The EmX Franklin Corridor
BRT Project Evaluation

Final Report - April 2009
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The EmX Franklin Corridor – BRT Project Evaluation

Funded by the Federal Transit Administration

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13. ABSTRACT

Lane Transit District began BRT service on its Franklin Corridor EmX in January 14, 2007. The four mile long route connects downtown Eugene and downtown Springfield, the two main hubs for LTD's system. The corridor, which has the greatest ridership of all LTD routes, also serves the University of Oregon (UO) and Sacred Heart Medical Center, which are two large markets for LTD's services. The EmX operates in dedicated lanes along mixed traffic as well as on separated running ways and was developed with eight stops located at major destinations. Each stop has a covered shelter or kiosk and is fully ADA accessible. Seating, trash receptacles, lights, maps of LTD bus service are some of the amenities provided at each shelter. Currently there is no charge to ride the EmX.

The EmX operates every day on a headway based schedule. Headways are 10 minutes, an upgrade from the former Route 11 standard bus service that served stations every 15-30 minutes. Evening and weekend headways are 15 - 20 minutes. Four EmX buses operate along the corridor during operating hours.

The Rapid employs several forms of Intelligent Transportation Systems (ITS) to help in the operations and image of the system. The systems include the use of Transit Signal Priority (TSP) along the route, the Automated Vehicle Locator (AVL), Automated Passenger Counters (APC), and computer automated dispatching (CAD).

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METRIC/ENGLISH CONVERSION FACTORS

ENGLISH TO METRIC

LENGTH (APPROXIMATE)

1 inch (in)	=	2.5 centimeters (cm)
1 foot (ft)	=	30 centimeters (cm)
1 yard (yd)	=	0.9 meter (m)
1 mile (mi)	=	1.6 kilometers (km)

AREA (APPROXIMATE)

1 square inch (sq in, in^2)	=	6.5 square centimeters (cm^2)
1 square foot (sq ft, ft^2)	=	0.09 square meter (m^2)
1 square yard (sq yd, yd^2)	=	0.8 square meter (m^2)
1 square mile (sq mi, mi^2)	=	2.6 square kilometers (km^2)
1 acre = 0.4 hectare (he)	=	4,000 square meters (m^2)

MASS - WEIGHT (APPROXIMATE)

1 ounce (oz)	=	28 grams (gm)
1 pound (lb)	=	0.45 kilogram (kg)
1 short ton = 2,000 pounds (lb)	=	0.9 tonne (t)

VOLUME (APPROXIMATE)

1 teaspoon (tsp)	=	5 milliliters (ml)
1 tablespoon (tbsp)	=	15 milliliters (ml)
1 fluid ounce (fl oz)	=	30 milliliters (ml)
1 cup (c)	=	0.24 liter (l)
1 pint (pt)	=	0.47 liter (l)
1 quart (qt)	=	0.96 liter (l)
1 gallon (gal)	=	3.8 liters (l)
1 cubic foot (cu ft, ft^3)	=	0.03 cubic meter (m^3)
1 cubic yard (cu yd, yd^3)	=	0.76 cubic meter (m^3)

TEMPERATURE (EXACT)

[(x-32)(5/9)] °F	=	y °C

METRIC TO ENGLISH

LENGTH (APPROXIMATE)

1 millimeter (mm)	=	0.04 inch (in)
1 centimeter (cm)	=	0.4 inch (in)
1 meter (m)	=	3.3 feet (ft)
1 meter (m)	=	1.1 yards (yd)
1 kilometer (km)	=	0.6 mile (mi)

AREA (APPROXIMATE)

1 square centimeter (cm^2)	=	0.16 square inch (sq in, in^2)
1 square meter (m^2)	=	1.2 square yards (sq yd, yd^2)
1 square kilometer (km^2)	=	0.4 square mile (sq mi, mi^2)
10,000 square meters (m^2)	=	1 hectare (ha) = 2.5 acres

MASS - WEIGHT (APPROXIMATE)

1 gram (gm)	=	0.036 ounce (oz)
1 kilogram (kg)	=	2.2 pounds (lb)
1 tonne (t)	=	1,000 kilograms (kg)
	=	1.1 short tons

VOLUME (APPROXIMATE)

1 milliliter (ml)	=	0.03 fluid ounce (fl oz)
1 liter (l)	=	2.1 pints (pt)
1 liter (l)	=	1.06 quarts (qt)
1 liter (l)	=	0.26 gallon (gal)
1 cubic meter (m^3)	=	36 cubic feet (cu ft, ft^3)
1 cubic meter (m^3)	=	1.3 cubic yards (cu yd, yd^3)

TEMPERATURE (EXACT)

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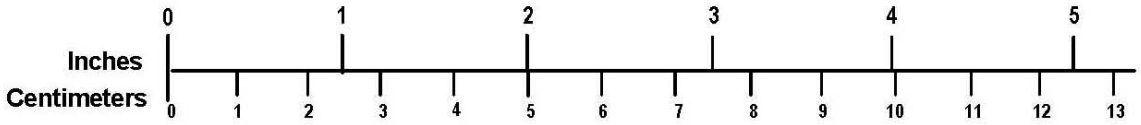
QUICK INCH - CENTIMETER LENGTH CONVERSION



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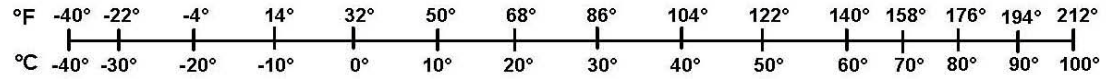

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Project Context

Since 1996 Lane Transit District (LTD) actively pursued the development of a bus rapid transit (BRT) system. As part of the update process of TransPlan, a 20-year government plan to spend $1.53 billion on the transportation system of the Eugene-Springfield metropolitan area, BRT became an important piece in the analysis of how to meet statewide transportation goals, and in 1998 it was determined that the BRT system would be provided for the Eugene/Springfield area. The EmX (Emerald Express), as the BRT system was named, would operate along the Franklin Corridor and was planned to be comparable to light rail system by providing comparable speed, convenience, and comfort. Final adoption of the project was made by the LTD Board, Eugene and Springfield City Councils, and the Lane County Commission.

Project Description

Lane Transit District began BRT service on its Franklin Corridor EmX on January 14, 2007. The four mile route connects downtown Eugene and downtown Springfield, the two main hubs for LTD's system. The corridor, which has the greatest ridership of all LTD routes, also serves the University of Oregon (UO) and Sacred Heart Medical Center, which are two large markets for LTD's services. The EmX operates in dedicated lanes along mixed traffic as well as on separated running ways and was developed with eight stations located at major destinations. Each station has a covered shelter or kiosk and is fully ADA accessible. Seating, trash receptacles, lights, and maps of LTD bus service are some of the amenities provided at each shelter. Currently there is no charge to ride the EmX.

The EmX operates every day on a headway based schedule. Headways are 10 minutes, an upgrade from the former Route 11 standard bus service that served stations every 15-30 minutes. Evening and weekend headways are 15 - 20 minutes. Four EmX buses operate along the corridor during operating hours.

The EmX employs several forms of Intelligent Transportation Systems (ITS) technology to help in the operations and image of the system. These include the use of Transit Signal Priority (TSP) along the route, the Automated Vehicle Locator (AVL), Automated Passenger Counters (APC), and computer automated dispatching (CAD).

System Costs

The total project capital cost was approximately $25 million to build, or $6.25 million per mile. This amount includes the purchase of six vehicles. System construction cost about $12 million and planning and design another $6 million. LTD used federal funds for 80% of projects costs.

System Performance

End-to-end travel times on the EmX vary between 14 and 16 minutes in both on and off-peak traffic conditions. Data collected by Lane Transit District and CUTR show that the EmX has reduced average end-to-end travel time by approximately 1 minute, equating to a 4 percent reduction compared to the local service. Over 80 percent of users perceived the EmX as faster than the previous service, with almost half of surveyed respondents indicating that the service was at least 15 minutes faster. Travel times decreased due to reductions in signal delay (28%), dwell time 10%), and time spent in transit (18%).

Service reliability and schedule adherence has improved over the Route 11. The EmX has decreased the variation of travel times and operates on schedule. Customers are also happy with reliability; it has received a rating of "good", as compared to the "fair" rating received by Route 11.

Lane Transit has been successful in creating a unique identity for its EmX service, using unique branding on buses, shelters and signs. Approximately 85 percent of users stated that the "ease of Bus identification" was "good" or "very good". General public perceptions of the EmX are good, achieving an average rating of 4.0 on a five-point scale (Route 11 and LTD's other services received a rating of 4.0).

In regard to safety, the EmX was involved in eight accidents since it began operation in January 2007. None of the reported accidents were due to negligence on behalf of an EmX operator; all accidents were the fault of the other party involved. In relation to user perceptions, the EmX was viewed as being "good" in terms of safety at stops on the on vehicle. This is an improvement from ratings received on the Route 11; personal safety at stops only received a "fair" rating.

Configured to the specifications of LTD, each New Flyer Vehicle can carry a maximum of 90 passengers (39 seated, 51 standing). The EmX operates with 10 minute headways, equating to 6 buses per hour. Thus, the EmX service has a one-way peak hour capacity of 540 passengers per hour (90*6), and bi-directional capacity of 1080 (90*12). These capacities are sufficient for the majority of passenger loads experienced throughout the day. Although the EmX received a mean score (3.9) that equates to a "fair" rating by passengers on the on-board survey, this is an improvement from previous service (3.5). Additionally, no comments were received regarding seating and capacity, while an approximate 14 percent of comments received on the Route 11 survey were complaints in this category.

System Benefits

Since it began operation on January 14, 2007, the EmX has continually increased its ridership. Ridership numbers have increased from approximately 4,000 riders in February 2007 to almost 5,400 in April 2008. Aside from decreases recorded during December and the summer of 2007, figures have been on a steady incline. When evaluating systemwide ridership to understand regional ridership trends, it was found that

LTD experienced an increase in ridership every year from 2004, yet a significant increase was noted from January 2007 to January 2008 during which the EmX was in operation.

The proportion of EmX users that previously used a car is around 16 percent. Additionally, seven percent of riders did not previously make the trip which suggests that users are accessing the system for trips they normally would not take.

Total capital cost of the EmX was approximately $25M, or $6.25 million per mile. Since the EmX includes a number of enhanced treatments, i.e., enhanced stops, transit signal priority, and articulated vehicles, as well as its operation on exclusive transitways for approximately 60 percent of the route (usual costs for this treatment equal $6.5 to 10.2 million per mile), costs for the EmX were on target. The outlay in capital costs has also resulted in successful branding of the system.

The EmX has also been successful in generating interest in land development. A local realty firm attributed increased interest in properties to the proximity to a bus rapid transit line. Purchasers of the properties intend to use it for investment purposes.

In regard to environmental quality, the system has successfully created a "green" image. LTD's commitment to the environment was recognized with a 2008 Sustainable Transport Honorable Mention from the Institute for Transportation and Development Policy. With less than a year in operation, the EmX was the only United States project selected as an award winner for 2008.

Project Context

1.1 Background

Lane Transit District (LTD) has been serving Lane County since 1970. Its annual ridership is 11 million, with 37,137 passengers per weekday. LTD provides fixed route, shuttle, and BRT service, as well as demand-responsive service for persons with disabilities, and a Commuter Solutions Program (vanpool, carpool, employer programs). A shuttle service is also provided for special events.

In 1996, discussion of a rapid transit system began as part of a regional transportation plan update. BRT quickly became the preferred mode as it was seen as a way to provide enhanced transit service without the high cost of light rail. By 1998, LTD had selected the Franklin Corridor for Phase I of the rapid transit line. In 2001 BRT was approved as a key element of the new transportation plan by Eugene, Springfield, Lane County, and LTD.

The LTD Board has adopted goals and performance objectives for the Phase 1 BRT project and included the following:

- Increase ridership
    - Reduce travel time
    - Increase reliability
    - Provide convenient neighborhood connections
- Reduce operating costs
- Increase person carrying capacity of the corridor
- Support planned land use patterns
- Enhance other infrastructure that is non-specific to transit
    - Bicycle improvements
    - New sidewalks
    - Traffic flow and traffic safety improvements
    - Landscaping
    - Undergrounding of utilities

Franklin Corridor links downtown Eugene with downtown Springfield, which are the two main hubs of LTD's transit service. In addition to providing a link between the two hubs, the corridor was selected because of its high traffic volume and population density, and its heavy transit ridership. This corridor also serves the University of Oregon, Northwest Christian College, and Sacred Heart Medical Center.

1.2 Corridor Characteristics

Previous to the opening of the EmX (Emerald Valley Express), the Franklin Corridor was served by Route 11, with an average weekday ridership of 2,667 during the fall and

spring of 2006. Route 11 operated between downtown Eugene Station on to downtown Springfield Station where it then continued onward toward the Thurston area with a terminus of 69th and Main Streets. The route serves both Thurston Middle and High schools. While the Route 11 still operates from Springfield Station to the Thurston area, the EmX replaced service between downtown Eugene and downtown Springfield. Prior to the implementation of the EmX, passenger stops were more frequent and closely spaced. An on-board passenger survey of Route 11 that was conducted in November 2006 allowed the following conclusions:

- Most riders board and disembark the vehicle at either Springfield or Eugene station;
- The primary use of the bus is for school or work trips, therefore the majority of passenger access the service five or more days a week;
- Existing passengers were satisfied with the convenience of the bus service (where it serves); and
- Passengers desired better quality of shelters/stops.

Discussions about new transportation options began in 1996 as part of a regional transportation plan update. During the update process, several transit options were considered, analyzed, and discussed in public forums. Bus Rapid Transit (BRT) emerged as the clearly preferred transit strategy. It was seen as a way to significantly enhance transit service and achieve many of the benefits of light rail without the high cost. As a result, BRT was approved in 2001 by Eugene, Springfield, Lane County, and LTD as a key element of the new transportation plan.

The EmX had been designed to operate six minutes faster during the initial peak-hour travel time. Because conventional bus service is likely to slow down as traffic congestion increases, the travel time savings of EmX compared to conventional bus service are projected to increase to 11 or 12 minutes within 20 years. The result of several years of planning the EmX was implemented with a combination of federal and local funds. Its key components include:

- Reducing stops from 18 to 10, for an average stop spacing of 0.5 miles
- Locating all stops at the far side of the intersection to allow EmX buses to take advantage of signal priority (extended or early greens)
- Headway based scheduling
- Operating on exclusive single or dual bus lanes for 60 percent of the corridor
- Installing transit priority along the entire corridor
- Installing a queue jump lane
- Branding the service with the EmX logo and decals on buses, shelters, maps and schedules
- Inaugurating the service with new 63 foot articulated New Flyer buses, which feature modern styling and are equipped with doors on both sides to accommodate shelters located in the median
- Installing new EmX bus shelters and kiosks along the route

Future corridors will include the Pioneer Parkway extension in Springfield, with an anticipated opening in 2010, and a route west from downtown Eugene near West 11th Avenue that could be operational in 2015. Coburg Road also remains a possibility, completing a loop with the Green Line and the planned Pioneer Parkway corridors.

The 7.8-mile Pioneer Parkway project will extend service from the east terminus of the Franklin corridor north to existing and new residential and employment areas in Springfield. Employment within a half-mile of the BRT route is expected to reach 15,500 jobs by 2010, which is 10% of the metropolitan area's total forecasted employment. The line will operate at-grade, with 10-minute headways. The project will include 14 new stations, signal priority and purchase of four low floor, branded, hybrid-electric vehicles. Expected capital cost is estimated at $36.99 million. Lane Transit District is seeking $29.59 million (80%) in Small Starts funding. Congress has appropriated $29.30 million for the project through FY 2008. FTA has recommended $296,000 in Small Starts funding for FY 2009.

The long term goal is for rapid bus development in all major corridors within 20 years. Selection criteria for corridors will include nodal development consideration, population and employment. Construction of the next corridors will depend upon available funding and traffic congestion issues. Significant ridership increases are not expected by LTD until additional corridors have been added to the initial EmX system.

2. Project Description

The EmX combines a number of rapid transit elements that create a unique and identifiable system. The purpose of this section is to provide a detailed description of the major BRT elements that are characteristic of the system as they are presented in the Characteristics of Bus Rapid Transit for Decision-Making (CBRT) report (2004).

- Running Ways
- Stations
- Vehicles
- Fare Collection
- Intelligent Transportation Systems (ITS)
- Service and Operations Plan

2.1 Running Ways

The four-mile EmX route uses exclusive single and dual bus lanes for about 60% of the route, whereas the remaining 40 percent operates in mixed traffic. Where a single busway lane is employed, both the east and west-bound buses travel along the same busway lane by taking turns and "block signaling" is used to indicate when it is safe for a bus to enter the lane. A section of parallel bus lanes is located along Franklin Boulevard between Agate and Moss streets. The bus lanes are 10 feet in width and are separated by an 18 inch curb. Operators can travel up to 45 mph along the bus lanes. Some portions of the busway employ a grassy median strip which absorbs fluid leaks and some vehicle noise, a solution that was readily accepted by the environmental community.

When operating among mixed traffic, the EmX uses signal priority and queue jump lanes. The lanes are for buses only and penalties are assessed for vehicles operating in the bus lanes or for parking in the lanes. The fines are $237 and $25, respectively.

2.2 Stations

The Green Line has ten stations including Eugene and Springfield stations. LTD built eight enhanced shelters about every half mile along the route. Passenger amenities include lighting, information displays, bike racks and eventually real-time vehicle information displays will be installed once LTD finds a financially viable option. Shelters are designed to be safe, attractive and easily maintained. Stations are listed below from west to east:

- Eugene Station (Eugene)
- High Street (Eugene)
- Hilyard (Eugene/Sacred Heart Medical Center)

- Dads' Gate (Eugene/University of Oregon)
- Agate (Eugene/University of Oregon)
- Walnut (Eugene)
- Glenwood (Springfield)
- Lexington (Springfield)
- McVay (Springfield)
- Springfield Station (Springfield)

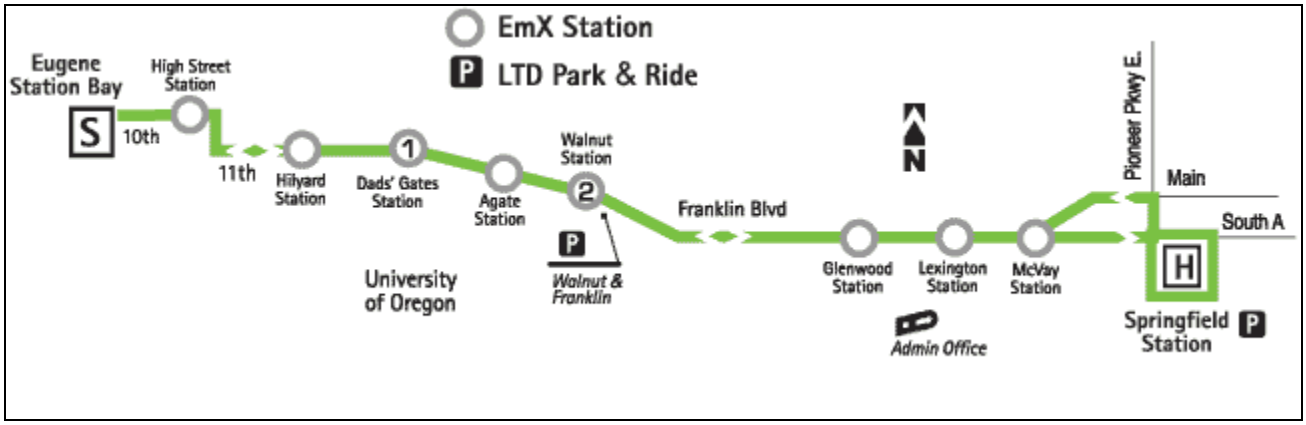


FIGURE 2.1 - EmX Stops

PIVOT, a local architectural firm, was hired to design the EmX stations. The design was to incorporate the concept of "masted sails" which provides coverage from the sun in the summer and rain year-round. The open design allows maximum visibility which is important for safety reasons and incorporates a number of operational factors while creating a new look for the service. Columns supported the shelter are centrally located which allow for vehicle boarding from both sides of the platform with minimal obstacles. To protect waiting passengers from rainwater, the roofs direct the water to a central gutter and downspout for distribution to the storm system. The single gutter minimizes time required for annual cleaning. Lighting is another amenity provided for waiting passengers; light is white in color when the system is operating at night, and blue when it is not.

FIGURE 2.2 – Hilyard Station

Median stations must accommodate left side boarding for eastbound and westbound buses. All stations feature raised platforms to achieve "near-level" boarding with the low-floor buses. Platforms are about 14 inches high. Among the permanent stops ("temporary" stops include Glenwood and Lexington and require a passenger to request the vehicle to stop), High Street is the only single sided station along the route due to space limitations, and provides a 10 foot wide roadway width for vehicles. Glenwood and Lexington stops will become permanent at a later date once modifications to Franklin Boulevard are made.

With roadway widths ranging from 9 to 14 feet at stations, vehicles have a very narrow area to pull up to the stations. To guide buses coming into these narrow stations, LTD placed yellow-gold strips made of a durable material at wheel height along the curbs. In addition to the yellow strips, LTD painted an EmX logo on the platform. When drivers pull in, they line up the front of the vehicle with the logo to achieve consistent boarding. Along the tactile surface, LTD also provided a different color where the doors of the vehicle line up to mark the boarding areas. LTD will have to provide a texture change as the colors that were initially used make it difficult for visually impaired persons to distinguish one color from the other.

FIGURE 2.3 – Yellow Striping for Vehicles

Steel was chosen as the material due to its sturdiness. High quality paint was applied to protect the steel from the weather and minimize maintenance. Many of the new stations have provisions to add an additional shelter should the ridership at a particular station warrant additional shelter space.

Although not required to fulfill Oregon's One Percent for Art legislation, which mandates that one percent of expenses for the construction of public buildings be spent on art to be displayed in and around the building, LTD included additional art to decorate the stations. A committee of artists selected Linn Cook, a local artist, to create cast and formed metal railings portraying indigenous plants. Each station is characterized by a different plant.

FIGURE 2.4 Dogwood Artwork At Hilyard

TABLE 2.1 Indigenous Plants by EmX Stop

Stop	Indigenous Plant
High	Maple
Hilyard	Dogwood
Dads' Gate	Iris
Agate	Rhododendron
Walnut	Oak
Glenwood	Fir
Lexington	Fern
McVay	Filbert

Eugene Station – Terminus of EmX

Eugene Station, located in downtown Eugene is bordered by 10th Avenue, Willamette Street, 11th Avenue, and Olive Street. Eugene Station was designed by PIVOT and extends the length of ¾ block. A customer service desk is located inside the service center where passengers can request information or purchase a pass for LTD services. Restrooms and a seating area are available in the service center as well. Originally providing 20 bus bays, Eugene Station has a reduced number of bays (19) since two bays are needed for the EmX vehicle. On its return from Springfield Station, the EmX enters Eugene Station from Willamette Street and departs to the north along 10th Avenue. Located in close proximity to the station are a police station and a newer library.

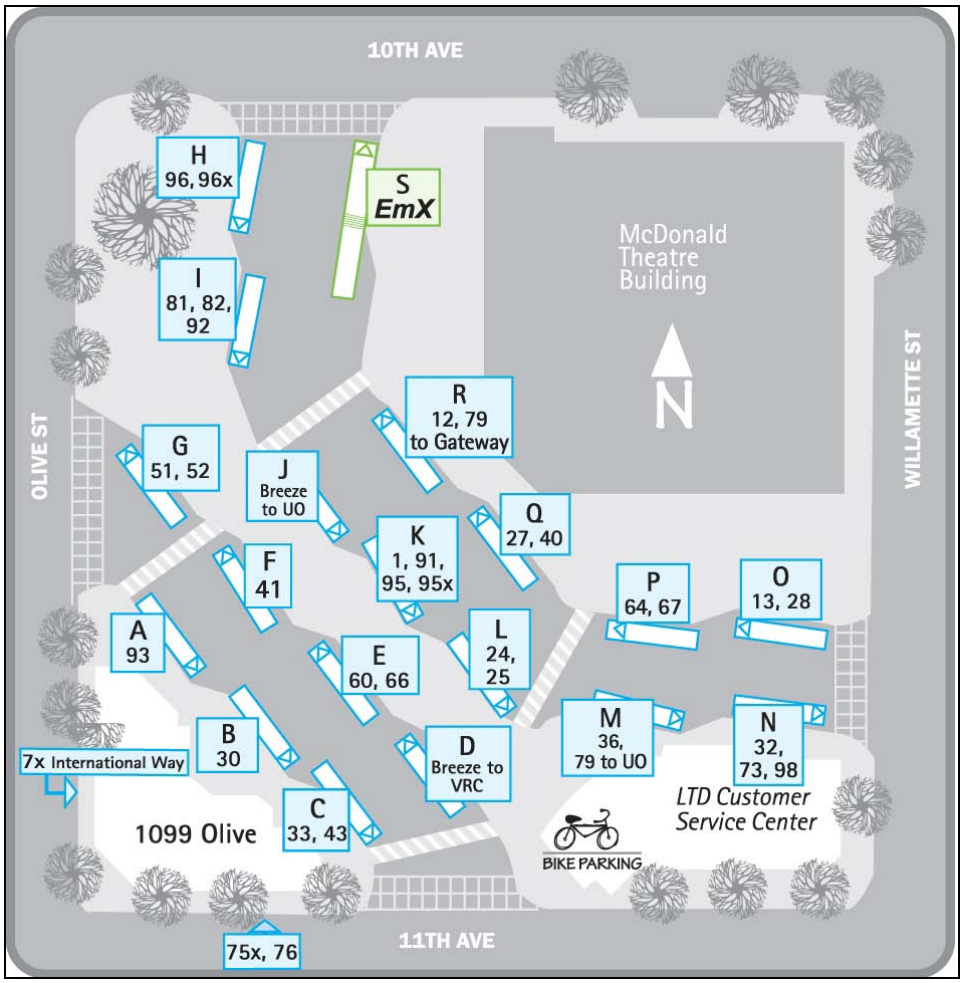


FIGURE 2.5 – Eugene Station Map Illustrating Bus Bay Locations

Artwork at the station includes arches that are adorned by fused glass artwork. The artist created an interpretation of each season, which can be viewed from each of the four directions the artwork faces. Glass prisms that shift with the light were also created for the clock tower.

FIGURE 2.6 – Eugene Station

Springfield Station – Terminus of EmX

Springfield Station, also designed by PIVOT, is one of the first properties that the Federal Transit Administration (FTA) agreed with joint development. It incorporates concepts of green building, but is not LEED certified due to the 7 percent increase in building costs to do so. Green building is a design and construction practice that promotes the health and well being of a family, community, and the environment (GreenBuilding.org). The Leadership in Energy and Environmental Design (LEED) Green Building Rating System™ is the nationally accepted benchmark for the design, construction, and operation of high performance green buildings.

The station provides a number of amenities to passengers accessing LTD services. Restrooms are located inside the facility, as well as a couple of small restaurants that pay LTD to rent the space. An operator office is also located inside the station, as well as information kiosks, telephones, restrooms and an automated teller machine (ATM). There are 44 park and ride spaces located on the opposite side of the building from the bus bays. Shuttles for special sporting events depart from this station, as passengers will often use the park and ride spaces at the station and then ride the shuttle to their final destination. A 50 foot mosaic wall created by a local artist is made up of recycled glass, and ceramic and glass tiles to tell a story of sunrise to sunset along the length of the wall.

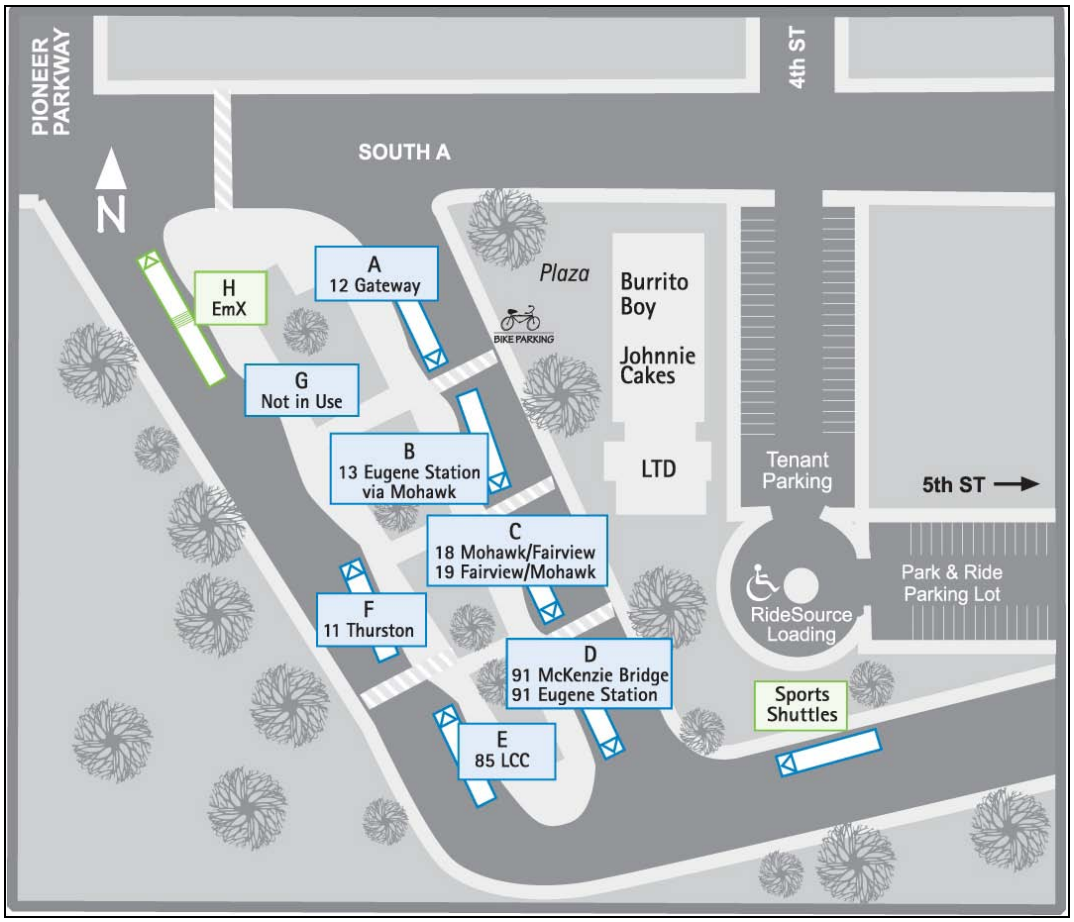


FIGURE 2.7 – Springfield Station Map Illustrating Bus Bay Locations

As part of environmental consideration, LTD created a platform rock garden at Springfield Station that functions as a bioswale which is a natural rainwater drainage system that keeps run-off out of storm drains and filters the water before it enters the waterway. There is also a biosphere located at the front of Springfield Station on South A. This biosphere is a funnel that holds rainwater and was enhanced with glasswork by another local artist. At the bottom of the sphere are lights that help create an aesthetically pleasing and functional sculpture.

FIGURE 2.8 – Springfield Station Bioswale

2.3 Vehicles

One of the major issues faced by LTD in implementing the EmX was obtaining vehicles with doors on both sides. Different manufacturers were engaged but ultimately fell through. Eventually, LTD and New Flyer Industries, a North American vehicle manufacturer, worked together to create a unique vehicle that was designed to meet the needs and expectations of EmX. Doors on both sides, styling, and bicycle boarding were three important features that LTD wanted to incorporate in their EmX buses. The new, reliable 63 foot-articulated vehicles (New Flyer DE60LFA) have a Caterpillar engine that is paired with the GM Allison transmission. This hybrid-electric propulsion allows for better fuel economy, longer life for brakes, and reduced maintenance costs. There are currently six EmX vehicles; each of which cost $960,000 to purchase. Two buses are used for reserves. Buses feature wide doors on both sides of the vehicle and are branded with the EmX logo and color design. LTD partnered with the Greater Cleveland Regional Transit Authority (GCRTA), which is currently constructing Cleveland's Silver Line BRT, for a bulk order to purchase the articulated New Flyer vehicles.

The first six hybrid-electric 63-foot articulated vehicles were delivered in late 2006. The hybrid vehicles went through a test period, followed by bus operator training, timing studies, and training for people with disabilities. The configuration of the interior of the vehicle allows for level boarding, which results in faster travel times and ease of use.

Each vehicle can also accommodate two wheelchairs and three bicycles. Customers using mobility devices board through the middle door. One wheelchair bay is forward facing and provides securement; the other faces the rear of the vehicle and does not have tie down straps.

FIGURE 2.9 – EmX Vehicle

Although these vehicles were built to accommodate a mechanical guidance system, it is not currently employed on the vehicle. LTD did hire an outside company to design a guidance arm on the vehicle that could serve as a method of mechanical guidance, but found that installing the guidance would result in a void in the vehicle warranty provided by New Flyer. LTD decided not to install the guidance and instead made other provisions to assist operators while pulling up to a station, as described in Section 2.2 Stops.

Since Lane County is known as a cycling community, it was important that accommodations be made to provide for this type of multi-modalism. It was also considered important that the bicycle bays be located onboard the vehicle and not at the front exterior so the look of the vehicle was not compromised. LTD staff worked with local cyclists to test the best way to secure bikes inside the vehicle. Riders with a bike board the vehicle through rear doors and stand in an area that has a flip-up seat. Grab rails and stanchion poles allow cyclists to hold their bikes and maintain their balance while traveling along the route.

FIGURE 2.10 – Bicycle Bay on Vehicle

FIGURE 2.11 - Wheelchair Ramp

2.4 Fare Collection

The EmX system began operating as a free system. The EmX system has been designed to operate as a "pre-paid" fare system. This means customers must have a valid fare instrument in their possession at all times while riding an EmX vehicle. Since the route operates between downtown Eugene and downtown Springfield, the majority of customers transfer to the EmX vehicle and therefore will have paid a fare on their previous bus. Because the two largest institutions along the route, UO and Sacred Heart Hospital, provide group passes the District will have already collected its fare revenue. LTD reports that the revenue loss is minimal, because most riders hold system-wide bus passes or have paid already on the feeder buses. Fares will be charged in the future once Phase II of the EmX (Pioneer Parkway) is implemented. It is intended that off-board fare collection machines will be used.

2.5 Intelligent Transportation Systems

The EmX employs several forms of Intelligent Transportation Systems (ITS) technology to help in the operations and image of the system. These include the use of Transit Signal Priority (TSP) along the route, the Automated Vehicle Locator (AVL), Automated Passenger Counters (APC), and computer automated dispatching (CAD).

Transit Signal Priority (TSP)

EmX vehicles are given signal priority via ground-loop signaling to the traffic control system at intersections. There are 23 signalized intersections along the outbound route from Springfield and 22 along the inbound route from Eugene. Of these intersections, 16 have the capability to grant signal priority. All TSP units are located in the City of Eugene which is responsible for the equipment and maintenance of the system.

Dependent on the type of request, granted signal priority is either an early or extended green. LTD originally requested headway based priority, but entered an agreement that would grant vehicles priority if it has not been granted in the past three signal cycles (recovery phase). Although it does not occur often, LTD has found that if a vehicle requests priority within the recovery phase it is usually granted.

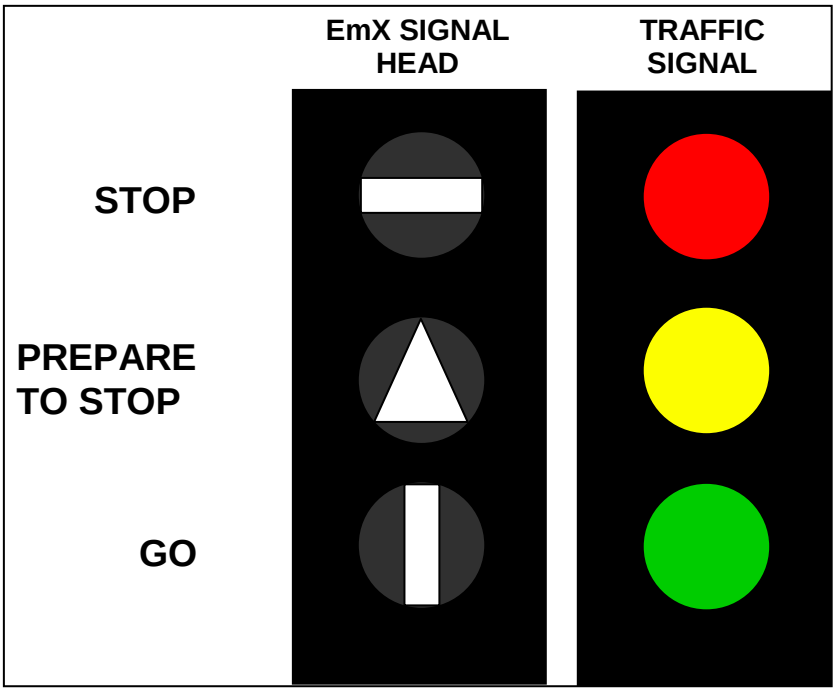
During the first month of operation LTD found that the vehicles had to be properly positioned in order to communicate with the signaling loop, therefore limiting the immediacy of the priority system. Additionally, early tests of the system caused the light control systems to crash when signal priority was requested, resulting in blinking reds in all directions until the terminal was reset. LTD worked with the software vendor to resolve these performance problems.

Two factors have the potential to slow an EmX vehicle while traveling along the corridor: 1) motorists making left turns, and 2) pedestrians activating crosswalk signals. In those instances, the motorist or pedestrian has first priority while the EmX bus waits its turn. LTD may consider altering the signally system so that the EmX would have first priority.

Further analysis of the TSP and its effect on travel time is discussed in Appendix B – Travel Time Component Analysis. This analysis found that savings in signal delays were often found to be significant.

Block Signaling

On significant portions of the dedicated guideway, buses share a single lane, passing each other at two-lane stations. To achieve this, LTD uses “block signaling.” Vehicles travel over sensors installed under the concrete at stations and intersections which signal approaching buses when the transitway is free.



Source: Lane Transit District 2006
FIGURE 2.12 – EmX and Traditional Signal Heads

Communications

All EmX vehicles are equipped with Automated Passenger Counter (APC) sensors and AVL. APCs are located at each door of the vehicle. The AVL system is based on a Geographic Point System (GPS) that had been installed on each of the buses. Operators also have an information box on the vehicle that informs them of the vehicles current location and whether or not it is on schedule. Cameras are also installed on each EmX vehicle. These provide a view of the doors, the rear view, and the front view. A computer that manages these systems is located above the operator on the vehicle. A fan is used to cool the computer unit, which then blows hot air on the operator. This often results in a temperature difference between the operators' area and the rest of the vehicle.

2.6 Service and Operations

EmX operates along Franklin Boulevard between downtown Eugene (Eugene Station) and downtown Springfield (Springfield Station). Weekday headways are 10 minutes, an upgrade from the former Route 11 standard bus service that served stations every 15-30 minutes. Evening and weekend headways are 15 - 20 minutes.

Four EmX buses operate along the corridor during operating hours. The average trip from Springfield to Eugene takes 14 minutes, 3 seconds. However, the return trip from Eugene to Springfield takes slightly longer, at 15 minutes, 3 seconds. LTD attributes the

faster trip to easier access out of the Springfield Station and better signal progression. Two other factors impacting travel times are situations that require EmX buses to yield right of way, such as left-turning motorists and pedestrians activating crosswalk signals.

Bus operator assignments for the EmX are based on a bid process which is directly related to seniority. EmX operators do not receive higher pay for driving the EmX, but do receive $1 to $2 more an hour than operators on traditional fixed routes. This additional compensation is part of an agreement with the union under which operators of the EmX agree to stay on the EmX for a period of six months, resulting in their forgoing of a bid (which occurs every three months). LTD entered this agreement due to the additional time requires to train an operator on the EmX; the agency did not want to train operators that would only be driving EmX vehicles for a period of three months and then have to train a new set of operators.

2.7 Marketing and Community Outreach

The community was involved in the corridor design process. LTD made an effort to meet with every owner and/or occupant located along the corridor to discuss the concept of the system as well to inform them of any potential impacts and encouraged feedback. A number of design charettes were also held during which attendees were asked to participate by providing input on the design of the system, as well as open houses during which LTD provided information about system elements and implementation. These public workshops, open houses, and public hearings were supplemented by working groups of elected officials and stakeholders.

Source: Lane Transit District 2006

FIGURE 2.13 – PUBLIC OUTREACH MEETINGS/CHARETTES

During construction, LTD made regular efforts to communicate with property owners along the route. In addition to these one-on-one communication efforts, LTD also provided weekly updates via email, press releases providing status information, engaged in media interviews, and informal "coffee and chat" engagements were held at locations on the corridor. An internal LTD newsletter was also distributed among all employees.

LTD's approach to marketing the system was to present the EmX as a piece of LTD's overall service. While LTD tried to avoid printing a lot of material, a "How to Ride" guide was placed in free standing brochure holders located at each stop along the route. An information brochure to be distributed on a smaller scale was also printed on recycled paper as part of the agency's commitment to sustainability. Marketing efforts were also focused on people with disabilities.

2.8 Lessons Learned

This section provides an overview of lessons learned during the planning and implementation process of the EmX. This information was gathered during interviews that were held with staff from LTD.

Consideration of City Ordinances

The City of Eugene is an environmentally minded community and has a city ordinance that doesn't allow the removal of any tree in the right of way that is over 50 years old without holding a public vote. LTD was required to airbrush the roots of trees located where the transitway was to be built to determine whether or not the tree could be removed. While it did not halt the construction process, LTD did incur an additional expense to determine the root structure. The cost, however, was relatively minimal.

Keep Stakeholders Informed

The City of Eugene has an active citizenry. Because of this, LTD approached the planning and implementation phases with stakeholders in mind. The agency was sure to keep all affected and interested parties informed throughout the process, which resulted in smoother implementation of the system.

Get a Political Champion

LTD asserts that having a political champion would have been a beneficial asset to the planning process. There were a number of challenges that LTD faced early on where having a political champion within the community may have helped with project acceptance.

Visualization is Important

The third lesson learned by Lane Transit during the planning process is the importance of visualization. Not only was it necessary to "sell" the community on the system, but LTD also found it important to keep employees interested and empowered throughout the process. This was partly achieved by providing a visualization of what the planned end result would be.

3. System Costs

The costs of the EmX are split among the following elements:

- Design/Consulting Services
- Property Acquisition
- Construction Costs
- Miscellaneous Costs/Utilities
- Plan Review/Permits/Inspections
- Construction Support Costs
- Project Contingency

Figure 3.1 provides a capital cost summary of the EmX by element. The Green Line cost $25 million to build, or $6.25 million per mile. System construction cost about $12 million and planning and design another $6 million. Six buses (at a cost of about $980,000 each) were procured; it was originally anticipated that only five vehicles would be purchased. The busway was expected to cost approximately $200 per lane foot.

TABLE 3.1 - Capital Costs

	Original Budget	Actual Cost
Design/Consulting Services	$2,445,474	$2,619,500
Property Acquisition	$1,350,000	$1,006,450
Construction Costs	$12,797,246	$12,469,480
Miscellaneous Costs/Utilities	$476,000	$517,170
Plan Review/ Permits/Inspections	$250,000	$545,610
Construction Support Costs	$1,300,000	$1,463,840
Project Contingency	$930,936	$0
Total Scope	**$19,549,656**	**$18,662,050**
Vehicles	**$5,500,000**	**$5,932,070**
Total	**$25,049,656**	**$24,554,120**

Source: Lane Transit, 2008

LTD used federal funds for 80% of project costs.

TABLE 3.2 – EmX Breakdown of Funding

	Federal Funding	Other Funding
	Section 5309 New Starts - $13.3 M Formula Funds $6.7 M	Local Funding $5 M
Percent Total	**80**	**20**

The most expensive project element was the purchase of the New Flyer vehicles. These vehicles are considered part of capital costs as they will not operate on other routes provided by LTD. The purchase of the vehicles is included in construction costs in Table 3.1. LTD did not immediately implement the proposed real time passenger information system, which is a costly item that requires the purchase of hardware, communications, and software. Once it finds a financially viable option, LTD plans to implement real time information on the route.

4. System Performance

The CBRT document identified five key BRT system performance attributes; (1) Travel Time, (2) Reliability, (3) Image and Identity, (4) Passenger Safety and Security, and (5) System Capacity. Each of these is discussed below.

4.1 Travel Time

Several performance indicators have been developed to assess the impact of BRT systems on corridor travel time (CBRT, 2004):

- Maximum (Peak hour) End-to-End Travel Time: Average weekday travel time required to complete a one-way trip from the beginning to the end of the route during peak hours
- Uncongested End-to-End Travel Time: Average weekday travel time required to complete a one-way trip from the beginning to the end of the route during off-peak hours
- Minutes Per Mile: Average obtained by dividing average route time by route distance
- Maximum Time on Local Line (peak hour): end-to-end travel time on the local line running along the same alignment as the BRT line
- Travel time reduction: Percentage difference between average peak hour route time on local service versus BRT service

4.1.1 Lane Transit District Travel Time Data

A collection of travel time data on the EmX was conducted by LTD from April 7 through May 16, 2008. The data was collected using the AVL system that are located onboard the vehicles. The results of weekday travel times are summarized in Table 4.1. The table shows that the average time needed for the EmX to complete the route from Springfield to Eugene Station was 14.6 minutes. The average time recorded for outbound trips was 16.1 minutes. LTD attributes the shorter travel times on the inbound route to better signal progression and the ease of departure from Springfield Station. EmX averaged inbound AM peak trips in 14.6 and PM peak in 15.3 minutes. Outbound peak times averaged 15.8 (AM) and 17.1 (PM) minutes.

Results of LTD's data collection also show that travel times on the EmX are similar in traditional travel patterns, where longer travel times are recorded during the PM peak hour of 5 pm. Interestingly, however, the EmX experienced shorter travel times during the AM peak hours (7:30 AM – 9:29 AM) as compared to travel times later in the AM (9:30 AM – 11:29 AM) for both inbound and outbound trips. This could be attributed to being in the vicinity of the University of Oregon, where college courses begin at varying times throughout the day.

TABLE 4.1 – Travel Time on EmX

	Time of Day							
	04:00-7:29	7:30-9:29	9:29-11:29	11:30-14:29	14:30-17:29	17:30-17:29	20:30-24:00	Average*
	Inbound							
April 2008	13.51	14.54	14.75	15.22	15.17	14.04	13.45	**14.6**
May 2008	13.46	14.56	14.90	15.23	15.38	14.30	13.50	**14.7**
Average*	**13.5**	**14.6**	**14.8**	**15.2**	**15.3**	**14.1**	**13.5**	**14.6**
	Outbound							
April 2008	14.66	15.78	16.30	16.75	17.03	15.25	14.75	**16.1**
May 2008	14.51	15.84	16.48	16.95	17.10	15.57	14.94	**16.2**
Average*	**14.6**	**15.8**	**16.4**	**16.8**	**17.1**	**15.4**	**14.8**	**16.1**

*****Average values are not computable based on presented numbers; data is effected by varying number of runs included in each time frame

***** Data Source: Lane Transit District 2008

4.1.2 CUTR Travel Time Study

CUTR conducted a "before and after" assessment of the EmX. Data collection for the study was conducted in two phases; November 2006 (pre-EmX), and November 2007 (see Appendix II for analysis). During the data collection process, travel time information was collected on both inbound and outbound trips. Route travel times were assessed by surveyors documenting what time each run began and ended, the time when designated time points were reached, and other components of travel time along each trip. A total of 62 Route 11 runs and 66 EmX runs were surveyed, with at least 20 runs in each of three defined time periods (AM Peak, PM Peak, and Off-Peak). Data was analyzed for a directional and temporal travel time comparison of Route 11 and the EmX, schedule adherence and system reliability, on-time performance, and commercial speeds.

Comparing CUTR's analysis of the EmX and the data provided by LTD, it can be observed that both data sets produced similar results. Inbound travel times recorded by APCs onboard the EmX vehicles showed an average of 14.6 minutes, compared to CUTR's 14.3, a 2.1 percent difference between the two datasets. A 5.1 percent difference was recorded for outbound trips between LTD and CUTR's data.

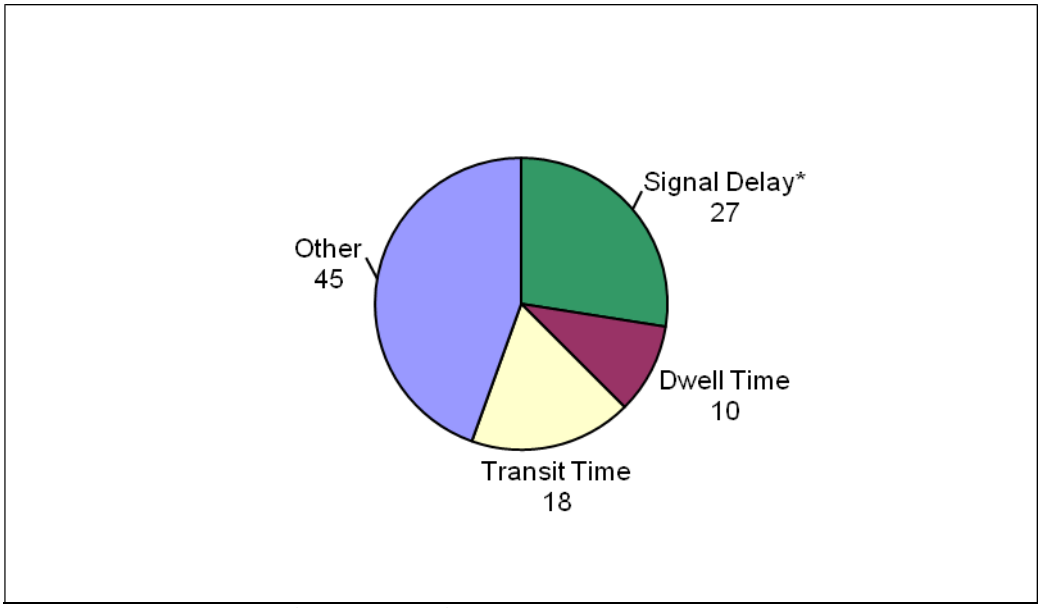
TABLE 4.2 – LTD and CUTR's Travel Time on EmX

	LTD April/May 2008	CUTR Nov. 2007	Time Difference	% Difference
Inbound	14.6	14.3	0.3	2.1
Outbound	16.1	15.3	0.8	5.1

4.1.3 Source of Travel Time Savings

Introduction of the EmX service has resulted in reduced travel times and improved levels of service reliability. The EmX reduced average travel times by one minute from 16 minutes on the old Route 11 service to 15 minutes on the EmX. This reduction has come from a number of different sources including reductions in the time spent in-transit and reductions in dwell time. Although this reduction may seem relatively small, it is important to note that the corridor is only four miles in length and the EmX may experience greater savings in travel times once the Pioneer Parkway extension is in operation.

Figure 4.2 shows that 28 seconds of travel time was saved due to reductions in signal delay which is statistically significant at the 99 percent confidence level. Time spent in transit was 18 seconds shorter than on the Route 11 which may be attributed to operating along dedicated transitways and signal priority. A decrease in average dwell times (10 seconds) may be the result of the 1) platform/near level boarding; and, 2) the EmX being a form of rapid transit, wherein operators are trained to let waiting patrons board and then immediately depart; they are not to wait for patrons trying to catch a bus or those not ready to leave the stop. These three measures were estimated to each be responsible for approximately 56 percent of total travel time savings.



*Statistically significant at 99% confidence level

FIGURE 4.2 – Estimated Sources of Travel Time Savings – Difference Between Route 11 and EmX (in seconds)

4.1.4 User Perceptions of Travel Time Savings

The EmX survey asked if respondent's travel time changed with the implementation of the EmX. Figure 4.3 shows that the majority of respondents thought that the EmX had reduced their travel time, with 26.9 percent stating that their travel time had remained unchanged, and approximately 10.7 percent stating that their travel time was now slower. Thus, over 60 percent of riders thought that their travel time had decreased as a result of the EmX. Of these, around 20 percent stated that the travel time saving was greater than 15 minutes. Since end to end travel time for the EmX is approximately 16 minutes, it is assumed that the majority of respondents that selected their total travel time as having decreased "11-15 minutes" or "15+ minutes" transfer to/from another route during their trip. Prior to the opening of the EmX, LTD stated there was concern that riders of the Route 11 would be unhappy since a large majority would now have to transfer once the EmX was implemented, yet the perception of their total travel time has been positive.

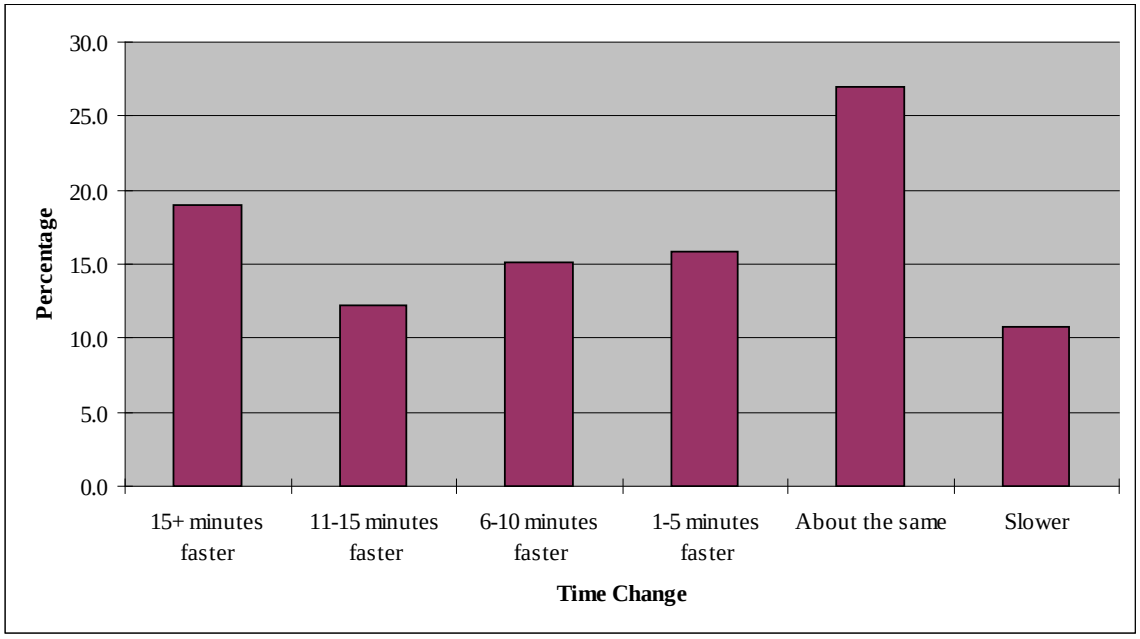


FIGURE 4.3 – Users Perception of Change in Travel Time on EmX

Data presented in Table 4.1 compare responses received to the questions "How has your travel time changed with the EmX?" and "Before the EmX opened, how did you make this trip?" As shown, the majority of riders (59.2 percent) that rode an LTD bus prior to EmX said that their travel time is now faster than before. In the case of individuals who drove, only 13.5 percent perceived the EmX to be slower than travel by car, while 59.2 percent believed the EmX was faster. In addition, close to 20 percent of riders that previously drove thought that the EmX was at least 15 minutes faster than the car. For those that rode with someone else, cycled, walked, or selected "other", the majority of responses illustrate that the EmX is perceived to complete the trip faster than the previous mode.

Table 4.1 - Impact of EmX on Travel Time for Different Prior Modes Used

Travel Time Impact	*Mode Used Prior to EmX*							
	Drove	Rode with someone else	Bicycle	Rode LTD bus	Walked	Taxi	Didn't make trip	Other
15+ minutes faster	17.0	29.8	22.5	17.2	23.6	0.0	20.7	25.0
11-15 minutes faster	15.7	5.3	15.5	11.3	14.9	12.5	11.7	7.1
6-10 minutes faster	14.8	15.8	20.9	14.1	15.5	25.0	13.5	28.6
1-5 minutes faster	11.7	12.3	11.6	16.6	21.6	12.5	10.8	7.1
About the same	27.4	33.3	23.3	29.1	20.3	25.0	37.8	21.4
Slower	13.5	3.5	6.2	11.7	4.1	25.0	5.4	10.7
TOTAL	100	100	100	100	100	100	100	100

In a separate survey question, in which respondents were asked to rate different aspects of the EmX service, "Travel time on the Bus" achieved an overall mean score of 4.2, one of the highest ratings and higher than the previous rating of 3.8 for Route 11. Overall, these results indicate that, from the viewpoint of its customers, the EmX had generally been successful in reducing travel times. Comparing perceived travel time savings with actual travel time savings, it is interesting to note that almost 60 percent of the sample thought that the EmX was more than 15 minutes faster than the previous service, while actual end-to-end travel time savings were measured at approximately 1 minute. This provides evidence of the fact that many users perceive any travel time savings associated with improved service as greater than they actually are.

4.2 Reliability

The CBRT document defines three different types of reliability, (i) running time reliability, (ii) station dwell time reliability, and (iii) service reliability.

4.2.1 Running Time Reliability

The CBRT document recommends the use of three performance indicators to measure running time reliability:

- Maximum end-to-end travel time: Average weekday travel time required to complete a one-way trip from the beginning to the end of the line during peak hours
- Unconstrained end-to-end travel time: Average weekday travel time required to complete a one-way trip from the beginning to the end of the line during non-peak hours of service

– Ratio of unconstrained to maximum travel time: Calculated by dividing unconstrained end-to-end travel time by maximum end-to-end travel time. The higher the ratio, the greater the impact of peak our traffic conditions on end-to-end travel times

These measures are shown in Table 4.2 below.

TABLE 4.2 – Running Time Reliability*

Reliability Performance Indicator	Route 11	EmX
Maximum (Peak hour) End to End Travel Time	984.5	914.8
Unconstrained End-to-End Travel Time	989.7	914.5
Ratio of Unconstrained to Maximum Travel Time	1.005	0.999

* Source: Characteristics of Bus Rapid Transit for Decision-Making. (2004).

Table 4.2 shows that the average difference between peak hour and unconstrained end-to-end travel times on Route 11 was 1.005 and 0.999 on the EmX. Since these values are both close to 1.0, it is shown that travel conditions during the peak and off peak periods have little variation. Although this variation is similar to Miami and Orlando (1.0) where vehicles operate on exclusive rights-of-way for either the entire length or portions of the respective route, it may also suggest that there is not much peak hour congestion along the corridor.

Using data collected by CUTR, an assessment of the impacts of EmX on reliability was conducted by comparing total travel times before and after the EmX began operating. The scatter plot graph below illustrates that the EmX, with a standard deviation of 79.1 from the mean for each sample as compared to 115.9 for Route 11, has decreased the level of travel dispersion with the majority of runs being between 800 (13 minutes, 20 seconds) and 1,000 (16 minutes, 40 seconds) long. The decreased travel dispersion shows the EmX has been successful in terms of improving reliability as compared to Route 11.

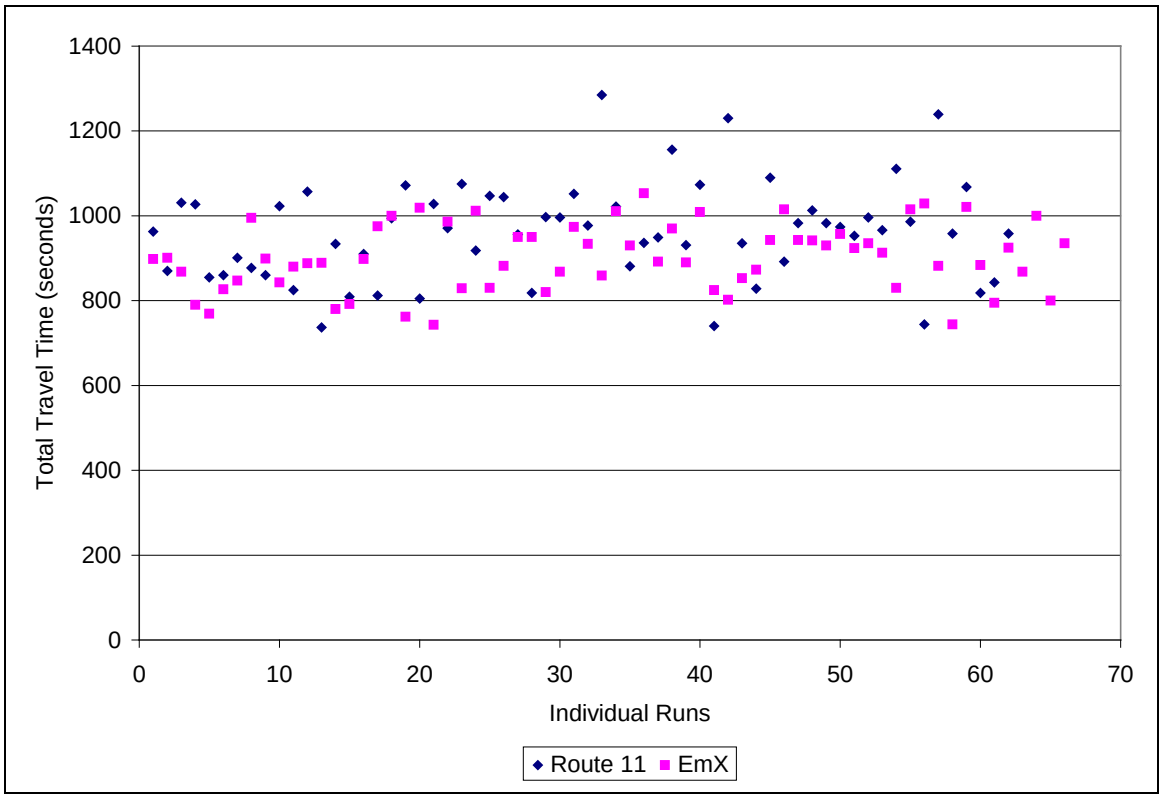


FIGURE X. – Route 11 vs. EmX – Travel Time Dispersion

4.2.2 Schedule Adherence

Table 3.1 summarizes the average differences between scheduled and actual travel times on the Route 11 and EmX service. The EmX has been successful in providing more reliable service than the Route 11 in terms of schedule adherence. When traveling inbound, the actual arrival time of vehicles is approximately 1.5 minutes less than the scheduled arrival. When traveling outbound toward Springfield, the EmX achieves an approximate 26 second early arrival. When Route 11 was operating on the corridor, vehicles would arrive about four minutes early when traveling inbound, and 1.5 on outbound trips. It should be noted that the standard deviation of the mean difference has been reduced in each direction by the introduction of the EmX, which further emphasizes the increased reliability achieved by the EmX.

TABLE 3.1 – Difference between Scheduled and Actual Travel Times

	Mean difference between Scheduled and Actual Travel Time (seconds)		Standard Deviation of Mean difference between Scheduled and Actual Travel Time (seconds)	
	Route 11	**EmX**	**Route 11**	**EmX**
Eugene Bound	-231.2	-91.3	96.9	75.3
Springfield Bound	-99.7	-25.8	88.8	69.5
Both directions	-165.5	-58.6	113.6	79.1

It is important to note that a simple comparison of actual time savings of the EmX to Route 11 would not equate to three minutes. Actual time savings is lower, with an average of only one minute (both directions). This is due to the extra time built into the scheduled run times for Route 11 of 17 to 21 minutes; although it did have a greater amount of travel time variation than the EmX, Route 11 actually averaged 16 minutes in travel time when it was operating and generally did not use the full time allotted.

4.2.3 User Perceptions of Reliability

The CUTR on-board surveys asked respondents to rate "Dependability of the Bus (on-time performance)" on a five-point scale. Their responses are provided below:

TABLE 4.3 – Consumer Ratings of Route 11 and EmX Reliability

Dependability of Bus (on time performance)	Rt. 11 Value	EmX Value
Very Poor	3.4%	1.4%
Poor	8.5%	4.1%
Fair	25.5%	18.8%
Good	37.2%	37.1%
Very Good	25.5%	38.6%
Mean Score	3.7	4.1

The table shows that the EmX received a mean score of 4.1 compared to the Route 11 rating of 3.7. Most respondents (75.7 percent) on the EmX rated service reliability as either good or very good and only 5.5 percent rated the service as poor or very poor. This resulted in a mean score of 4.1, which is about average in comparison to the ratings for other service aspects. Route 11, however, received twice the percent value of ratings among the poor and very poor categories. It should be noted, however, that Route 11 operates on a fixed schedule, with exact arrival and departure times provided. In contrast, the EmX runs on a headway-based schedule without any published arrival and departure times, which perhaps makes it less obvious when the buses are late.

4.3 Identity and Image

The green image is an important part of the system branding. The branding strategy is to complement the area's natural beauty which led to the agency planting grass in the center of the guideways. The grass not only looks appealing but also helps absorb surface runoff from the buses. LTD also landscaped with native plants along the corridor and at stations.

On-board survey respondents were asked to rate different aspects of the EmX branding efforts:

- Ease of identifying the bus service
- Location of bus signage
- The look / design of the new vehicles used for the EmX

The ratings received for these service aspects are shown in Table 4.5 below, along with overall ratings for the EmX and other services provided by LTD.

TABLE 4.5 – Consumer Ratings for Different Aspects of EmX

EmX Service Element	Response Category (%)					TOTAL	Mean Score
	Very Poor (1)	Poor (2)	Fair (3)	Good (4)	Very Good (5)		
Ease of identifying bus service	0.9	1.7	13.1	42.2	42.2	100	4.2
Location of bus signage	1.0	1.9	15.7	44.7	36.8	100	4.1
The look/design of the new vehicles used for EmX	2.3	2.6	14.6	40.0	40.5	100	4.1
Overall satisfaction with the EmX	1.8	3.2	13.5	41.5	40.1	100	4.1
Overall satisfaction with LTD	1.7	3.7	16.9	43.6	34.1	100	4.0

Table 4.5 shows that all three elements related to service branding received high ratings, with the majority of respondents providing a "good" or "very good" rating. The ratings given for "ease of identification" of EmX services were the highest with a mean score of 4. This data illustrates that LTD's efforts to create a unique identity and image for the EmX has been successful. Customers also rated their overall satisfaction with the EmX higher than their overall satisfaction with LTD, yet the mean scores were very close, with values of 4.1 and 4.0, respectively.

Table A.8 in Appendix I summarizes the additional comments on the EmX. Approximately 11 percent of the general comments were positive as compared to a 2.3 percent of general dissatisfied comments. The majority of the comments were made on the theme of service provision. The most frequently cited comment in this category was the need for better service (22.9 percent), followed by the need for more stops (7.5 percent). The need for more bicycle racks/better bike securement made up the second largest group of comments (13.8 percent). Given the frequency of bicycle usage in the community, the recorded number of comments in relation to bicycles is not surprising. A possible reason for dissatisfaction is the requirement of bicyclists to secure their bicycles onboard the vehicle instead of on the exterior of the vehicle as it is the general practice on traditional fixed-route services. Comments provided on the Route 11 survey regarding bicycle facilities were not as prevalent (Table A.9), with only 5 percent of total comments expressing this concern.

A variety of comments were made about the EmX bus drivers. Four (0.73 percent) respondents gave positive comments (good drivers / courteous drivers), while the rest of the comments were negative (10.5 percent). Criticisms included not waiting for people, poor driving (too fast / jerky / leave before people can sit down), and not enforcing the rules (controlling rowdy student passengers).

Comments were also made that more parking should be available nearby the stations (3.6 percent of comments). This is a small increase in the percentage of comments for this issue, as only 1.1 percent of surveyed riders on Route 11 made this comment. Currently, there are two park and ride lots located near EmX stations (the former DMV at the corner

of Franklin and Walnut, and Springfield station). The increase in comments may be attributed to attracting choice riders that previously did not ride the bus, but are now complementing their trip on the EmX.

4.4 Safety and Security

4.4.1 Accident Rates

Shortly after opening, the EmX experienced several collisions between the buses and other vehicles at guideway intersections. As of November 2007, eight collisions have occurred. This has been a problem for other BRTs with at-grade intersections, such as the Los Angeles Orange Line. However, none of the accidents were the fault of EmX operators, and the accident rate declined once area drivers became accustomed to the Busway.

4.4.2 User Perceptions of Safety

On-board survey respondents were asked to rate two different aspects of safety in relation to EmX and Route 11 use; safety while on the vehicles, and safety while waiting at stops.

TABLE 4.6 – Customer Ratings of Different Aspects of the Franklin Corridor Service

	Response Category (%)											
	11	EmX	11	EmX	11	EmX	11	EmX	11	EmX	11	EmX
Service Element	Very Poor (1)	Very Poor (1)	Poor (2)	Poor (2)	Fair (3)	Fair (3)	Good (4)	Good (4)	Very Good (5)	Very Good (5)	Mean Score	Mean Score
Personal safety on bus	1.6	2.1	4.3	3.1	17.1	16.0	44.9	39.9	32.1	38.9	4.0	4.1
Personal safety at stops	2.0	1.8	5.7	3.9	25.4	18.4	42.3	41.7	24.6	34.2	3.8	4.0

The table shows that the EmX received a higher mean score than the Route 11. The biggest difference was when asked about "personal safety at stops," with a rating of 4.0 for the EmX and 3.8 for Route 11. When comparing the categories among the EmX, the table also shows that personal safety on the EmX rated slightly higher than personal safety at stops, but both categories received a "good" rating. Only 5.2 percent of respondents rated personal safety on the EmX as poor or very poor, and only 5.1 percent rated personal safety at EmX stops as poor or very poor. Overall, this suggests that user perceptions of personal safety while using the EmX is high.

4.5 Capacity

Configured to the specifications of LTD, each New Flyer Vehicle can carry a maximum of 90 passengers (39 seated, 51 standing). The EmX operates with 10 minute headways, equating to 6 buses per hour. Thus, the EmX service has a one-way peak hour capacity of 540 passengers per hour (90*6), and bi-directional capacity of 1080 (90*12). Table 4.7 displays the one-way percent capacity use of vehicles on the EmX. As ridership has increased on the EmX, the percent capacity use of EmX vehicles has increased as well.

TABLE 4.7 – Capacity Use of Vehicle

Month	Passengers/ Revenue Hour	Carrying Capacity/ Hour	Capacity Use %
February 2007	69.98	540	12.9
March 2007	73.54	540	13.6
April 2007	76.32	540	14.1
May 2007	77.75	540	14.4
Summer 2007	75.99	540	14.1
October 2007	83.55	540	15.5
November 2007	86.61	540	16.0
December 2007	78.33	540	14.5
January 2008	87.91	540	16.3
February 2008	91.00	540	16.9
March 2008	87.92	540	16.3
April 2008	93.88	540	17.4

Table 4.8 shows that approximately 70 percent of riders on the EmX rated the availability of seating on the vehicle as "good" or "very good" as compared to 52.4 percent of riders on the previous Route 11. The EmX also received significantly fewer responses in the "very poor" (1.5) and "poor" (6.1) categories than the Route 11.

TABLE 4.8 – Customer Ratings of Availability of Seating on Bus

	Response Category (%)											
	11	EmX	11	EmX	11	EmX	11	EmX	11	EmX	11	EmX
Service Element	Very Poor (1)	Very Poor (1)	Poor (2)	Poor (2)	Fair (3)	Fair (3)	Good (4)	Good (4)	Very Good (5)	Very Good (5)	Mean Score	Mean Score
Availability of seats on bus	4.7	1.5	13.4	6.1	29.6	23.1	33.6	40.8	18.8	28.4	3.5	3.9

It should be noted that on the EmX on-board survey, no comments were recorded in relation to capacity, yet a number of comments were made on the Route 11 survey. These are shown below.

TABLE 4.9 – User Comments on Route 11 Capacity

	N.	%.
Not enough seats / too crowded / buses too small / need bigger buses	31	10.9%
Need more buses	12	4.2%

The table shows that 31 Route 11 users commented on the lack of space on Route 11, and twelve users commented on the need for more buses. Route 11 was traditionally the busiest route of all LTD's fixed route services, which would suggest that congestion on the bus is not indicative of LTD's overall fixed routes, and further suggests that implementing rapid bus service on this corridor with articulated vehicles was a necessary measure.

4.6 Summary of System Performance

End-to-end travel times on the EmX vary between 14 and 16 minutes in both on and off-peak traffic conditions. Data collected by Lane Transit District and CUTR show that the EmX has reduced average end-to-end travel time by approximately 1 minute, equating to a 4 percent reduction compared to the local service. Over 80 percent of users perceived the EmX as faster than the previous service, with almost half of surveyed respondents indicating that the service was at least 15 minutes faster. Travel times were decreased due to reductions in signal delay (28%), dwell time 10%), and time spent in transit (18%). Over 60 percent of riders thought that their travel time had decreased as a result of the EmX, with approximately 20 percent stating that the travel time savings was greater than 15 minutes.

Service reliability and schedule adherence has improved over the Route 11. The EmX has decreased the dispersal of travel times and operates on schedule. Customers are also happy with reliability; it has received a rating of "good", as compared to the "fair" rating received by Route 11.

Lane Transit has been successful in creating a unique identity for its EmX service, using unique branding on buses, shelters and signs. Approximately 85 percent of users stated that the "ease of Bus identification" was "good" or "very good". General public perceptions of the EmX are good, achieving an average rating of 4.0 on a five-point scale (Route 11 and LTD's other services received a rating of 4.0).

In regard to safety, the EmX was involved in eight accidents since it began operation in January 2007. None of the reported accidents were due to negligence on behalf of an EmX operator; all accidents were the fault of the other party involved. In relation to user perceptions, the EmX was viewed as being "good" in terms of safety at stops on the on

vehicle. This is an improvement from ratings received on the Route 11; personal safety at stops only received a "fair" rating.

Configured to the specifications of LTD, each New Flyer Vehicle can carry a maximum of 90 passengers (39 seated, 51 standing). The EmX operates with 10 minute headways, equating to 6 buses per hour. Thus, the EmX service has a one-way peak hour capacity of 540 passengers per hour (90*6), and bi-directional capacity of 1080 (90*12). These capacities are sufficient for the majority of passenger loads experienced throughout the day. Although the EmX received a mean score (3.9) that equates to a "fair" rating by passengers on the on-board survey, this is an improvement from previous service (3.5). Additionally, no comments were received regarding seating and capacity, while an approximate 14 percent of comments received on the Route 11 survey were complaints in this category.

5. System Benefits

5.1 Higher Ridership

5.1.1 EmX Corridor Ridership Before and After EmX Implementation

Since it began operation on January 14, 2007, the EmX has increased ridership along the corridor. As illustrated in Figure 5.1, ridership numbers have increased from approximately 4,000 riders in February 2007 to almost 5,400 in April 2008. Aside from decreases recorded during December and the summer of 2007, figures have been on a steady incline. LTD did not originally anticipate such a large increase in ridership this early in operation. LTD had predicted that ridership over the twenty year design period would increase by approximately 50% over a conventional transit service: this equated to a ridership of approximately 4,200 passengers per day. EmX ridership has grown to over 6,600 passengers a day in October 2008 .

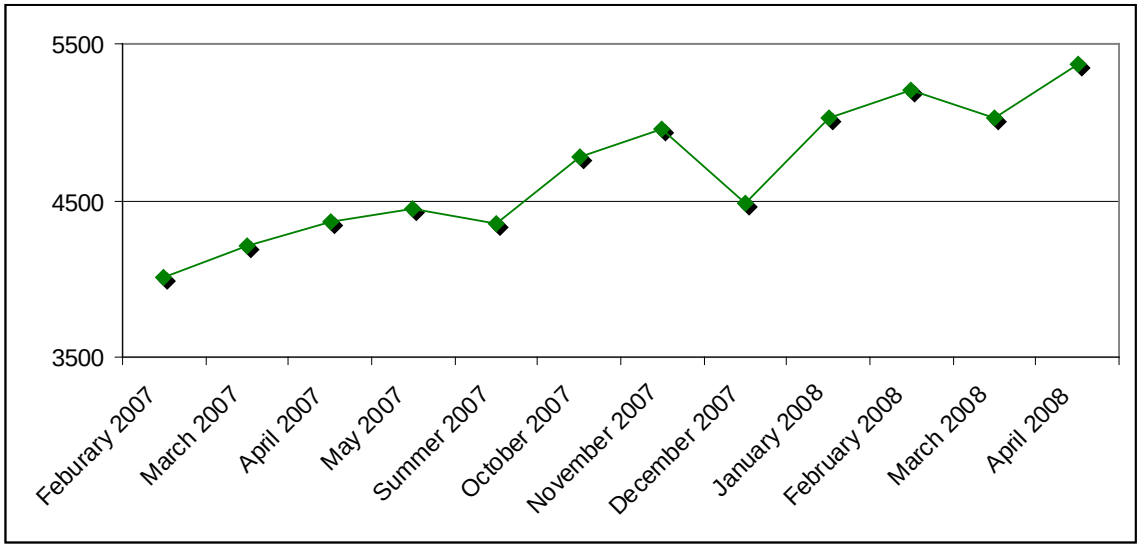


FIGURE 5.1 – EmX Ridership

Table 5.1 shows the percent increase of riders along the EmX route from Route 11 along the same portion of the corridor. Figures for Route 11 are recorded as 2,667, as this was the average ridership on the Route 11 during the spring and fall of 2006. It should be noted that data that is being compared is from different time frames and cannot be equally compared. In addition, LTD has experienced an overall trend of increased ridership since July 2003 (see Figure 5.2). As a general trend, however, it has been shown that ridership on the EmX shows significant percent increases over the average ridership on the Route 11, with an initial increase of 50 percent, which is significant given the relatively small lapse in time between the Fall 2006 (Route 11 average ridership) and February of the following year.

TABLE 5.1 – Franklin Corridor Ridership Increase

Month	Route 11	EmX	% Increase
February 2007	2667	4004	50.1
March 2007	2667	4208	57.8
April 2007	2667	4367	63.7
May 2007	2667	4449	66.8
October 2007	2667	4781	79.3
November 2007	2667	4956	85.8
December 2007	2667	4482	68.1
January 2008	2667	5030	88.6
February 2008	2667	5207	95.2
March 2008	2667	5031	88.6
April 2008	2667	5372	101.4

*Summer months are absent from the table as an average ridership for Route 11 was not available for comparison

5.1.2 Analysis of Corridor Service Quantity over Time

Implementing the EmX increased the amount of service on the corridor in terms of service frequency. The Route 11 operated on weekdays from approximately 5:30 am to 10:45 pm (inbound) and 6:00 am to 10:45 pm (outbound), at 15 to 30 minute frequencies. The EmX operates with 10 to 20 minute frequencies from 5:40 am to 10:45 pm (inbound) and approximately 6:00 am to 10:45 pm.

TABLE 5.2 - Corridor Revenue Hours and Ridership on EmX

Month	Daily Revenue Hours	Daily Boardings	Passengers/ Revenue Hour
February 2007	57.2	4,004	69.98
March 2007	57.2	4,208	73.54
April 2007	57.2	4,367	76.32
May 2007	57.2	4,449	77.75
Summer 2007	57.2	4,348	75.99
October 2007	57.2	4,781	83.55
November 2007	57.2	4,956	86.61
December 2007	57.2	4,482	78.33
January 2008	57.2	5,030	87.91
February 2008	57.2	5,207	91.00
March 2008	57.2	5,031	87.92
April 2008	57.2	5,372	93.88

Table 5.2 shows corridor service provision (revenue hours) on the Franklin corridor beginning one month after EmX implementation through April 2008. The number of passengers per revenue hour has increased from approximately 70 to 94 within 14 months. This equates to a percent increase of 34.

5.1.3 Regional Ridership Trends

As an overall trend, LTD has experienced an increase in ridership since January 2004. LTD also experiences predictable patterns each year with decreased ridership occurring during the winter holiday season and summer months.

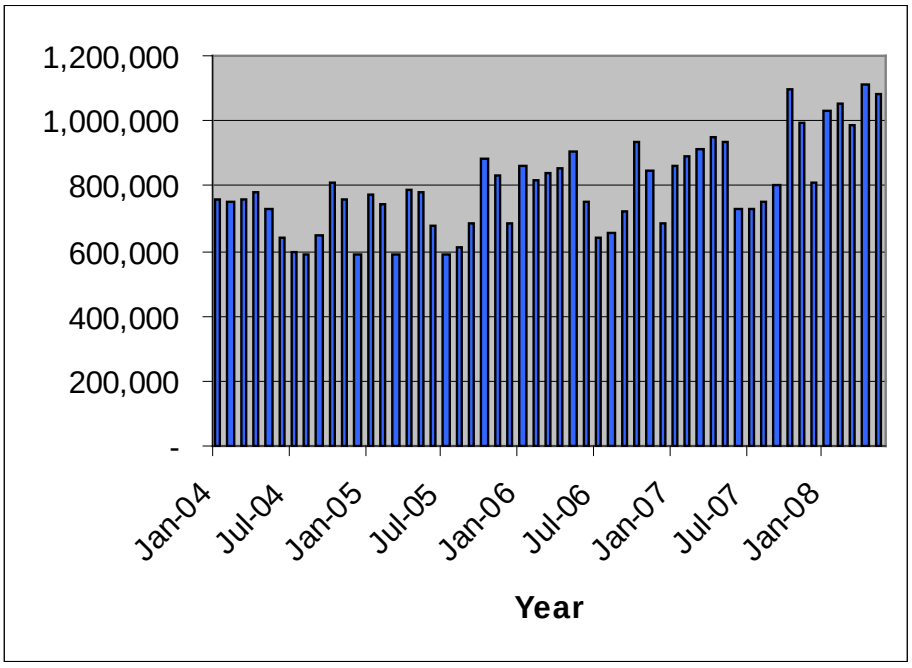


FIGURE 5.2 – Lane Transit District Ridership Trends

Table 5.3 shows the percent increase of LTD systemwide ridership from January 2004 through January 2007 by calendar year. Between 2004 and 2005, ridership increased by 2.33 percent. Ridership in 2005 increased 10.7 percent, yet LTD only experienced a 0.41 increase in 2006. In 2007, when the EmX was operating, LTD systemwide ridership increased approximately 20 percent. This may suggest the EmX has had an impact on LTD systemwide ridership.

TABLE 5.3 – Percent Change of LTD Systemwide Ridership

Year	Percent Change
Jan '04 - Jan '05	2.33%
Jan '05 - Jan '06	10.70%
Jan '06 - Jan '07	0.41%
Jan '07 - Jan '08	19.89%

EmX closely mimics overall LTD ridership by month. As Table 5.4 shows, EmX ridership was successful in maintaining a positive percent change in ridership during May and December 2007, when LTD experienced a percent decrease. EmX did experience a decrease in ridership during the summer months as well as during December 2007 and March 2008, yet LTD experienced decreases as well. These decreases may be related to student ridership.

TABLE 5.4 – Percent Change of Ridership on EmX and LTD Fixed Route

	Month and Percent Change											
System/Route	Feb '07	Mar '07	April '07	May '07	Summer '07	Oct '07	Nov '07	Dec '07	Jan '08	Feb '08	Mar '08	Apr '08
LTD	----	3.0%	3.9%	-1.3%	-19.7%	45.9%	-9.5%	-18.6%	27.7%	1.8%	-6.5%	12.6%
EmX	----	5.1%	3.8%	1.9%	-2.3%	10.0%	3.7%	-9.6%	12.2%	3.5%	-3.4%	6.8%

5.1.4 Sources of EmX Ridership

As shown in Figure 5.3, the majority of riders on the EmX previously made the trip on Route 11 (57.6 percent). Approximately 16 percent of EmX riders previously drove or rode with someone else which is indicative of the service attracting choice riders. About seven percent of riders indicated on the survey that they did not previously make the trip. This may directly correlate with riders who indicated they were making the trip to visit family/friends and/or recreation which was an increase from results on Route 11. This may suggest that the EmX has been successful in attracting leisure riders.

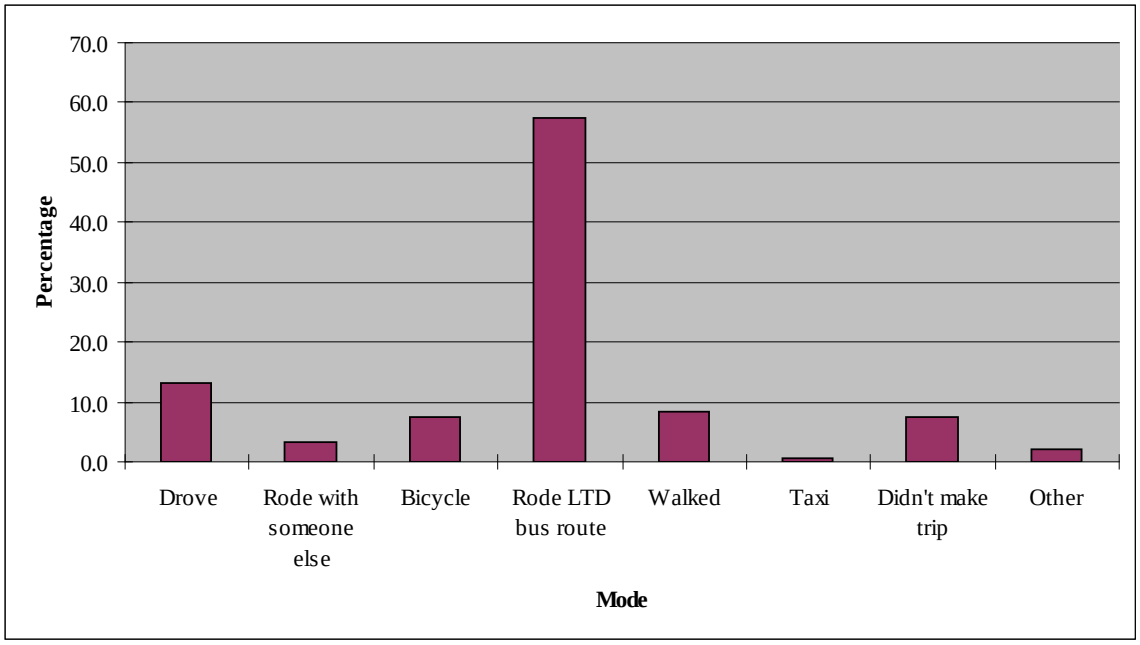


FIGURE 5.3 – Mode Used Before the Introduction of the EmX

5.2 Capital Cost Effectiveness

The total capital cost of the EmX Green Line project was approximately $25M for the 4 mile route. This equates to $6.25 million per mile. System construction cost about $12 million and planning and design another $6 million. Since the EmX includes a number of enhanced treatments, i.e., enhanced stations, transit signal priority, and articulated vehicles, as well as its operation on exclusive transitways for approximately 60 percent of the route (costs $6.5 to 10.2 million per mile), costs for the EmX were on target. The outlay in capital costs has also resulted in successful branding of the system.

5.3 Operating Cost Efficiency

No data available

5.4 Transit Supportive Land Development

Along the EmX, there are a number of opportunities for redevelopment to occur, especially in the Glenwood/Springfield area. Additional interest in the development of properties has been expressed since the opening of the EmX.

There are no large plots of vacant land in Springfield's North Gateway area. On December 1, 2006 a 13-acre piece of property located at the northwest corner of International Way and Corporate Way was sold for $5.8 million. This parcel of land was one of the last large properties available to sell in the area. According to Greg Buller, a

broker with J.B. Realty which sold the property, the location of the property, directly on the EmX route, resulted in many interested buyers. The land is also in close proximity to PeaceHealth's Riverbend medical campus. Another property, which had sold a few weeks prior, was a 7-acre plot which was purchased for $3 million. David Blewett, a principle in Corporate Way Properties and president of the Kendall Automotive Group, says that he and his business partner bought the land strictly for investment purposes. The developers plan to divide the parcel into six campus industrial sites (Register-Guard, December 2006).

FIGURE 5.4 – Intersection at Walnut Station: Potential Development Sites

5.5 Environmental Quality

Environmental quality is the measure of the quality of life of a region in terms of the heath and well-being of the public, as well as the attractiveness and sustainability of both the natural environment and the urban environment. By implementing a BRT system in a given corridor there are three possible effects that can serve to improve the environmental quality of the region. These effects are:

- Technology Effect – Propulsion technology reduces bus vehicle emissions

- Ridership Effect – Transit ridership increases because people make fewer trips in their private vehicles
- System Effect – Congestion is reduced thereby reducing vehicle emissions

LTD's commitment to the environment was recognized with a 2008 Sustainable Transport Honorable Mention from the Institute for Transportation and Development Policy. A "green" image is a central theme of the branding strategy of the EmX and with less than a year in operation, the EmX was the only United States project selected as an award winner for 2008.

The system was designed to have a consistent look that would complement the character of the community. Concern for the environment and appreciation of local culture and ecology are central to the hallmark "green" image of the EmX. Grass in the center lane of the running way adds greenery while also helping to absorb noise while native landscaping at stations and along the corridor benefit the natural ecosystem. A unique trait of the EmX is that each station showcases the metalwork of local artist Linn Cook, who uses aluminum forms of native plants to feature a different species at each station.

The EmX is a prime example of a BRT system which is having a technology effect on emissions. The new EmX vehicles are characterized by their GM Allison hybrid-electric propulsion system. A 12 month study of King County Metro (KCM) found that the GM Allison hybrid-electric buses had a 27% higher fuel economy on average when compared to the diesel buses (http://www.greencarcongress.com/hybrids/index.html).

Although there was an increase in service hours, the ridership effect of EmX was fairly significant. Prior to the opening of EmX, 42.4 percent of riders made the trip using a method other than the bus. Of those, 13.3 percent were driving a personal vehicle. The remaining people were riding with someone else, biking, walking, riding a taxi, or not making the trip at all.

It is difficult to say exactly how EmX has impacted traffic congestion. Common sense would say that congestion has decreased due to increased bus ridership. However, since the EmX is not always operating in mixed traffic, the travel time change before and after the implementation of EmX is not an accurate measure of the traffic congestion. However, based on the fact that 19 percent of respondents found their trip to be 15 or more minutes faster and 12.3 percent recorded their trip as 11-15 minutes faster, it would be pretty safe to conclude that the EmX has been successful in changing the perception of riders in regard to congestion.

EmX is steadily growing and becoming more widely known. As ridership increases and demand becomes higher more EmX routes and shelters will be constructed. With the passage of time the overall environmental quality benefits of this BRT system will become more apparent.

5.6 Summary of System Benefits

Since it began operation on January 14, 2007, the EmX has continually increased its ridership. Ridership numbers have increased from approximately 4,000 riders in February 2007 to almost 5,400 in April 2008. Aside from decreases recorded during December and the summer of 2007, figures have been on a steady incline. This is a larger increase than originally anticipated. When evaluating systemwide ridership to understand regional ridership trends, it was found that LTD experienced an increase in ridership every year from 2004, yet a significant increase was noted from January 2007 to January 2008 during which the EmX was in operation.

The proportion of EmX users that previously used a car is around 16 percent. Additionally, seven percent of riders did not previously make the trip which suggests that users are accessing the system for trips they normally would not take.

Total capital cost of the EmX was approximately $25M, or $6.25 million per mile. Since the EmX includes a number of enhanced treatments, i.e., enhanced stops, transit signal priority, and articulated vehicles, as well as its operation on exclusive transitways for approximately 60 percent of the route (usual costs for this treatment equal $6.5 to 10.2 million per mile), costs for the EmX were on target. The outlay in capital costs has also resulted in successful branding of the system.

The EmX has also been successful in generating interest in land development. A local realty firm attributed increased interest in properties to the proximity to a bus rapid transit line. Purchasers of the properties intend to use it for investment purposes.

In regard to environmental quality, the system has been successful in creating a "green" image of the EmX. LTD's commitment to the environment was recognized with a 2008 Sustainable Transport Honorable Mention from the Institute for Transportation and Development Policy. With less than a year in operation, the EmX was the only United States project selected as an award winner for 2008.

Lack of available data precluded the evaluation of Operating Cost Efficiency.

References

Diaz, R. B., et al. (2004). *Characteristics of Bus Rapid Transit for Decision-Making.* Federal Transit Administration, U.S. Department of Transportation, Washington, D.C.

Carey, Graham. (2006-08). *Personal Communication. 2006 - 2008.*

Register-Guard, “Kendall Purchases 13 acres in Gateway.” December 5, 2006.

Appendix A – On-Board Survey Analysis

A.1 Introduction

To understand the public perception among riders of the EmX, an analysis has been completed based upon data that were collected from two on-board surveys. One on-board survey was conducted prior to the opening of the EmX; surveying occurred along the four miles of Route 11 that was to be replaced by the EmX. This survey was conducted in November 2006 and resulted in 1283 completed surveys. These data has allowed for an analysis that compares public perception before and after the operation of EmX. The on-board survey of the EmX riders produced 1833 completed surveys and was conducted in May 2007. This report presents and compares the results obtained from the two surveys.

A.2 Methodology

The Route 11 survey was conducted during the week of November 13th, while the majority of the 2007 EmX on-board survey was conducted during the week of May 14th. The dates of the survey were chosen to capture the midweek data. On Wednesday, buses were surveyed from the early morning until the afternoon. Afternoon and evening service was surveyed on Thursday. Over the two-day period the route was surveyed once for its entire service span; thus, the survey results represent one weekday of service. Survey distribution was carried out by temporary employees hired through Lane Transit District (LTD).

In all cases, one surveyor was assigned to a particular bus on a particular route. Surveys were personally handed to riders as they boarded the bus or just after they found their seats. Riders were encouraged to return completed surveys to the surveyor as they exited the bus. However, due to the short distance traveled by some passengers, some were allowed to take the survey with them to fill out and return to a bus driver at a later time. As time permitted, surveyors also walked through the bus asking for completed surveys. In some instances, surveyors assisted some riders with disabilities in the completion of their surveys. Riders were asked to complete a survey each time they boarded a bus regardless of whether they had previously completed a survey on a previous day or earlier trip.

The instrument(s) that were utilized for the Route 11 and EmX on-board survey(s) contained approximately 25 questions, some with multiple components. The majority of questions were closed-ended in nature, simply requiring customers to select from a list of responses provided. Since answering every question on the survey was not a requirement for the survey to be included in this analysis, many of the records in the final survey database had missing values for various questions.

A.3 Comparison of Sample and Population Demographics

The rider characteristics of the two on-board surveys conducted in 2006 and 2007 are compared in Table A.1 below. These demographics are compared against the population characteristics of Lane County (from Census 2000).

Table A.1 – Sample and Population Demographics

		11	EmX	US Census	
Demographic Variable	Categories	Survey Results (%)	Survey Results (%)	Lane County	
N (Population / Sample Size)		1283	1833	322,959	
Age	Under 18	12.2	9.7	22.8	
	18 to 24	25.5	29.0	11.9	
	25 to 34	20.0	18.7	13.0	
	35 to 49	21.6	23.5	22.6	
	50 to 64	17.0	15.2	16.0	
	65 or over	3.7	3.9	14.0	
Gender	Female	51.2	51.5	51.0	
	Male	48.4	48.4	49.0	
Household Vehicles				Owned Household	Rented Household
	None	58.9	57.5	2.9	16.1
	One	18.6	21.2	26.0	46.9
	Two	13.1	13.1	45.5	27.4
	Three	5.3	5.3	18.2	6.9
	Four	2.0	1.6	5.2	1.9
	Five or more	2.2	1.3	2.1	0.9
Annual Household Income	Less than $10,000	40.4	35.8	11.0	
	$10,000 to $14,999	14.8	16.0	7.3	
	$15,000 to $24,999	15.4	13.6	14.6	
	$25,000 to $34,999	10.8	12.7	14.2	
	$35,000 to $44,999	5.5	6.7	12.8	
	$45,000 to $59,999	4.8	6.9	14.5	
	$60,000 to $74,999	2.4	3.4	9.7	
	$75,000 to $99,999	2.0	2.4	8.0	
	$100,000 or more	3.8	2.5	7.8	

* Income figures are indicative only because data has not been adjusted to account for inflation between 2000 and 2007

Table 1 shows that the demographic characteristics of the two survey samples are very similar to each other, which validate the accuracy of each survey's findings. Comparing the population characteristics of Route 11 riders with those of EmX, it can be seen that the greatest percentage of riders are aged between 18 and 49 compared to the total population within these age groups, with around 70 percent of EmX riders in this age group, compared to only 48 percent of the total population in this age group. It can also be seen that the majority of previous riders of Route 11 and those currently using the EmX for transportation do not own a vehicle which is indicative of being a captive transit

rider. A small increase of 2.6 percent, however, occurred among users with one vehicle available among their household. This may suggest an increase of choice riders with the EmX. Over 65 percent of EmX riders earn less than $25,000, which is double the amount of those within the population in Lane County.

Type of Employment

Respondents were asked to choose any of the six provided options for employment status. Although multiple responses were permitted the results were not greater than 100 percent.

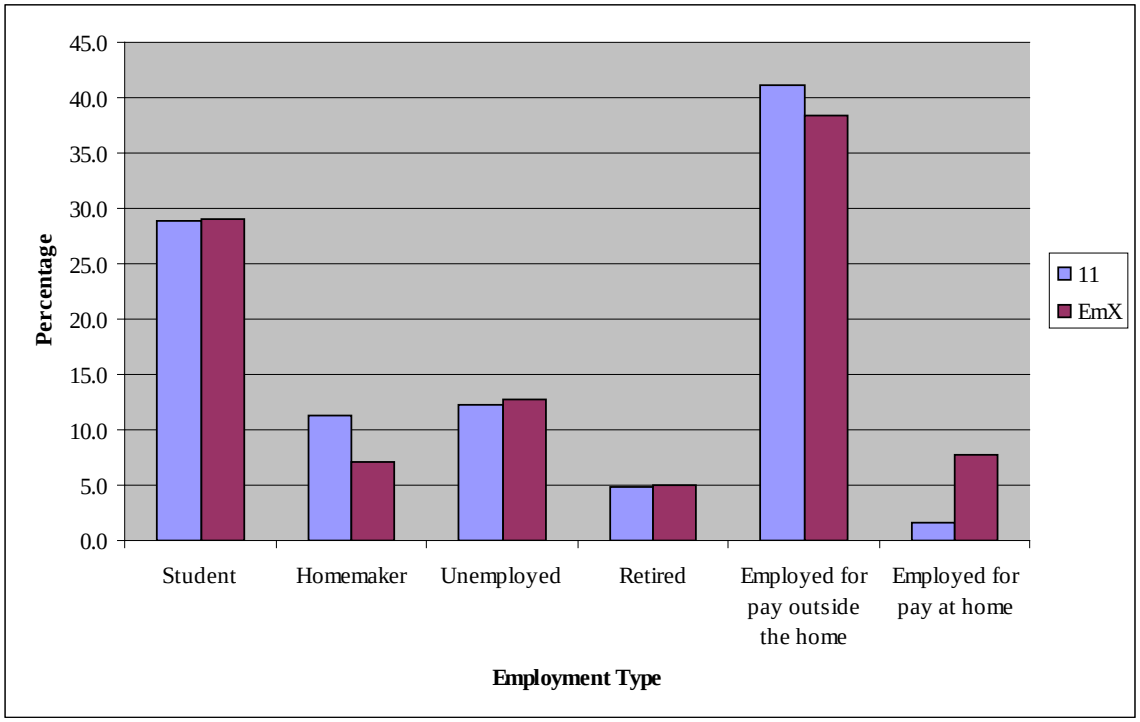


FIGURE A.1 - Employment/Educational Status

Overall the percent of students, the unemployed, and those retired that are riding EmX remained relatively consistent with the percentages reported by those riders from Route 11. A smaller percentage of homemakers rode the EmX (7.1 percent) as compared to Route 11 (11.2 percent), as well as those employed for pay outside the home (38.4 versus 41.1 percent). Approximately eight percent of riders on the EmX categorized themselves as having been employed for pay at home, compared to less than two percent on Route 11.

The EmX survey asked riders what their occupational/educational status was. As can be seen in Figure 2, the largest percentages of riders are students (59.3 percent). The University of Oregon students make up 32.3 percent of riders, Lane Community College account for 10.8 percent, while the remaining students are K-12 (16.2 percent). The next largest group that is represented is the Group Pass Participant at 14.3 percent. The Group

Pass Program is offered through Lane Transit District's Commuter Solutions Program. This program offers employers with 10 employees or more discounted transit passes for their employees. The Group Pass Program is an annual contract with LTD and requires photo-identification for each employee.

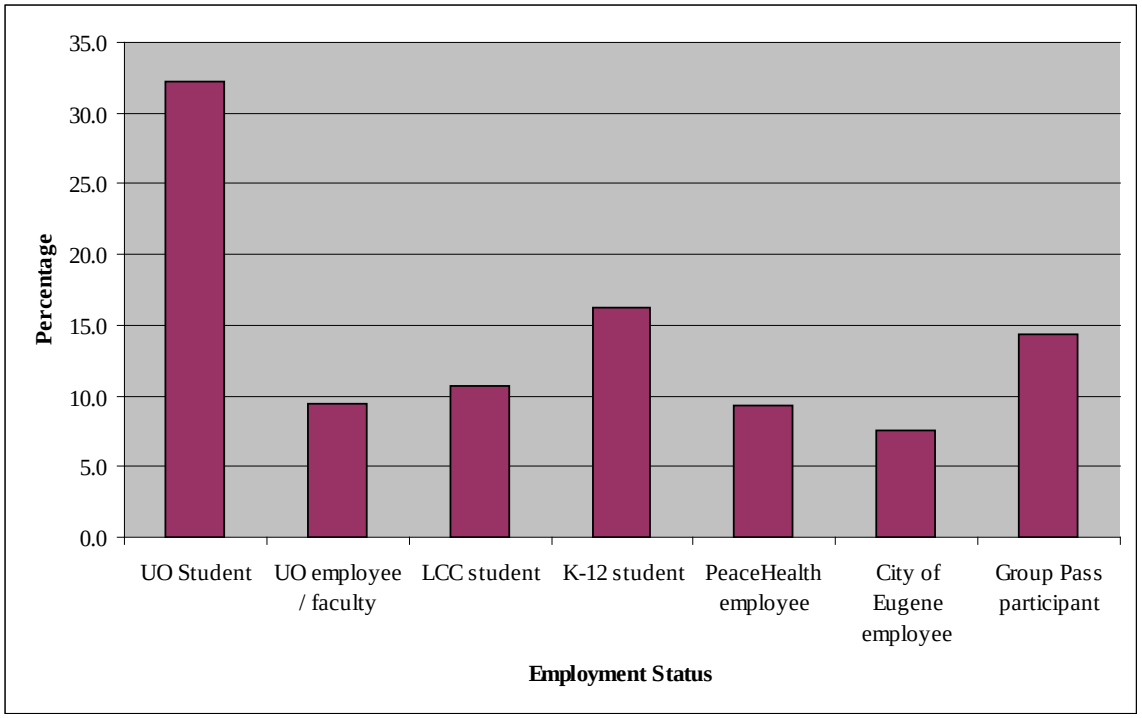


FIGURE A.2 - Type of Employment/Educational Status

A.4 Characteristics of Current EmX Use

A.4.1 Reasons for Riding the Bus

Respondents were asked "Why are you riding the bus today?", and given eight response options. Multiple responses were permitted.

Over 30 percent of respondents reported that they rode the EmX because they did not have access to an automobile. This reported percentage was twice the amount recorded for this category on Route 11. Data shows that there were slight increases in the percent of riders that chose to ride the bus either to avoid traffic or because they found the EmX more convenient than alternative modes. These increases may suggest that the EmX appeals to leisure riders. There was a substantial decrease in the percent of riders that indicated that they rode the bus due to having a bus pass, but this may be considered insignificant as the EmX service is provided at no cost to the riders.

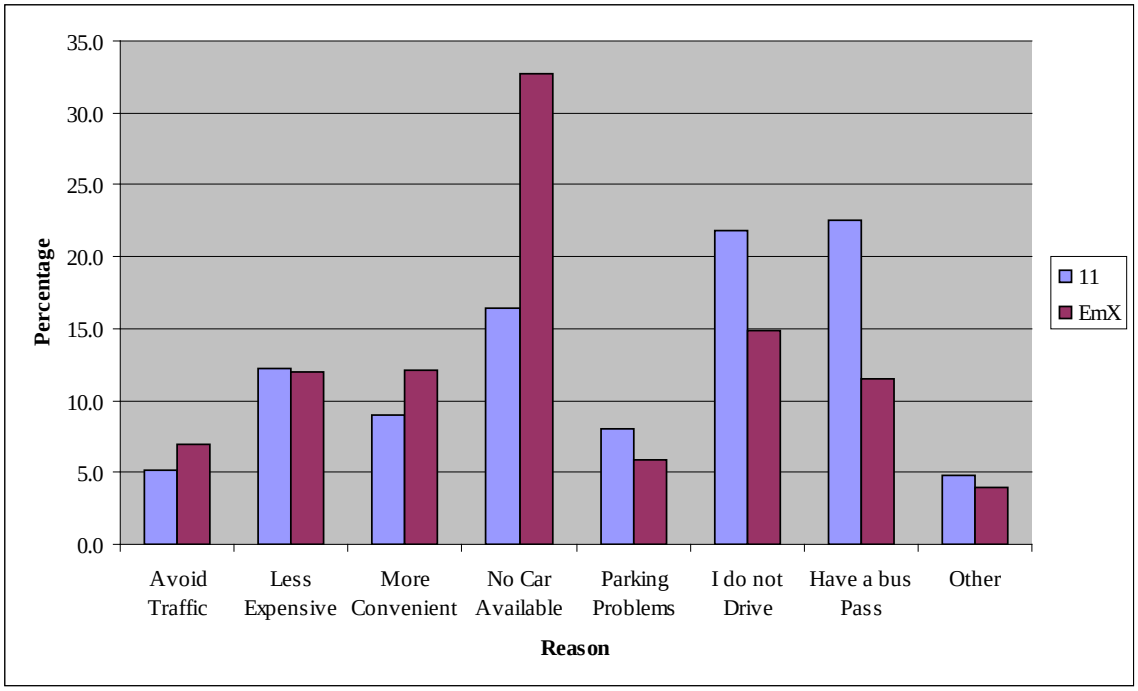


FIGURE A.3 - Why are you riding the bus today?

A.4.2 Trip Purpose

Figure A.4, on the following page, shows the stated trip purposes of EmX riders. The figure shows that more than 30 percent of trips taken on the EmX are for work purposes. School related trips are the next most common trip purpose, accounting for approximately 20 percent of total trips. As previously noted, a relatively large increase in leisure riders, or those with a trip purpose described as visiting friends/family or recreational, resulted with the implementation of the EmX.

Riders were also asked to identify the stop at which they boarded the vehicle as well as which stop they were to get off to complete their trip. As shown in Figure A.4, over 70 percent of riders boarded the bus at either end of the route (Eugene and Springfield stations), compared to an approximate 60 percent of riders previous to the EmX. Hilyard, Dad's Gate, Agate, and Walnut stations each had the next significant proportion of boardings. This could be attributed to the relative close proximity to the University of Oregon and the Sacred Heart Medical Center, as well as the higher densities that exist around these stations.

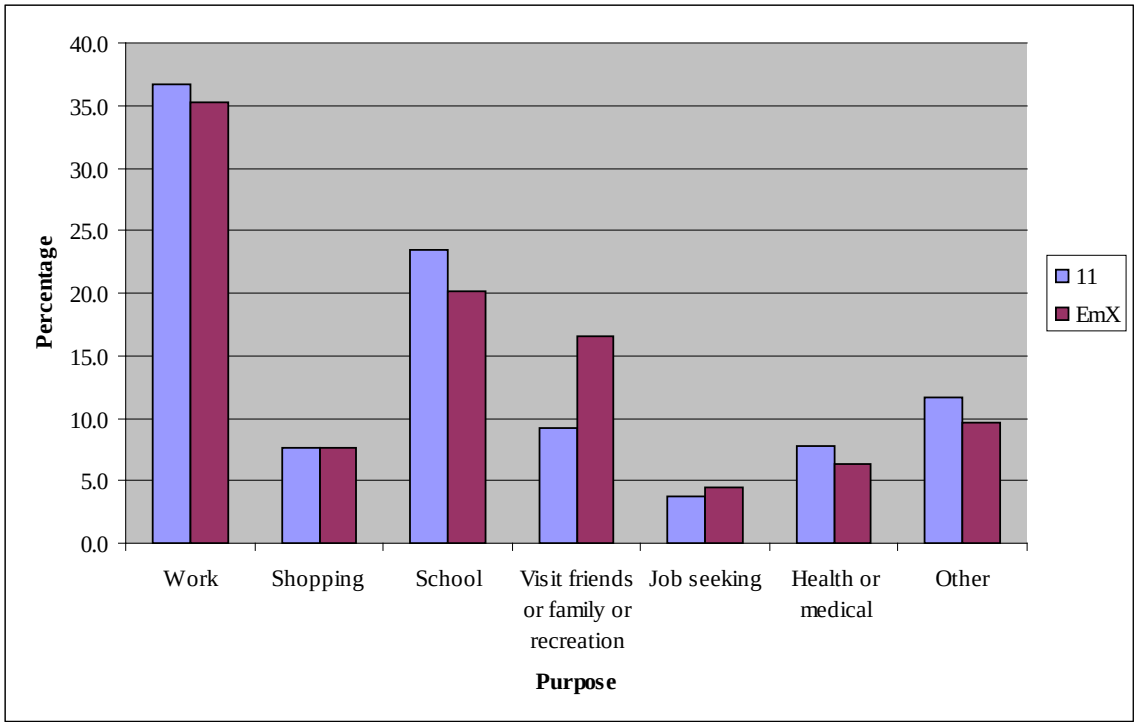


FIGURE A.4 - What is the main purpose of your trip today?

As shown in Figure A.5, the locations where riders departed from the bus generally mirror those locations where they had boarded. A few stops, such as Dad's Gate and Agate Station experienced a higher percentage of riders disembarking the vehicle rather than boarding.

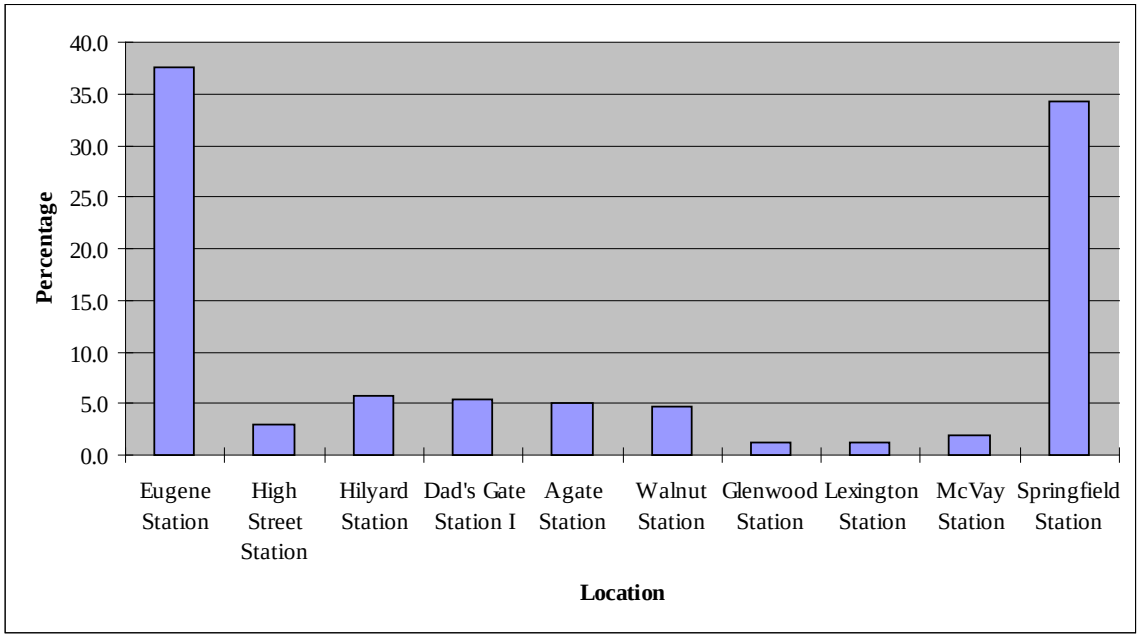


FIGURE A.5 - Where did you get on this bus?

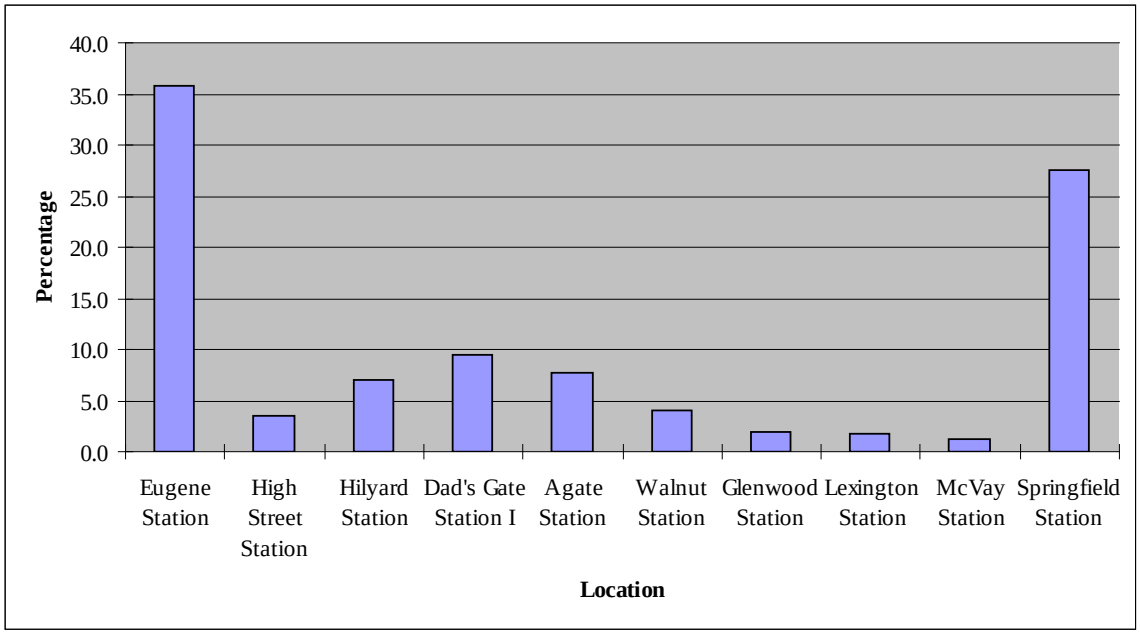


FIGURE A.6 - Where will you get off this bus?

Although not directly comparable, the survey taken on-board the Route 11 asked respondents the locations where they boarded and disembarked the vehicle (see Figure A.7). Available choices included Eugene and Springfield stations and a category of "Other". Similar to the results of the EmX survey, the largest group of respondents boarded and disembarked at Eugene station, yet fewer riders designated Springfield station. Specifically, "Eugene Station" accounted for 39 percent of all responses, whereas "Other" and "Springfield Station" accounted for 36.9 percent and 24.1 percent, respectively, in regard to the question "Where did you get on the bus today?" In the survey, 40.1 percent of respondents said that they exit the bus at Eugene Station, whereas only 12.9 percent were exiting at Springfield Station.

Where will you get on the bus? *Where will you get off the bus?*

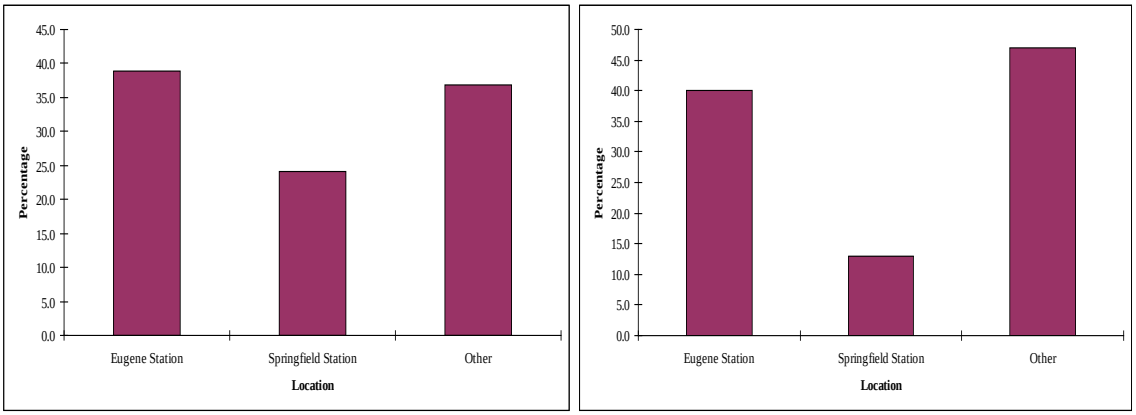


FIGURE A.7 - Locations of boarding and exiting the bus – Route 11

A.4.3 Mode of Access to and from EmX

Figure A.8 below shows how EmX riders got to the bus, while Figure 9 shows how riders on Route 11 had previously gotten to the bus to make their trip. It is apparent that the majority of riders walked to the bus for both the EmX and the Route 11. Before boarding the EmX, 34.8 riders transferred from another bus route, 7 percent biked and 5.4 percent drove. The relatively high percent of cyclists is characteristic of the community. Of those individuals surveyed for Route 11, 80.8 percent walked, 6.7 percent drove, 3.8 percent were driven by someone else, 3.2 percent rode a bicycle, 0.4 percent rode in a taxi, and 5.1 percent arrived via some other mode.

While not directly comparable due to the differences in response options provided, one could note the increase among riders that traveled by bicycle to the EmX. In addition, 34.8 respondents of the EmX survey indicated that they transferred from another bus route, while only 5.1 percent of respondents from the Route 11 survey reported that they arrived via some other mode.

Figure A.9 shows how riders were planning on traveling to their final destination after getting off the bus on both Route 11 and EmX. While on Route 11, most riders will walk to arrive at their final destination. Walking made up 76.6 percent of all responses and transfer to another bus was the second most frequently selected response, accounting for 14.2 percent. On the EmX, 57 percent of riders will walk to reach their final destination, and 30.1 percent will transfer to another bus. The percent of riders that will transfer to another bus significantly increased from the Route 11 to the EmX. Previous riders were able to ride Route 11 from downtown Eugene to Springfield station and onward toward Thurston station. Riders that wish to travel from Eugene to Thurston station must now transfer from EmX at Springfield station onto Route 11.

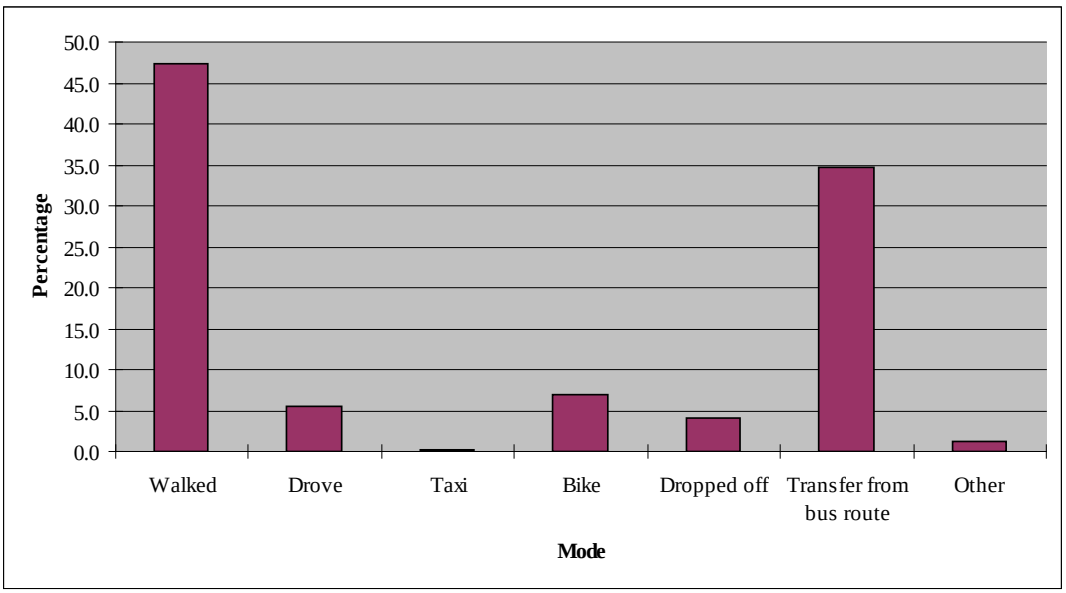


FIGURE A.8 - EmX survey - How did you get to the LTD stop where you boarded the first bus you used for this trip?

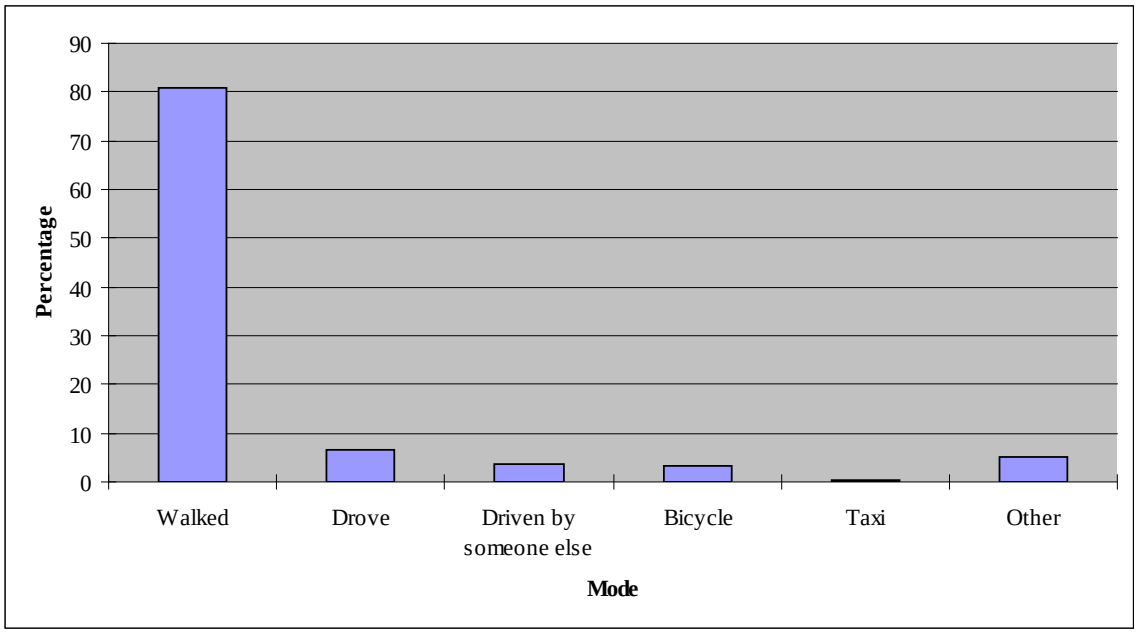


FIGURE A.9 - Route 11 survey - How did you get to the LTD stop where you boarded the first bus you used for this trip?

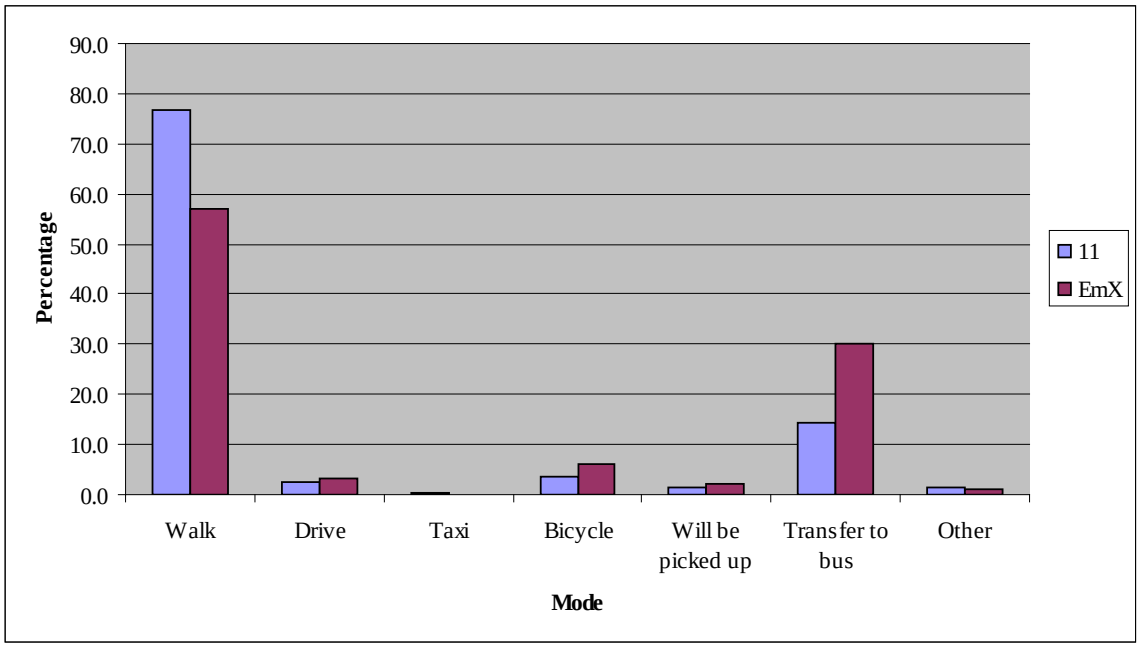


FIGURE A.10 - How will you get to your final destination?

Riders were also asked "How long will it take you to reach your final destination?" Based on Figure A.11, the majority of riders on Route 11 took one to five minutes to get to the bus stop. For the EmX, 30.8 percent of riders took one to five minutes. Time intervals of one

to five and six to ten minutes had a greater percentage of respondents among riders on Route 11 than on the EmX. With the inverse occurring among responses for the 11 to 20 minute and longer time intervals, it is apparent that the travel time among riders to reach their final destination once they disembarked the EmX significantly increased. As previously discussed, a greater percentage of riders had to transfer to another bus to arrive at their final destination on the EmX as compared to riders of the previous Route 11. This increase in travel time to reach a final destination may be attributed partially to the need for more riders to transfer to another route to complete their trip.

Within the survey questions, "How will you get to your final destination?" and "How did you get to this EmX bus?" respondents that selected that they needed to transfer to/from a bus were also prompted to answer which route would be necessary for them to complete their trip. In an effort to understand the change in perceived travel time among those individuals that now must transfer to/from Route 11 to complete their trip, a crosstabulation was generated between responses that designated Route 11 as their transfer bus and the survey question "How has your travel time changed with the EmX?". Data presented in Table A.2 compare these responses and show that approximately 71 percent of riders that will have to transfer to Route 11 to complete their trip perceive their travel time to be faster or about the same as before EmX. A larger percentage (76 percent) that had transferred from Route 11 onto the EmX perceived their travel time as less or about the same as well.

Table A.2 - Travel time impact among riders transferring to/from Route 11

Travel Time Impact	Will transfer to Route 11 to complete trip (%)	Have transferred from Route 11 to complete trip (%)
15+ minutes faster	9.7	15.2
11-15 minutes faster	5.8	5.1
6-10 minutes faster	13.6	13.3
1-5 minutes faster	11.7	12.7
About the same	30.1	29.7
Slower	29.1	24.1
TOTAL	100	100

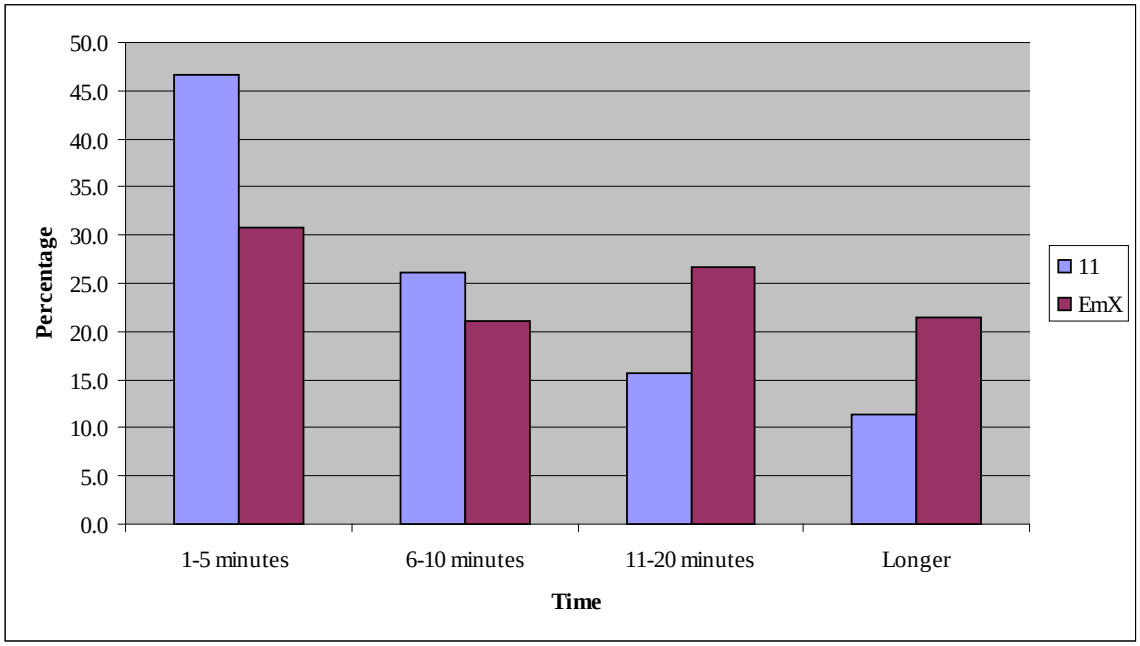


FIGURE A.11 - How long will it take you to reach your final destination?

A.4.4 User Perceptions of EmX Impact on Travel Time

The EmX survey asked if respondent's travel time changed with the implementation of the EmX. Figure 17 shows that the majority of respondents thought that the EmX had reduced their travel time, with 26.9 percent stating that their travel time had remained unchanged, and approximately 10.7 percent stating that their travel time was now slower. Thus, over 60 percent of riders thought that their travel time had decreased as a result of the EmX. Of these, around 20 percent stated that the travel time saving was greater than 15 minutes.

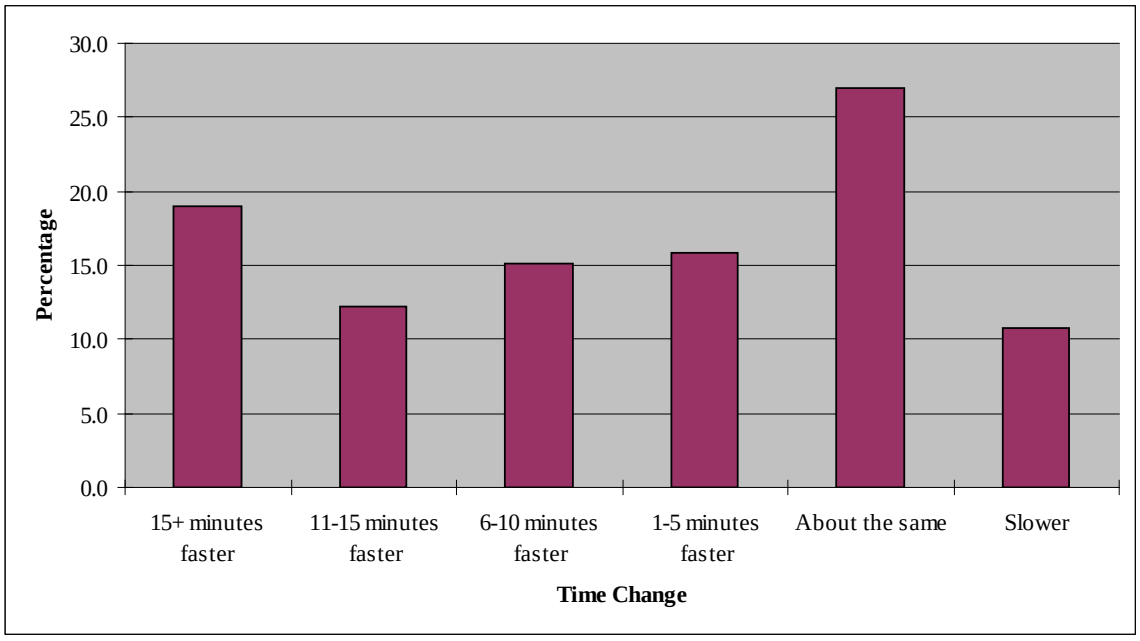


Figure 17. How has your travel time changed with the EmX?

Data presented in Table 6 compare responses received to the questions "How has your travel time changed with the EmX?" and "Before the EmX opened, how did you make this trip?". As shown, the majority of riders (59.2 percent) that rode an LTD bus prior to EmX said that their travel time is now faster than before. In the case of individuals who drove, only 13.5 percent perceived the EmX to be slower than travel by car, while 59.2 percent believed the EmX was faster. In addition, close to 20 percent of riders that previously drove thought that the EmX was at least 15 minutes faster than the car. For those that rode with someone else, cycled, walked, or selected "other", the majority of responses illustrate that the EmX is perceived to complete the trip faster than the previous mode.

TABLE A.3 - Impact of EmX on Travel Time for Different Prior Modes Used

Travel Time Impact	*Mode Used Prior to EmX*							
	Drove	Rode with someone else	Bicycle	Rode LTD bus	Walked	Taxi	Didn't make trip	Other
15+ minutes faster	17.0	29.8	22.5	17.2	23.6	0.0	20.7	25.0
11-15 minutes faster	15.7	5.3	15.5	11.3	14.9	12.5	11.7	7.1
6-10 minutes faster	14.8	15.8	20.9	14.1	15.5	25.0	13.5	28.6
1-5 minutes faster	11.7	12.3	11.6	16.6	21.6	12.5	10.8	7.1
About the same	27.4	33.3	23.3	29.1	20.3	25.0	37.8	21.4
Slower	13.5	3.5	6.2	11.7	4.1	25.0	5.4	10.7
TOTAL	100	100	100	100	100	100	100	100

When respondents were asked, "Approximately how many minutes will this entire one-way bus trip take from the beginning to the end of your trip when you get off the last bus?" they presented a wide variety of answers (Figure 18). The time with the largest percentage of the answers was 6-10 minutes with 17.7 percent. Another popular response, by 13.7 percent of individuals surveyed, was 16-20 minutes.

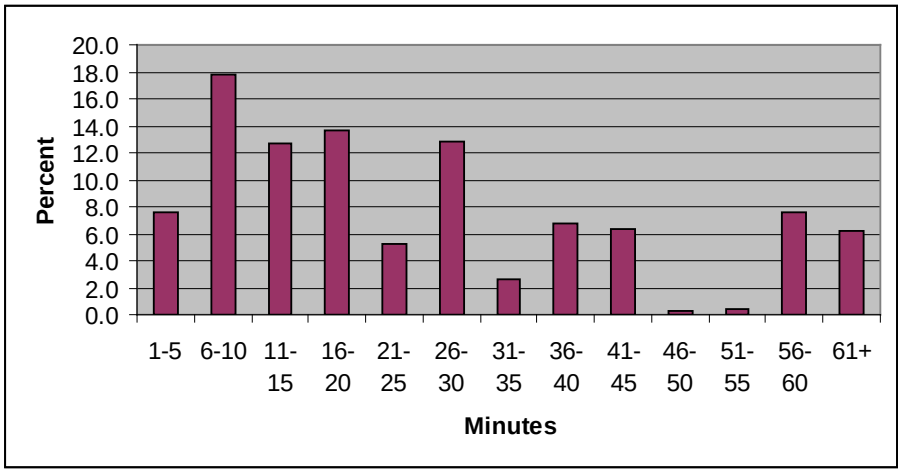


Figure 18. Approximately how many minutes will this entire one-way bus trip take from the beginning to the end of your trip when you get off the last bus?

A.4.5 Characteristics of Transit Use

In an effort to understand the frequency of use among riders on the EmX, riders were asked how many days per week they rode the particular route (Figure 12). The group with the largest percentage of respondents was for five days per week (29.1), followed by four days (14.8) and three days (12.8). This is indicative that the majority of riders use the EmX to travel to and from work and school. Approximately 11 percent of riders used the EmX seven days per week.

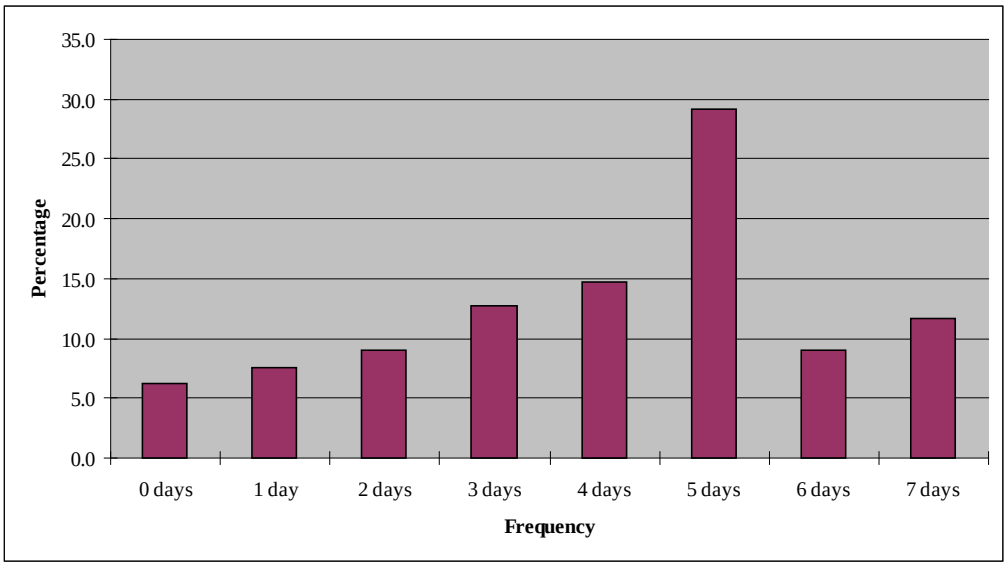


Figure 12. How many days per week do you ride on the EmX?

Riders were also asked how many days they have ridden on a Lane Transit District (LTD) bus within the past seven days. As shown in Figure 13, most riders either ride the bus five days out of the week or seven days out of the week. The percentage breakdown for Route 11 was 30.3 percent of respondents rode the bus seven days in the past week and 23.9 percent rode the bus five days in the past seven days. For EmX, a total of 50 percent of responses were recorded within the five or seven days per week. This further emphasizes the fact that most of the surveyed population is either employed or a student.

Table A.3 shows the results of a crosstabulation of the survey questions "What is your annual household income?" and "How many days per week do you *usually* ride the EmX?" Approximately 23 percent of respondents that ride the system five days a week live in a household with an annual income of $35,000 or more.

TABLE A.3 - Percent of riders by Annual Household Income and Days Riding EmX/Week

	Days Per Week							
Annual Household Income	**0* (None)**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
	%	**%**	**%**	**%**	**%**	**%**	**%**	**%**
Less than $10,000	26.0	28.4	41.7	39.3	34.2	28.9	41.3	49.0
$10,000 to $14,999	12.3	14.7	16.7	11.7	12.8	16.4	22.2	17.9
$15,000 to $24,999	11.0	15.8	13.3	15.3	9.1	16.7	12.7	11.7
$25,000 to $34,999	13.7	12.6	9.2	8.6	15.0	15.4	12.7	9.7
$35,000 to $44,999	8.2	7.4	3.3	8.6	8.6	7.4	5.6	4.8
$45,000 to $59,999	11.0	7.4	9.2	7.4	9.6	8.0	1.6	2.8
$60,000 to $74,999	6.8	4.2	3.3	3.1	3.7	3.2	3.2	0.7
$75,000 to $99,999	5.5	4.2	0.8	3.7	3.7	2.1	0.0	1.4
$100,000 or more	5.5	5.3	2.5	2.5	3.2	1.9	0.8	2.1
TOTAL	100	100	100	100	100	100	100	100

*Zero days per week was a provided response, as the question asked about usual travel behavior

Riders were also asked "Last year at this time, how many days per week were you riding the LTD buses?" Figure 14 shows that there was very little change in frequency of bus use from one year to the next for Route 11. For both Route 11 and the EmX, more people reported riding the bus seven days per week than the previous year, and five and seven days per week were the two most popular responses for both years. It should be noted that a greater percentage of responses of the EmX survey were noted for having not ridden an LTD bus the prior year (21.4 percent versus 28.9 percent). This may be attributed to a number of different factors. It is possible that the EmX has been able to attract new choice riders to the system. Another possible factor could be that riders can ride the EmX for free.

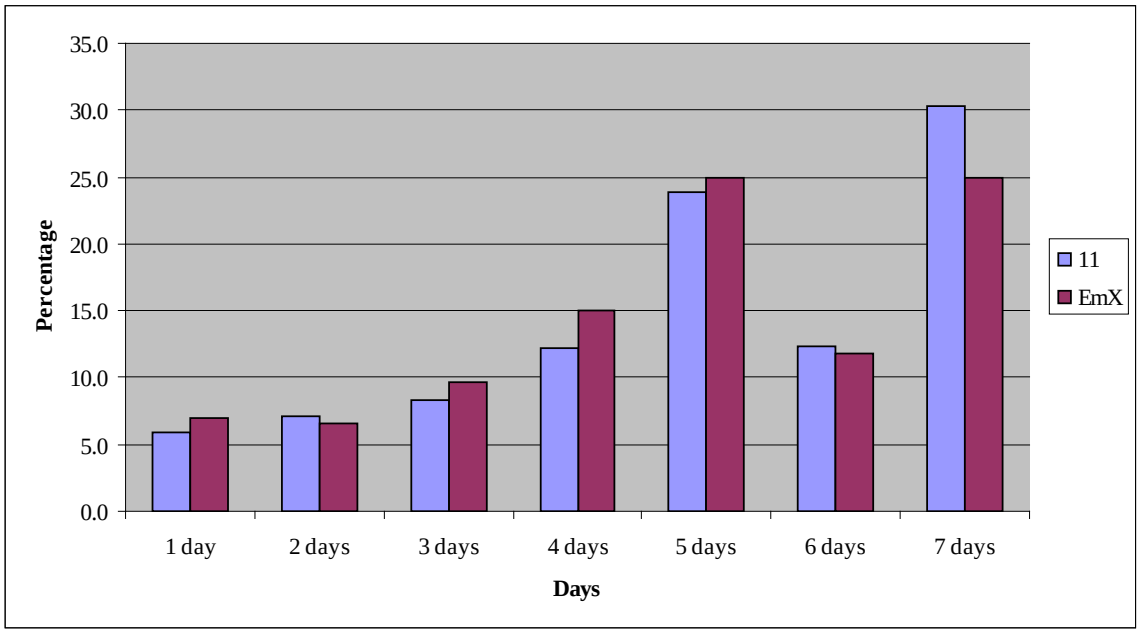


Figure 13. In the past seven days, how many days have you ridden on an LTD bus (including the bus today)?

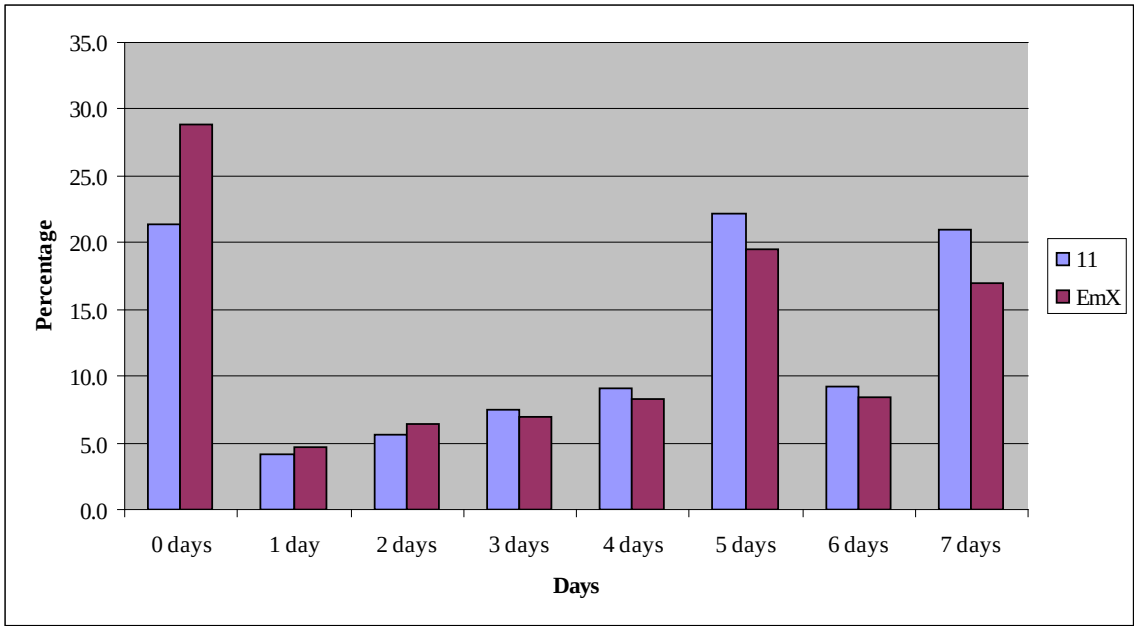


Figure 14. Last year at this time, how many days per week were you riding the LTD buses?

An additional question that was asked, "How long have you been using LTD service?" resulted in responses that support the rationale that EmX has been successful in attracting new riders. Figure 15 shows that there was an increase in riders, from 10.2 percent to 14.2 percent, among those that have ridden a bus less than three months. At the time of the EmX survey, the service had been operating approximately four months.

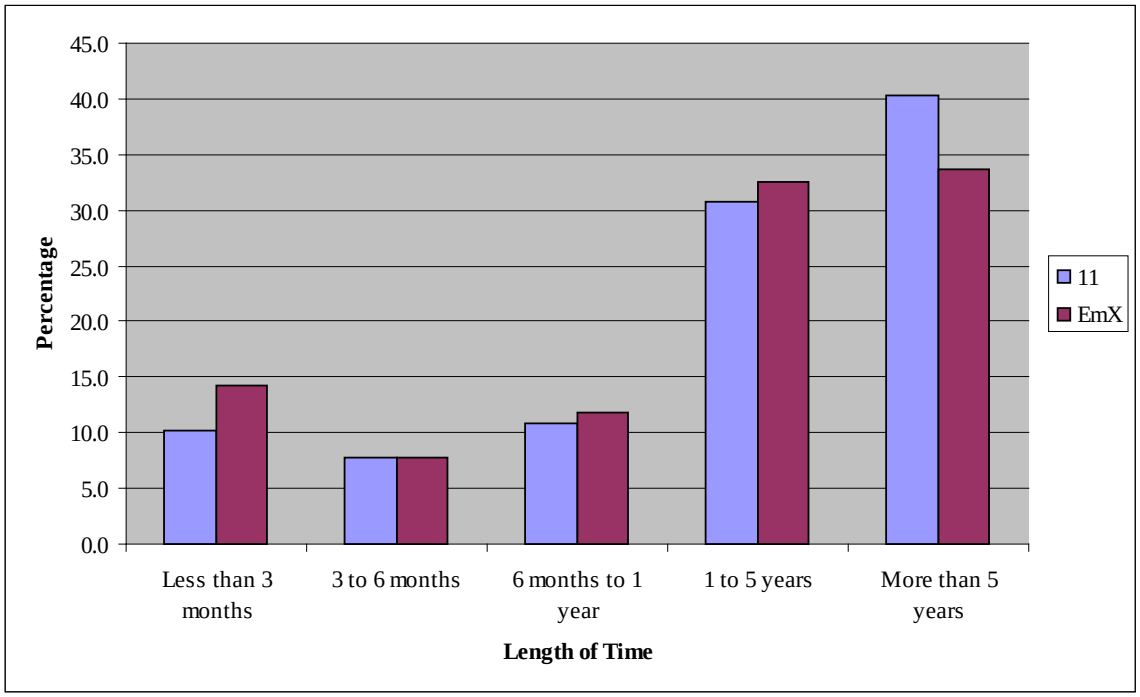


Figure 15. How long have you been using LTD service?

Based on responses to the question, "Before the EmX opened, how did you make this trip?" it is apparent that the majority of riders used the Route 11 (57.6 percent). As shown in Figure 16, there is a significant percentage that previously drove or rode with someone else (16.3 percent), which is also indicative of the EmX attracting choice riders. Approximately seven percent of riders responded that they did not make the trip previously, which may explain the percent increase of riders that responded they made the trip to visit family/friends and/or recreation when asked the purpose of their trip. Those that previously walked (8.3 percent) may be making the trip on EmX due to the lack of a fare. Other reported responses were rode with someone else (3.3 percent), bicycle (7.5 percent), taxi (0.5 percent), and other (2.1 percent).

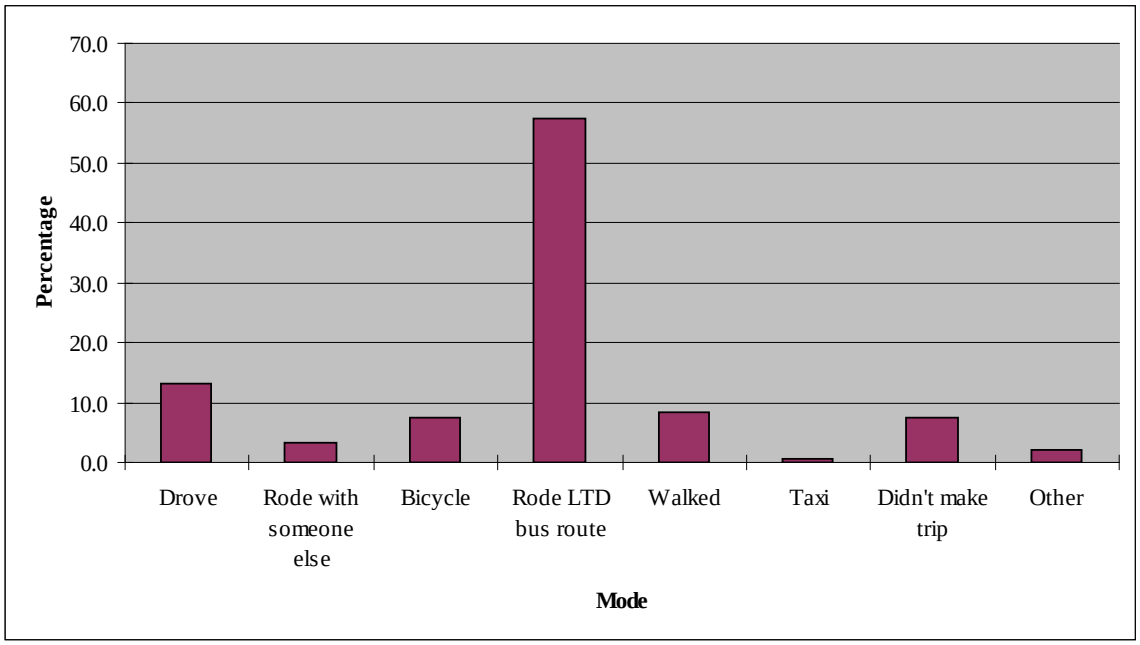


Figure 16. Before the EmX opened, how did you make this trip?

In an effort to further understand the group of respondents that stated that they have been using LTD service for less than three months, a crosstabulation was completed between these data and data from the question, "Do you own a car or other motor vehicle, or have access to one?" (Table A.4). Since the EmX had been in operation for four months at the time of the survey special consideration is given to the "Less than 3 months" and "3 to 6 months" categories. Results show that a significant percentage (56.7 percent) of those using LTD service for less than three months do own a motor vehicle or have access to one. In addition, a higher percentage of riders using LTD service from three to six months own a car or have access to one as well. Even though it is possible that these data may represent individuals that will not be retained riders, it strongly suggests that the EmX has been successful in attracting choice riders. This argument is further supported by looking at percentages related to car ownership/access in correlation to length of time of LTD ridership; an inverse relationship occurs.

TABLE A.4 - Length of time using LTD services and Motor Vehicle Ownership

	Own a Car or Other Motor Vehicle		
Length of Time	**Yes**	**No**	**Total**
	%	**%**	**%**
Less than 3 months	56.7	43.3	100.0
3 to 6 months	52.6	47.4	100.0
6 months to 1 year	48.0	52.0	100.0
1 to 5 years	45.3	54.7	100.0
More than 5 years	38.9	61.1	100.0

Another crosstabulation was comparing car ownership and the number of days per week respondents rode EmX. The information presented in Table A.5 shows that approximately 36 percent of respondents with access to a motor vehicle ride the EmX five days a week compared to 27.5 percent that do not have access.

TABLE A.5 - Number of days/week riding EmX and Motor Vehicle Ownership

	Own a Car or Other Motor Vehicle	
Days per Week	**Yes**	**No**
	%	**%**
0	9.5	4.2
1	9.2	7.0
2	11.1	8.5
3	13.1	13.3
4	17.8	14.2
5	36.4	27.5
6	5.4	13.4
7	7.0	16.1
TOTAL	100	100

A.4.6 Rating of Different Aspects of EmX Use

Survey respondents were asked to rate different aspects of the Route 11 and the EmX service on a scale of 1 (very poor) to 5 (very good). The final two questions related to public perceptions of the Route 11 and EmX service overall, and other LTD bus services overall. Table A.6 below provides the analysis of these responses showing, for each service element, the sample proportions in each response category, the overall mean score, and the response rate. The service elements have been sorted based on the overall mean score that they achieved.

Table A.6 indicates that the EmX is highly regarded by its customers, with 81.6 percent of responses rating the EmX overall as either the “good” or “very good” category. These ratings compare favorably with LTD services overall, which received a mean score of

4.0, and around 80 percent rated LTD services as “good” or “very good”. None of the service elements of the EmX were rated “poor” or “very poor” by more than 10 percent of the sample, with only a few elements receiving more than 5 percent or more of their total responses in these two categories. It can also be seen that the responses were relatively consistent across the different service elements. The elements receiving the highest rating of 4.4 included “doors on both sides of the bus”, and “cost of riding the bus”. Service elements receiving a 4.2 or 4.3 rating included frequency, travel time, availability of information at stations, ease of identifying services, “operator driving competence,” “additional door in middle of bus,” and level boarding. In terms of accessibility, wheelchair securement and accessibility of vehicles both received high ratings of 4.3 or 4.2.

The EmX received a mean score of 0.3 points higher than Route 11 among seven categories. Those categories that are related to service provision include: dependability of the bus (on-time performance), wait time at station/stop for the bus, and travel time. The mean score for the cost of riding the EmX was 0.4 higher; this can be directly attributed to the lack of a charged fare for riding EmX. Two categories in relation to shelters, 1) cleanliness of shelters, and 2) amenities provided at shelters, received significantly higher mean scores. In regard to vehicles, the availability of seats on the bus was rated higher also.

TABLE A.6 - Customer Ratings of Different Aspects of the EmX Service

	Response Category (%)											
	11	EmX	11	EmX	11	EmX	11	EmX	11	EmX	11	EmX
Service Element	Very Poor (1)	Very Poor (1)	Poor (2)	Poor (2)	Fair (3)	Fair (3)	Good (4)	Good (4)	Very Good (5)	Very Good (5)	Mean Score	Mean Score
Hours of Service	1.6	1.7	5.1	3.0	20.1	14.8	41.8	41.2	31.3	39.3	4.0	4.1
Frequency of the bus (how often buses run)	0.9	1.5	4.4	3.1	21.2	14.3	38.4	35.9	35.1	45.2	4.0	4.2
Convenience of the bus (where buses go)	1.5	1.8	3.0	4.0	17.2	20.4	44.6	37.8	33.8	36.0	4.1	4.0
Dependability of the bus (on-time performance)	3.4	1.4	8.5	4.1	25.5	18.8	37.2	37.1	25.5	38.6	3.7	4.1
Wait time at station/stop for the bus	2.9	1.7	5.7	3.7	30.2	22.1	39.4	38.7	21.8	33.8	3.7	4.0
Travel time on this bus	1.4	1.1	5.9	3.1	25.6	15.0	44.8	39.4	22.3	41.4	3.8	4.2
Cost of riding the bus (value for what you pay)	2.9	1.0	6.1	3.0	20.3	10.2	30.0	24.3	40.6	61.5	4.0	4.4
Availability of bus information/maps at stations	1.8	0.9	4.7	2.9	15.5	13.6	39.6	36.4	38.4	46.1	4.1	4.2
Availability of seats on bus	4.7	1.5	13.4	6.1	29.6	23.1	33.6	40.8	18.8	28.4	3.5	3.9
Personal safety on bus	1.6	2.1	4.3	3.1	17.1	16.0	44.9	39.9	32.1	38.9	4.0	4.1
Personal safety at stops	2.0	1.8	5.7	3.9	25.4	18.4	42.3	41.7	24.6	34.2	3.8	4.0
Quality of bus shelters/stops	6.7	2.9	12.6	7.1	31.9	17.8	31.4	39.0	17.5	33.2	3.4	4.0
Smoothness of ride on vehicles	2.8	2.6	7.5	7.0	33.0	23.7	37.7	39.0	19.0	27.7	3.6	3.8
Ease of getting on and off vehicles	1.1	1.3	3.2	1.8	18.5	14.8	46.8	40.4	30.5	41.7	4.0	4.2
Location of bus signage	1.0	1.0	2.7	1.9	19.8	15.7	49.6	44.7	26.9	36.8	4.0	4.1
Ease of identifying bus service	0.9	0.9	2.0	1.7	16.4	13.1	46.6	42.2	34.1	42.2	4.1	4.2
Wheelchair securement on vehicles	0.9	0.9	2.1	1.8	12.0	12.9	45.3	40.9	39.7	43.4	4.2	4.2
Accessibility of vehicles to handicapped	1.0	1.0	1.9	1.3	12.5	11.9	42.8	40.8	41.7	45.0	4.2	4.3
Operator courtesy	1.6	1.5	2.2	3.5	17.4	17.1	40.0	38.2	38.8	39.7	4.1	4.1
Operator driving competence	0.7	1.2	1.1	2.5	13.5	14.7	45.2	40.1	39.4	41.5	4.2	4.2
Cleanliness of buses	1.1	1.5	6.0	3.0	23.9	17.0	41.8	41.2	27.2	37.3	3.9	4.1
Cleanliness of shelters	2.5	1.8	12.6	5.5	28.7	18.7	35.8	40.2	20.4	33.7	3.6	4.0
Amenities provided at the shelters (benches, etc.)	3.9	2.1	10.4	5.8	31.8	19.9	33.1	38.9	20.6	33.3	3.6	4.0
Availability of bike racks	4.3	5.3	9.3	8.4	25.2	23.2	37.8	36.1	23.4	27.0	3.7	3.7
The look/design of the new vehicles used for EmX	-	2.3	-	2.6	-	14.6	-	40.0	-	40.5	-	4.1
Additional door in the middle of the bus	-	0.7	-	1.5	-	10.5	-	41.2	-	46.2	-	4.3
Doors on both sides of the bus	-	1.0	-	0.7	-	8.7	-	37.0	-	52.6	-	4.4
Level boarding onto the bus	-	1.1	-	1.2	-	10.2	-	39.3	-	48.2	-	4.3
Connectivity to other bus service	-	1.8	-	3.7	-	17.3	-	38.2	-	39.0	-	4.1
Parking cost/availability	-	2.8	-	4.7	-	19.2	-	34.9	-	38.4	-	4.0
Your overall satisfaction with this route	**1.2**	**1.8**	**2.9**	**3.2**	**19.7**	**13.5**	**46.6**	**41.5**	**29.6**	**40.1**	**4.0**	**4.1**
Your overall satisfaction with LTD	**1.4**	**1.7**	**4.5**	**3.7**	**17.0**	**16.9**	**47.4**	**43.6**	**29.7**	**34.1**	**4.0**	**4.0**

A.5 Additional Comments and Suggestions

The final section of the on-board survey provided space for respondents to write any other comments or suggestions that they had about the EmX service. These comments have been categorized to facilitate a quasi-quantitative analysis. Table 8 provides the results of this analysis.

The table shows that a total of 550 separate comments were coded. While the majority of respondents only made one comment, some commented on a range of different issues, and were thus assigned multiple codes. The comments were separated into seven major themes; service provision, drivers, vehicles, fares, shelters, bike racks, and overall.

For the EmX, approximately 11 percent of the general comments were categorized as satisfaction with the service as compared to a 2.3 percent of general dissatisfied comments. The majority of the comments were made on the theme of service provision (Table A.9). The most frequently cited comment was that there was a need for better service (22.9 percent). Other negative comments on the service were made in regard to the lack of stops (7.5 percent) to the need for better timing (4.8 percent) and for more buses/overcrowding issues (4.2 percent). The majority of comments/suggestions provided by riders of Route 11 were also made on the theme of service provision. The most frequently cited comment was the need to extend service (both hours and frequency of stops) making up 17.9 percent of the comments. The next most frequent negative comments included the bus always being late (12.3 percent), and the need for better weekend hours (6.7 percent). In terms of positive comments the most frequent response was thanking LTD for a job well done (8.1 percent). Positive comments on signs, service, and rider courtesy were also observed, but with much lower frequency.

On the EmX, the need for more bicycle racks/better bike securement made up the second largest group of comments (13.8 percent). Given the frequency of bicycle usage in the community, the recorded number of comments in relation to bicycles is not surprising. A possible reason for a concern regarding bike racks is the lack of available bike racks on the vehicle. Bicyclists are to secure their vehicles by hand while riding on the vehicle. Comments regarding bicycle facilities on Route 11 were not as prevalent, with only 5 percent of total comments expressing this concern.

A variety of comments were made about the EmX bus drivers. Four (0.73 percent) respondents gave positive comments (good drivers / courteous drivers), while the rest of the comments were negative (10.5 percent). Criticisms included not waiting for people, poor driving (too fast / jerky / leave before people can sit down), and not enforcing the rules (controlling rowdy student passengers).

In regard to shelters for EmX, a few comments were made in regard to improving shelters such as the need for more coverage/protection from weather. Comments were also made that more parking should be available nearby the stations (3.6 percent of comments). This is a small increase in the percentage of comments for this issue, as only 1.1 percent

of riders on Route 11 made this comment. Currently, there are two park and ride lots located near EmX stations (the former DMV at the corner of Franklin and Walnut, and Springfield station).

Table A.8. Additional Comments/Suggestions on EmX

Comment Category		N.	%
Service Provision	Great Service	9	1.64%
	Need better service	126	22.91%
	Need more buses / Over crowded	23	4.18%
	Need better timing / synchronization	26	4.73%
	Needs to be on-time	10	1.82%
	Needs more stops and better routes	41	7.45%
Drivers	Satisfied with Drivers	4	0.73%
	Dissatisfied with Drivers	58	10.55%
Vehicles	Need stroller strap	2	0.36%
	Replace the high floor	1	0.18%
	Needs clocks at stops	2	0.36%
	Need better maps	1	0.18%
	Printed schedules	2	0.36%
	Need Air-Conditioning	5	0.91%
	Seats are uncomfortable	6	1.09%
	Need newer buses	1	0.18%
	Dirty	2	0.36%
	Smell bad	2	0.36%
	Voice recording is annoying	3	0.55%
	Rude passengers	9	1.64%
	Safety and Security	11	2.00%
	Concerned with wheelchair ramp	1	0.18%
Fares	Keep it free/cheap	12	2.18%
	Too expensive	7	1.27%
Shelters	Need better shelters	8	1.45%
	Need more parking	20	3.64%
Bike Racks	Like the bike racks	1	0.18%
	Need more bike racks / Bikes need better securement	73	13.27%
Overall	Overall satisfied with EmX	59	10.73%
	Overall dissatisfied with EmX	13	2.36%
	Should have kept the 11; waste of money	12	2.18%
TOTAL		550	100%

Table A.9. Additional Comments/Suggestions on Route 11

	Comment Category	N.	%
Service Provision	Pleased with LTD / Keep up the good work / Thank you	21	7.4 %
	Wonderful service / Thanks for the service	2	0.7%
	Signs are nice	1	0.4%
	Riders are kind to one another	1	0.4%
	Security is nice	1	0.4%
	Children need supervision / too many confrontations / Loud People	17	6.0%
	Need better weekend hours / better hours on Sunday	19	6.7%
	Need to extend service (both hours and frequency of stops)	51	17.9%
	Always late / Wait too long / Need to run more frequently / Unreliable / Too slow	35	12.3%
	Waste of money	1	0.4%
	Need to a call-in time table like Tri-Met	1	0.4%
	Need transfers	1	0.4%
	If bus is packed do not ask people to move for a wheelchair	1	0.4%
	Bus should not pull away when someone is running after it	2	0.7%
	Coordinate departures	1	0.4%
Drivers	Courteous Drivers / Drivers are nice	7	2.5%
	Safe Drivers	1	0.4%
	Rude drivers / Bad operator courtesy	10	3.5%
	Unsafe drivers	1	0.4%
	Drivers use their brake too much	1	0.4%
Vehicles	Love the bus	4	1.4%
	Need bigger buses / Too crowded / More seats	31	10.9%
	Not clean / Need to be sanitized / Smell bad	7	2.5%
	Need more buses	12	4.2%
	Need better reading lights	1	0.4%
	Need better ventilation	1	0.4%
	Need safety belts	1	0.4%
	All seats should be cushy	1	0.4%
	Scary exiting when floors are wet	1	0.4%
	Clean up emissions	1	0.4%
	Double-decker instead of accordion	1	0.4%
	No bikes on buses	2	0.7%
	Need better safety	2	0.7%
Fares	Freeze the cost of fares	1	0.4%
	Cheaper fares / Charge too much	2	0.7%
	Should be free	1	0.4%
Shelters	Need more trash barrels	1	0.4%
	Need better shelters / More covered stops / Shelter against the rain	15	5.3%
	Need more lighting at bus stops	1	0.4%
	Need posted schedules / Small schedules to keep in wallet	4	1.4%
	No smoking in shelters	1	0.4%
	Need more parking	3	1.1%
	Need better safety	1	0.4%
Bike Racks	Like the bike racks	1	0.4%
	Need better access to bike racks	1	0.4%
	Need more bike racks / Bike racks should hold more bikes / bigger bike racks	13	4.6%
	TOTAL	285	100%

APPENDIX B – Travel Time Component Analysis

B.1 Introduction

This document presents the assessment of travel time and reliability on the new EmX service implemented in Eugene, Oregon, as compared to the Route 11 service that it replaced. Baseline data on the Route 11 service were collected on November 14 to 16, 2006. Data on the EmX service, introduced in January 2007, were collected on November 14 to 16, 2007. Data collection involved surveyors riding the Route 11 and EmX services between Eugene Station and Springfield Station, documenting the time that each run began and ended, when each time point was reached, and the different components of travel time as the journey progressed. Data for a total of 62 Route 11 runs and 66 EmX runs were obtained, achieving the target of at least 20 runs in each of the three defined time periods (AM Peak, PM Peak, and Off-Peak) before and after EmX implementation.

B.2 Travel Time Component Analysis

B.2.1 Total Travel Time

Figure B.2.1 below compares the mean travel time (in seconds) of the Route 11 service with the mean travel time on the EmX. The figure also shows how the different travel time components contribute to total travel time in each case.

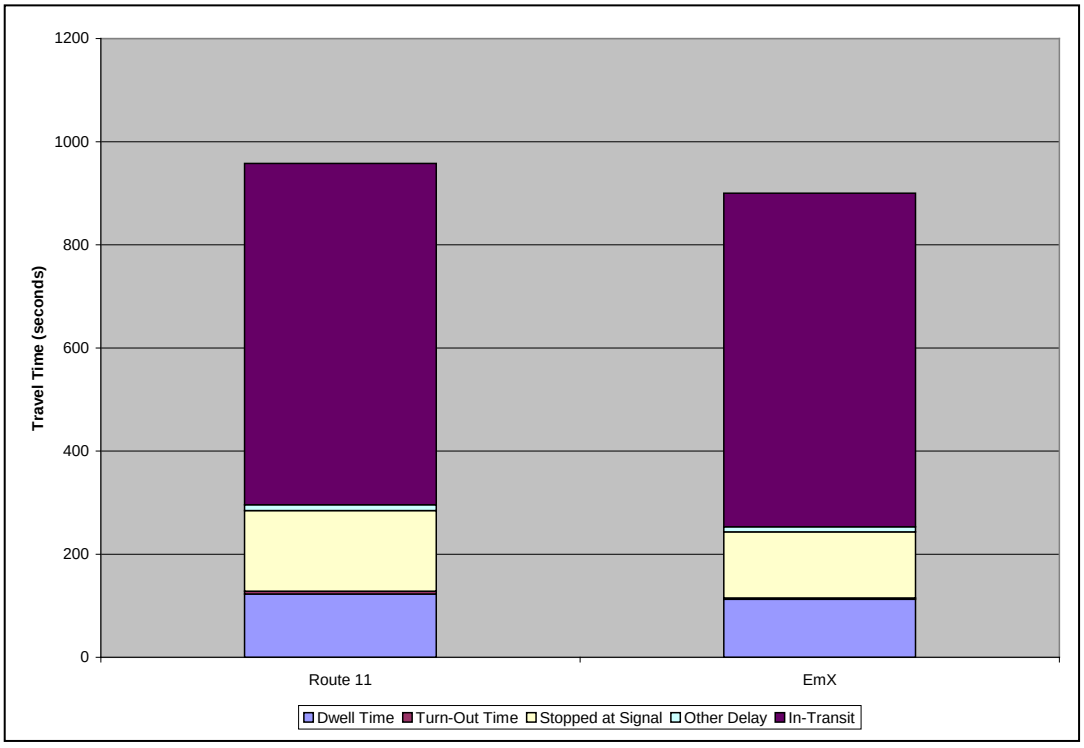


FIGURE 2.1 – Route 11 vs. EmX – Aggregate Travel Time Comparison

Tables B.2.1 and B.2.2 provide the mean for each component of travel time, along with the results of an independent sample t-test, used to determine whether any differences observed between the Route 11 and the EmX were statistically significant.

TABLE B.2.1 - Route 11 vs. EmX – Aggregate Travel Time Comparison Statistical Analysis of Significance

Travel Time Components	Mean (seconds)			t-statistic	Sig. (2-tailed)
	Route 11	EmX	Diff.		
Dwell Time	122.7	112.7	10.0	1.328	0.187
Turn-Out Time	5.5	2.3	3.2	1.94	0.056
Signal Delay	**156.3**	**128.8**	**27.5**	**2.811**	**0.006****
Other Delays	11.6	9.9	1.7	0.417	0.678
In-Transit	665.9	647.7	18.2	1.636	0.105
Total Travel Time	**962.0**	**901.4**	**60.5**	**3.429**	**0.001****

* Significant at the 95% confidence level
** Significant at the 99% confidence level

Table B.2.1 shows that the mean total travel time on Route 11 was 962 seconds (16 mins, 2 seconds). The implementation of EmX reduced mean total travel time on the route by an overall average of just over one minute (60.5 seconds) to 15 minutes, 1 second. This was found to be statistically significant at the 99% confidence level. Most of the overall time savings originated from reduction in signal delays (reduced by an average of 27.5 seconds), which was also found to be statistically significant at the 99 percent confidence level. Smaller travel time savings were observed in dwell time (10 seconds) and in-transit time (18 seconds), but these changes were not found to be statistically significant.

B.2.2 Travel Time by Direction

Figure 2.2 and Tables 2.2 and 2.3 compare the mean travel time (in seconds) of the Route 11 and EmX services in each service direction (Eugene bound and Springfield bound). As before, the figure shows how the different travel time components contribute to total travel time in each case.

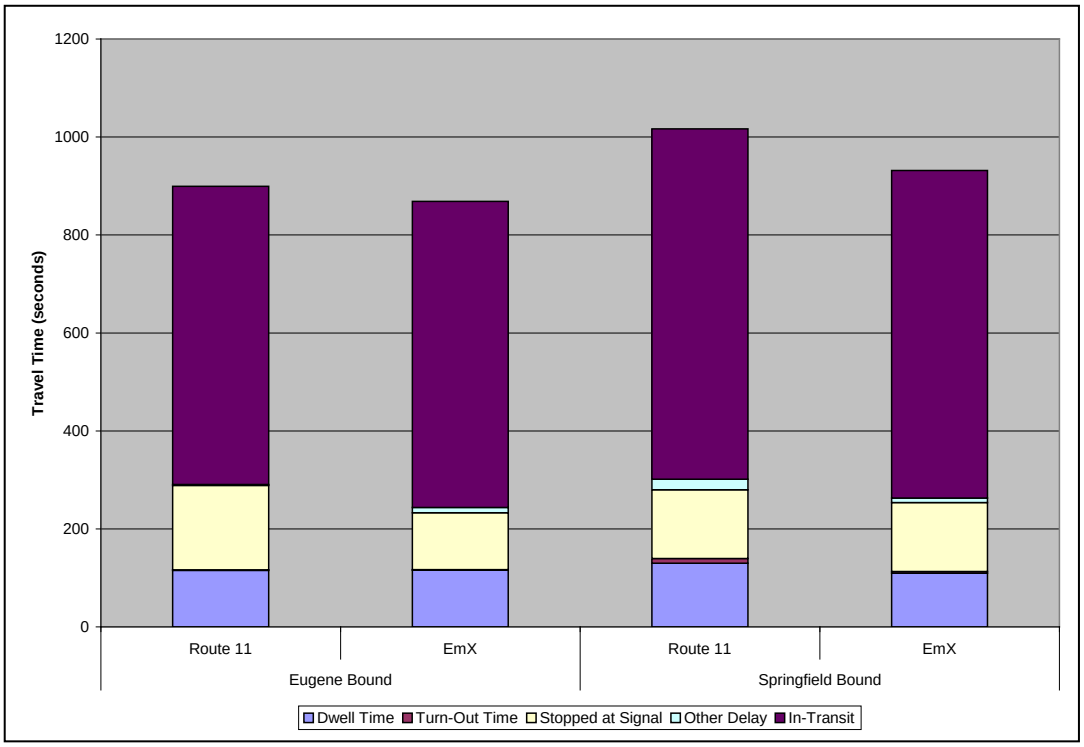


FIGURE B.2.2 – Route 11 vs. EmX – Directional Travel Time Comparison

TABLE B.2.2 - Route 11 vs. EmX – Travel Time Comparison
Directional Comparison – Eugene Bound

Travel Time Components	Mean			t-statistic	Sig. (2-tailed)
	Route 11	EmX	Diff.		
Dwell Time	115.3	115.7	-0.4	-0.035	0.972
Turn-Out Time	1.3	1.2	0.1	0.112	0.911
Signal Delay	**172.3**	**116.3**	**56.0**	**3.884**	**0.000****
Other Delays	1.9	10.5	-8.6	-1.826	0.076
In-Transit	610.2	625.0	-14.8	-1.223	0.226
Total Travel Time	901.1	868.7	32.4	1.54	0.129

* Significant at the 95% confidence level
** Significant at the 99% confidence level

TABLE B.2.3 - Route 11 vs. EmX – Travel Time Comparison
Directional Comparison – Springfield Bound

Travel Time Components	Mean			t-statistic	Sig. (2-tailed)
	Route 11	EmX	Diff.		
Dwell Time	130.0	109.6	20.4	1.910	0.062
Turn-Out Time	**9.7**	**3.5**	**6.2**	**2.120**	**0.040***
Signal Delay	140.3	141.3	-1.0	-0.081	0.936
Other Delays	21.2	9.3	11.9	1.981	0.052
In-Transit	**721.6**	**670.5**	**51.1**	**4.803**	**0.000****
Total Travel Time	**1022.9**	**934.2**	**88.7**	**3.996**	**0.000****

* Significant at the 95% confidence level
** Significant at the 99% confidence level

The information provided above shows that the mean travel times from Springfield to Eugene were lower than in the opposite direction, both before and after EmX implementation (almost two minutes quicker Eugene bound on Route 11 and just over one minute quicker Eugene bound on EmX). Around 90 percent of this difference originated in the in-transit component of total travel time. LTD attributes this time difference to better signal progression and the ease of departure from Springfield Station.

Comparing the Route 11 with the new EmX service, travel time savings in the Eugene bound direction came almost entirely from the reduction in signal delays (mean saving of 56 seconds), which were significant at the 99 percent confidence level. Despite the 56 seconds saved in reduced signal delay, the overall travel time saving was only 32 seconds. From Table 2.2 it can be seen that this was because time spent in transit and other delays were actually greater after EmX implementation. In the opposite direction (Springfield bound), the statistically significant difference in travel time, a total of 89 seconds, came primarily from reductions in time spent in-transit (51 seconds), with some time savings also observed in dwell time (20 seconds), other delays (12 seconds) and turn-out time (6 seconds).

B.2.3 Travel Time by Direction

Figure B.2.3 and Tables B.2.4 to B.2.6 compare the travel time on Route 11 and EmX for each of three defined time periods; AM Peak, Off Peak, and PM Peak. The three periods were defined as 7:00am to 9:00am, 10:45am to 1:45pm, and 3:30pm to 6:30pm.

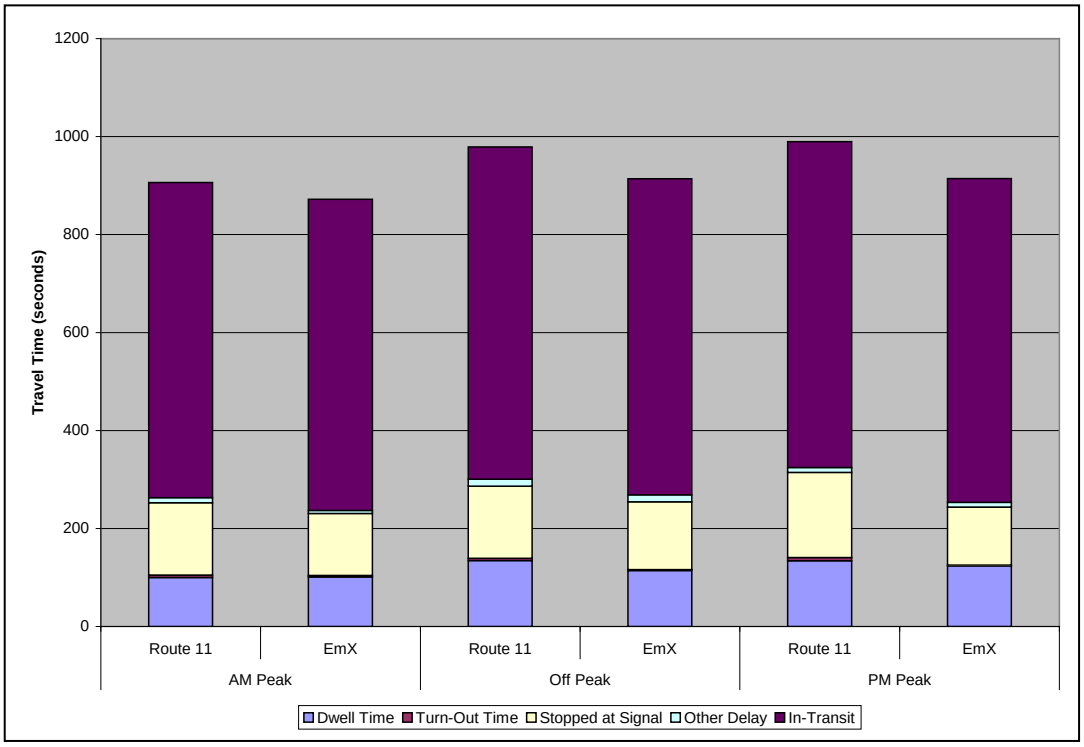


FIGURE B.2.3 – Route 11 vs. EmX – Temporal Travel Time Comparison

TABLE B.2.4 - Route 11 vs. EmX – Travel Time Comparison
Temporal Comparison – AM Peak

Travel Time Components	Mean			t-statistic	Sig. (2-tailed)
	Route 11	EmX	Diff.		
Dwell Time	100.1	101.0	-0.9	-0.080	0.937
Turn-Out Time	4.9	3.4	1.5	0.647	0.521
Signal Delay	147.5	126.4	21.1	1.301	0.200
Other Delays	10.5	6.0	4.4	0.995	0.326
In-Transit	649.9	638.2	11.7	0.679	0.501
Total Travel Time	912.8	875.0	37.9	1.390	0.172

TABLE B.2.5 - Route 11 vs. EmX – Travel Time Comparison
Temporal Comparison – Off Peak

Travel Time Components	Mean			t-statistic	Sig. (2-tailed)
	Route 11	EmX	Diff.		
Dwell Time	134.4	114.1	20.3	1.796	0.080
Turn-Out Time	4.9	2.1	2.7	1.076	0.288
Signal Delay	147.3	139.5	7.8	0.463	0.647
Other Delays	14.3	14.0	0.3	0.032	0.974
In-Transit	683.6	645.2	38.4	1.871	0.072
Total Travel Time	**984.5**	**914.8**	**69.6**	**2.534**	**0.015***

* Significant at the 95% confidence level
** Significant at the 99% confidence level

TABLE B.2.6 - Route 11 vs. EmX – Travel Time Comparison
Temporal Comparison – PM Peak

Travel Time Components	Mean			t-statistic	Sig. (2-tailed)
	Route 11	EmX	Diff.		
Dwell Time	134.1	123.8	10.3	0.686	0.498
Turn-Out Time	6.7	1.4	5.3	1.553	0.135
Signal Delay	**173.7**	**118.8**	**55.0**	**3.245**	**0.002****
Other Delays	10.1	9.3	0.8	0.135	0.893
In-Transit	665.1	661.3	3.8	0.19	0.851
Total Travel Time	**989.7**	**914.5**	**75.2**	**2.232**	**0.031***

* Significant at the 95% confidence level
** Significant at the 99% confidence level

Figure B.2.3 shows that the mean off-peak travel time is greater than the AM Peak travel time, both before and after EmX implementation. Peak travel times would normally be expected to be larger than off-peak times. However, inspection of the service schedules showed that off-peak scheduled running times are generally higher than AM Peak running times in the Springfield-bound direction (see Figure B.3.3).

Comparing Route 11 with the EmX in the AM Peak, it can be seen that no statistically significant impacts on travel time were observed, with an overall mean travel time saving

of just 38 seconds. In the off-peak period, the overall time saving of 70 seconds was found to be statistically significant, even though no statistically significant impacts were observed in relation to the individual components of total travel time. In the PM Peak, an overall time saving of 75 seconds was found to be statistically significant, originating mainly from reductions in signal delay (55 seconds).

B.3. Reliability/Schedule Adherence

B.3.1 Overall Impact of EmX on Reliability

Assessment of the impacts of the new EmX service on reliability were initiated with a scatter plot analysis of total travel times before and after EmX implementation. This is shown in Figure B.3.1 below.

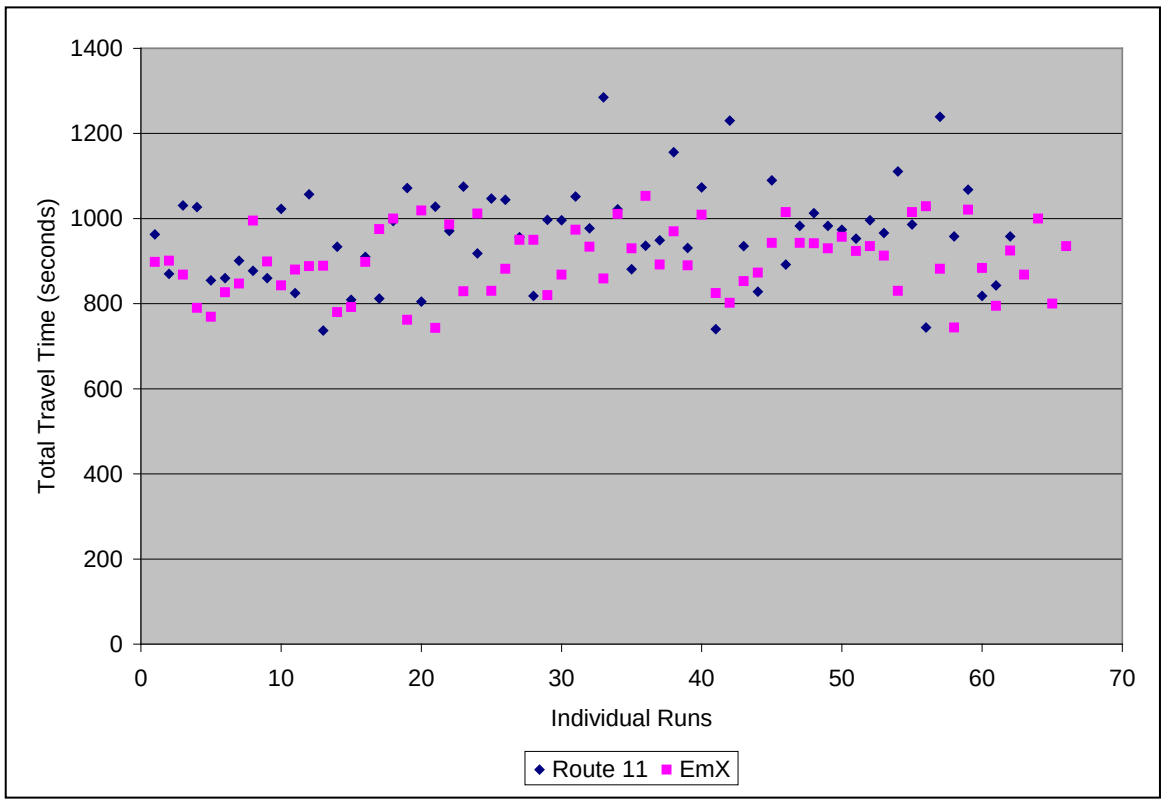


FIGURE B.3.1 – Route 11 vs EmX - Travel Time Dispersion

The figure clearly shows that the EmX has not only lowered the mean travel time, but has reduced the level of travel time dispersion, so that the majority of EmX runs were between 800 and 1000 seconds long. This effect can be quantified by measuring the standard deviation from the mean for each sample; for Route 11 this was measured as 115.9 for Route 11 compared to 79.1 for the EmX.

B.3.2 Schedule Adherence

Figures B.3.2 to B.3.5 compare the scheduled travel times versus actual travel times on the Route 11 and EmX services.

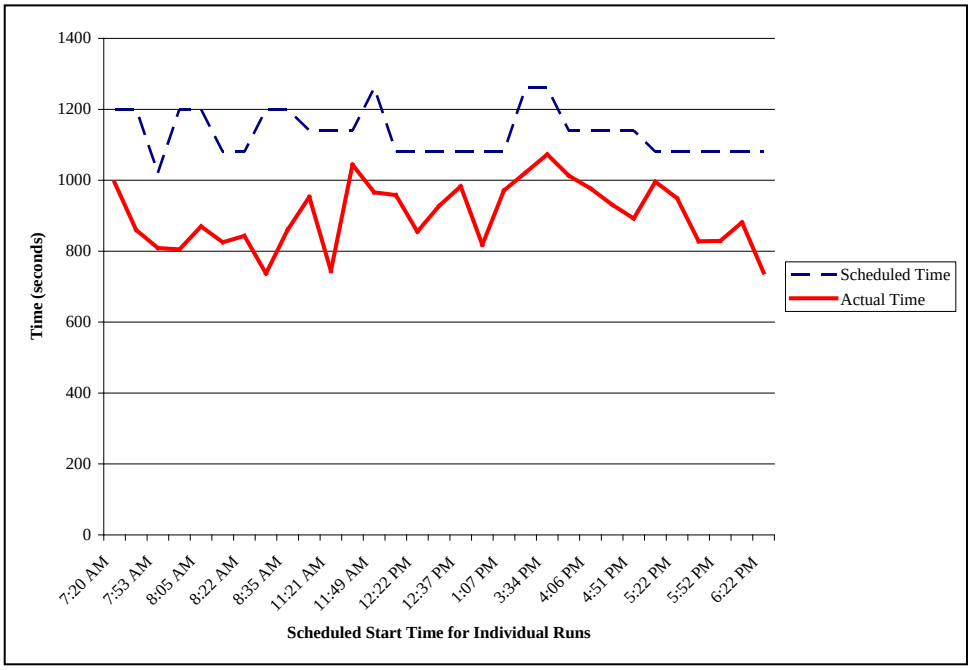


FIGURE B.3.2 – Route 11 Schedule Adherence – Eugene Bound

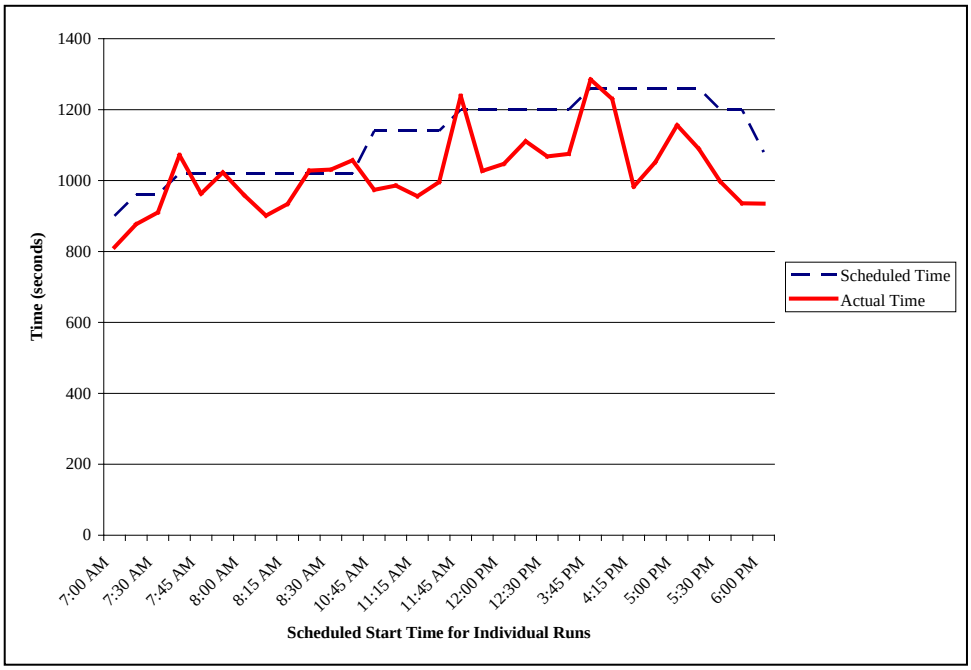


FIGURE B.3.3 – Route 11 Schedule Adherence – Springfield Bound

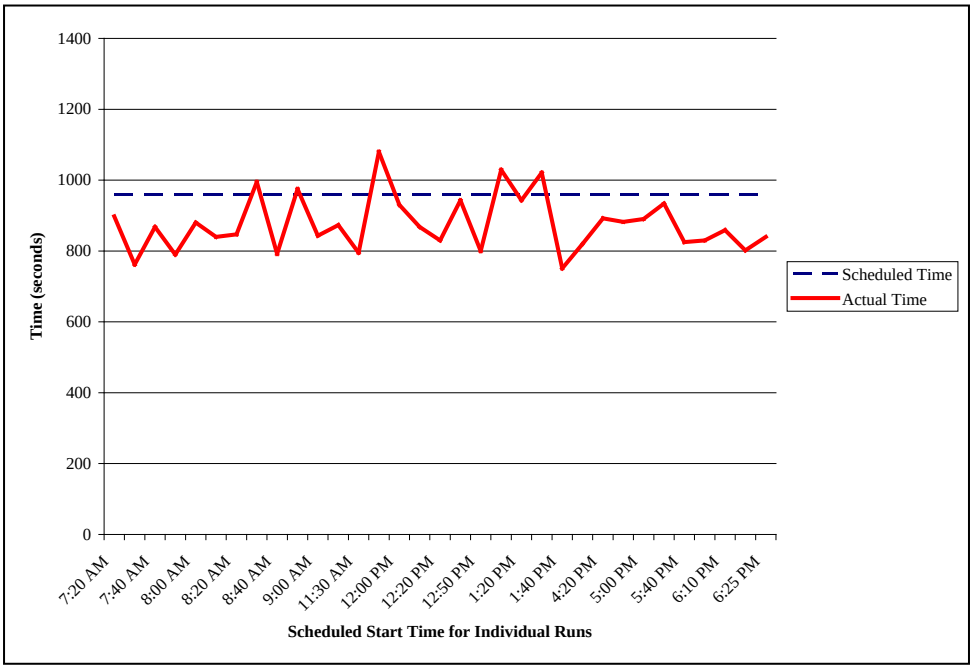


FIGURE B.3.4 – EmX Schedule Adherence – Eugene Bound

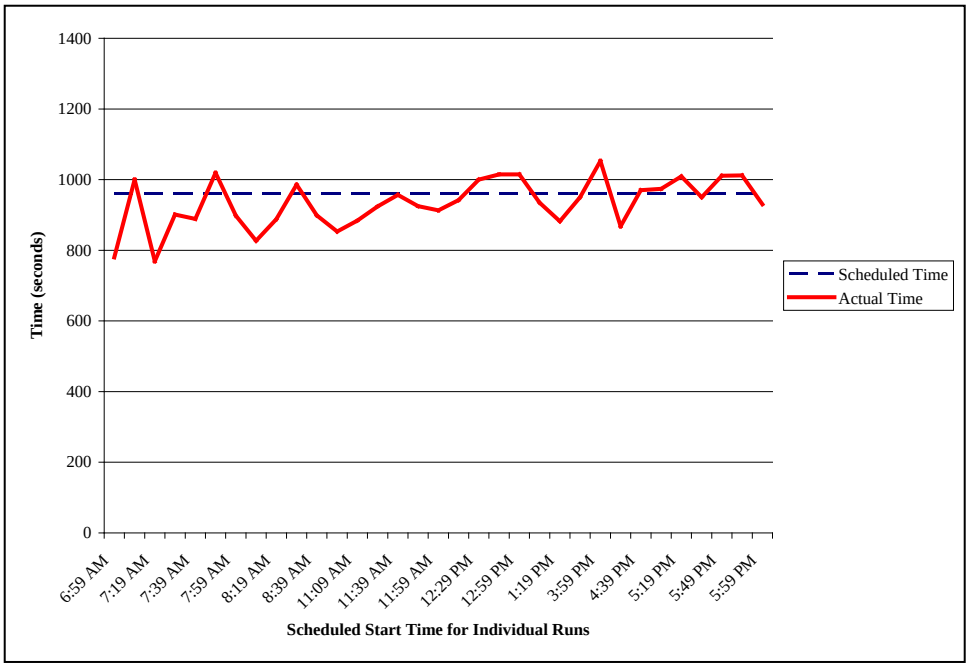


FIGURE B.3.5 – EmX Schedule Adherence – Springfield Bound

It is apparent that the Eugene bound Route 11 trips were always completed ahead of schedule. This suggests that there was considerable "slack" built into the Eugene bound Route 11 schedule. Trips in the opposite direction adhered much more closely to the schedule, and a small number of trips were observed to be behind schedule.

The EmX schedule is clearly more consistent, with trips throughout the day scheduled to be 960 seconds (16 minutes) long in both directions. As with the Route 11 service, Eugene bound trips on the EmX tended to arrive ahead of schedule, while Springfield bound trips adhered more closely to the scheduled arrival time at Springfield station.

Table B.3.1 summarizes the average differences between scheduled and actual travel times on the Route 11 and EmX service, quantifying some of the effects observed in Figures B.3.2 to B.3.5. Average travel times on Route 11 were significantly below actual travel times; almost 4 minutes below for Eugene bound routes and over 1.5 minutes below for Springfield routes. The introduction of the EmX has clearly brought the actual times much closer to the scheduled times; in the Eugene bound direction, actual arrival time is around 1.5 minutes lower, on average, than the schedule time, and only 26 seconds less than the scheduled time, on average, in the Springfield bound direction. It should also be noted that the standard deviation of the mean difference has been reduced in each direction by the introduction of the EmX, which reinforces the fact that the EmX service is more reliable.

TABLE B.3.1 – Difference between Scheduled and Actual Travel Times

	Mean difference between Scheduled and Actual Travel Time (seconds)		**Standard Deviation of Mean difference between Scheduled and Actual Travel Time (seconds)**	
	Route 11	**EmX**	**Route 11**	**EmX**
Eugene Bound	-231.2	-91.3	96.9	75.3
Springfield Bound	-99.7	-25.8	88.8	69.5
Both directions	-165.5	-58.6	113.6	79.1

A final point to note is that a simple comparison of the Route 11 schedule with the EmX schedule would suggest that EmX introduction has resulted in an average time saving of almost 3 minutes. However, the actual time saving is much lower, due to the significant amount of "slack" in the Route 11 schedule – scheduled run times varied from 17 to 21 minutes. In reality, the average actual run time was 16 minutes, and EmX implementation resulted in an average time saving of just one minute (for both directions combined). A larger amount of "slack" could be expected to be built into the Route 11 schedule due to the greater level of travel time variation associated with this service.

B.3.3 On-time Performance

Tables B.3.2 to B.3.5 provide a summary of on-time performance for each direction of the Route 11 and EmX services, expressed as the percentage of runs early, on-time (within one minute of the scheduled time), and late, for each time-point.

TABLE B.3.2 – Route 11 - On-time Performance Assessment – Eugene Bound

	Springfield Station	Agate	-	Eugene Station
> 1 min early	0%	0%		81%
on time	84%	76%		16%
1 to 3 mins late	13%	16%		0%
3 to 5 mins late	0%	4%		0%
> 5 mins late	3%	4%		3%
Observations	31	25		31

TABLE B.3.3 – Route 11 - On-time Performance Assessment – Springfield Bound

	Eugene Station	Kincaid	Agate	Springfield Station
> 1 min early	0%	0%	0%	68%
on time	97%	93%	32%	29%
1 to 3 mins late	3%	4%	53%	3%
3 to 5 mins late	0%	4%	11%	0%
> 5 mins late	0%	0%	5%	0%
Observations	31	28	19	31

TABLE B.3.4 – EmX - On-time Performance Assessment – Eugene Bound

	Springfield Station	Walnut	Dads Gate	Eugene Station
> 1 min early	0%	0%	3%	52%
on time	100%	79%	91%	48%
1 to 3 mins late	0%	18%	6%	0%
3 to 5 mins late	0%	3%	0%	0%
> 5 mins late	0%	0%	0%	0%
No. of Observations	33	33	33	33

TABLE B.3.5 – EmX - On-time Performance Assessment – Springfield Bound

	Eugene Station	Dads Gate	Walnut	Springfield Station
> 1 min early	0%	6%	0%	21%
on time	97%	91%	76%	76%
1 to 3 mins late	3%	3%	21%	3%
3 to 5 mins late	0%	0%	3%	0%
> 5 mins late	0%	0%	0%	0%
No. of Observations	33	32	33	33

While previous analyses have shown the schedule adherence for the total trip, these tables measure schedule adherence over the length of the route. It can be seen that the vast majority of Route 11 and EmX services left on time, and arrived either on time or early (most Route 11 services arrived more than one minute early). However, more than half the Springfield bound Route 11 services fell behind schedule at Agate, but generally made up the time by the end of the route. The EmX services were much more reliable, typically on time or early, with no observed runs more than 5 minutes late.

Overall, 97% of Route 11 services arrived at their end-point on time or ahead of schedule, with the corresponding EmX service figures of 100 percent in the Eugene-bound direction and 97 percent in the Springfield bound direction. However, as previously noted, the high level of schedule adherence on the Route 11 service is largely due to the large amount of "slack" that were built into these schedules.

B.3.4 Travel Time Ratios

This ratio compares the travel time during unconstrained travel conditions (typically of-oeak) with travel time during peak periods, in order to assess the impact of peak hour travel conditions on end-to-end travel times. This is particularly important when the BRT service runs in general purpose lanes (CBRT, 2004). Only the PM Peak has been used to calculate constrained travel conditions, because the mean AM Peak travel time was actually lower than the mean Off-Peak travel time (see Tables B.2.4 to B.2.6). The following table provides the ratios for the Route 11 and EmX services in each travel direction.

TABLE B.3.6 – Travel Time Ratios

Mean End-to-End Travel Time	Route 11	EmX
Unconstrained (Off-Peak)	984.5	914.8
Constrained (PM Peak)	989.7	914.5
Ratio	1.005	0.999

The table shows that the ratio for both Route 11 and EmX is close to 1.0, illustrating the fact that travel conditions in Eugene are very similar between peak and off-periods.

B.3.5 Commercial Speeds

Route lengths were obtained in each direction for the Route 11 and EmX services, allowing commercial speeds to be calculated, as shown in Table B.3.7 below.

TABLE B.3.7 – Commercial Speeds

	Route 11		EmX	
	Eugene Bound	Springfield Bound	Eugene Bound	Springfield Bound
Mean End-to-End Travel Time (seconds)	901.1	1022.9	868.7	934.2
Distance (miles)	3.7	3.85	3.7	3.7
Commercial Speed (mph)	14.8	13.5	15.3	14.3

Table B.3.7 shows that commercial speeds have been increased slightly in each direction, by 0.5mph in the westbound direction and 0.8mph in the eastbound direction.

B.4. Conclusions

Introduction of the EmX service has resulted in reduced travel times and improved levels of service reliability. The new service has reduced average travel times by one minute from 16 minutes on the old Route 11 service to 15 minutes on the EmX. This reduction has come from a number of different sources including reductions in the time spent in-transit, and reductions in dwell time. However, the primary source of this overall reduction was found to be reductions in signal delay, which were found to be significant at the 99 percent confidence level.

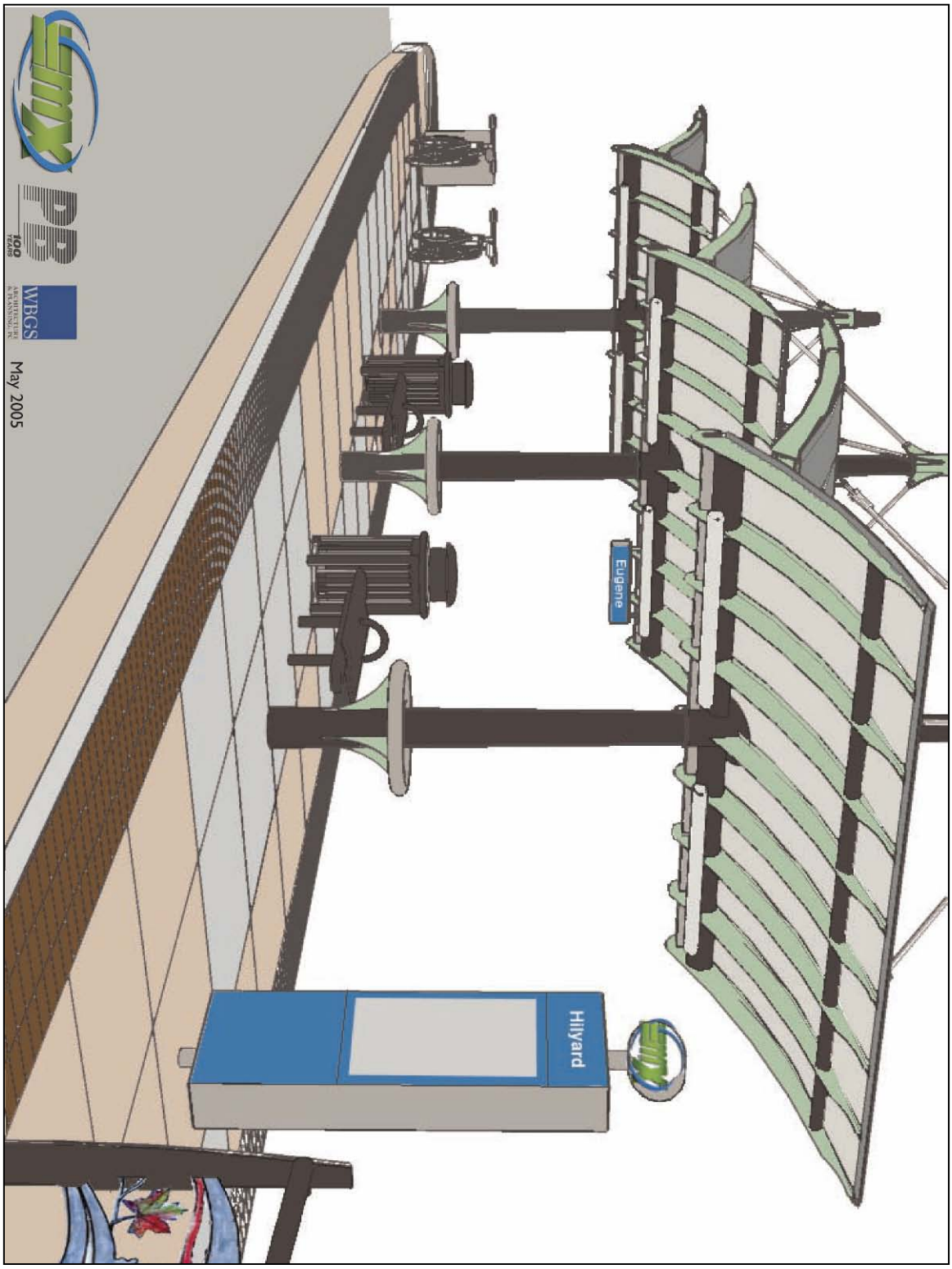
EmX implementation has had a greater impact in the Springfield-bound direction, reducing mean travel times by almost 1.5 minutes, compared to only 32 seconds on the opposite direction. This overall reduction came primarily from reductions in dwell time and time spent in transit.

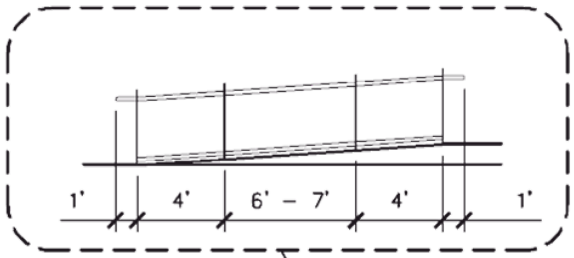
A temporal travel time comparison found that mean travel times on the Route 11 and EmX service during the off-peak period of the day (around noon) were only slightly lower than those experienced during the PM Peak and actually higher than those experienced during the AM Peak. This finding was also reflected in the Route 11 schedules, and relate to the fact that temporal fluctuations in travel demand in the Eugene-Springfield area have relatively little impact on transit services.

The new EmX service has had a major impact on service reliability, increasing the level of schedule adherence and on-time performance, although these impacts were masked to some degree by Route 11 schedules that consistently overestimated travel times on the route. Thus, it should be noted that while schedule inspection alone would suggest travel

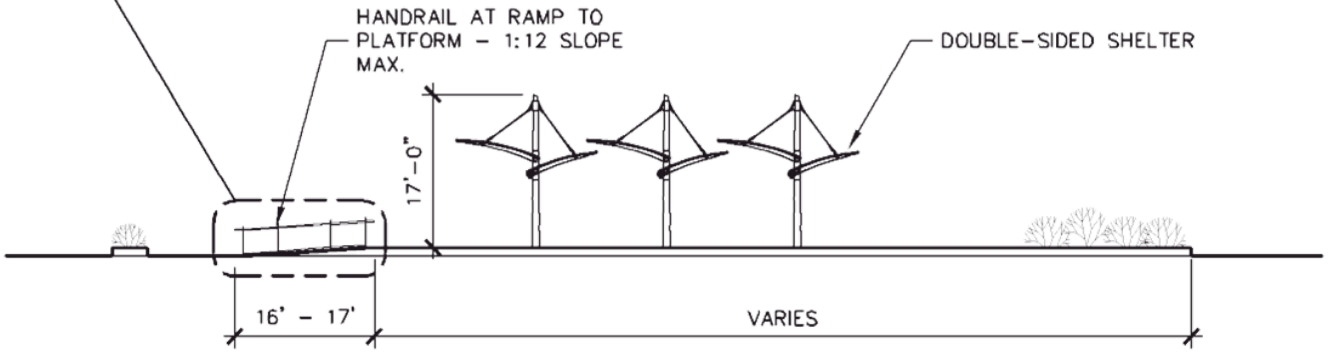
time savings of one to five minutes in comparison to the Route 11 service, actual mean travel time savings are more of the order of one to 1.5 minutes, depending on service direction and time period.

APPENDIX C – Station Design Schematics





ELEVATION @ TYPICAL RAMP HANDRAIL



ELEVATION @ TYPICAL DOUBLE-SIDED STATION

4 OF 8 STATIONS