CONNECTING TEXAS

Assessing the Viability of High-Speed Rail Across Texas

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Abstract

This paper investigates the potential for a high-speed rail network in Texas, assessing its feasibility through a comprehensive analysis of existing rail infrastructure and demographic indicators. By conducting a shortest path analysis and market research, this study identifies optimal routes between major metropolitan areas and strategically located station sites. Despite limitations in forecasting specific ridership, the research emphasizes the substantial demand for such a system and its potential to cater to a large target demographic. The findings suggest that high-speed rail could offer the fastest and most efficient mode of transportation for intercity travel in Texas, catering to a growing need for improved regional transit options.

Introduction

The United States and Canada are currently the only G7 countries without expansive high-speed rail systems. High-speed rail is a somewhat ambiguous concept; however, it can be loosely defined as specially built High-Speed lines and trains, “equipped for speeds generally equal to or greater than 250 km/h,” or as specially upgraded high-speed lines and trains, “equipped for speeds of the order of 200 km/h.” (EU, 1996)

Commuter rail presents a multitude of advantages over other modal transportation options, the most obvious being its lower environmental impact. According to the BBC, domestic rail produces two to three times fewer emissions than a domestic flight and three times fewer emissions than a single passenger traveling in an average diesel car (BBC, 2019). Furthermore, the extreme efficiency of commuter rail is evidence of its lower environmental impact and its ability to reduce congestion by taking drivers off the road.

Many train cabs can hold up to 1,000 passengers, meaning that high-speed rail can carry the same number of passengers as a Boeing 737 every 45 seconds. The most intriguing part of commuter rail is the fact that it can achieve all this while also getting passengers to their destination quicker than commuting by car or by plane over certain distances.

For journeys of less than 150 km, cars offer the most efficient transportation because they require no boarding time. For journeys between 150 km and 400 km, rail is faster than air travel even if it is not high-speed. This is because of the extensive security and check-in process that flights require (Gleave, 2004). Most airlines recommend arriving at the airport a whole two hours before your flight (Elliott, 2022); in comparison, most commuter train companies recommend arriving at their station only thirty minutes before train departure.

For journeys farther than 400 km, high speeds are necessary for rail to be competitive with planes, and for journeys beyond 800 km, air travel will always have a competitive advantage.

Texas, centrally located in the American South, currently houses an extremely meager rail system (figure 2) that, most notably, has no direct passenger rail connection between Houston and Dallas-Fort Worth, two of the largest metropolitan areas in the state. Currently, a company named Texas Central Railway is in the advanced stages of planning a high-speed rail line in Texas; however, their project has run into massive legal issues over the purchase of private property along their proposed line.

This report aims to test the viability of a high-speed rail network in Texas based on the upgrade of existing passenger and freight rail in the state.

Methodology

The development of this potential rail network occurred in two stages: Firstly, a shortest path analysis was conducted to find the most efficient route between Houston, Dallas, and San Antonio. Subsequently, a market analysis was employed to determine the optimal county subdivisions for locating train stations along this generated network.

For the shortest path analysis, a freight rail line shapefile was merged with an Amtrak (passenger rail) line shapefile. This combined layer was then clipped to a shapefile of Texas, resulting in a comprehensive shapefile containing all existing rail lines in the state. This shapefile served as the basis for creating the network used in the shortest path analysis. The resulting route connected Houston, Dallas, and San Antonio, prioritizing these three largest metropolitan areas in Texas.

Station locations were chosen based on demographic data at the county subdivision level. The demographic indicators used to predict potential ridership were the populations of individuals aged twenty-five to sixty-four, who had graduated from high school at a minimum, and the population counts of individuals without access to a vehicle for their work commute. These indicators were incorporated into a polygon shapefile representing county subdivisions in Texas. Utilizing a bivariate symbology for these indicators facilitated the selection of optimal metropolitan areas for station sites along the previously generated route.

Subsequently, the potential ridership base for each newly selected station location was estimated at various distances from each station. Using age and education demographic data from the previous bivariate analysis, buffers of 20km, 30km, and 40km were created around each selected metropolitan area point file. The buffers of Dallas and Fort Worth were merged at 30km and 40km. The percentage of intersection between these buffers and the county subdivisions was calculated to determine the total population of individuals aged twenty-five to sixty-four with at least a high school education within 20km, 30km, and 40km of each potential rail station. These calculations were then transposed into Excel for easier data interpretation.

Shortest Path Analysis results

The initial route analysis among Houston, Dallas, and San Antonio yielded three distinct lines of varying lengths (figure 1). The route from Dallas to San Antonio closely mirrored the existing Amtrak route and measured 503.5 kilometers (figure 5). Likewise, the link between Houston and San Antonio predominantly followed the existing Amtrak route and covered 357.98 kilometers (figure 6). The final line connecting Houston and Dallas relied entirely on existing freight lines due to the absence of passenger rail and spanned 381.99 kilometers (figure 4).

Station Market Analysis results

A bivariate visualization combining age, education, and access to vehicle data revealed the highest concentration of the target demographic within the three metropolitan areas already included in the analysis (figure 7). Additionally, Austin and Fort Worth emerged as county subdivisions with notably high concentrations of this specific demographic, leading to their inclusion as potential stations along this route. Moreover, Waco and Killeen were also identified as potential station sites. However, while adding Waco did not alter the original route, incorporating Killeen necessitated a significant detour. Consequently, a station was designated for Waco, but not for Killeen.

The last county subdivision selected was College Station, housing one of the largest universities in Texas. Despite its population being notably younger than the previously identified ideal demographic, it exhibited a high concentration of residents without personal vehicle access. Thus, it was chosen as the final station along the line.

The total estimated potential ridership within the 20km buffer was 2,849,481 (figure 8), rising to 5,303,478 at 30km (figure 9), and reaching 7,015,255 at 40km (figure 10). The Dallas-Fort Worth connection reported the highest counts at both 30 and 40km, primarily due to their combined data. However, Houston consistently led the rankings as the metro area with the largest concentration of the chosen demographic profile. Given the broad nature of this demographic group, the results closely mirrored the total population in each metropolitan area.

Limitations

This study has provided a broad overview of a potential high-speed rail system; however, it was limited in its forecasting specificity. In the market research section, only a general population count of potential riders was identified. While this statistic does offer insight into potential demand for this hypothetical rail system, it lacks the specificity required to estimate the number of potential trips and a deeper understanding of the potential shift towards rail as a preferred mode of transportation.

Conclusion

This study has demonstrated the viability of a high-speed rail system in Texas, highlighting its potential for significantly enhanced travel efficiency compared to other transportation modes, along with the substantial projected demand for such a system.

The longest line within this hypothetical network spans from San Antonio to Dallas, covering 503.5 km. The average driving time between San Antonio and Dallas is 4 hours and 10 minutes, whereas the average flight duration is 1 hour and 10 minutes. However, factoring in the recommended arrival time of 2 hours for flights, the total travel time becomes 3 hours and 10 minutes. Considering a recommended arrival time of 30 minutes before departure for rail travel, a train traveling at an average speed of 187.64 km/h or higher will consistently prove to be the fastest and most efficient mode of transportation.

This study has also shown the large presence of one general target demographic for public transportation usage. At various scales, this population count exceeds 2 million potential transit users. Moreover, research indicates a notable increase in the number of individuals classified as 'super-commuters' (those with commutes exceeding 90 minutes) (Egan, 2022). This underscores the growing demand for more frequent and efficient regional transportation options within Texas.

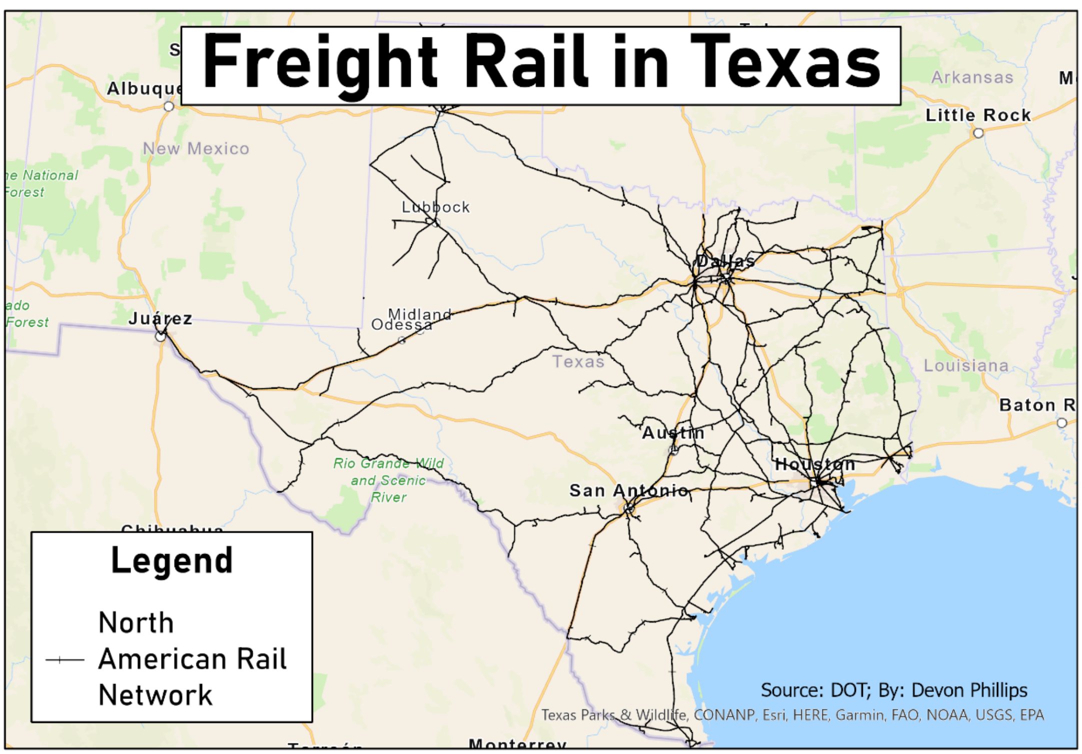


Figure 1

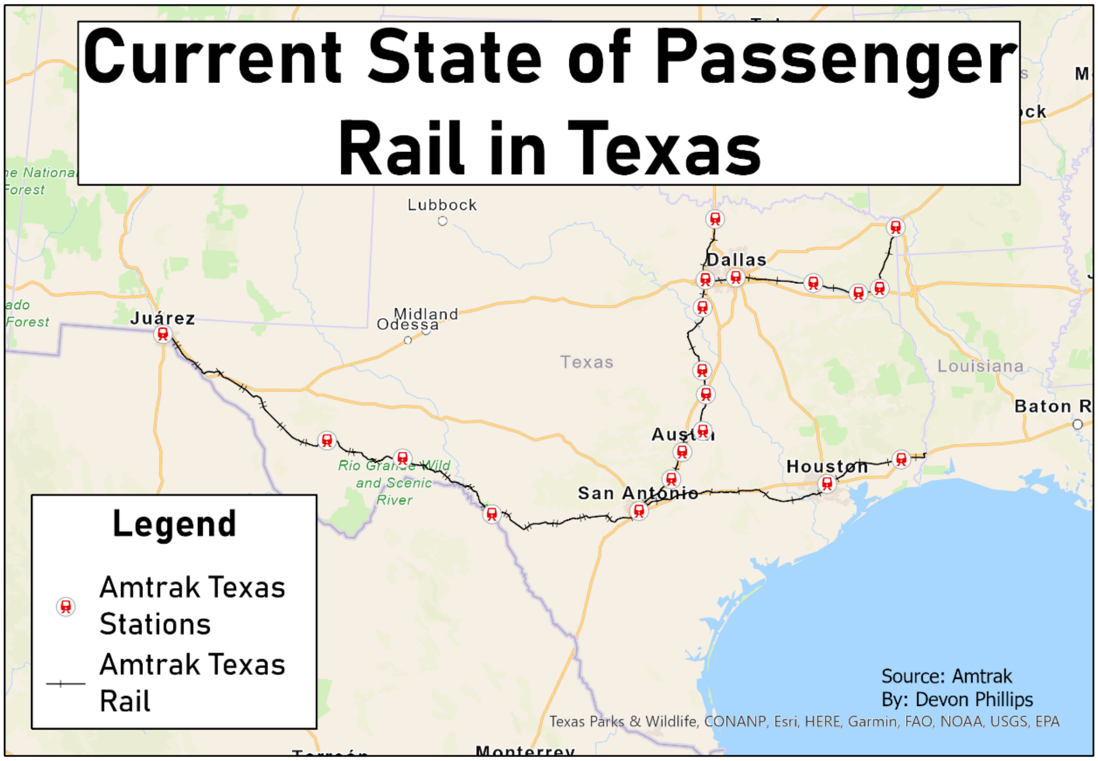


Figure 3

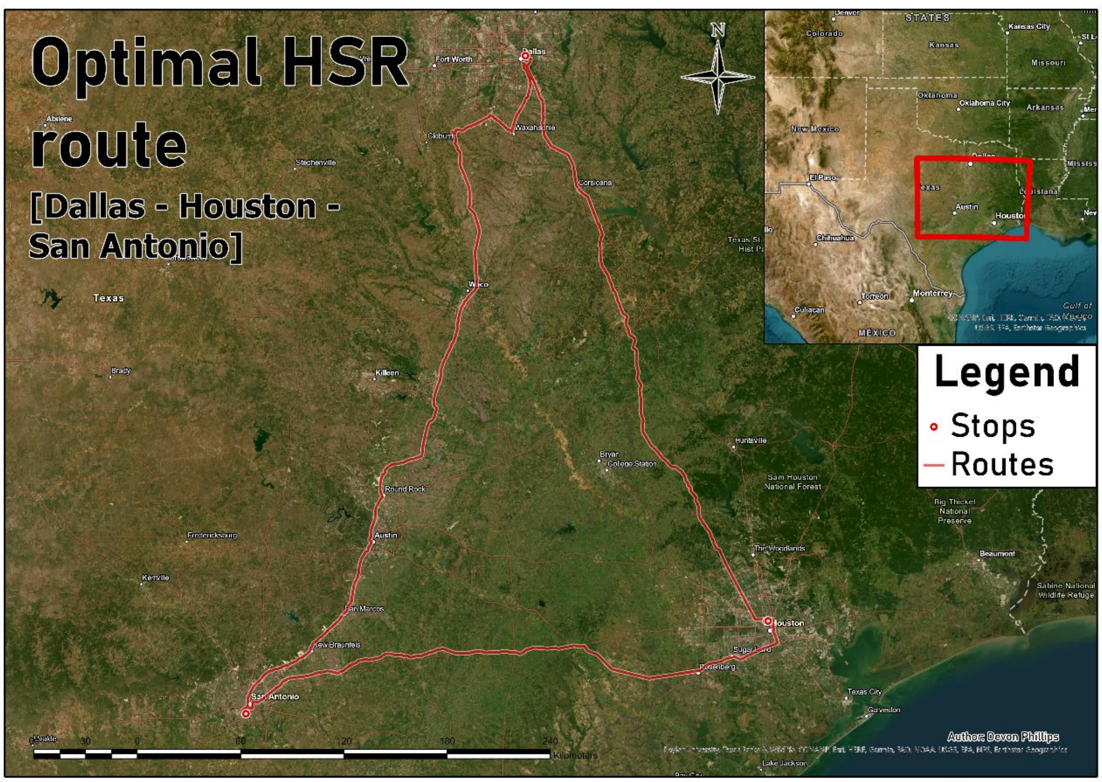


Figure 2

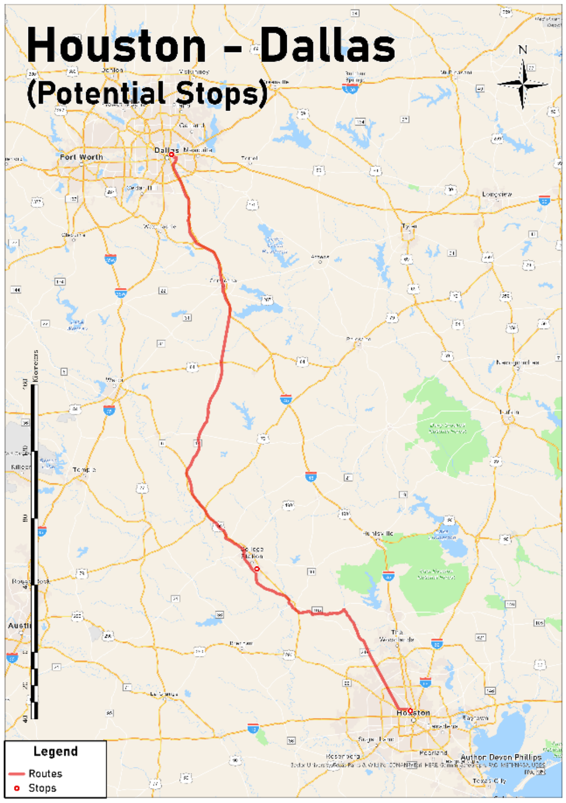


Figure 5

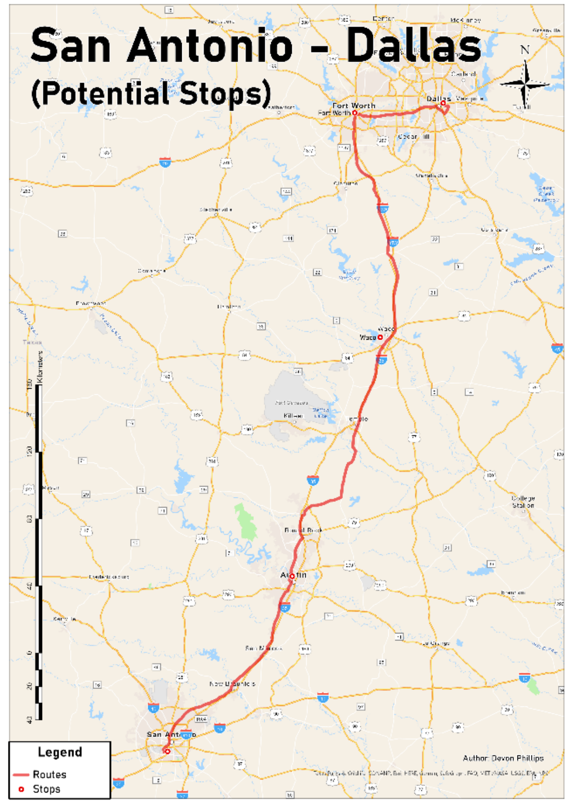


Figure 4

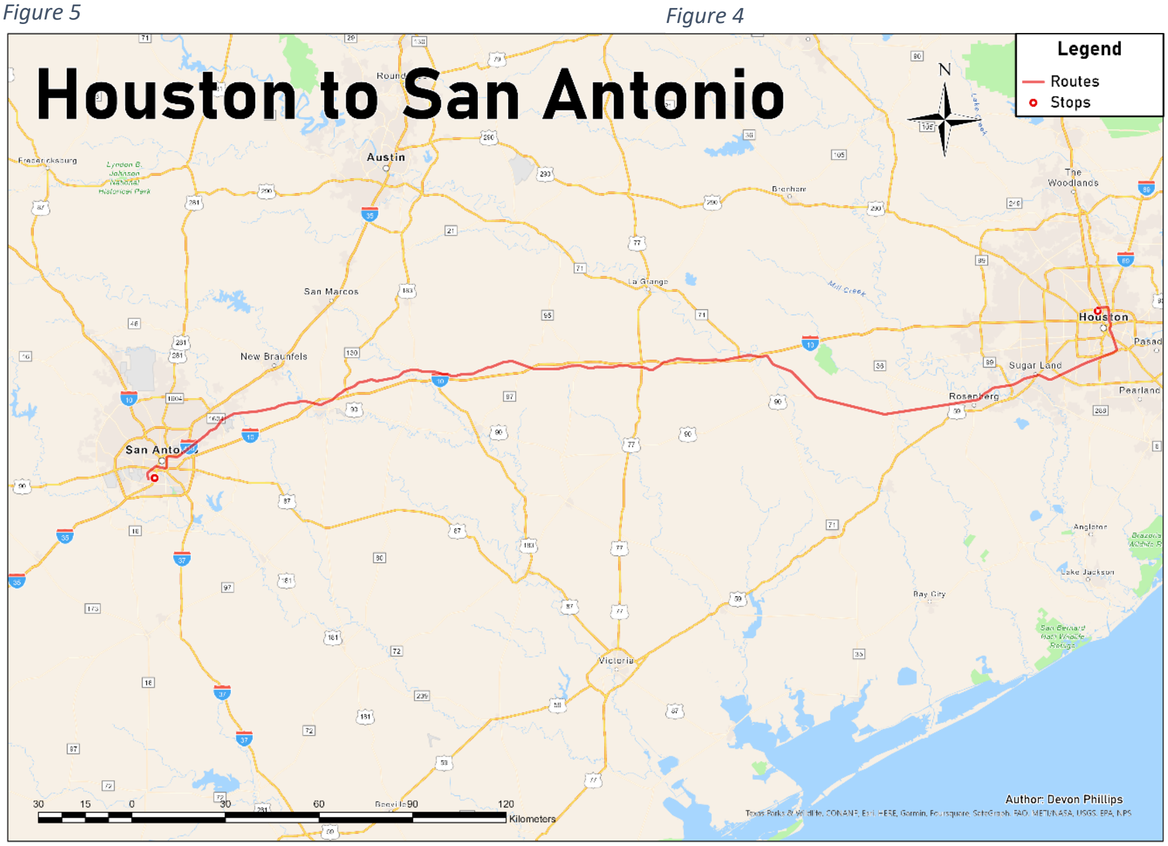
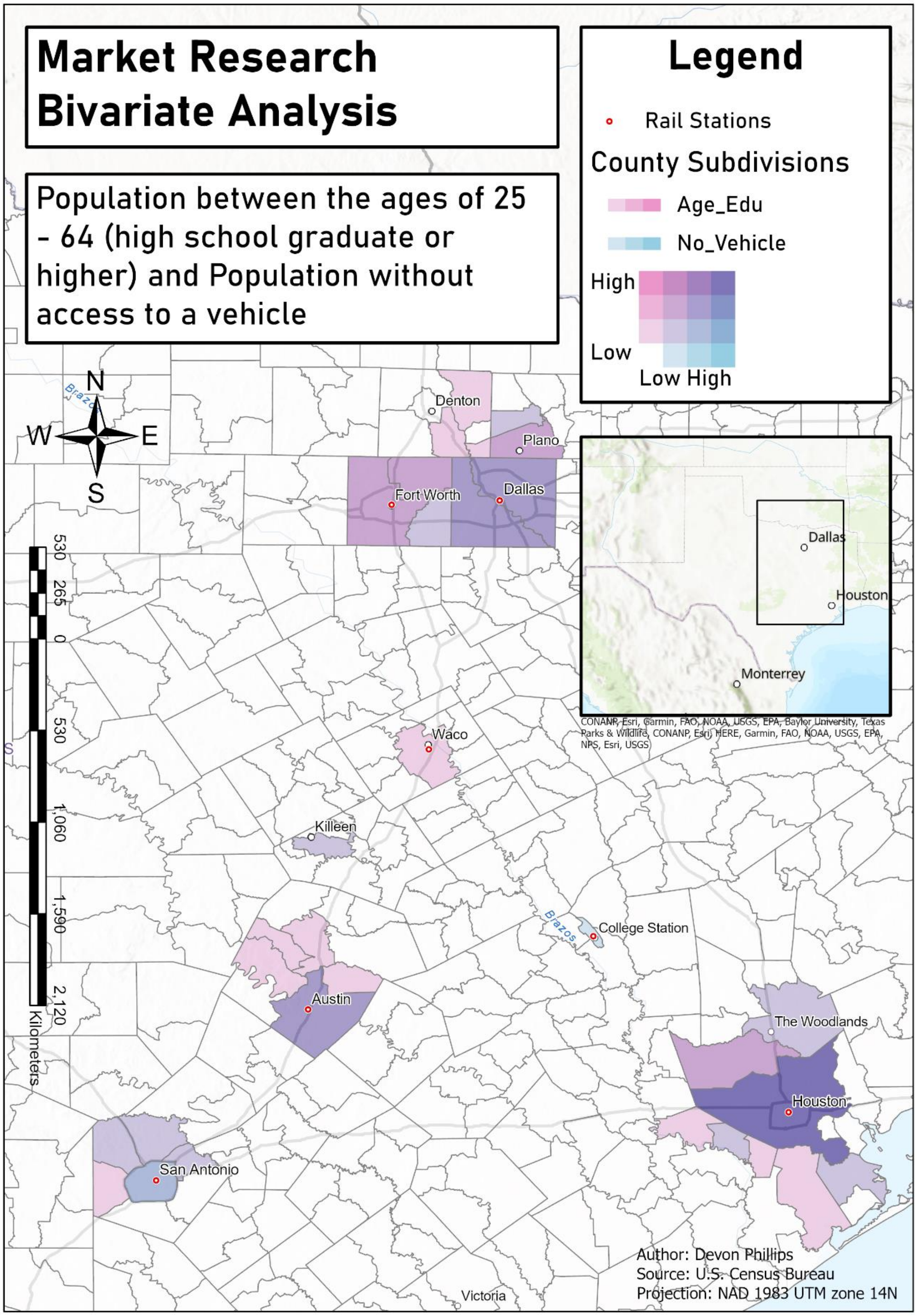


Figure 6



Market Research
Bivariate Analysis
Population between the ages of 25 - 64 (high school graduate or higher) and Population without access to a vehicle
Legend
Rail Stations
County Subdivisions
Age_Edu
No_Vehicle
High
Low
Low High
N
W
E
S
530
265
0
530
1,060
1,590
2,120
Kilometers
Denton
Plano
Fort Worth
Dallas
Waco
Killeen
College Station
Brazos
Austin
The Woodlands
Houston
San Antonio
Victoria
Monterrey
CONANP, Esri, Garmin, FAO, NOAA, USGS, EPA, Baylor University, Texas Parks & Wildlife, CONANP, Esri, HERE, Garmin, FAO, NOAA, USGS, EPA, NPS, Esri, USGS
Author: Devon Phillips
Source: U.S. Census Bureau
Projection: NAD 1983 UTM zone 14N

Figure 7

Metro Area (20km buffer)	Total Population (25-64 hs grad)
Houston	725,303
Dallas	609,235
Fort Worth	474,288
San Antonio	449,147
Austin	432,806
Waco	85,626
College Station	73,076
Sum	**2,849,481**

Figure 9

Metro Area (40km buffer)	Total Population (25-64 hs grad)
Dallas - Fort Worth	2,780,311
Houston	2,114,963
San Antonio	978,264
Austin	922,333
Waco	115,893
College Station	103,491
Sum	**7,015,255**

Figure 10

City Buffer (30km)	Total Population (25-64 hs grad)
Dallas - Fort Worth	2,181,433
Houston	1,447,842
San Antonio	769,579
Austin	711,916
Waco	101,356
College Station	91,352
Sum	**5,303,478**

Figure 8

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