Identifying Transit Deserts in Texas Cities

The Gap Between Supply and Demand

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Identifying Transit Deserts in Texas Cities: The Gap Between Supply and Demand

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1. Introduction

This study builds on previous research that has been done on “transit deserts.” This concept is similar to the popular and thoroughly studied concept of a “food desert,” which is a geographic area where there is no or limited access to fresh food (Clark et al. 2002; Jiao et al. 2012; Whelan et al. 2002; Wrigley 1993; Wrigley et al. 2002). The food desert concept has received a lot of attention and influenced planning policies and practices. By applying the same idea to transit systems within urban areas, geographic areas can be identified where there is a lack of transit service. There are three main steps to this process. This involves identifying the transit dependent populations as a measure of transit demand, calculating the transit supply, and then subtracting the supply from the demand to measure the gap (Jiao & Dillivan 2013).

The transit dependent populations are those who might require transit service to get around more than other people. These are typically people who are too old, too young, too poor, or physically unable to drive (Grengs 2001). The supply is measured by aggregating a number of criteria that contribute to transit supply and, in this case, access to it to receive a measurement of the transit service within a designated geographic area. The demand is subtracted from the supply to find the gap. Transit deserts are areas where the transit demand is significantly greater than the supply.
2. Literature Review

Identifying and measuring transit deserts is a relatively new practice that has been applied to a handful of locations, both in the US and abroad (Jiao & Dillivan 2013; CNT 2014; Currie 2008). However, no known research on the subject has been applied to cities within Texas. While the methods and purpose might vary, the overall theme is the same. Identifying areas where transit dependent people don’t have access to transit services. Previous research has also focused on transit access to housing as well as employment. A study conducted by the Center for Neighborhood Technology estimated that there are over 400,000 people living in transit deserts in Cook County, Illinois as well as over 250,000 jobs in transit deserts (CNT 2014).

While much of the previous research address transit supply and demand, factors that might affect access to the transit supply were given limited consideration. The previous study that this study is based on examined sidewalk length and bike route length as measures of access to transit (Jiao & Dillivan 2013). However, other aspects were not considered. Characteristics of the built environment, such as connectivity, travel speed, and other walking indices can contribute to the overall walkability of an area and mode choice of a trip (Leslie et al. 2005, Maghelal & Capp 2011, Handy et al. 2002). Applying further indices of walkability to the evaluation of transit supply could help to create a more accurate picture of a city’s transit supply.

While there are varying reasons why one might measure transit gaps, it can be argued that this is important due to the significant role that public transportation plays in society. However, transit agencies have failed to address the needs of transit dependent populations (Garrett & Taylor 1999). The political influence and demands of suburban populations often trump the needs of the poor who might live in the central city, who are traditionally more dependent on public transportation (Garrett & Taylor 1999). Today’s transit riders are poorer than the general population; it would be ideal to plan for their needs, resulting in a more equitable and socially just transportation environment.
3. Objective

The main objective of this research is to identify areas of a city where there are significant gaps between transit supply and demand. Through a clearly defined methodology and a quantitative analysis of transit supply and demand within Texas cities it should be possible to highlight areas of a city that might need more attention in regards to transportation access and planning. The implications of this research are that transit agencies could use this information to plan transit more efficiently and effectively as well as highlight areas that need attention in future planning efforts. There are also social justice implications of this research. A thorough examination of the gap between supply and demand can help provide improved services to those who are most in need within a city.
4. Research Methods

Research Design
A transit gap analysis was conducted in four Texas cities. The selected cities were Austin, Dallas, Houston, Fort Worth, and San Antonio. These cities were selected based on their size and the availability of data as well as their relatively similar development patterns. The transit gaps are measured by calculating the transit supply and the transit demand in each city at the block group level, then subtracting the demand from the supply. The difference between supply and demand is the gap.

Data
The transit demand, or the transit dependent population, was calculated with census data from the 2012 American Community Survey. These data were joined with GIS shapefiles from the US Census so as to spatially display the demand data at the block group level. Transit supply was calculated with data collected directly from the involved municipalities and transit agencies. These data included street networks, bike routes, sidewalks, and transit stops. Data used to measure transit frequencies were collected from Google’s General Transit Feed Specifications (GTFS).

Measurement
A formula created by the US Department of Transportation was used to calculate the transit dependent population at the block group level within each city. First, the household drivers are calculated by subtracting the persons living in group quarters from the population that is 16 years or older. Then, the transit dependent household population is calculated by subtracting the vehicles available from the household drivers.
Household Drivers =
(population age 16 and over) - (persons living in group quarters)

Transit Dependent Household Population =
(household drivers) - (vehicles available)

Census data on vehicles available is not publically available at the block group level. This data was collected at the census tract level and then estimated at the block group level by dividing the number of vehicles available within each census tract by the number of acres in each census tract to get a value for the number of vehicles available per acre. This value was then multiplied by the number of acres in each block group that falls within the census tract to get an approximate value for the number of vehicles available in each block group. In some block groups, there are more vehicles available than household drivers, thus resulting in a negative value for the transit dependent population. In these cases, the transit dependent population was adjusted to a value of 0 since it would be impossible to have a negative number of people.

Once the transit dependent population was calculated for each block group, that value was divided by the total population within each block group to calculate the percentage of the population within each block group that is transit dependent. These values were used to generate the transit dependent population maps. Then, the transit dependent population within each block group was divided by the number of acres in each block group to receive a value for the transit dependent population per acre. Z-scores were then calculated based on these values.

Transit supply was measured in each city based on seven criteria:

1. number of transit stops within each block group
2. frequency of transit service within each block group (based on weekday service)
3. number of transit routes within each block group
4. total length of sidewalks (miles) in each block group
5. total length of bike routes (miles) in each block group
6. total length of low speed limit roads (miles) in each block group

7. intersection density in each block group

These seven criteria were chosen because together they address both the physical presence of transit as well as the ability to access it. Numerous transit stops and frequent transit services are not effective if it is too difficult to easily access the transit services. Geospatial data for each of these seven criteria were spatially joined in GIS with block group shapefiles in each city. Once each of these criteria was measured at the block group level, the values were divided by the number of acres in each block group to receive per acre calculations. Z-scores were then calculated for these per acre measurements of the seven criteria and then aggregated together. The resulting average of these criteria were then used to show the transit supply in the supply maps.

The final demand values that were calculated were then subtracted from the final supply values. This shows the lack or surplus of transit supply in each block group. Block groups with significantly less supply than demand were shown to have transit gaps and were identified as possible transit deserts.

Transit Gap =

Supply - Demand
5. Analysis

The analysis was conducted by using various geospatial functions in ArcGIS so as to measure supply and demand at the block group level within the study areas. Using the formula that was mentioned previously, the demand was calculated and then joined with the corresponding block group shapefiles in ArcGIS. Supply was measured using the seven criteria that were listed in the previous section. This was done using shapefiles and data collected from the various cities and transit agencies. The seven criteria were given z-score values and aggregated. The aggregated z-score value for each block group was then used to calculate demand. The demand score was subtracted from the supply score to receive a gap calculation. The block groups with transit gaps are highlighted in the maps shown in figures 1-5 and the neighborhoods with the largest and smallest transit gaps are shown in tables 2 and 3.
6. Results

The supply, demand, and gap were calculated for each of the Texas cities and mapped using GIS. There were some differences among the transportation systems for each city. While all of them have some form of bus service and all have some form of rail service, with the exception of San Antonio, others have much more extensive transportation systems. Central Houston has a streetcar service while Austin has a single commuter rail line that connects downtown with the northern suburbs. Dallas has a very extensive light rail system and a commuter train that connects downtown Dallas to downtown Fort Worth. Fort Worth’s only rail service is the commuter train that is shared with Dallas. That being said, the differences in supply and demand within each city could be attributed to the differences in transit services that are available as well as differences in the built environment. Supply, demand, and gap maps for each of the five cities can be seen in figures 1-5.

Measurements of each city’s transit services as well as characteristics of the built environment that were used to calculate the transit supply in each of the Texas cities are summarized in table 1. Out of the five cities that were examined, Houston has the largest population, largest land area, and highest population density. Houston also has the most transit lines and transit stops, but more trips are made within a 24-hour period in San Antonio. Houston also has the highest average weekday ridership out of the transit systems in Texas cities. However, this is not surprising considering that Houston is the most populous city by almost 800,000 people. Houston and San Antonio also have an average intersection density of roughly 102 intersections per square mile. This suggests that the two cities might have similar development patterns.

It is also interesting to compare the transit and built environment characteristics in Austin and Fort Worth. The two cities have comparable populations, with Austin having roughly 90,000 more people, and comparable land areas, with Fort Worth having roughly 40 more square miles. Both cities also have the two lowest intersection densities out of the five Texas cities that were examined and total sidewalk lengths within the two cities are almost identical. However, the two cities have drastically different transit systems and transit use. Both systems are made up of bus lines and a single commuter rail line, but the ridership and the number of trips made within a 24-hour period are drastically different. In Austin,
more than twice as many trips are made within a 24-hour period than in Fort Worth. Austin’s average weekday transit ridership is also almost four times higher than Fort Worth’s, which is surprising since Austin’s transit system only makes about 2.5 times more trips than Fort Worth’s and has 1.6 times as many transit lines. The difference in ridership is disproportionate considering the relative sizes of the two cities and transit systems.

Table 1: Transit and Built Environment Characteristics of Texas Cities

<table>
<thead>
<tr>
<th>Measurements</th>
<th>Austin</th>
<th>Dallas</th>
<th>Fort Worth</th>
<th>Houston</th>
<th>San Antonio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population (2013 estimate, July 2013)</td>
<td>885,400</td>
<td>1,257,676</td>
<td>792,727</td>
<td>2,195,914</td>
<td>1,409,019</td>
</tr>
<tr>
<td>Transit Dependent Population</td>
<td>130,146.56</td>
<td>329,386.94</td>
<td>178,058.99</td>
<td>839,284.33</td>
<td>334,529.53</td>
</tr>
<tr>
<td>Percent Transit Dependent</td>
<td>14.70%</td>
<td>26.19%</td>
<td>22.46%</td>
<td>38.22%</td>
<td>23.74%</td>
</tr>
<tr>
<td>Area (sq. mi.)</td>
<td>297.9</td>
<td>340.52</td>
<td>339.82</td>
<td>599.59</td>
<td>460.93</td>
</tr>
<tr>
<td>Density (pop/sq. mi.)</td>
<td>2,972.14</td>
<td>3,693.40</td>
<td>2,332.79</td>
<td>3,662.36</td>
<td>3,056.90</td>
</tr>
<tr>
<td>Routes</td>
<td>80 bus 1 rail</td>
<td>113 bus 6 rail</td>
<td>47 bus 1 rail</td>
<td>134 bus 1 rail</td>
<td>111 bus</td>
</tr>
<tr>
<td>Stops Within City Limits</td>
<td>2,620</td>
<td>7,653</td>
<td>1,977</td>
<td>9,182</td>
<td>6,810</td>
</tr>
<tr>
<td>Average Weekday Ridership</td>
<td>120,500 bus 2,500 rail</td>
<td>128,511 bus 103,789 rail</td>
<td>25,000 bus 6,000 rail</td>
<td>236,402 bus 42,652 rail</td>
<td>139,335 bus</td>
</tr>
<tr>
<td>Trips [24 hr, weekday]</td>
<td>144,158</td>
<td>350,969</td>
<td>56,832</td>
<td>528,367</td>
<td>559,984</td>
</tr>
<tr>
<td>Length, bike routes [mi]</td>
<td>623.81</td>
<td>320.59</td>
<td>310.21</td>
<td>505.69</td>
<td>238.19</td>
</tr>
<tr>
<td>Length, sidewalks [mi]</td>
<td>2,306.73</td>
<td>6,199.98</td>
<td>2,326.00</td>
<td>N/A</td>
<td>4,777.34</td>
</tr>
<tr>
<td>Length, low-speed roads [mi]</td>
<td>2,653.93</td>
<td>5,159.37</td>
<td>3,714.45</td>
<td>6,748.78</td>
<td>4,859.63</td>
</tr>
<tr>
<td>Intersections</td>
<td>19,357</td>
<td>65,823</td>
<td>26,217</td>
<td>61,686</td>
<td>47,242</td>
</tr>
<tr>
<td>Intersection density [intersections/area]</td>
<td>64.98</td>
<td>193.30</td>
<td>77.15</td>
<td>102.88</td>
<td>102.49</td>
</tr>
</tbody>
</table>
Comparing Dallas and San Antonio also tells an interesting narrative. The two cities have similar populations, with San Antonio being roughly 12 percent larger. The cities also have a comparable number of transit lines, however, Dallas has six rail lines, which includes light rail, commuter rail, and a streetcar. San Antonio’s transit system makes roughly 60 percent more trips than DART in Dallas, but DART’s ridership is about 67 percent higher on an average weekday. The disproportionate difference in ridership between Dallas and San Antonio could be attributed to a more diverse range of transportation options in Dallas.

It is apparent that the similarities and differences between the five largest cities in Texas provide an interesting case study for measuring transit deserts. These cities are diverse yet have key similarities with one another that make for an interesting case study.
### Table 2: Largest Transit Gaps in Texas Cities

<table>
<thead>
<tr>
<th>Neighborhood</th>
<th>Gap</th>
</tr>
</thead>
<tbody>
<tr>
<td>West Campus (25th Street)</td>
<td>-12.90</td>
</tr>
<tr>
<td>West Campus (22nd Street)</td>
<td>-5.87</td>
</tr>
<tr>
<td>West Campus (27th Street)</td>
<td>-5.58</td>
</tr>
<tr>
<td>Pleasant Valley (East Riverside Drive)</td>
<td>-4.84</td>
</tr>
<tr>
<td>West Campus (26th Street and shoal Creek)</td>
<td>-4.78</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Neighborhood</th>
<th>Gap</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dallas North Tollway &amp; President George Bush Turnpike</td>
<td>-8.59</td>
</tr>
<tr>
<td>1635 &amp; Walnut Hill Lane</td>
<td>-8.32</td>
</tr>
<tr>
<td>Dallas North Tollway &amp; Lemmon Avenue</td>
<td>-6.02</td>
</tr>
<tr>
<td>Royal Lane &amp; Skillman Street</td>
<td>-5.73</td>
</tr>
<tr>
<td>Old East Dallas (Bennet Avenue)</td>
<td>-5.59</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Neighborhood</th>
<th>Gap</th>
</tr>
</thead>
<tbody>
<tr>
<td>TCU</td>
<td>-11.63</td>
</tr>
<tr>
<td>Ridgemar (Ridgemar &amp; I30)</td>
<td>-6.91</td>
</tr>
<tr>
<td>Western Hills (Between Cherry Lane &amp; Las Vegas Trail)</td>
<td>-5.87</td>
</tr>
<tr>
<td>I30 (Between Oakland Hills Drive &amp; Country Club Lane)</td>
<td>-5.60</td>
</tr>
<tr>
<td>South Hills (Crowley Road &amp; Altamesa Boulevard)</td>
<td>-4.92</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Neighborhood</th>
<th>Gap</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sharpstown (Westpark Tollway &amp; I65)</td>
<td>-12.55</td>
</tr>
<tr>
<td>Chinatown (Westpark Tollway &amp; Sam Houston Parkway)</td>
<td>-10.37</td>
</tr>
<tr>
<td>145 &amp; I610</td>
<td>-8.86</td>
</tr>
<tr>
<td>Gulfton (I69 &amp; Westpark Tollway)</td>
<td>-8.82</td>
</tr>
<tr>
<td>145 &amp; I610</td>
<td>-7.86</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Neighborhood</th>
<th>Gap</th>
</tr>
</thead>
<tbody>
<tr>
<td>Braun’s Farm</td>
<td>-6.44</td>
</tr>
<tr>
<td>110 &amp; Wurzbach Road</td>
<td>-6.10</td>
</tr>
<tr>
<td>Hausman Road &amp; Babcock Road</td>
<td>-5.51</td>
</tr>
<tr>
<td>1410 &amp; I10</td>
<td>-4.59</td>
</tr>
<tr>
<td>Wurzbach Road &amp; Evers Road</td>
<td>-3.65</td>
</tr>
</tbody>
</table>
### Table 3: Smallest Transit Gaps in Texas Cities

<table>
<thead>
<tr>
<th>Smallest Gaps</th>
<th>Neighborhood</th>
<th>Gap</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austin</td>
<td>1. Downtown</td>
<td>2.09</td>
</tr>
<tr>
<td></td>
<td>2. North Campus</td>
<td>2.04</td>
</tr>
<tr>
<td></td>
<td>3. UT Campus (Northeast)</td>
<td>1.65</td>
</tr>
<tr>
<td></td>
<td>4. Heritage (Between Lamar and Guadalupe)</td>
<td>1.59</td>
</tr>
<tr>
<td></td>
<td>5. North Downtown &amp; Capitol</td>
<td>1.55</td>
</tr>
<tr>
<td>Dallas</td>
<td>1. Downtown</td>
<td>7.16</td>
</tr>
<tr>
<td></td>
<td>2. Downtown (East)</td>
<td>5.18</td>
</tr>
<tr>
<td></td>
<td>3. Downtown (North)</td>
<td>4.19</td>
</tr>
<tr>
<td></td>
<td>4. Downtown (West)</td>
<td>3.77</td>
</tr>
<tr>
<td></td>
<td>5. Oak Lawn (North Hall Street)</td>
<td>3.61</td>
</tr>
<tr>
<td>Fort Worth</td>
<td>1. Downtown</td>
<td>3.72</td>
</tr>
<tr>
<td></td>
<td>2. Downtown (Panther Island)</td>
<td>3.63</td>
</tr>
<tr>
<td></td>
<td>3. Boca Raton Boulevard &amp; Country Club Lane</td>
<td>2.36</td>
</tr>
<tr>
<td></td>
<td>4. Medical district (Rosedale &amp; Hemphill)</td>
<td>2.25</td>
</tr>
<tr>
<td></td>
<td>5. Arlington Heights (Camp Bowie &amp; Hulen)</td>
<td>2.15</td>
</tr>
<tr>
<td>Houston</td>
<td>1. Downtown on Buffalo Bayou</td>
<td>7.52</td>
</tr>
<tr>
<td></td>
<td>2. Downtown (I45 and Eastex Freeway)</td>
<td>7.06</td>
</tr>
<tr>
<td></td>
<td>3. Midtown</td>
<td>4.02</td>
</tr>
<tr>
<td></td>
<td>4. Northeast Downtown</td>
<td>3.52</td>
</tr>
<tr>
<td></td>
<td>5. Midtown (Houston Community College)</td>
<td>3.24</td>
</tr>
<tr>
<td>San Antonio</td>
<td>1. Downtown (West Riverwalk)</td>
<td>7.67</td>
</tr>
<tr>
<td></td>
<td>2. Downtown (East Riverwalk)</td>
<td>3.89</td>
</tr>
<tr>
<td></td>
<td>3. Midtown (San Antonio College)</td>
<td>2.60</td>
</tr>
<tr>
<td></td>
<td>4. Fredericksburg Road &amp; I10</td>
<td>2.56</td>
</tr>
<tr>
<td></td>
<td>5. Midtown (San Pedro Park)</td>
<td>2.44</td>
</tr>
</tbody>
</table>
Figure 1: Transit Deserts Analysis in Austin, Texas

Austin

Demand

Supply

Gap

Transit Dependent Population

- Under 10%
- 10% - 24.9%
- 25% - 49.9%
- 50% - 74.9%
- Over 75%
- Water

Transit Supply

- -0.59 - -0.251
- -0.25 - -0.01
- 0 - 0.249
- 0.25 - 0.249
- 0.5 - 6.14
- Water

Gap (Supply) - (Demand)

- -12.9 - -1.01
- -1 - -0.01
- 0 - 0.99
- 1 - 1.99
- 2 - 6.53
- Water
Figure 2: Transit Deserts Analysis in Dallas, Texas

Dallas

Demand

Supply

Gap

Transit Dependent Population
- Under 10%
- 10% - 24.9%
- 25% - 49.9%
- 50% - 74.9%
- Over 75%
- Water

Transit Supply
- -0.92 - -0.51
- -0.5 - -0.01
- 0 - 0.49
- 0.5 - 0.99
- 1 - 6.92
- Water

Gap (Supply) - (Demand)
- -8.59 - -1.01
- -1 - -0.01
- 0 - 0.99
- 1 - 1.99
- 2 - 7.16
- Water
Figure 3: Transit Deserts Analysis in Fort Worth, Texas

Fort Worth

Demand

Supply

Gap

Transit Dependent Population

Under 10%

10% - 24.9%

25% - 49.9%

50% - 74.9%

Over 75%

Water

Transit Supply

-0.9 - -0.41

-0.4 - -0.1

0 - 0.39

0.4 - 0.79

0.8 - 3.9

Water

Gap

(Supply) - (Demand)

-11.63 - -1.01

-1 - -0.01

0 - 0.99

1 - 1.99

2 - 3.72

Water
Figure 4: Transit Deserts Analysis in Houston, Texas

Houston

Demand

Supply

Gap

Transit Dependent Population

- Under 10%
- 10% - 24.9%
- 25% - 49.9%
- 50% - 74.9%
- Over 75%
- Water

Transit Supply

- -0.82 - -0.51
- -0.5 - -0.01
- 0 - 0.49
- 0.5 - 0.99
- 1 - 6.88
- Water

Gap (Supply) - (Demand)

- -12.55 - -1.01
- -1 - -0.01
- 0 - 0.99
- 1 - 1.99
- 2 - 6.53
- Water
Figure 5: Transit Deserts Analysis in San Antonio, Texas

San Antonio

Demand  
Supply  
Gap

Transit Dependent Population
- Under 10%
- 10% - 24.9%
- 25% - 49.9%
- 50% - 74.9%
- Over 75%
- Water

Transit Supply
- -1.04 - -0.51
- -0.5 - -0.01
- 0 - 0.49
- 0.5 - 0.99
- 1 - 6.79
- Water

Gap
- Supply - Demand
- -6.44 - -1.01
- -1 - -0.01
- 0 - 0.99
- 1 - 1.99
- 2 - 7.67
- Water
7. Discussion

The pattern for transit supply was more or less the same for each city. Most of these cities have a “hub and spoke” style transportation system with a network of lines that congregate near the city center and spread outwards from there. This means that block groups in the city center, where the transit lines congregate, are going to have the highest supply. The areas with high concentrations of supply often extended along major corridors.

Transit demand was often scattered sporadically throughout each of the cities. The only consistency for transit dependent populations was that they were not located in the central part of the city or downtown. These areas almost always had fewer than 10 percent transit dependent populations.

As far as transit demand is concerned, it is not clear whether or not, and to what extent, the supply has an effect on the demand. It is possible that people living far outside of a transit system’s service area might make ends meet to have a car and operate it even when it is not economically feasible purely out of necessity. In situations like this, these people wouldn’t necessarily be considered transit dependent, but could greatly benefit from improved transit service. Likewise, the same could be said for people living in areas with excellent transit service. People who might normally have a car do not have one because it is not needed. These people might be considered transit dependent even though their ability to own a car and not be transit dependent is not taken into consideration. One way of addressing this would be to use income as a factor. Wealthy people with cars might never use transit even if the service were the best in the world.

The quantity and layout of areas with high transit gaps was not uniform for the Texas cities. San Antonio had a higher quantity of areas with larger transit gaps than other cities and they were spread throughout the city and not concentrated in any particular area. While the distribution of Houston’s transit deserts is similar to San Antonio’s, the north-eastern part of the city is almost entirely without transit deserts and the southwest part of the city has a higher concentration.
Austin provides an interesting story since it is the only city where there was a clear grouping of transit deserts. This becomes more interesting when compared to the supply map since the very same area has relatively high transit supply compared to the rest of the city. The population density and a high concentration of students in that part of the city could contribute to this situation.

Additional applications of this research include transit optimization. This is where a transit system might be re-structured to maximize the use of the available resources to better serve a city and its population. Such practices involve identifying where transit service is needed and where there is an overabundance of transit service. However, previous research on this does not provide an approachable method of examining a city’s transit supply, demand, and transit needs [Klier & Haase 2014].

Further examination of these areas could help reveal whether or not, and to what extent, these areas are transit deserts.
8. Conclusions and Limitations

This research is important because it highlights the areas of a city where the transportation needs are far greater than the transportation service. This information can help to plan more effective and efficient transportation systems that serve those who need it most. In an age where transit systems often operate on very limited financial resources, it is extremely important that these systems operate and function as efficiently as possible, serving not only a high number of people, but also highly dependent people, resulting in a more socially just transit system.

While this study might have its limitation, it should be noted that the concept of a transit desert and methods used for measuring them are relatively new. This paper might not provide a definitive, fool-proof way of addressing the transit desert problem, but it does act as a step in the right direction. By providing a clear and concise method for measuring transit deserts, this can act as a foundation for future research in the field. The straightforward methods make this research accessible to academics, and most importantly, to the cities and transit agencies that will actually benefit from this research and have the ability to implement changes based on the findings.

This main difference between this study and previous studies is that more emphasis was placed on access to public transportation, and not just the actual transit service. Factors that are typically associated with walkable landscapes, such as small block lengths and low speed roads were taken into consideration for transit supply. Essentially every transit trip is going to begin and end with walking. If someone is not willing, or unable to walk to or from a transit stop, then a transit trip will not likely be made. This is why the physical characteristics of the built environment that might contribute to or discourage walkability are vitally important when considering access to or from a transit stop at the beginning or end of a transit trip.

There are some limitations on this research due to the difficult nature of calculating transit gaps. Predicting a population’s travel needs is not an easy task when working with census data. The smallest geography that most data is available is the census block group, which makes pinpointing areas of interest rather difficult. Instead, only general areas
of a city can be highlighted. It should be noted that census data for vehicles available is not available at the block group level and had to be adjusted at the census tract level to meet the needs of the study.

Calculating transit supply is not without its limitations. The data that is necessary for making such calculations must be collected from a variety of sources and jurisdictions. Since this data is not standardized, there is often a wide variety in the quality and extent of the data. Some of the data is inaccurate and other parts are non-existent. The process of standardizing data from the five cities so as have a consistent and high-quality analysis is important and provides some limitations. For example, speed limits in Houston’s street network data were largely inaccurate, often stating that many streets had speed limits over 100 mph. Instead of using speed limits for the analysis, highways and other large roads were subtracted from the network so as to leave only streets with lower speeds. Other data were missing. For example, Dallas does not have linear sidewalk data; an estimation for sidewalk length was done based on the perimeters of sidewalk polygons. Houston does not have any sidewalk data, meaning that sidewalk length had to be left out of the Houston analysis.
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