responses	Responses	%
1	Inconvenience		561	68%
2	Long intervals in bus schedule		451	54%
3	Bus stop too far from home		337	41%
4	Safety		182	22%
5	Bus fare not reasonable		97	12%
6	Too crowded		92	11%
7	Others		187	23%
		Total number of responses	825	-

Note: Respondents could select multiple answers so totals may not sum to 100%.

Some of the reasons provided in other categories are:

- Takes too long a time to travel from and to UNLV.
- Too many transfers in between the origins and destinations.
- Lives near to campus, therefore, no need to travel by cars or public buses.
- No public bus service connecting to UNLV.
- Public buses are not reliable.
- Lack of information, do not know the public bus services that run to the university.
- Frequently faced scary/smelly/weird passengers.

The responses received in this study revealed some deficiencies in RTC's public transportation service. Therefore, the respondents were asked about the improvements that they would like to see in the public bus system so they would be encouraged to take the bus. Some of the comments provided by the respondents are as follows:

- Better seating at transit stations as well as inside buses.
- Well-maintained shelters providing protection from the sun and rain.
- More frequent bus service so that waiting time is less.
- Many routes that cover all parts of the city.
- More safety while riding the bus.
- Free internet while riding the bus as well as at transit stations.
- Well-conditioned restrooms.
- Hygienic condition in buses and stations.
- Ticket kiosk machine at the transit stations.
- Secure bike parking at UNLV.
- Real-time bus service information.
- A drinking water station at transit stations.

Amenities in Public Bus Stations

The respondents were asked about some of the basic amenities they expected to be in the public bus stations (Figure 5). Wireless internet connection (Wi-Fi) was given the top priority by the respondents (21%), followed by the location of bus stations close to their residences (18%). Another top amenity suggested by respondents was the shelter at bus stations (13%). They suggested that covered transit stations would provide shade during hot weather and offer protection from rain. A detailed list of amenities provided by the respondents is shown in Appendix E.

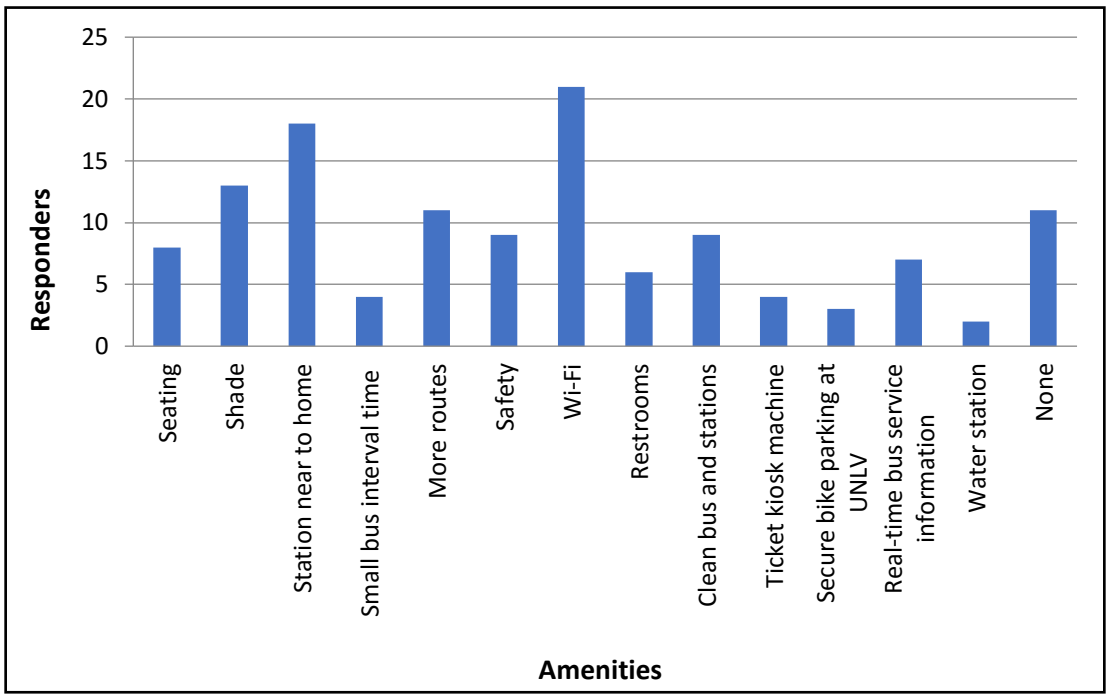

Figure 5. Amenities in Bus Stations Suggested by Respondents

The respondents were asked whether they would take buses if the suggestions for improvement are incorporated. About 54% of the respondents stated that they would take the bus if the amenities of bus stations were improved (Table 17). However, 29% responded that they would not take the bus to UNLV, even if the service was improved. About 29% of the respondents were not sure about this.

Table 17. Willingness to Ride the Public Bus

	Willing to take Bus						
	Yes		No		Not Sure		Total
Age Group	Count	%	Count	%	Count	%	Count
Less than 20 years old	40	6	19	2	21	2	80
21 to 30 years old	118	14	36	5	65	8	219
31 to 40 years old	83	10	26	3	36	4	145
41 to 50 years old	65	8	10	1	47	6	122
Above 50 years old	136	16	49	6	73	9	258
Total	442	54%	140	17%	242	29%	824

When the data were analyzed based on the age groups, it showed that a higher percentage of age groups 50 years older and between 21 to 30 years were willing to take the bus (Figure 6). In all age groups, the number of respondents willing to ride public buses was higher than the number of respondents not willing and not sure about riding them. This showed that more people were willing to ride public buses if the problems in bus stations were addressed.

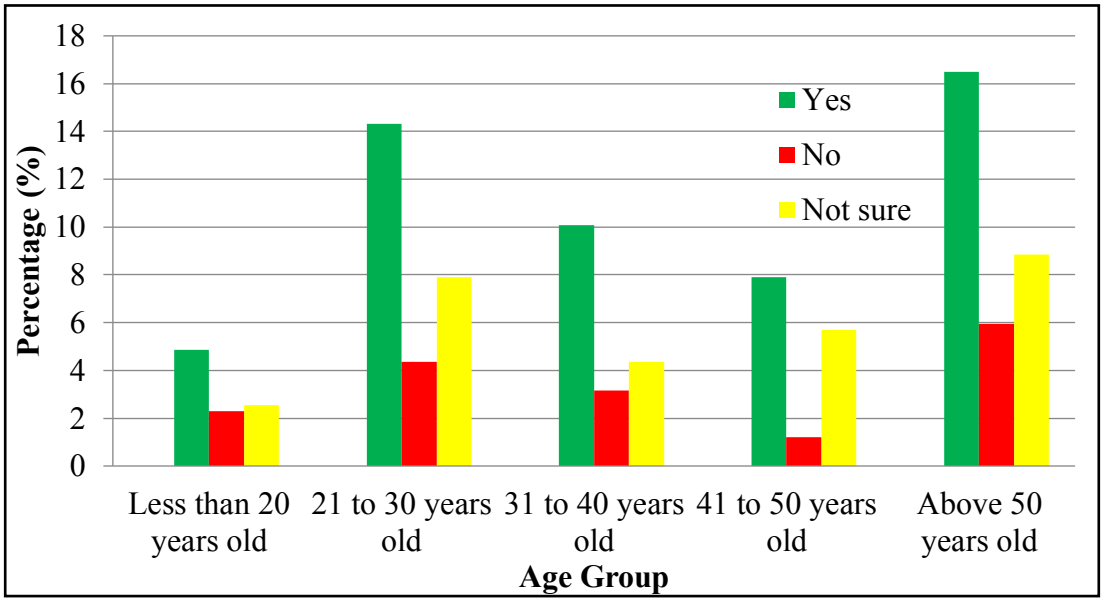

Figure 6. Respondents Who were Willing to Ride Public Buses

The responses related to the above-mentioned question were analyzed for the group of respondents who stated that they never or rarely took bus to come to the campus (provided in Table 11). This analysis was conducted to determine whether the respondents were willing to take the bus if the system was improved. As shown in Table 18, the group of respondents who stated that they rarely took the bus to come onto campus was more willing to use the bus service compared to the group that stated they never took the bus to come to the campus. About 48% of the respondents who stated that they never took the bus to campus were willing to take the bus if improvements were made. However, 54% said that they would take the bus if the service was improved.

Table 18. Willingness to Take a Bus Based on Existing Commuting Behavior

	After addressing problem(s) you mentioned, are you willing to ride public buses?			
How often do you ride public buses?	**Yes**	**No**	**Not sure**	**Total**
Never	330 (48%)	139 (20%)	215 (32%)	684
Rarely	118 (80%)	3 (2%)	27 (18%)	148
Total	448 (54%)	142 (17%)	242 (29%)	832

A statistical test of proportion was conducted to determine whether the proportion of respondents who stated that they would take the bus to come onto campus was different for these two groups. As shown in Table 19, the proportion of these two groups was statistically significant, because the p value was less than 0.05. Therefore, it can be concluded that a significantly higher proportion of respondents who stated that they rarely took the bus to come onto campus might change their mind and take the bus after the service is improved, compared to the group who stated that they never took the bus to come onto campus.

Table 19. Results of Proportion Test

	After addressing problem(s) you mentioned, are you willing ride public buses?					
	Yes		**No**		**Not sure**	
How often do you ride public buses?	**Prop.**	**p-value**	**Prop.**	**p-value**	**Prop.**	**p-value**
Never	0.48	<0.01	0.20	<0.01	0.31	<0.01
Rarely	0.80		0.02		0.18	

Preference Regarding Transportation Modes

When asked to rank the transportation modes they preferred, respondents indicated that a private car (7.2) was the most preferred mode of transportation, followed by carpooling and public buses (Figure 7). The respondents ranked light rail fourth, even though there is no current plan to add light rail to campus. However, the respondents thought that light rail is an option that might mitigate a number of traffic problems.

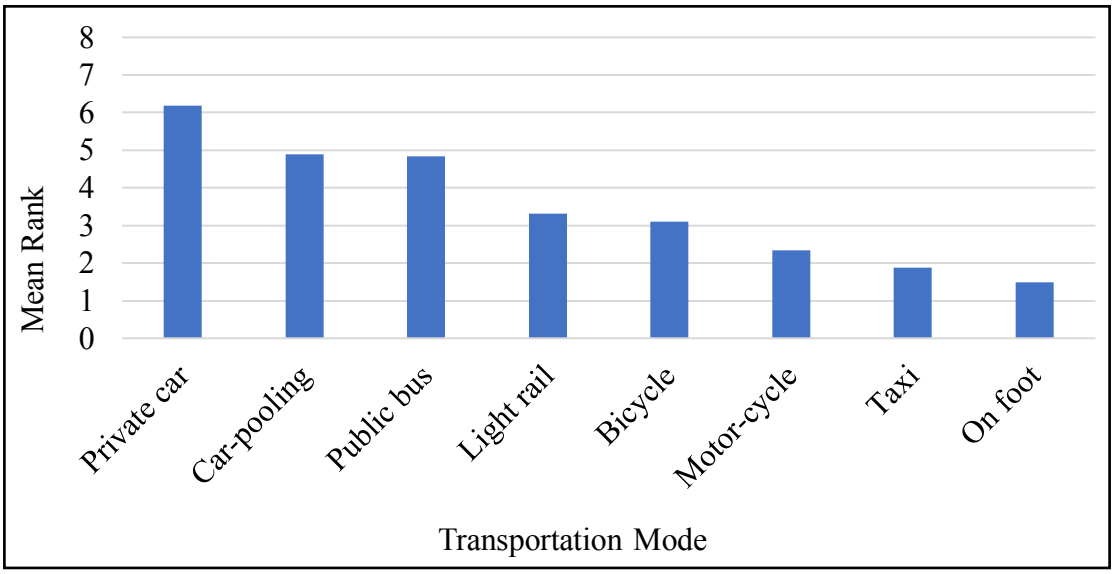

Figure 7. Ranking of Transportation Modes

The respondents were asked to rank their preferred mode of transportation to come to campus from 1 to 8, with 8 as "most preferred" and 1 as "least preferred." Table 20 shows the mean ranking value and the number of responses in each category of ranking for each mode of transportation. Most respondents ranked private car as 1, followed by public bus service, with the number of responses being 654 and 183, respectively. This shows that most respondents preferred public bus service after private cars.

Table 20. Responses Received for Preferences Regarding the Mode of Transportation

S.N.	Mode of Transportation	Rankings (1 to 8) [8-most preferred, 1- Least preferred]								Mean Rank
		8	7	6	5	4	3	2	1	
1	Private car	654	200	147	45	27	21	7	3	7.2
2	Carpooling	45	394	313	210	71	43	21	7	5.9
3	Public bus	183	263	275	175	92	49	27	40	5.8
4	Light rail	152	120	129	132	125	97	127	222	4.3
5	Bicycle	33	40	90	263	317	153	192	16	4.1
6	Motorcycle	10	36	62	117	257	290	156	176	3.3
7	Taxi	1	4	53	116	131	307	303	189	2.9
8	On Foot	26	47	35	46	84	144	271	451	2.5
	Total	1,104	1,104	1,104	1,104	1,104	1,104	1,104	1,104	-

Parking Permits

The respondents were asked about the types of parking permits they purchase in order to park their vehicles on campus. As shown in Table 21, 40% of the respondents purchased student parking permits and 34% purchased faculty and staff permits. Because they may commute to campus by bus or bike, or park their vehicles outside the UNLV campus for free, 24% did not purchase the parking permits.

Table 21. Categories of Parking Permits the Respondents Purchased

S.N.	Categories	Proportion of Responses		Responses	%
1	Student parking permit			401	40%
2	Faculty/staff parking permit			336	34%
3	Reserved parking permit			14	2%
4	None of the above			238	24%
			Total	989	100%

When asked about the types of parking permits they prefer to purchase, most stated that the annual permit is their preference (Table 22). One reason could be the low price compared to other types of permits, such as monthly, weekly, or daily permits. The cost for an annual parking permit for staff/faculty was $274;[26] if paid monthly, the total cost was $300. Similarly, the cost for an annual parking permit for students was $137; if paid monthly, it was $150. Very few respondents purchased monthly parking permits.

Table 22. Preferred Types of Parking Permits

S.N.	Types of Parking Permits	Proportion of Responses		Responses	%
1	Annual permit			643	65%
2	Daily temporary permit			46	5%
3	Monthly permit			39	4%
4	Weekly temporary permit			8	1%
5	None			251	25%
			Total	987	100%

The respondents who stated that they did not buy parking permits were asked about their willingness to pay for annual parking permits. A large number of respondents (44%) stated that they were ready to pay less than $50 for an annual parking permit (Figure 8). Equal percentages of respondents (18%) said that they prefer to pay between $51 to $100 and $101 to $150 for an annual permit. The data shows that 29% of the respondents were willing to pay more than $150 for an annual permit. The annual parking permits for the students and faculty/staff now are $137 and $274, respectively.

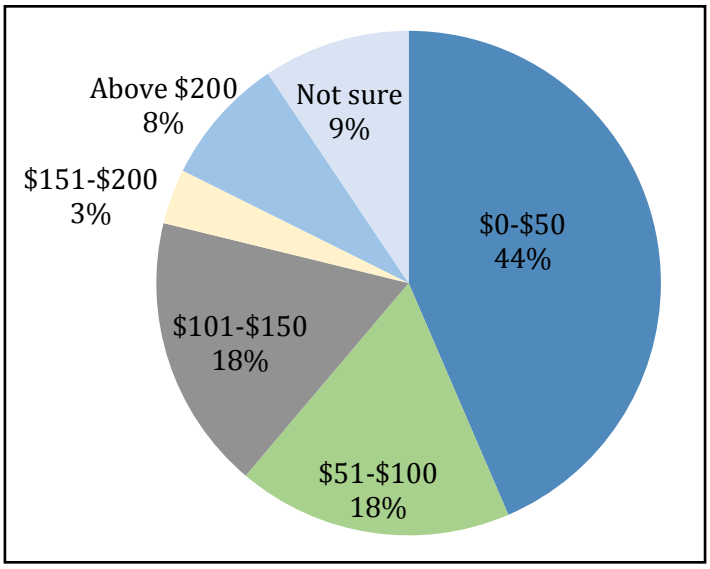

Figure 8. Preferred Cost of Annual Parking Permits

When asked about the most preferred types of bus fares, respondents stated that the semester U-Pass was the most preferred type of fare, followed by the 30-day U-Pass (Figure 9). The least preferred fare type was a two-hour pass. A survey conducted at Western Washington University revealed that most students preferred mandatory bus passes with unlimited access.[15] The cost proposed by the students was $15 to $20 per quarter, based on a 2006 base cost. UNLV students also prefer the U-Pass with the cost of $104 per semester, which is equivalent to $208 per year.

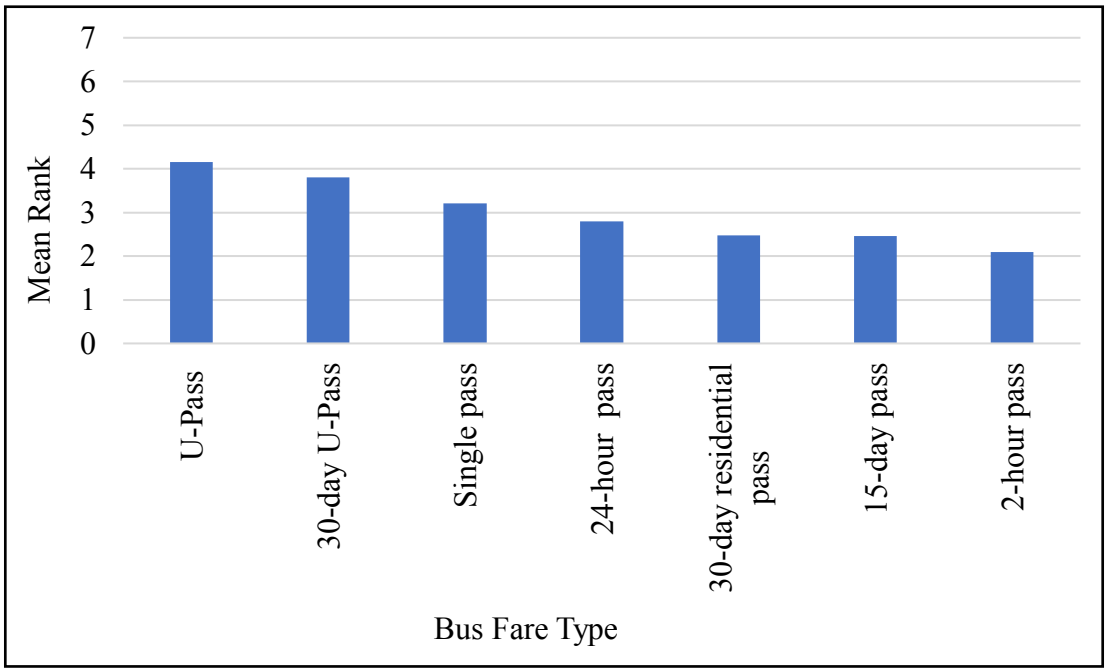

Figure 9. Ranking of Types of Bus Fares

The respondents were asked to rank the seven types of permit fares from 1 to 7, with 7 as "most preferred" and 1 as "least preferred." Table 23 shows the mean ranking value and the number of responses in each category of ranking for each type of permit fare. Most respondents ranked semester U-pass as 1, followed by 30-day U-Pass (167), and single pass (155). This shows that most respondents preferred the semester U-Pass.

Table 23. Preferred Bus Fare Types

		Rankings (1 to 7) [7-most preferred, 1- Least preferred]							
Rank	**Bus Pass Type**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**Mean Rank**
1	Semester U-Pass ($104)	521	114	47	38	38	29	199	5.2
2	30-day U-Pass ($32.5)	155	368	130	79	57	118	79	4.8
3	Single pass ($2)	167	162	169	112	110	116	150	4.2
4	24-hour pass ($5)	78	91	162	162	273	152	68	3.8
5	15-day pass ($34)	14	46	95	373	230	152	76	3.5
6	30-day residential pass ($65)	34	106	246	83	153	173	191	3.5
7	2-hour pass ($3)	17	99	137	139	125	246	223	3.1
	Total	986	986	986	986	986	986	986	-

The respondents were asked whether they support the idea of including a bus-fare cost in the semester fee. About half of the respondents rejected this idea (Table 24) and the other half supported the idea. When follow-up questions were asked of the respondents about the cost of the bus service to be included in the semester fees, 22% stated that $10 to $15 per semester was a reasonable cost for the bus service. Only 8% of the respondents stated that they were willing to pay more than $30 per semester.

Table 24. Cost Ranges That Respondents Were Willing to Pay Per Semester

S.N.	Price Range	Proportion of Responders	Response	%
1	It is not good idea to include transportation cost in semester fee		549	50%
2	$10 to $15 per semester		245	22%
3	$15 to $30 per semester		220	20%
4	Greater than $30 per semester		88	8%
		Total	1,102	100%

IV. RECOMMENDATIONS TO IMPROVE BUS SERVICES

Based on the results of the survey, the research team has provided the recommendations in three key areas:

1. Reroute existing buses so that students can reach their destinations without much walking.

2. Plan new bus routes so that areas in which a large number of students reside can be covered by the UNLV bus system.

3. Provide a fee structure for UNLV bus service.

These recommendations are described in detail below.

Proposed Rerouting of Existing Bus Service

Based on the origin and destination data from the survey, several alternatives were studied for the best RTC bus route through UNLV. The Centennial Express (CX) route was identified as one that could be rerouted; currently, it connects the Las Vegas downtown area to McCarran International Airport by way of the UNLV Transit Center. The current route that this bus travels on Flamingo Road and Maryland Parkway is designed to serve UNLV students, staff, and faculty. The existing transit stations for the CX are along the Maryland Parkway and Flamingo Road, which is in the vicinity of UNLV. The last station of this route, southbound, is McCarran Airport Terminal 3. If the CX route was altered, there would be no negative effects to public riders but could benefit UNLV students, staff, and faculty. While rerouting the CX, additional transit stations would be required inside the university's campus. These additional transit stations would provide easy access to UNLV destinations. Figure 10 shows the existing route and bus stations for the CX route surrounding UNLV, the red line designating the southbound route and the yellow line designating the northbound route.

The proposed route for the CX is presented in Figures 10 and 11. For the purposes of this study, alternative routes were identified. The entry and exit points to the campus area are the same for both the northbound and southbound routes. Figure 11 presents the proposed northbound route, with new transit stations inside UNLV for the CX bus service. The proposed northbound CX route begins at the bus stop at McCarran Airport Terminal 3 and passes through the Thomas & Mack Center at UNLV, then onto Paradise Road. Due to this change, there could be a higher chance of UNLV students, staff, and faculty travelling back from UNLV to their residences on this route, since most of them reside south of the campus.

Figure 10. Exiting Route of the Centennial Express (CX) around UNLV

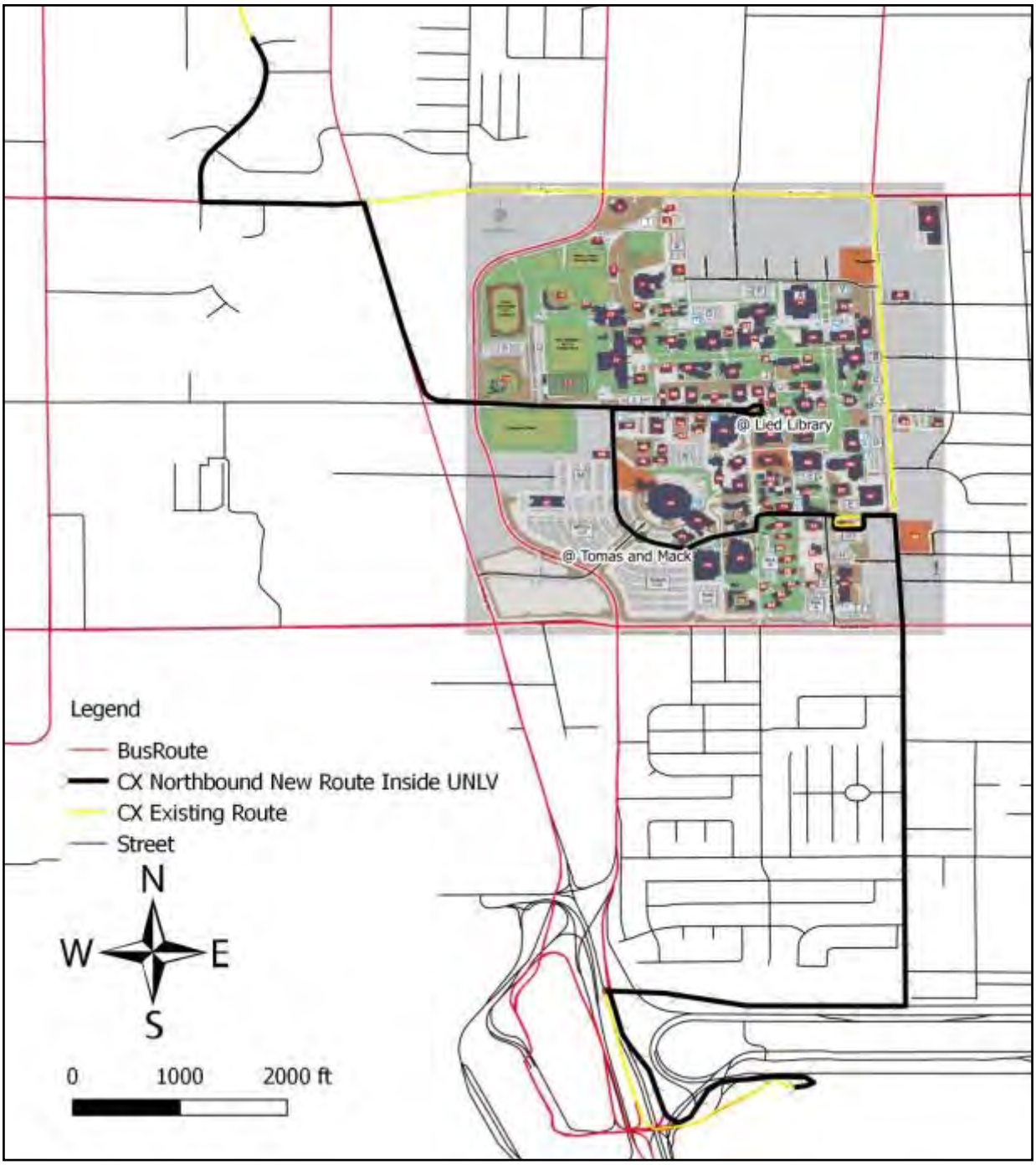

Figure 11. Proposed Northbound Route for the Centennial Express, Including Bus Stations Inside UNLV

As shown in Figure 12, the proposed southbound route of the CX would travel on its existing route along the Flamingo Road and Maryland Parkway, and enter UNLV at the existing transit center. From this transit center, the bus would be rerouted to a new bus stop located at Lied Library (LLB). Finally, the bus would exit to Paradise Road and connect to McCarran Airport Terminal 3. In this new southbound route, the CX bus would turn right to LLB after leaving the UNLV Transit Center, located on University Road. After arriving at LLB, it would turn left onto Harmon Avenue and turn left onto Paradise Road, then travel

on its existing route. The addition of this bus stop at LLB would help to gain easy access to the central part of UNLV, because LLB is at the center of campus and is a common destination for students, staff, and faculty.

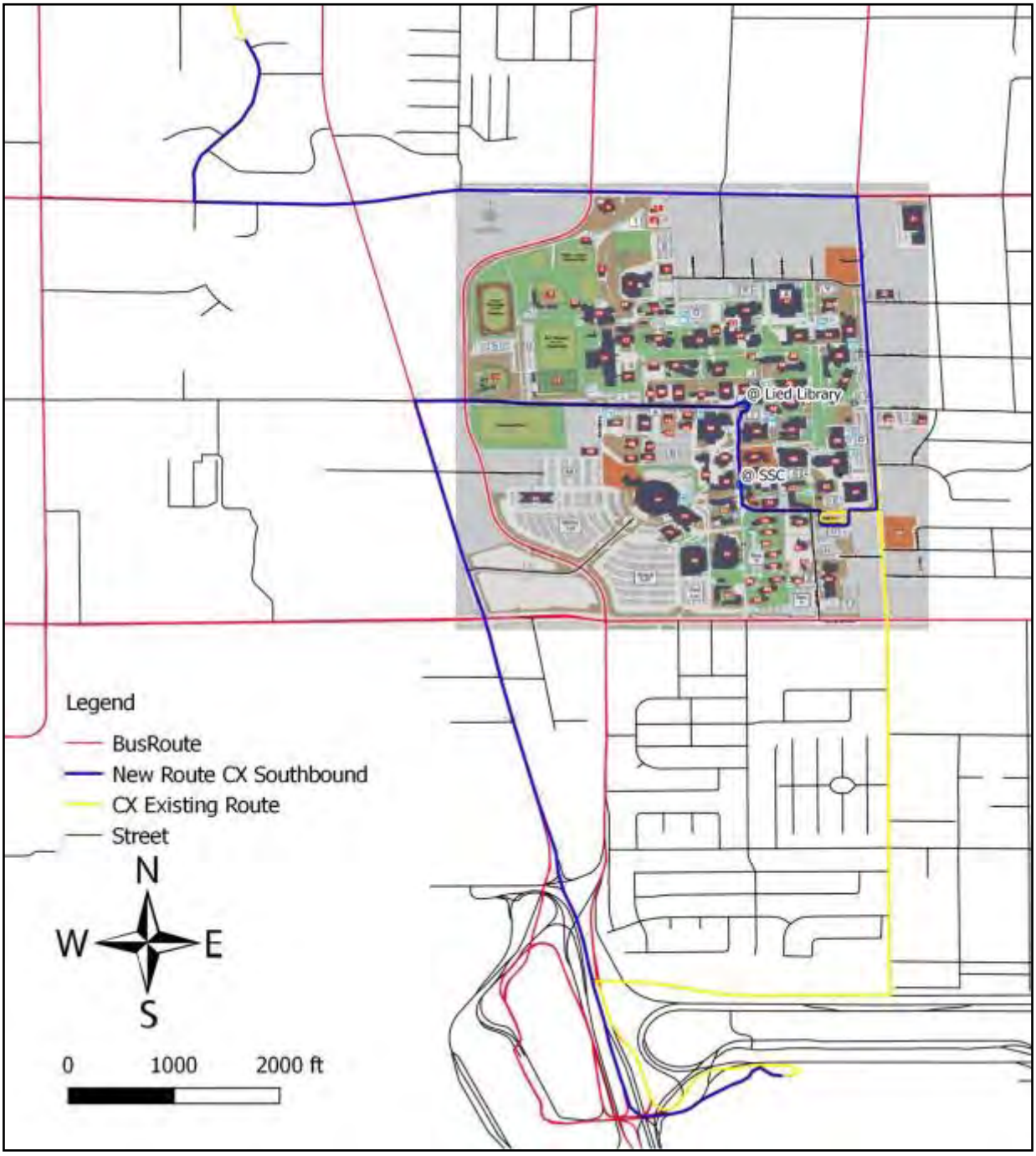

Figure 12. Proposed Southbound Route for the Centennial Express, Including a New Bus Station Inside UNLV's Campus

Proposed New Bus Service

As shown in Figure 13, RTC bus service does not provide sufficient service coverage to some densely populated residential areas for UNLV students, staff, and faculty. In order to connect these areas, new bus routes should be developed. The red line represents the existing routes of the RTC buses. A proposed bus route, shown by the blue lines, would serve places in between UNLV and the city of Henderson. Another proposed route, shown by green lines, would serve areas whose zip codes are 89120, 89014, and 89012.

In order to establish the new routes, RTC would have to add new buses and many bus stations. A reasonable headway should be maintained for both routes. Based on the hourly service cost provided by RTC, the total cost of bus service was computed. In addition to this, the construction cost of bus stations and the cost of purchasing buses also were computed.

However, during the cost analysis these new bus route costs were not included. RTC suggested not adding the new bus routes because it is very difficult. Adding new bus routes requires a major investment by RTC, and this requires a thorough geographical analysis of the demand for these new routes.

However, based on this survey, adding new bus routes to cover these three zip codes might help to increase the number of students taking the bus. A demand analysis, along with the cost analysis, should be conducted to implement this recommendation for new bus routes. In the cost calculation for this study, the cost associated with improving the existing bus service was only calculated by adding new bus stations and decreasing the headways.

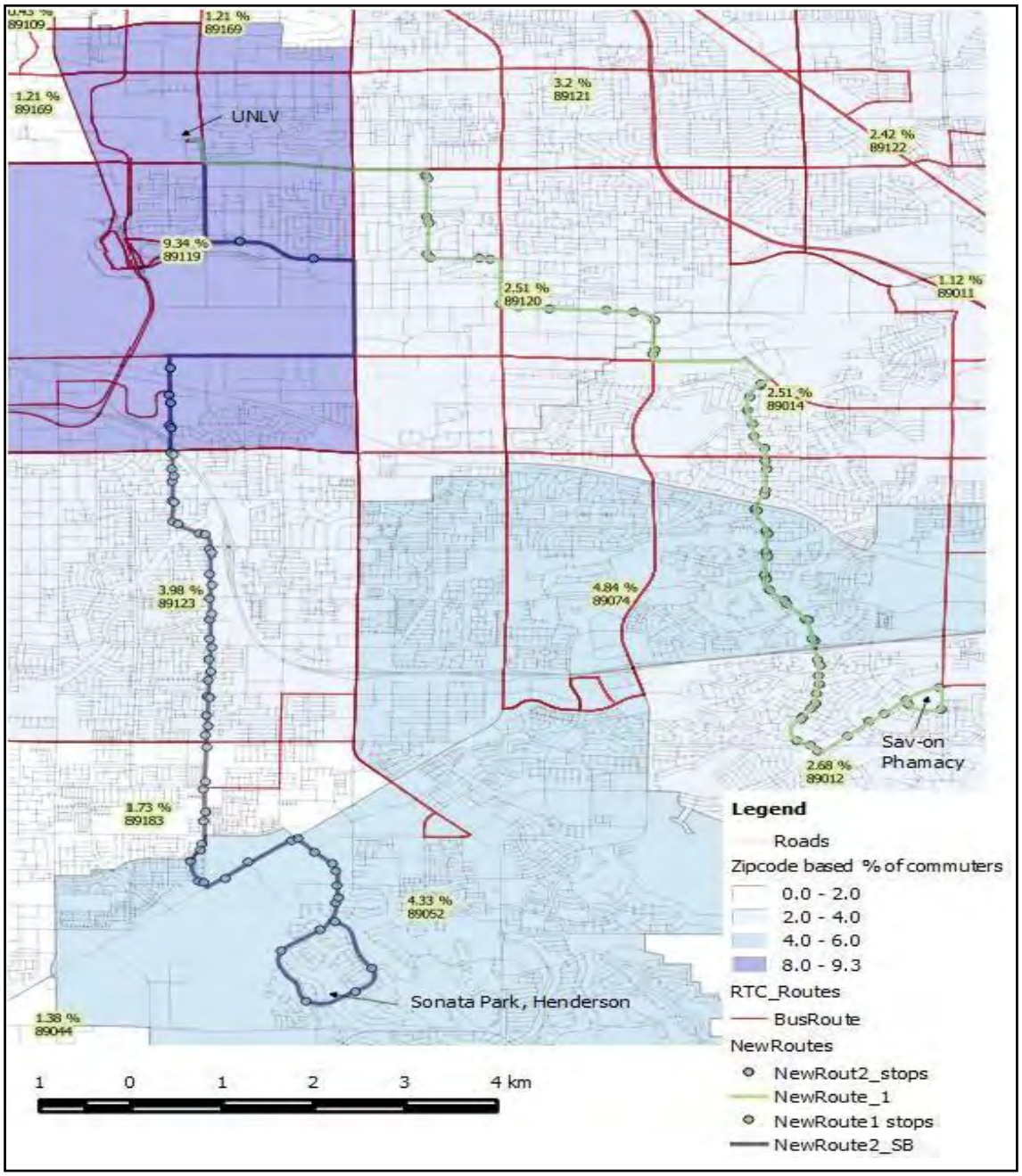

Figure 13. Proposed New RTC Bus Routes

Cost Analysis Based on Improved Bus Service

A detailed cost analysis for rerouting existing RTC buses and new headway for existing bus service was conducted to determine the total cost to be spent by RTC. In order to make the buses more reliable and provide the necessary headways (the average interval time between the consecutive buses moving in the same direction), RTC could collect revenue either by selling the bus passes to students, staff, and faculty or by imposing a mandatory transportation fee to students in the semester fee.

The ridership data for RTC routes around UNLV was collected from RTC. The traffic volume for one year (January 2014 to December 2014) is presented in Table 25. This table shows that the busiest route is Route 202, running along Flamingo Street, followed by Route 201 along Tropicana. The least busy route is the Centennial Route along Maryland Parkway.

Table 25. The RTC Fixed-Route Ridership (January 2014 to December 2014)

Route	Street	Total ridership	Average daily ridership			Peak-time weekday ridership (Assuming 25 % travel at peak time)
			Weekday	Saturday	Sunday	
108	Paradise	774,007	2,288	1,979	1,535	572
109	Maryland	2,946,633	8,905	6,703	5,810	2,227
CX	Centennial	373,110	1,118	837	779	280
201	Tropicana	3,269,045	9,521	8,565	6,918	2,381
202	Flamingo	4,046,366	11,930	10,181	8,303	2,983

Source: RTC.

During the survey, the respondents were asked about their use of existing RTC bus routes while coming to UNLV. The data indicated that the route along Maryland Parkway and Tropicana were the most used routes (Table 26). Some participants also travelled by using Route 108. Because Route 109 and Route CX travel along Maryland Parkway, the estimated number of respondents travelling through these routes was calculated based on the percentages of ridership data for these two routes.

From the survey, it was found that 81% of the respondents took Route 109 and CX buses; the proportion of respondents taking these routes was 58% and 42%, respectively. The survey also found that 26% of the students, staff, and faculty commuted to campus using a public bus. This percentage was used to calculate the total number of the students, staff, and faculty who would take the bus in the future, which would be about 7,346 out of UNLV's population of 28,600. The ridership count at the peak time for the RTC routes was calculated assuming that 25% of these travelers take the bus at peak times (see Table 26).

Table 26. Ridership of Future Bus Systems

Bus route	Participants percentage (%)	Ratio divided for the CX and 109	Students, staff, and faculty count out of 7,436 (26 % of 28,600)	Peak time students, staff, and faculty counts (Assuming 25% travels at peak time)
108- Paradise	9%		670	168
109 - Maryland	47%	58%	2,028	507
201 - Tropicana	35%		2,603	651
202 - Flamingo	27%		2,008	502
CX- Centennial	34%	42%	1,468	367

Based on the probable count of peak-hour ridership and the existing capacity of the buses running through these routes, the number of buses required is given in Table 27. The maximum time required for a round trip on each route was collected from the RTC bus schedule. The headway required for a route was computed by dividing the total round-trip time by the number of buses required to meet the peak-time demand along the route. As presented in Table 27, different routes had different headway requirements. However, to determine common headways for each route, an 18-minute headway was adopted in this study.

Table 27. Headway Computed Based on Projected Ridership

Bus route	Students, staff, and faculty counts (C)	Bus type (ft.)	Bus capacity/trip (N)	Number of buses (m=N/C)	Round-trip time (T) min	Headway (T/m) min
108- Paradise	168	40’	45	4	90	23
109 - Maryland	507	60’	75	7	100	15
201 - Tropicana	651	60’	75	9	156	18
202 - Flamingo	502	Double-decker	80	7	164	24
CX-Centennial	367	40’	45	9	120	14

The current bus schedule for these routes was studied and the bus operational headways for the normal school time (the target period), such as from 7 a.m. to 8:30 p.m. (13.5 hours), were calculated. First, the total hours per day RTC buses are running in each route is calculated based on the number of buses running in the routes and total hours of operation on weekdays. Then the number of buses required for improved service was calculated and the total hours of operation per day is determined. Then the difference between the required and existing hours of operation was calculated for each bus route. The detailed calculation of extra service hours required for Route 108 based on improved service is shown below. For other bus routes, the calculation is given in Appendix F.

Total Hours of Operation for Existing Bus Service

Round-trip duration for Route 108/Paradise bus = 90 minutes

Headway between buses = 30 minutes

Number of buses required = 90 minutes/30 minutes = 3 buses

Total hours of operation (7 a.m. to 8:30 p.m.) = 13.5 hours

Total hours the buses have to operate = 3 buses x 13.5 hours = 40.5 hours

Total Hours of Operation for Improved Bus Service

Based on the survey data, the headway required is at least 23 minutes. Assuming an 18-minute headway for the improved bus service to meet the demand:

Number of buses required = 90 minutes/18 minutes = 5 buses

Total hours the buses have to operate = 5 buses x 13.5 hours = 67.5 hours

Difference of total hours between the existing and improved bus service

= 67.5 hours-40.5 hours = 27 hrs/day

A similar calculation was performed for Route 109 along Maryland Parkway. The analysis showed that no extra service hours were required to maintain the 15-minute headway during the target period. The current bus schedule showed that the route already served a 15-minute headway during some peak hours on weekdays. Therefore, there was no requirement to add new buses to Route 109 along Maryland Parkway.

For Route 201, about 15.5 extra service hours per day was identified, and no extra buses were needed. For Route 202, 21 extra service hours per day were required, and no extra bus was needed. For Route CX, the number of extra hours required was found to be 59.5 hours, and the number of extra buses required was found to be one bus.

The total extra hours of bus operations required for two long semesters (eight months) were calculated, as shown in Table 28. For all five routes, the total extra hours of operation per day was found to be 123, and the total extra buses needed was three. RTC needs to run 21,320 hours of extra bus service to meet the demand by UNLV students, staff, and faculty.

Table 28. Estimation of Extra Hours of Bus Operations

SN	Bus Route	Target headway (min)	Extra hours/day	Extra buses
1	108- Paradise	18	27	2
2	109 - Maryland	18	0	0
3	201 - Tropicana	18	15.5	0
4	202 - Flamingo	18	21	0
5	CX- Centennial	18	59.5	1
		Total	123	3
		Total hours per five weekdays	615	
		Total hours per eight months	21,320	

Once the extra hours of operation and the number of extra buses required were calculated, the total cost for providing improved bus service was calculated. To calculate the bus cost, a tentative cost of a 45-foot natural-gas bus was provided by RTC, estimated at $550,000. The operation and maintenance cost per hour data, provided by RTC for FY 2012, was

$109.15. That price was inflated to 2016 by using the average consumer price inflation factor for three consecutive financial years from 2012 to 2016.[27]

The detailed cost calculation is shown in Table 29. The cost analysis shows that the total cost of providing extra service hours would be approximately $.2.7 million per year. RTC now receives revenue of $200,655 by selling the U-Pass. Therefore, the net revenue needed to provide this improved bus service to UNLV students, staff, and faculty would be about $2,288,188.

In order to maintain the break-even point between the revenue and expenses, 28,600 students would have to pay a mandatory bus fee of $47.15 per semester. In this calculation, the research team assumed that RTC is getting enough revenue to sustain existing bus service to the UNLV community.

Table 29. Calculation of Cost for Improved Bus Service

S. N.	Items Descriptions	Total Cost
1	Bus purchase cost	$550,00 per bus
2	Total bus purchase cost for three buses (3 x $550,000)	$1,650,000
3	Operation & maintenance (O&M) cost per hour in 2012	$109.15/hr
4	Cost inflation per year	1.73%
5	Total cost inflation factor from 2012 to 2016 = $(1.0173)^4$	1.071
6	Adjusted O & M cost for 2016 = 1.071 x $109.15	$116.90
7	Total number of hours of operations in long semester (eight months)	21,320 hrs
8	Total O & M cost required in 2016 base cost = 21,320 x $116.90	$2,492,308
9	Total amount collected in FY 2015 by selling U-Pass	$200,655
10	Adjusted amount based on FY 2016 = 1.0173 x $200,655	$204,126
11	Additional cost required = $2,492,308-$204,126	$2,288,188
12	Total number of students in 2016	28,600
13	Cost per student for two semesters = $2,288,188/28,600	$94.28 per two sem.
14	Cost per student per semester = $94.28 /2	$47.14 per sem.

The survey results reveal that 50% of the respondents were against the plan to include bus fees in the semester bill. Therefore, if the bus fees cannot be included in the semester fees, then RTC has to raise the revenue by selling 30-day passes and U-Passes to UNLV students, staff and faculty. Based on the assumption that the estimated number of students (7,436) would buy these passes, the cost for a 30-day pass and a U-Pass is calculated as follows;

Cost of 30-day Pass and U-Pass Based on Improved Bus Service

The data for FY 2015 shows that out of 4,370 passes sold, 81% were 30-day passes and 19% were U-Passes (Table 1). Therefore, out of 7,436 estimated bus users:

30-day pass users = 0.81 x 7,436 = 6,023

U-Pass = 0.19 x 7,436 = 1,413

This analysis assumes that the cost of a 30-day pass and a U-Pass are in similar proportions. Based on FY 2015 prices, a U-Pass costs 3.2 times more than a 30-day pass. If the cost of a 30-day pass is X, then:

6,023 X + 3.2 X (1,413) = $2,288,188

X = $217

This shows that the cost of the 30-day pass should be $277. For a U-Pass, the cost should be:

= 3.2 x $217

= $694 per semester

If the 30-day pass is eliminated, and everyone has to by a U-Pass each semester, then the cost of the U-Pass per semester would be:

= $2,288,188 / (two semesters x 7,436) = $154/ semester

V. KEY FINDINGS/RECOMMENDATIONS

This study collected the travel behavior, preferred routes, required bus amenities, and estimated bus fees that respondents (students, staff, and faculty at UNLV) were willing to pay. The data analysis revealed that 26% of the respondents currently use RTC buses to access UNLV. The top three reasons provided by the respondents for not taking the buses were inconvenience, long headway between two buses, and bus stations located too far away from their residences.

The bus routes mostly used were Route 109 and CX, both of which run along Maryland Parkway. Most respondents said their residences were more than 10 minutes away from the nearest bus stations. They ranked private car, followed by carpooling, as the best preferred mode of transportation. When they were asked about their perceptions regarding RTC buses, most said that the buses' and stations' seats needed to be improved, headways of the buses should be decreased, and more bus routes should be introduced to cover other areas of the Las Vegas Valley. However, when asked if bus service were improved 80% of the respondents in the group who rarely took the bus were willing to take the bus. However, the group who never took the bus (48% of the total respondents) said that they were willing to take the bus. This shows that more people who rarely took the bus would take the bus after improvements to the service. The statistical test showed that the difference was significant at alpha level 0.05.

In addition, most respondents preferred the U-Pass system, followed by the 30-day pass. However, the revenue data provided by RTC showed that in 2015, 81% of UNLV students bought the 30-day pass compared to just 19% who bought the semester U-Pass.

Based on the survey data of those who stated that they would use the bus service if improved, 26% of the total UNLV population sampled would take the bus. New bus routes are proposed to cover riders living in areas around the Valley where currently no service exists. In addition, the rerouting of existing RTC buses is proposed so that they would be convenient for riders in reaching their destinations at UNLV. Based on this rerouting, new headways of each existing bus system were calculated based on the number of riders. The number of buses required to provide headways of 18 minutes in each of these existing routes was calculated.

Finally, the cost required to provide improved bus service was calculated to be $2,288,188. To generate this much revenue, the total fees to be charged for each semester to all the students would be $47.17. This semester fee is reasonable, based on other universities' fees. However, during the survey, 50% of the respondents said that they were against including bus fees in semester fees. Out of the remaining 50%, only 8% said that they were willing to pay more than $30 per semester.

Additional cost analysis was conducted to determine what should be the cost of a 30-day pass and a semester U-Pass based on improved services. The analysis showed that the cost of the 30-day pass and the semester U-Pass should be increased by sevenfold to generate the required revenue. If the 30-day pass was removed and every UNLV student, staff, and faculty member had to buy only the semester U-Pass, then the cost should

be increased by 5%. Therefore, the fees were calculated based on the survey, and the students' willingness to pay for the bus service using the 30-day pass and the semester U-Pass had a significant difference. A study conducted by Meyer et al. found a difference by a factor of two in the required cost to sustain bus service and students' preferences regarding the cost of a bus pass.[15]

Based on the literature review, other universities finance their transit systems using revenues from sales of parking permits and citations.[15] UNLV should consider financing its public transit using parking and citation revenue to enhance the quality and reliability of its public transit system. This may require in-kind support from other regional and state agencies, such as the State of Nevada.

Due to relatively low response rates, another study should be conducted to collect additional responses and statistically validate the findings. In the cost analysis, the total revenue required for improved service was assumed to be governed by UNLV students, staff, and faculty. However, bus service also is used by the public, so they need to contribute as well. However, RTC was unable to provide the percentage of the UNLV population and the public who used this bus system. In a further study, a cost analysis should be done based on these data. Finally, future research should consider the impact of a potential National Football League (NFL) stadium on the ridership of these bus routes.

ABBREVIATIONS AND ACRONYMS

ANOVA	Analysis of Variance (test)
ASU	Arizona State University
APTA	American Public Transportation Association
B/C	Benefit-Cost (ratio)
BRT	Bus Rapid Transportation
BTS	Bearcats Transportation System (of the University of Cincinnati)
CBC	Classroom Building Complex
CTS	Campus Transit System (of the University of Cincinnati)
CX	Centennial Express
EPA	Environmental Protection Agency
FSU	Florida State University
FY	Fiscal Year
GPS	Global Positioning System
IRB	Institutional Review Board
LLB	Lied Library Building
NAU	Northern Arizona University
NFL	National Football League
O&D	Origin and Destination
O&M	Operations and Maintenance
OIT	Office of Information Technology
PI	Principal Investigator
RAVE	Rebel Announcements Via E-mail
RTC	Regional Transportation Commission of Southern Nevada
SOV	Single Occupant Vehicle
SU	Student Union
TBE	Engineering Complex, Thomas T. Beam
TRB	Transportation Research Board
TCRP	Transit Co-Operation Research Program
UI	University of Iowa
UNLV	University of Nevada, Las Vegas
UTA	Utah Transit Authority
UTC	Transit Center, UNLV
Wi-Fi	Wireless Fidelity
WTP	Willing To Pay

APPENDIX A: EXISTING TRANSIT SERVICES IN U.S. UNIVERSITIES

S. N.	Name of the University Source:	Name of Transit Service	Operation Status	Online Tracking System	Service Interval		Included in Semester ($)	Fee structure				
								Ride basis ($)				
					Long (min)	Short (min)		Per Day	Monthly	Semester	Nine Months	Yearly
1	Auburn University (Auburn, AL) (http://www.auburn.edu/administration/parking_transit/transit/index.php)	Tiger	Days /Night	Transloc	15-30	10-15	included			131		
2	Arizona State University (Tempe, AZ) (https://cfo.asu.edu/pts)	Gold , Maroon, and Flash shuttles	Days (Several routes)	Real-time map	60	10-15	Free, funded from revenue received from the sale of parking permits				200	275
3	Northern Arizona University (Flagstaff, AZ) (http://nau.edu/parking-shuttleservices/)	Louie Line & Rapid ride	Days (Several routes)	Transloc	60	3-5	Free					
4	University of Arizona (Tucson, AZ) (https://parking.arizona.edu/alternative/cattran.php)	CatTran	Days/Night	Transloc/ SMS	30	18	Free on campus; managed by Parking & Transportation Services					
5	Azusa Pacific University (Azusa, CA) (http://www.apu.edu/shuttle/)		Does not operate in summer		60	7-10						

S. N.	Name of the University Source:	Name of Transit Service	Operation Status	Online Tracking System	Service Interval		Included in Semester ($)	Fee structure				
								Ride basis ($)				
					Long (min)	Short (min)		Per Day	Monthly	Semester	Nine Months	Yearly
6	California State University (Sacramento, CA) (http://www.csus.edu/aba/utaps/index.html)	Hornet shuttle	Day/ Night		40	13	Free; funded by sale of parking permits and citations					
7	Stanford University (Stanford, CA) (http://transportation.stanford.edu/)	Marguerite Shuttle	Days/ Night till 12 a.m.	Real-time map	30	5	Free					
8	University of California (Davis, CA) (http://unitrans.ucdavis.edu/)	Unitrans	Day/ Night till 10:35 p.m.	SMS, website			Free for undergraduates	1	25	64 for 3M		180
9	University of California (Riverside, CA) (http://parking.ucr.edu/index.php?content=services/shuttle.html)	Point to Point (P2P) shuttle	Monday to Friday 6-11:30 p.m.			30	Free					
10	Yale University (New Haven, CT) (http://to.yale.edu/)	Yale Shuttle	Days/Night	Transloc		12-15	Free					
11	Georgetown University (Washington D.C.) (http://otm.georgetown.edu/guts/index.cfm)	Georgetown University Transportation Shuttle (GUTS)	Days/Night 5 a.m. to 12 p.m.	NextGUTS software for mobile device	60	10-20	Free					
12	University of Delaware (Newark, DE) (http://www.facilities.udel.edu/)	University of Delaware Shuttle	Day/Night 4:20 a.m. to 12:45 a.m.	UD shuttle powered by Google	60	15						
13	Florida State University (Tallahassee, FL) (https://transportation.fsu.edu/)	Seminole Express	Day/Night Only Fall/Spring	Transloc& myFSU mobile software			$8.9/credit					

S. N.	Name of the University Source:	Name of Transit Service	Operation Status	Online Tracking System	Service Interval		Included in Semester ($)	Fee structure				
								Ride basis ($)				
					Long (min)	Short (min)		Per Day	Monthly	Semester	Nine Months	Yearly
14	University of South Florida (Tampa, FL) (http://www.usf.edu/administrative-services/parking/)	Bull Runner	Day/Night	Bull Trackers ™			Free					
15	Emory University (Atlanta, GA) (http://transportation.emory.edu/)	Cliff Shuttles	Day/Night	Transloc	35	12-15						
16	Georgia Tech (Atlanta, GA) (http://pts.gatech.edu/Pages/default.aspx)	Tech Trolley and midnight ramble, The Outlet, Red/blue/green stringer Buses	Day/Night (Several routes)	Nextbus	60	6	Free					
17	University of Georgia (Athens, GA) (http://www.transit.uga.edu/)	Campus Transit such as Ag Hill, Orbit, Milledge Avenue	Day/Night (Several routes)	Real-time tracking web + mobile	20-25	5-10	Free					
18	Idaho State University (Pocatello, ID) (http://www.isu.edu/departments/transp/)	Commuter Express	Does not operate in summer					24/ 20		687/ 484		
19	Northern Illinois University (DeKalb, IL) (http://huskieline.com/)	HuskieLine	Days	Check it again		20	Free for students, otherwise $1/ride					

S. N.	Name of the University Source:	Name of Transit Service	Operation Status	Online Tracking System	Service Interval		Fee structure					
								Ride basis ($)				
					Long (min)	Short (min)	Included in Semester ($)	Per Day	Monthly	Semester	Nine Months	Yearly
20	Indiana University (Bloomington, IN) (http://www.iubus.indiana.edu/campus_bus/index.html)	IU Campus Bus Service	Day/Night	Double Map	60	8-20	Free, mandatory fee $63.84/year					
21	Iowa State University (Ames, IA) (http://www.cyride.com/)	cyRide	Day/Night	NextBus software	60	10	Free for students	1.3	40	160	320	420
22	University of Iowa (Iowa City, IA) (http://transportation.uiowa.edu/)	Cambus	Day/Night (Several routes)	Bongo	45-60	10-15	Free for public, fee included in semester fee for students ($14.03/ summer)			28.2		
23	University of Kansas (Lawrence, KS) (http://www.lawrencetransit.org/)	Lawrence Transit	Day/Night (Several routes)	A mobile tool	60	15-30	Free for students, staff, and faculty	2.8	34			
24	University of Kentucky (Lexington, KY) (http://www.uky.edu/pts/)	UK CATS	Day/Night (Four routes)	Transloc	30	3-10	Free					
25	Harvard University (Cambridge, MA) (http://www.transportation.harvard.edu/)	Harvard Shuttle	Day/Nigh (Several routes)	Transloc	30-40	10-20	Free for students, staff, and faculty					
26	University of Massachusetts Amherst (Amherst, MA) (http://www.umass.edu/vehicle/)	UMass Transit Service – PVTA	Several routes	PVTA and a mobile tool	60	15-20	SPECTRANS free for disabled students, but PVTA is not free	3	45			

S. N.	Name of the University Source:	Name of Transit Service	Operation Status	Online Tracking System	Service Interval		Included in Semester ($)	Fee structure				
					Long (min)	Short (min)		Ride basis ($)				
								Per Day	Monthly	Semester	Nine Months	Yearly
27	University of Nebraska (Lincoln, NE) (http://parking.unl.edu/transit)	StarTrans	Day/Night. Three routes - Fall and Spring only.	StarTrans Bus tracker web and mobile app		10	Free for students; paid by a transit fee. Staff and faculty paid for with parking permits.		17	45	90	120
28	University of New Hampshire (Durham, NH) (http://www.unh.edu/transportation/wildcat-transit)	WildCat Transit	Several routes	NextBus app	30	10-20	Free for students, otherwise $1.50/ride					
29	Rutgers, The State University of New Jersey (New Brunswick, NJ) (http://gobble.rutgers.edu/)	Rutgers University Shuttle/Buses	Day/Night Several routes	NextBus	35	3-12						
30	East Carolina University (Greenville, NC) (http://www.ecu.edu/transit/)	ECU Transit	No service on holidays and weekends Day/Night (Several fixed routes)	Nextbus	60	9	Free					
31	University of North Dakota (Grand Forks, ND) (http://und.edu/financeoperations/transportation/)	UND Campus Shuttle	Day/Night (Several routes)	RouteShout mobile app	30	15	Free					
32	Ohio State University (Columbus, OH) (http://ttm.osu.edu/)	Campus Area Bus Service (CABS)	Day/Night	TRIP	30-34	10-15	Free					

S. N.	Name of the University Source:	Name of Transit Service	Operation Status	Online Tracking System	Service Interval		Included in Semester ($)	Fee structure				
					Long (min)	Short (min)		Ride basis ($)				
								Per Day	Monthly	Semester	Nine Months	Yearly
33	University of Toledo (Toledo, OH) (http://www.utoledo.edu/facilitie s/transit/)	UT Transit Service	Day	Transloc	30	15	Free					
34	Shippensburg University (Shippensburg, PA) (http://www.ship.edu/RRT/)	Raider Regional Transit (RRT)	Day		40	20	Free					
35	University of Pennsylvania (Philadelphia, PA) (http://cms.businessservices.upenn.edu/transportation/)	Penn Transit Sevices	Day/Night	PennRides / Penn Transit Web page		15-20	Free					
36	University of Pittsburgh (Pittsburgh, PA) (http://www.pc.pitt.edu/transportation/)	Safe Riders	Day/Night	Shuttle tracker website/ Android and iPhone apps	30	5-10	Free					
37	University of South Carolina (Columbia, SC) (http://www.sc.edu/vmps/shuttle.html)	Carolina Shuttle	Day/Night	NextBus		15	Free					
38	Rice University (Houston, TX) (http://parktrans.rice.edu/)	Rice Shuttle	Day/Night Several route	Rice website	30-45	5-15	Free					
39	Texas A&M University (College Station TX) (http://transport.tamu.edu/transit.aspx)	AggieSpirit	Days/Night Several routes	Mobile app			Free, financed through university advancement fee					

S. N.	Name of the University Source:	Name of Transit Service	Operation Status	Online Tracking System	Service Interval		Included in Semester ($)	Fee structure				
								Ride basis ($)				
					Long (min)	Short (min)		Per Day	Monthly	Semester	Nine Months	Yearly
40	University of Utah (Salt Lake City, UT) (http://commuterservices.utah.edu/)	The University of Utah Campus Shuttle	Day/Night	Live Tracker web-based and mobile app	30		Free			$23.2/ 12 hr or $33.6/ 20 hr		
41	Utah State University (Logan, UT) (http://parking.usu.edu/)	Aggie Shuttle	Day/ Evening till 9:30 p.m.	Aggie Shuttle Tracker			Free – student funded					
42	University of Vermont (Burlington, VT) (http://www.uvm.edu/~tpswww/)	CATS	Day/Night	Transloc	30	10						
43	University of Virginia (Charlottesville, VA) (http://www.virginia.edu/parking / uts/index.html)	University Transit Service (UTS)	Day/Night	Transloc	20	10						
44	West Virginia University (Morgantown, WV) (http://transportation.wvu.edu/)	WVU Campus Shuttle	Day/ Night till 10:30 p.m.			10	Free - Not available during breaks and holidays.					
45	University of Wisconsin (Milwaukee, WI) (http://www4.uwm.edu/parking/)	Milwaukee County Transit System					U-Pass – included in tuition fee.					

APPENDIX B: RELATED LITERATURE REVIEW

In a survey conducted by Daggett, 29 universities provided complete data to a questionnaire designed to identify the relationship between the transit performance and the university policies.[28] The author found that 83% of the universities had unlimited access to transit systems for students, and 74% of them had unlimited access for staff and faculty as well. The author indicated that about 83% had transit service at the center of the campus, 52% at the edge of the campus, and 13% at the periphery of the campus.

Limanond et al. performed the analysis of variance (ANOVA) test on a travel diary that captured information on 130 students who were living on campus at Suranaree University of Technology (SUT) in Thialand.[24] The students were divided into four groups: male students with their own private cars, male students without a private car, female students with a private car, and female students without a car. The analysis showed that the trip rates generated on weekdays among the four groups were not statistically different; similar results were found for the weekends. However, the mode-split behaviors between these groups were found to be different. The groups having cars seemed more reliant on their cars for travelling, and hardly used any other transportation modes. The groups without cars mostly got rides in their friends' cars, drove their friends' cars, and sometimes travelled on public buses. This paper presented data analysis of the trips per hour data, which showed that students normally travelled more at noon, during lunchtime, and during the late afternoon.

Using an internet-based survey, Wang et al. studied travel behaviors of students at the Old Dominion University in Virginia, capturing the details of student characteristics, residential locations, and their academic status.[29] The authors analyzed travel behaviors of 1,468 students by obtaining travel information through the students' trip diaries. The authors performed a descriptive analysis to analyze the students' personal and travel details, and divided them into three categories: on-campus students, near-campus students, and students who lived farther from campus. They concluded that near-campus students and farther-from-campus students walked less and drove more compared to on-campus students. Further, their study showed that students who worked also made more trips compared to others; in particular, undergraduate students made more trips by driving, bicycling, and walking. The authors claimed that the university-based traffic model prepared during the study could help improve the regional transportation model.

A website maintained by the University of Virginia stated that this school had set several routes–Northline, Inner U-loop, Outer U-loop, Central Ground shuttle, Colonnade shuttle–that connected many places within the area in which the university was located, parking, and shopping centers.[30] The transit system developed separate schedules for individual routes, and was provided free for university students, faculty, and staff. The transit stations in the Northline Connector route were running on a schedule of every 10 minutes from Monday to Friday, starting at 7:30 a.m. to 8 p.m. At night, from 8 p.m. to 12:30 a.m., the service operated at 15-minute intervals and seven days a week. During weekends, the transit service operated every 20 minutes from 12 p.m. to 8 p.m. Similarly, at the exam time, transit services operated according to daytime and evening schedules for exams. The webpage stated that the university transit service was student driven, and used to provide training for students that would prepare them for employment as a commercial bus driver.

The University of Georgia operated a non-fare bus transit system for students, staff, and faculty.[31] The transportation fee that students pay to the university was used on the transportation system. The website provided all the information needed for the bus transit, including the route numbers on a map, the bus schedule, and the location of the bus stops. The campus transit system covered most of the campus, providing bus service on the weekdays as well as some predefined night services. The transit service had headways ranging from five minutes to 20 minutes, depending upon the route and the operation period. During the weekends, Saturday services operated from 10 a.m. to 10 p.m. and Sunday from 12 p.m. to 10 p.m. The university website shows the schedule and route maps as well as other detailed information about the campus transit system. In addition, the transit system provided charter bus service for eligible groups.

The University of Tennessee operated fare-free transit service for all passengers.[32] The transit system, known as "The T," had several routes that operated at short interval times ranging from five- to seven-minute headways at the peak time and 10-minute intervals during normal hours. The university developed a webpage to identify the locations of the buses live. This webpage is supported by TransLoc®, a software application service that provides a visualization of bus movements on a map. Hence, a user could find out the current schedule and location of the bus on the travel route very easily.

A website maintained by the University of Indiana showed that this university had five bus routes, namely Routes A, B, D, E, and X. The bus service times were different on the weekdays and weekends.[33] However, this campus bus service did not provide any transfer services to the public bus. Nevertheless, the campus bus service used a fare-free system, so no passengers had to pay a fare. All buses were equipped with a wheelchair ramp for disabled passengers. The transit system also provided a night service that normally operated from 10 p.m. to 3 a.m. The website used the DoubleMap application, which is an online bus tracking system that provides real-time information of buses on the routes selected.

Baylor University provides a campus bus system to the students for no cost.[34] The daily bus service operates every 15 minutes on the Blue Route and every 7.5 minutes on the Red Route from 7 a.m. to 5:25 p.m., Monday to Friday. For other hours, routes were operated every 20 minutes from 6.30 p.m. to 1.30 a.m. through Monday to Thursday. In addition, the transit service offered free rides from Baylor to downtown Waco on Friday nights from 8:30 p.m. to 2:30 a.m. This transit service provided an online bus tracking system that had an information system for the location of arriving buses and estimated arrival times, using a GPS system that had been installed in the Baylor University shuttles.

Transportation services at the University of Cincinnati was managing two transit services, namely, the Bearcats Transportation System (BTS) and the Campus Transit System (CTS).[35] University students, staff, and faculty could ride CTS at no cost. The BTS was an off-campus transit service, while the CTS was a campus-to-campus bus service. The BTS connected the uptown campus with Cincinnati entertainment areas and neighborhoods. To ride the BTS service, students had to show their university card with a photo identification for free rides, and had an option to travel with a guest. The BTS service did not operate during college breaks, official holidays at UC, and during hazardous conditions. The CTS had several shuttles, some operating at an interval of 10 minutes and some at an interval

of 20 minutes. The DoubleMap application was used to show the shuttle locations and schedules in real time.

A bus service operated by Florida State University (FSU), the Seminole Express, provided free rides to students, staff, faculty, and visitors.[36] The service operates throughout the year. Normally, it operates from 7 a.m. to 7 p.m. during the Fall/Spring semester, and 7 a.m. to 5 p.m. in the summer. The bus service provides transportation services to some of the off-campus apartment complexes. All students, staff, and faculty could ride the StarMetro bus, free of cost, by swiping their FSU card. All buses are visible in the app provided, using the real-time visualization software, TransLoc.

The system used by NextBus, Inc. tracks the bus by means of a GPS installed in the bus.[37] NextBus provides real-time passenger information by internet or text. The website for NextBus lists most of the public transit, shuttles, and trains that have this GPS system.

APPENDIX C: SURVEY QUESTIONNAIRE

UNLV Transit Survey:

Your participation in this study is voluntary. The purpose of this study is to develop framework for improved transit services inside UNLV. We are conducting this survey with UNLV faculty, staffs, and students. All information gathered in this study will be kept as confidential as possible. No reference will be made in written or oral materials that could link you to this study. If you have any questions please contact PI of this study, Dr. Pramen P. Shrestha, phone 702-895-3841, email: pramen.shrestha@unlv.edu I have read the above information and agree to participate in this study.

- ❍ I do not agree (1)
- ❍ I agree (2)

If I do not agree Is Selected, Then Skip To End of Survey

Q1 What is your relationship with UNLV?

- ❍ Student (1)
- ❍ Administrative Staff (2)
- ❍ Faculty member (3)
- ❍ Others (4) _____

Answer If What is your current status to UNLV? Student Is Selected

Q2 Select the option that best describes you.

- ❍ Undergraduate (1)
- ❍ Graduate (2)
- ❍ Doctoral (3)
- ❍ Guest (4)
- ❍ Others (5)

Q3 Specify your age group.

- ❍ Less than 20 years old (1)
- ❍ 21 to 30 years old (2)
- ❍ 31 to 40 years old (3)
- ❍ 41 to 50 years old (4)
- ❍ Above 50 years old (7)

Q4 UNLV and RTC are working to improve the university transit service. To locate the bus stops for new improved service, we are collecting the residence zip code of students, staff, and faculty. Please provide your residence zip code while staying in southern Nevada.

Q5 Are you residing in southern Nevada just to attend the school?
- ❍ Yes (1)
- ❍ No (2)

Answer If Are you residing in southern Nevada just to attend the school? Yes Is Selected

Q6 Where is your permanent residence location?

Q7 How many trips do you make to campus each week?
- ❍ None (1)
- ❍ Once a week (6)
- ❍ Twice a week (2)
- ❍ Three times a week (3)
- ❍ More than three times a week (4)

Q8 When do you travel from your home to UNLV?
- ❍ Spring Semester only (1)
- ❍ Summer Semester only (2)
- ❍ Fall Semester only (5)
- ❍ Spring/Fall Semesters (7)
- ❍ Throughout a whole year (3)

Q9 What is a normal time period of the travel from your home to UNLV?
- ❑ Morning (7 am to 12 pm) (1)
- ❑ Afternoon (After 12 pm to 5 pm) (2)
- ❑ Evening (After 5 pm to 10 pm) (3)

Q10 What is a normal time period of the travel from UNLV to your home?
- ❑ Morning (7 am to 12 pm) (1)
- ❑ Afternoon (After 12 pm to 5 pm) (2)
- ❑ Evening (After 5 pm to 10 pm) (3)

Q11 When you come to UNLV which location do you go to frequently? (For multiple selection, please hold Ctrl key and click the items)

- ❑ Academic Success Center (ASC) (2)
- ❑ Accelerator Lab Building (ALB) (87)
- ❑ Administration & Justice James E. Rogers Center (RAJ) (3)
- ❑ Alumni Center, Richard Tam (TAC) (4)
- ❑ Architecture Building, Paul B. Sogg (ARC) (5)
- ❑ ……..
- ❑ …….

Q12 Select the modes of transportation that you use to travel to UNLV.

- ❑ Public bus (1)
- ❑ Private car (2)
- ❑ Car pooling (3)
- ❑ Bicycle (4)
- ❑ Motor Cycle (5)
- ❑ Taxi (6)
- ❑ Walked (7)
- ❑ Others (8) _____

Q13 Have you ever come to UNLV with your private car?

- ❍ Yes (1)
- ❍ No (4)

Answer If Have you ever come to UNLV with your private car? Yes Is Selected

Q14 What type of parking permit do you buy when you come to UNLV with your private car?

- ❍ Faculty/Staff parking permit (1)
- ❍ Student parking permit (2)
- ❍ Reserved parking permit (3)
- ❍ Vendor parking permit (4)
- ❍ Resident Parking permit (5)
- ❍ None of above (6)

Answer If Have you ever come to UNLV with your private car? Yes Is Selected

Q15 Select the parking permit plan that you recently purchased.

- ❍ Annual permit (1)
- ❍ Monthly permit (2)
- ❍ Weekly temporary permit (3)
- ❍ Daily temporary permit (4)
- ❍ None (5)

Answer If Select the parking permit plan that you recently purchased. Monthly permit Is Selected Or Select the parking permit plan that you recently purchased. Weekly temporary

permit Is Selected or Select the parking permit plan that you recently purchased. Daily temporary permit Is Selected

Q16 Approximately how much do you spend on the purchase of parking permit per year?

Q17 Drag the items and move up and down to rank your preference for modes of transportation while coming to UNLV. (1 being highly preferred and 8 being less preferred).

_____ Public bus (1)
_____ Private car (2)
_____ Carpooling (3)
_____ Bicycle (4)
_____ Motor Cycle (5)
_____ Taxi (6)
_____ On Foot (7)
_____ Light Rail (8)

Q18 How often do you use public bus to come to UNLV?

- ❍ Never (1)
- ❍ Rarely (2)
- ❍ 2-3 Times a Week (7)
- ❍ Sometimes (3)
- ❍ Often (4)
- ❍ All of the Time (5)

Answer If How often do you use public bus to come to UNLV? Never Is Selected Or How often do you use public bus to come to UNLV? Rarely Is Selected

Q19 What are the reasons for not taking the public bus to UNLV?

- ❑ Safety (1)
- ❑ Inconvenience (7)
- ❑ Bus stop too far from home (2)
- ❑ Long intervals in bus schedule (3)
- ❑ Too crowded (4)
- ❑ Bus fare not reasonable (5)
- ❑ Others (6) _____

Answer If How often do you use public bus to come to UNLV? Never Is Selected Or How often do you use public bus to come to UNLV? Rarely Is Selected

Q20 If the problems you mentioned above are addressed, are you willing to take bus service to UNLV?

- ❍ Yes (1)
- ❍ No (2)
- ❍ Not sure (3)

Answer If How often do you use public bus? Never Is Not Selected

Q21 Which bus routes do you often take?

- ❑ 108- Paradise (1)
- ❑ 109 - Maryland Parkway (2)
- ❑ 201 - Tropicana (3)
- ❑ 202 - Flamingo (4)
- ❑ CX - Centennial Express (UNLV transit) (5)
- ❑ None of above (6)

Q22 Rank your preference of the fare pass for public transportation. Drag the items and move up and down to rank your preference. (1 being highly preferred and 7 being less preferred)

_____ Single pass ($2) (1)
_____ 2 hours pass ($3) (2)
_____ 24 hours pass ($5) (3)
_____ 15 days pass ($34) (4)
_____ 30 days residential pass ($65) (5)
_____ 30 days U-pass ($32.5) (6)
_____ A semester U-pass ($104) (7)

Q23 If UNLV decides to include the transportation cost in your semester fee, what is the reasonable cost range to pay? [Note: Onetime payment will allow every student to ride RTC bus in Nevada free for the entire semester]

- ❍ $10 to $15 per semester (1)
- ❍ $15 to $30 per semester (2)
- ❍ Greater than $30 per semester (3)
- ❍ It is not good idea to include transportation cost in semester fee (4)

Q24 Is a public bus stop located in a walking distance from your home?

- ❍ Yes (1)
- ❍ No (2)
- ❍ Do not know (3)

Answer If Is public bus stop located in a walking distance from your home? Do not know Is Not Selected

Q25 How many minutes does it take you to get to the bus stop?

- ❍ Less than 10 minutes (1)
- ❍ 10 to 20 minutes (2)
- ❍ 20 to 30 minutes (3)
- ❍ Greater than 30 minutes (4)

Answer If Is public bus stop located in a walking distance from your home? No Is Selected Or How many minutes does it take you to get the bus stop? Greater than 30 minutes Is Selected

Q26 If public bus service is located within few blocks from your home, will you use public bus service?

- ❍ Yes (1)
- ❍ No (2)
- ❍ Don not know (3)

Q27 What amenities you would like to see in the transit station that will motivate you to ride public bus?

Q28 Are you familiar with Bike Share System?

- ❍ Yes (1)
- ❍ No (2)

Answer If Are you familiar with Bike Share System? No Is Selected

"A bicycle sharing system, or bike share scheme, is a service in which bicycles are made available for shared use to individuals on a very short term basis." [source: http://en.wikipedia.org/wiki/Bicycle_sharing_system]

Q29 If Bike share system is used in UNLV, would be you willing to take a bicycle while moving around the campus?

- ❍ Yes (1)
- ❍ No (2)

Survey Data:

Table 1. Categorization of the responders

S.N.	Responder Category	Proportion of responses	Response	%
1	Student		833	63%
2	Administrative Staff		240	18%
3	Faculty member		135	10%
4	Others		121	9%
	Total		1,329	100%

Table 2. Categorization of the student responders

S.N.	Student Category	Proportion of responses	Response	%
1	Undergraduate		557	70%
2	Graduate		92	12%
3	Doctoral		45	6%
4	Guest		16	2%
5	Others		81	10%
	Total		791	100%

APPENDIX D: COMMENTS RECEIVED ON QUESTION: "WHAT ARE THE REASONS FOR NOT TAKING THE PUBLIC BUS TO UNLV?"

Such reasons such as 'long transfer time,' and 'the transit station too far from their residence' played big role for not using the public bus. The main reasons are summarized as follows:

- Long travel time as compared to traveling by car,
- The RTC bus route does not cover their residence,
- Weird feeling while travelling because of the inconvenient bus environment,
- Their own preference to travel by private car rather than the public bus, and
- Family reasons, such as dropping their kids to school and picking up them while returning back.

Some comments given below are exactly what was received from participants.

1. End stop of my route too far from campus to walk SAFELY (down Tropicana, across intersection), would have to switch lines for less than a mile.
2. Bus stop too far from work.
3. Too many rude people.
4. Too many transfers, too long of travel time.
5. I choose to walk. I would ride when it is cold or too hot in the summer, but I calculated that the semester bus pass and the staff permit for parking are almost nearly the same price.
6. Not reliable, takes too long.
7. Length of travel time & needing to transfer.
8. Very near to residence.
9. Not enough other options in public transportation look at every great city has trams, subways, buses. Las Vegas only busses.
10. Bus route from CSN to UNLV takes too long to make it on time.
11. AC often not working.
12. I have to take my kid to school and there is no other way to get her there.

13. Inadequate bus service. Would take too long with too many connections. No adequate service to UNLV from either Boulder City or from Henderson.

14. Travel time too long.

15. Trip takes too long, no express buses; requires transfer between two bus lines.

16. It would take two buses.

17. The route information is over 100 pages long!

18. Dealing with drunk/high/abusive passengers.

19. Scary people on busses.

20. Two buses change and an hour of time.

21. Too far from my home to UNLV.

22. Need to carry bulky art supplies.

23. I'm a music major who needs to take a cello to class, so having to spend an hour on a bus and walk 10 or 20 minutes to a connection isn't something I'm willing to do on days when I have my instrument. Plus, there are days where I need to stay later than the last time buses run.

24. I come to UNLV from work, so I have my car.

25. The RTC buses are filthy. It's almost like they assume that disabled persons are not deserving of clean transport.

26. Ride takes too long takes all day.

27. No reasonable route/schedule.

28. Commute time is too long.

29. Requires 2 busses.

30. I stop off at UNLV after work.

31. Takes too long due to transfer timing.

32. Bus stop on Tropicana at night seems unsafe.

33. Takes five times long than driving car.

34. Lack of time to try it; also, have to take kids to charter school across town.
35. Don’t live in an area serviced by public transpiration.
36. From North Las Vegas to UNLV it took two hours one way!
37. Didn’t know there was a bus to campus.
38. I want light rail, not a bus!
39. Takes much longer.
40. Frequent stops/takes too long.
41. I would need to transfer two times as I live in Henderson.
42. Can’t count on them to be on time.
43. My home is close enough to walk to school.
44. Residence is walking distance from campus.
45. I am just close to UNLV.
46. The bus stop is as far away as the school.
47. No direct route from my residence.
48. Unaware.
49. Not able to take my instrument on the bus.
50. Too many other stops during the trip, should be a straight shot to campus.
51. I live close to UNLV.
52. Need for transportation during the day to off-site meetings, and limited options that are time effective.
53. My apartment complex is located within walking distance of UNLV.
54. It would take a couple hours to get here!
55. Unaware of the bus stop near my home.
56. Live too close to the school.
57. The closet stop to my house is a 1/2 mile away.

58. Arrival time is much slower compared to a personal vehicle.

59. I have two young children that I have to drop off and pick up on my way to and from school, so taking the bus would not only add to my already incredibly long travel time but would make a very uncomfortable/stressful commute.

60. Time to take bus (without including walking to bus stops that aren't that close) is longer than it takes me to drive in my car.

61. People on the bus are often smelly and weird.

62. Bus takes an hour, car takes 15 minutes.

63. I do not know how to take the bus to UNLV, the commute would be longer than driving.

64. Don't know how to read a bus schedule.

65. Have to drop son off at school.

66. Too long (95 min for 20 mile).

67. RTC does not provide bus service in my rural community.

APPENDIX E: COMMENTS RECEIVED ON QUESTION: "WHAT AMENITIES YOU WOULD LIKE TO SEE IN THE TRANSIT STATION THAT WILL MOTIVATE YOU TO RIDE A PUBLIC BUS?"

Many of the respondents mentioned that they wanted to see better seating and shades at the Transit Station. Many wanted to have free Wi-Fi services and screen displays regarding information about the real-time bus schedules, particularly arrivals and departures. One good suggestion was for having online software to stay up to date on the bus schedule. Similarly, some respondents suggested making transit service more frequent so that waiting times would be less than 20 minutes. Bathroom or restrooms were demanded by the respondents. Most wanted clean and covered transit stations as well as clean public buses.

Some comments given below are exactly what received from participants.

1. Nice seating.

2. It's not the Transit Center. It's the transit itself. I live 7 miles from UNLV and it takes less than 20 minutes to drive. When I take the bus to UNLV in the morning, it takes an hour.

3. It takes 1.5 hours to get home from UNLV because routes do not run as frequently after 5 p.m., particularly for those of us who do not live near a major route such as 109, 202, etc. The UNLV Transit Center would be an option for me except that the only route that services it is the CX, which runs once an hour. Factor in that I must take 2 busses and have to make a transfer. Some transfer stops are in rough neighborhoods and I do not feel safe waiting. If RTC had well-lit bus stops, I might consider it. But the ones I use don't even have benches. While I appreciate the bike racks and bikeshare programs, the bike racks on my bus routes are full by the time they get to my stop, thus bringing my own bike is no guarantee. Even so, the recent deaths of many bicyclists and the lack of bicycle lanes in Las Vegas makes riding a bike here the equivalent of skydiving without a parachute. You're not creating a solution by having the bikeshare program. You're just creating another problem because the city cannot safely accommodate bicyclists.

4. None, the transit station is not the problem, the bus routes are.

5. Convenient pickup times and fast direct service to and from general locations in town.

6. Bathrooms.

7. Wi-Fi, better shade and shelter from rain and sun.

8. Express service to UNLV from Summerlin, closer access to bus stop.

9. As long as it wasn't a long ride and it's clean, I'd be happy.

10. I would like to see it moved off campus. By putting it on campus, it reduced the amount of student parking, and no one that I know even uses the bus. It's a waste of space.

11. Something that takes away body odor and perfume when people get on the bus.

12. Screen that shows next arrival/departure.

13. Bathroom with security patrol so homeless don't live there.

14. Real-time schedules, free Wi-Fi, security, park/greenway or plaza, shops.

15. Books.

16. More relevant and exciting advertisements about what's going on campus and Las Vegas. The UNLV transit center needs a ticket kiosk machine to purchase tickets before boarding. I would also like to see more programming or events taking place near the UNLV transit center i.e. live music--a sax player, something simple.

17. More frequency than almost 20 minutes.

18. More routes to the Henderson & Green Valley area.

19. UNLV needs secure bike parking, riding my bike to a bus stop and then taking the bus to/from work would be much more convenient for me, but every week, the police blotter mentions stolen bikes. These are just the ones people bother to report. Trying to encourage students and staff to use bikes in conjunction with the bus is ridiculous when our bikes are pretty much guaranteed to be stolen on campus. A chain or u-lock is not sufficient. A thief dismantled my friend's bike that had been secured with a steel u-lock, leaving just the front wheel and lock still attached to the bike rack. I'm guessing this $500 bike was stolen for $10 of scrap metal. That's just the reality of the rough neighborhood UNLV is in. The transit center needs to provide actual lockers for bikes or have an attendant station like the one at the Bonneville Transit Center.

20. Wi-Fi, vending machines.

21. Wi-Fi, shorter routes to get to and from work.

22. Web based app for bus schedule.

23. Have some sort of cooling using solar energy.

24. More frequent arrivals at the station near me, takes way to long 1 hour intervals every great city has intervals of 15 minutes.

25. Benches, climate control, power outlet, and Wi-Fi.

26. Express route to UNLV.

27. Small building for when the weather is rough.

28. Doesn't matter, I just don't care to sit on a bus for an hour and a half to get to/from school.

29. Security guard armed with a gun.

30. Wi-Fi, clean bathrooms, up-to-the minute bus status.

31. Covered seating.

32. Direct bus line to campus.

33. Water Station.

34. Shade and proper protection from traffic.

35. Not stink, cleaner, less crowded.

36. Express bus from Boulder City or from Henderson.

37. Free Wi-Fi, ticketing machine, credit/debit card purchase ability.

38. Easy and fast transfer to other routes 38. Air conditioning. Minimal number of stops.

39. Shelter, ample seating, security.

40. Shade, protection from cars.

41. Safety, cover from the elements.

42. More bike storage.

43. Wi-Fi, time schedules, pre-buy fare stations.

44. Cleaner bus stops, more seats to seat on, better shading by the roof at the bus stops, nicer bus drivers, clean and normal looking people, cheap errors fare, and no more wheelchairs.

45. A single bus line all the way to campus.

46. Wi-Fi and better idea of bus positions (if they are delayed or not).

47. Nothing, just it being able to pick me up and drop me off near my house.
48. Shaded seating bench, a hydrating station, and clean restrooms.
49. Free rides for students.
50. Safe place to park your car.

APPENDIX F: TABLES PREPARED FOR CALCULATING MANDATORY TRANSPORTATION FEES

	Running bus along the Maryland Parkway in Weekday								
	Bus Route	CX							
	Round trip time	120	minutes						
	Round trip		**Northbound**					**Southbound**	
SN	**Operation time**	**Hours included**	**Headway (min)**	**No. of buses**	**Operation time**	**Hours included**	**Headway (min)**	**No. of buses**
1	7:00 am to 3:00 pm	8	60	1	7:00 am to 7:30 am	0.5	15	4
2	3:00 pm to 8:00 pm	5	30	2	7:30 pm to 9:00 am	1.5	30	2
3	8:00 pm to 8:30 pm	0.5	60	1	9:00 am to 8:30 pm	11.5	60	1
	Total hours of operation		35	hours				
	Headway required from survey		14	min				
	Now if the headway is to be provided		18	min				
	Number of buses required		7	buses				
	Extra buses required		1	buses				
	Total hours required to be servered per day		13.5	hours				
	Total demanded hours		94.5	hours				
	Extra hours/day		**59.5**	**hours**				

Figure 14. The Extra Service Hours and Buses Required for Route CX

	Running bus along the Tropicana Road in Weekday								
	Bus Route	201							
	Round trip time	156	minutes						
	Round trip		**Eastbound**					**Westbound**	
SN	**Peak operation time**	**Hours included**	**Headway (min)**	**No. of buses**	**Operation time**	**Hours included**	**Headway (min)**	**No. of buses**
1	7:00 am to 12:00 pm	3	25	4	7:00 am to 12:00 pm	5	20	4
2	7:00 am to 12:00 pm	2	15	6	12:00 Pm to 5:30 pm	5.5	15	6
3	12:30 pm to 5:30 pm	2	10	8	5:30 Pm to 8:30 pm	3	20	4
4	12:00 pm to 8:30 pm	4.5	20	4				
5	6:00 pm to 8:30 pm	2	25	4				
	Operation hours for headway more than 15 minutes		38	hours			32	hours
	Headway required from survey		18	min				
	Now if the headway is to be provided		18	min				
	Number of buses required		9	buses				
	Extra buses required		0	buses				
	Total hours required to be servered per day		9.5	hours				
	Total demanded hours		85.5	hours				
	Hours spent (considering only the headway more than 18 minutes)		70	hours				
	Extra hours/day		**15.5**	**hours**				

Figure 15. The Extra Service Hours and Buses Required for Route 201

	Running bus along the Flamingo Road in Weekday								
	Bus Route	202							
	Round trip time	164	minutes						
	Round trip		**Eastbound**					**Westbound**	
SN	**Peak operation time**	**Hours included**	**Headway (min)**	**No. of buses**	**Operation time**	**Hours included**	**Headway (min)**	**No. of buses**
1	7:00 am to 11:30 pm	0.75	6	14	7:00 am to 6:00 pm	11	15	6
2	7:00 am to 6:00 pm	6	15	6	6:00 pm to 8:30 pm	2.5	20	5
3	7:00 am to 11:00 pm	3.5	25	4				
4	6:00 pm to 8:30 pm	2.5	20	5				
	Operation hours for headway more than 15 minutes		26.5	hours			12.5	hours
	Headway required from survey		24	min				
	Now if the headway is to be provided		18	min				
	Number of buses required		10	buses				
	Extra buses required		0	buses				
	Total hours required to be servered per day		6	hours				
	Total demanded hours		60	hours				
	Hours spent (considering only the headway more than 15 minutes)		39	hours				
	Extra hours/day		**21**	**hours**				

Figure 16. The Extra Service Hours and Buses Required for Route 202

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