Frontier - A Bus Rapid Transit system in Frisco, TX

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FRONTIER
A Bus Rapid Transit for Frisco, TX
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Executive Summary

This study explores the increasing inaccessibility produced by reliance and catered infrastructure to mass ownership of personal vehicles. Accessing employment, service, and activity destinations has become extremely difficult for those who cannot possess, afford, or operate personal vehicles; even cyclists have a more difficult time navigating roads due to limited infrastructure and accommodations. Public transit has often become an afterthought within cities, with local routes competing with other cars on the road and adding to overall traffic volume. Bus-Rapid Transit (BRT) systems are an expanding concept within car-centric regions, often being called the "subways, but on wheels", that not only change the hierarchy of traffic were implemented but make bus-form transportation more efficient and accessible.

The North Texas city of Frisco was chosen for two reasons; the city has an increasing presence in the region due to the multitude of diverse businesses and people wishing to call the municipality home, and there is an absence of a centralized public transit system. According to the Department of Transportation, economically thriving communities are often the ones with good public transit systems.

Finally, this study proposes a BRT route within Frisco called "Frontier" (page 23). The purpose of this system is to improve interconnectivity and accessibility of Frisco's residents, giving them an option for an alternative, affordable, and efficient mode of transportation.
Project Site
The city of Frisco is on the rise in North Texas, as observed by the population boom the city has experienced. The population has grown steadily to over 200,000 residents since the 90s, surpassing neighboring McKinney and potentially Plano. In addition to a growing population, the city is self-described as a “first choice for established corporations and start-ups looking to accelerate the growth of their business, relocate to a dynamic city or start a new enterprise with all the necessary assets for success” and is home to organizations and destinations, including Headquarters of PGA, Headquarters and training facility of the Dallas Cowboys, professional Soccer Club FC Dallas, multiple local and national museums; and soon a Universal Resort and University of North Texas campus. While this city seems like the most optimal destination for business and pleasure alike, the one aspect that Frisco seems to lack is a functioning mass transit system.

The following pages display maps of Frisco. Figure 1 (page 11) is an employment map of the city showing the location of major employment centers.
Demographics

- Most workers are found in southern portion of the city limit, concentrated mostly in service commercial areas, or towards the city center where there is a mix of administrative and service jobs.

- Most residents (18.6%) work within Frisco, while the others work in neighboring Dallas (8.6%), Plano (8.2%), and McKinney (7.8%), respectively.

- Frisco experiences a daily influx of 58,269 workers and an outflow of 83,512 workers; 12,472 Frisco residents work within the city.

- Most residents, regardless of profession, live within suburban neighborhoods in tract housing.

- Most workers travel either 10 miles or less (46%) or 10-24 miles (30.2%), respectively.
  - Their work destination is primarily at the southern municipal border between Frisco and Plano, as well as towards the city center.
Standards
Current

According to the city’s website, Frisco does have a transit system; however, the current system is a 'dial-a-ride" that can only be accessed by residents aged 65 and older, operating during the hours of 6 am to 6 pm. Frisco's current public transit system is unfavorable, especially when compared to neighboring Dallas Area Rapid Transit (DART). The current system is exclusive and inaccessible, defeating the primary function of public transit, resembling a service similar to a ride-share or taxi service.

Figure 2 City of Frisco public transit section.

Public Transit

The City of Frisco provides curb-to-curb demand response transit service within the City of Frisco and designated portions of Plano through the Denton County Transportation Authority (DCTA). Frisco residents must apply for service and be eligible based on the 'passenger qualifications' listed below:

Passenger Qualifications for all Frisco Services:
- Frisco residents who are 65 years of age and older
- Frisco residents who are disabled
- Frisco residents, who are younger than 65 years of age or not disabled, but require transportation for medical care-related purposes
- To apply for the Frisco Demand Response service, please complete and submit the Frisco Response Application here.
- Read Frisco's Demand Response Service Guidelines.

Hours of Operation for all Frisco Services:
- Monday through Friday
- 6 a.m. to 6 p.m.
- Service will not operate on the following holidays: New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day and Christmas Day

Fares:
- One-way local trip: $3 (traveling within Frisco)
- One-way regional trip: $5 (traveling outside Frisco)
- Payment for fare is cash only.
- Fare is collected by shuttle/taxi driver.
- Tipping is not required.

Scheduling Trips:
- Requests must be made at least 24 hours in advance.
- Applications may be submitted by email, fax, in person or by mail.
  - Email: applications@dcta.net
  - FAX: 940-387-1461
  - In person: Monday through Friday from 8 a.m. to 5 p.m.
  - Mail to: DCTA, 604 E. Hickory Street, Denton, TX 76205
In terms of addressing the limited transportation options, Frisco's Planning Department has adopted its 2015 Comprehensive Plan; which will maximize current use and interconnect streets, encourage the use of alternative transportation methods, and create aesthetically pleasing transportation facilities (City of Frisco 2015 Comprehensive Plan). In addition to this, there are plans to expand the DART system to destinations throughout the Dallas area by 2045.

In the author's opinion, though these plans to make transportation alternatives more accessible, both Frisco and DART's plans fall short of having an effective and lasting impact that would make residents and visitors consider different options. In the case of DART, the 2045 expansion only stretches as far as the western edge of Plano via express bus line. As far as Frisco’s plan, specifically Chapter 9: Transportation Mobility, the plan addresses the inconvenience of the current transit system and the region’s reliance on personal vehicles; However, the plan only calls for a light rail line with five stops as shown in Figure 3. Unfortunately, this proposed rail line does not appear to serve the major points of employment that are shown in Figure 1.

Figure 3 City of Frisco 2015 Comprehensive Plan Transit Circulator Map.
Bus Rapid Transit (BRT)
Bus Rapid Transit (BRT) is an innovative, cost-effective, and fast-paced public transit system that provides quality service through a bus based system.\(^1\) Such systems have been referred to as a "subway, but on wheels" and have been implemented in large metropolitan areas but are emerging in mid-sized metropolitan areas as well. BRT is more effective in transporting passengers when compared to standard bussing systems due to the utilization of signature technologies and infrastructure, including dedicated rights-of-ways, limited stops, level-boarding, and fuel-efficient vehicles.

\(^1\) *Bus Rapid Transit.* (2015, December). Federal Transit Administration.
Benefits of BRT

Reducing wait times and danger.

The introduction of BRT changes the on-road environment since it changes the hierarchy of traffic. BRT differs from other local bus lines due to it taking priority on the road, resulting in shorter wait and travel times for riders. Rather than making frequent stops and competing with other vehicles, BRT offers higher frequency through fewer stops, dedicated lanes, and signal priority. This makes navigating traffic swifter and easier. In addition to saving time, BRT has the potential to make roads safer. While dedicated lanes save riders time, it also minimizes interaction between buses and other cars on the road, decreasing competition. Furthermore, a single BRT vehicle reduces 60 to 90 cars on the road: lowering the overall volume of traffic and decreasing the potential for accidents (World Resource Institute).

Reducing GHG and other local air pollutants.

Expanding upon the idea that shifting drivers to high-capacity rapid buses greatly decreases the number of cars on the road; such an action also reduces the total amount of air pollutants created by vehicle emissions. In addition to contributing to the overall effects of climate change, over exposure to emissions have long-lasting effects on peoples' health. Motor vehicles are the leading source of ground level smog, especially those that are used for freight/consume diesel. Breathing particulate matter subscribes people to reduced lung capacity, vulnerability to respiratory illnesses, and, in severe cases, heart attacks and lung cancer. Reliance on personal vehicles may be convenient for carrying out daily tasks, but it has come at the cost of one's overall health (US DoT). Though BRTs aren't the absolute solution in reducing vehicle emissions, it is one of many steps that should be taken in the reduction of use of personal vehicles. Moreover, BRT utilizes vehicles that exercise the use of technologies that consume lower to no amounts of fuel, reducing traffic and emissions simultaneously.

Making alternative transit more appealing.

Opposed to local bus systems, BRT makes the travel experience more appealing and convenient; this is done through methods that make trip taking more efficient. When boarding a bus, the common experience is paying a fare whilst entering. BRT stations practice pre-paid boarding, such as a subway or train, streamlining the process. Stations also have live information regarding arrivals and near-level boarding. Near level on-boarding makes the process more accessible to people who are handicapable or have physical limitations, it also allows cyclists to board with their bike on-hand; rather than securing it at the front of the vehicle. Overall, BRT makes traveling to destinations more convenient and accessible, especially for those who cannot operate or possess a personal vehicle.
Ridership Data

To display the use of public transportation systems, DART was selected since it is the nearest mass transit system to Frisco and reflects regional attitudes towards alternative transit usage. The network of rail and bus service transports over 200,000 passengers across 700-square miles per day. The following is 2021 DART ridership data:

Primary Purpose

*Figure 4 DART survey data for primary purpose of trip use.*

<table>
<thead>
<tr>
<th>Overall Percentage</th>
<th>Key Demographics by Service Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) To and From Work</td>
<td>65.76%</td>
</tr>
<tr>
<td>(2) School or College</td>
<td>5.74%</td>
</tr>
<tr>
<td>(3) Medical</td>
<td>7.13%</td>
</tr>
<tr>
<td>(4) Other</td>
<td>20.51%</td>
</tr>
<tr>
<td>(99) Response Not Given</td>
<td>0.86%</td>
</tr>
</tbody>
</table>

When it comes to the purpose of using DART, the data reflects that a majority of riders rely upon provided routes to reach destinations of employment. Other than employment, school and medical are the next specifics uses. This proves that the routes are a crucial aspect in the lives of many riders.
When it comes to usage, trip frequency data reflects that DART is relied upon by most of its riders as a main source of transportation to destinations for the majority of the week, especially the workweek.

### Car-owners

When it comes to usage, trip frequency data reflects that DART is relied upon by most of its riders as a main source of transportation to destinations for the majority of the week, especially the workweek.
This segment of data helps illustrate the destination of riders, with the bulk being local across most routes. In addition to destinations, fare-type also indicates where the economic benefits of public transit originate from.

**Ridership age**

With a clear majority of the rider population being 25 and older, this displays that DART is primarily used for employment and service trips, as reflected in trip frequency and primary purpose data. Though the margin appears minimal, the population of riders 24 and younger exhibits that DART is also used for schooling and leisure purposes.
Case Studies

Montgomery County, AL

Flash is a planned branded, limited-stop bus service that connects 5 corridors within Montgomery County. In addition to connecting riders to activity and employment centers, pedestrian and cycling infrastructure will be improved for riders to reach stations safer and easier. These stations will feature real-time information, near-level boarding, and off-board fare collection. To prioritize travel times and efficiency, Flash buses transit-signal priorities and queue jumps; in addition to strategically placed dedicated lanes.

Figure 9 Flash fast facts.

**FAST FACTS**

**RELIABLE** Frequent service, dedicated lanes, and green light priority signaling keep Flash vehicles moving.

**EFFICIENT** One Flash vehicle can take up to 90 cars off the road, making our transportation network more efficient and your commute easier.

**CLEAN** Flash reduces harmful greenhouse gas emissions, making our air cleaner.
City Line is the planned BRT for the city of Spokane, WA that is set to begin service July 2023. The bus system is designed to be a frequent and efficient form of transportation that benefits local communities and businesses within downtown Spokane. Through its 6-mile route, City Line improves connectivity and accessibility by connecting to students at local colleges and universities, as well as intersecting with local transit routes.

City Line Spokane Transit route map.

City Line is expected to have frequent service schedule with seven days a week, with arrivals occurring every 15-minutes. The all-electric fleet will have 60-foot buses with distinct branding. Stations will have near-level boarding, as well as real-time signage and off-board ticketing. These stations will be designed by local entities for each one to reflect the characteristics of the communities they are situated in.
This section presents a proposed BRT line for the city of Frisco, the Frisco Frontier. This transit line would accomplish two priorities: introducing a centralized, mass transit system to the north Texas city and increasing accessibility to destinations of employment and activity to those who primarily cannot operate or afford a personal vehicle. The name "Frontier" was inspired by Frisco's ever-expanding presence in the North Texas region.

Frisco Frontier would provide direct access to destinations of interest, especially since the route would be primarily based upon the destinations of employment. Besides being places of employment, these destinations are also places of amusement and leisure, providing direct access to businesses, and therefore direct support to the local economy.

Figure 11 Frisco Frontier logo.

Figure 12 Visual inspiration for Frisco Frontier vehicles.
Phase I of the BRT will start towards the southern end of Frisco's city limit, adjacent to Plano. Since there is a high concentration of jobs in this area (Figure 1), it is important for the BRT to have a direct route. The route continues to follow where there are higher concentrations of employment. As the route continues past residential areas, stations will strategically be placed towards the outer bounds of these areas to increase access to local ridership. The route itself is concentrated along major thoroughfares and intersects the planned transit route.

Figure 13 Frisco Frontier route stops.
Phase II is separate from Phase I due to on-going and planned construction of multiple projects being completed within the city. These projects include a Universal Resort, a campus for the University of North Texas, and the construction of multiple residential areas. There will be 4 stops along this phase, with a majority being next to places of employment and interest, with the route ending at the headquarters of PGA. This route increases accessibility to points of interest, providing visitors and workers with an alternative transit option to decrease traffic.

Figure 15 Universal Project location.
Figure 16 Frisco Frontier route map.
The provided implementation method and cost standards are based upon the information provided by the US Department of Transportation.

Running Ways & Markings

Bus rapid transit vehicles travel on guideways and are considered a major defining factor of a BRT system due to it determining speed and reliability of service. Running ways are often the most significant cost item in the entire BRT system.

Designated (Reserved) Arterial Lanes: In corridors where the alignment of the BRT route follows an existing arterial roadway, designated lanes provide BRT vehicles with a fast and reliable alternative lane restricted from mixed flow traffic lanes. This is enforced through a physical barrier or police enforcement.

Cost: $2.5 - $2.9 million per plane mile (excluding ROW acquisition) (US DoT).

Signage and Striping: Signage is the most basic form of marking a lane as reserved for BRT service. It often includes the use of “diamond” lane symbols to restrict automobile service from the lane and are provided in each direction at each intersection.

Alternate Pavement Color/Texture: Implementing alternate pavement color through colored asphalt or concrete reduces conflicts with other vehicles and reinforces the notion that a particular lane.

Figure 17 BRT Running Ways & Markings.
At-Grade Transitways

*Standard Lane:* Some urban corridors have new or existing rights-of-way available for the construction of infrastructure for exclusive use of transit vehicles. Exclusive facilities offer significant potential for speed, reliability and safety improvements since they physically separate BRT vehicles from the general stream of traffic, eliminating the potential for general traffic to encroach on the BRT lanes. Because other traffic cannot interfere with BRT vehicles, service can be operated safely at much higher speeds between BRT stations. Exclusive lanes at-grade do, however, interact with other traffic at cross streets.

*Bi-Directional Lane:* In certain cases, right-of-way for exclusive lanes may only be wide enough to accommodate one single bi-directional lane. At low frequencies of service, single bi-directional exclusive lanes can provide many of the same benefits as two exclusive lanes. At higher frequencies, sophisticated signal systems and coordinated schedules may be required to ensure safe and unimpeded operation of BRT vehicles.

*Cost (not including ROW):* $6.5 – 10.2 million per plane mile (US DoT).

*Figure 18 BRT At-Grade Transitways.*
Passing Capability

The ability for BRT vehicles in service to pass one another at stations is important in two primary cases:

- In mixed flow operation, where frequency is high and travel times are highly variable.
- In cases where multiple types of routes (local and express) operate along the same running way and serve uneven levels of demand.

**Bus Pull-outs:** For both arterial BRT operation and exclusive lanes, bus pull-outs at stations allow buses serving a station to pull out of the BRT running way and, thus out of the way of BRT vehicles that need to pass vehicles stopped at the stations.

*Cost:* $0.05 million – 0.06 million per pull-out (per station platform) (US DoT).
**Station Types**

*Enhanced Stop:* Enhanced BRT stations include enhanced shelters, which are often specially designed for BRT to differentiate it from other transit stations and to provide additional features such as more weather protection and lighting. This BRT station type often incorporates additional design treatments such as walls made of glass or other transparent material, high quality material finishes, and passenger amenities such as benches, trash cans, or pay phones.

*Cost:* $25,000 to $35,000 per shelter. (Only includes cost of the shelter, does not include cost of platform or soft costs) (US DoT).

*Figure 20 Enhanced BRT stop.*

*Designated Station:* The designated BRT station may include level passenger boarding and alighting, a grade separated connection from one platform to another and a full range of passenger amenities including retail service and a complete array of passenger information.

*Cost:* $150,000 to $2.5 million per station (lower cost stations include cost of canopy, platform, station enclosure and pedestrian access; higher cost stations designed for higher ridership and include longer platforms and canopies, larger station structure, passenger amenities and roadway access; parking facility costs are not included nor are soft costs) (US DoT).

*Figure 21 Designated BRT station.*
Station Access

Transit systems require linkages to adjacent communities in order to draw passengers from their market area – either through pedestrian linkages to adjacent sites or connections through the roadway network to adjacent neighborhoods by automobile or non-motorized modes.

*Pedestrian Linkages:* Pedestrian linkages, such as sidewalks, overpasses and pedestrian paths are important to establish physical connections from BRT stations to adjacent sites, buildings, and activity centers.

*Cost: Typically included in the base cost for Designated Stations and Intermodal Terminals or Transit Centers (US DoT).*

*Figure 22 Pedestrian linkage to BRT station.*

*Park-and-Ride Facility:* Park-and-ride lots allow stations, especially those without significant development, to attract passengers from a wide area around BRT stations. Because services can be routed off the primary running way, regional park-and-ride facilities can also be located off the running way. This arrangement can link BRT service with existing parking lots, potentially reducing capital investment costs.

*Cost: $3,500 - $5,000 for a surface space $10,000 to $25,000 per space for structured space (US DoT).*

*Figure 23 Park & ride BRT facility.*
Platform Height & Layout

Level Platform: A raised curb reduces the vertical gap between the platform and the vehicle floor. The raised curb platform height should be no more than 10 inches above the height of the BRT running way or arterial street on which the BRT system operates. In some cases, the raised curb will more closely match the height of BRT vehicle’s entry step or floor to accommodate “near” level boarding. This treatment is preferred over the standard curb.

Cost: No significant incremental cost, requires an additional 3-4 inches of concrete depth (US DoT).

Figure 24 Level platform at BRT station.

Platform Layout: Platform layouts range from single vehicle length with a single berth (boarding position), usually from 60 feet where only conventional 40-foot buses are used, to as long as 300 or more feet where multiple articulated buses must be accommodated:

Single Vehicle Length Platform: This is the shortest platform length necessary for the entry and exit of one BRT vehicle at a time at a station.

Extended Platform with Un-Assigned Berths: Extended platforms usually accommodate no less than two vehicles and allow multiple vehicles to simultaneously to load and unload passengers. Since this platform can accommodate more than one vehicle at a time, overlay services can more easily utilize the BRT stations and running way.

Cost: Incremental cost will be a multiple of a single vehicle length platform based on the maximum number of vehicles accommodated (US DoT).

Figure 25 BRT station with Extended platform.
Fare Collection

**Barrier Enforced Fare Payment system** (i.e., pay-on-entering and/or exiting a station or loading area): Involves turnstiles, fare gates, and ticket agents or some combination of all three in an enclosed station area or bus platform. It may involve entry control only or entry and exit control (particularly for distance-based fares).

*Cost:* $30,000 to $60,000 per Ticket Vending Machine (TVM); $20,000 to $35,000 per Fare Gate. May include additional station hardware/software costs. Estimated additional labor requirements for a small implementation.

**Barrier-Free** (self-service) or **Proof-of-Payment (POP) system:** Requires the rider to carry a valid (usually by time and day) ticket or pass when on the vehicle and is subject to random inspection by roving personnel. It typically requires ticket vending and/or validating machines. The advantage of this less restrictive systems that it supports multiple door boarding and thus lower dwell times. The disadvantage is the increased risk of fare evasion. When implementing proof-of-payment, transit agencies should consider how passenger loads, passenger turnover, and how interior layout may affect the ability and ease of inspection onboard vehicles.

*Cost:* $30,000 to $60,000 per Ticket Vending Machine (TVM); labor costs for roving personnel. May include validator equipment and/or additional station hardware and software costs. Estimated additional labor requirements for a small implementation (i.e., 150 validators and associated systems) may involve maintenance personnel (US DoT).

*Figure 26 Barrier-free/Proof-of-payment system.*
Vehicle Configuration

The vehicle configuration is the primary vehicle planning/design parameter for BRT systems. This captures the combination of the length (capacity), body type, and floor height of the vehicle. In practice, BRT systems can use a variety of different vehicle configurations on a single running way, each configuration can be tailored to a specific service profile and market.

*Stylized Standard:* Stylized Standard vehicles have all of the features of a conventional step low-floor vehicle, they differ since they incorporate slight body modifications or additions to make the body appear more modern, aerodynamic and attractive.

Capacity: A typical 40-foot vehicle has seating for 35-44 patrons expanding to between 50 and 60 seated and standing.

A typical 45-foot vehicle can carry 35-52 passengers seated and 60-70, seated and standing, counting stands.

*Cost:* Typical base price range-$300,000 to $370,000 (US DoT).

*Figure 27 Stylized standard of BRT vehicle.*

*Stylized Articulated:* Stylized articulated vehicles are more modern, comfortable, and sleeker vehicles. Step-low floors, at least three doors, with 2 double stream and quick deploy ramps all facilitate boarding and alighting to shorten stop dwell times.

Articulated vehicle seating capacity depends heavily on the number and placement of doors ranging from 31 (four wide doors) to 65 (2 doors) and total capacity of 80-90 passengers, including standees.

*Cost:* Typical price range - $ 630,000 to $950,000 (US DoT).

*Figure 28 Stylized Articulated of BRT vehicle.*
Spurred on by the evolution of regulations supporting clean air, the number of choices in vehicle propulsion systems is increasing. Technology is evolving to provide new propulsion systems that use cleaner, alternative fuels and new controls on emissions, resulting in reduced pollution and lower noise emissions. Because many new technologies are being introduced and market conditions, such as demand and cost of production, are evolving.

**Hybrid-Electric Drives:** Hybrid-electric drive systems offer improved performance and fuel economy with reduced emissions (e.g., of nitrogen oxides (NOx) and particulates (PM). They differ from dual-mode systems in that they incorporate some type of on-board energy storage device (e.g., batteries or ultra capacitors).

Though the thermal or internal combustion engines used for hybrid drives are diesel in most transit applications, in a number of cases (e.g., Denver 16th Street Mall Vehicles) CNG or gasoline fueled engines have been used. Fuel economy gains of up to 60% are being claimed in urban service. Operational tests show improved range and reliability over ICE buses. Hybrid buses have entered operation in places such as New York and Seattle.

**Hybrid drive offers numerous operational advantages over conventional diesel buses, such as smoother and quicker acceleration, more efficient braking, improved fuel economy and reduced emissions.**

**Cost:** Price increment over diesel ICE is $100,000 to $250,000 (US DoT).
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