Vulnerable Communities:

Texas Triangle with Extension from Houston to Corpus Christie and from Houston East to Texas County Line

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16. Abstract Rural and low-density residents proximate to megaregion anchor cities could be advantaged by improved public transportation and micro mobility options providing connection into nearby large urban areas. This research expands the traditional method of querying the socio-demographic variables by identifying vulnerable communities that align the freeway corridor linkages of Texas' megaregion cities and compares the vulnerable community characteristics with their county cohorts. The question was whether the gap between vulnerable residents in rural and small urban communities and others in their counties can be measured using demographic variables. A Composite Vulnerability Index (CVI) measures the gap for Texas Triangle and Texas' Gulf Coast megaregion corridors confirming the poverty of selected rural residents compared to their county cohorts.		
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Chapter 1 Background

Twenty-first century communities are not bound by time and space as communities were decades ago. Wealth, intellectual capital, natural or developed resources are often concentrated in urban areas. Moreover, locales are connected by environmental, economic, energy and public interests. These linked locales have been termed Megaregions by several researchers, referring to more than one large anchor city symbolically connected to other large anchor cities in their region. Many small urban and rural communities have low-income residents, who are disconnected from essential services available in a nearby large urban center. Often population declines in these communities lead to fewer opportunities for jobs, education, and core elements necessary for desirable life quality (Cromartie et al., 2015). Conversely, these communities may attract new residents due to lower housing costs. Urban areas, particularly those serving as anchor cities for megaregions, are strengthening concentrations of educational institutions, medical facilities, and an array of employment prospects. As growth in the megaregion cities continues, the need for multiple travel options from rural areas and small towns into these urban centers will increase. Good transportation is essential to rural areas as a link to employment, to facilitate the movement of goods, to access health care and educational opportunities, and to provide links to quality food choices and necessary social services.

Traditional transportation planning processes are led by metropolitan planning organizations (MPOs) who produce coordinated short- and long-range plans for communities in their regions. Difficulty occurs because the federal government requires an MPO for each urban area with a population of more than 50,000 people; many of the interstice areas are smaller than 50,000 people. There is inadequate to no transportation planning done for these communities, especially as it relates to public transportation or ride sharing.

A purpose and need statement are required for any transportation project to be considered for approval by the USDOT. The purpose and need reflect the gap between the existing conditions and the improvements essential for better functioning of the transportation system. Therefore, the first step in planning any transportation project or service is assessing the need to support its implementation. It is often a challenge to strongly support the need for transportation improvements or developments for rural and small towns because their problems do not seem as significant as those of urban areas. That is, they do not struggle with congestion mitigation or air quality. Therefore, the severity of transportation need for these communities must be quantified and justified using the challenges to the community's well-being and vulnerability as the foundation. Such documentation would validate a need for increased travel opportunities into the urban areas from the interstices in the Texas Triangle, along the Texas Border to the state line with Louisiana along the southern Texas coast.

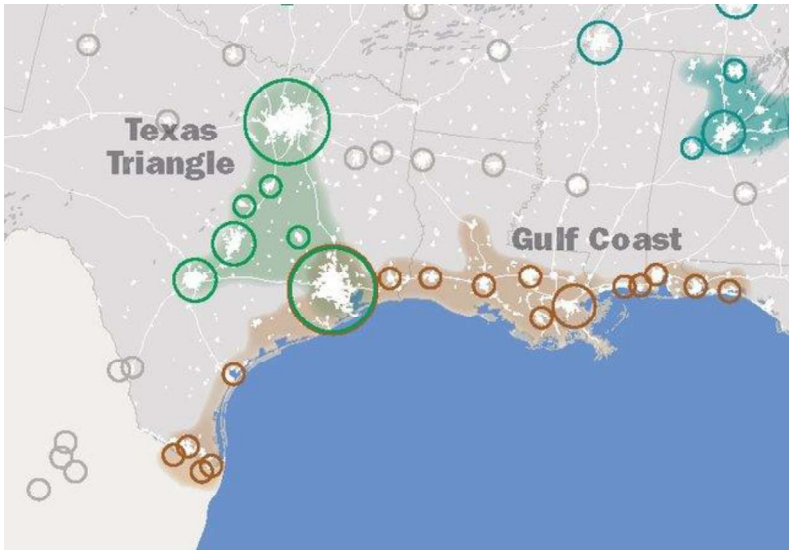

Figure 1. Texas Triangle and Gulf Coast Megaregions
Source: America 2050

Chapter 2 Literature Review

According to the U.S. Department of Transportation, issues related to transportation for residents of non-urban communities can make the goal of meeting needs particularly difficult (USDOT, 2017, Beyond Traffic 2045). There are many different existing ways to define and classify the welfare of a community, which often have in common components related to quality of life including general health, formed relationships, social, economic, environmental, cultural and political conditions, and a feeling that one has something valuable to contribute to society. Some criterions may appeal to the entire community as a necessity for a consideration to be equitable while individuals may have additional requirements such as religion, satisfaction of level of livelihood etc., to claim a thriving state. (Padgett, R., Lee, N., Wilkinson, R., Tsavaris, H., VanderWeele, T., 2024). (Sung et al., 2018) enumerate the different community well-being indicators which relate to employment, health, educational outcomes, access to quality healthcare services, transportation services, ability to vote, and financial stability. When these are inadequate, they describe communities as vulnerable.

The widening urban-rural income disparity runs counter to the construction of a harmonious society since is not conducive to the improvement of the production enthusiasm of low-income people, which will affect the production efficiency of the entire society (Lee et al., 2017). Amidst challenges such as social overcapacity and inadequate domestic demand, the widening gap in income between urban and rural areas exacerbates these issues. This not only constitutes a big obstacle to social fairness and justice but also severely hinders the coordinated development of economy and society. Therefore, the causes of the income gap between urban and rural areas should be analyzed, and active and effective measures should be taken to reduce

this gap. By bridging the income gap between urban and rural areas, we can contribute to the establishment of a more equitable and sustainable society. (Chen & Shen, 2021)

Vulnerable populations are characterized by having life circumstances that strip autonomy, the ability to make important choices for wellbeing, or those being taken advantage of by an unforgiving system. People in these unconventional circumstances are often facing financial deficiencies, the neglect that comes with being a rural minority, being uninsured, low-income children, elderly age, homelessness, and chronic health (Wendy Pearlman, 2024).

The vulnerable populations include the economically disadvantaged as well as the racial and ethnic minorities, the uninsured, low-income children, the elderly, homeless individuals, those with chronic health conditions, and others without access to social services according to the American Journal of Managed Care, 2006. Results comparing 2019 and 2021 revealed that poverty increased nationally in rural areas by 5 percent. The unemployment rate, elderly population, minority population, and lack of education have also increased (USDA, 2021). Outside of urban areas, housing may be more affordable, but employment opportunities, access to health professionals, educational and training opportunities, and recreational and social amenities are often limited.

Parker et al. (2018) established that rural residents consider access to jobs and public transportation as major challenges, with these deficiencies perceived as related to race and class. Transportation policies narrowly focused on mitigating energy use, air pollution, and climate change-by way of, for example, fuel-efficient vehicles or alternative fuels-are likely to do little to alleviate social inequities, such as those related to poor accessibility for pedestrians and cyclists. (Manaugh, K., Badami, M., & El-Geneidy, A. 2015). Improving accessibility is key to enhancing wellbeing in non-urban communities, with this being a particularly critical aspect for people in

these communities. Transportation professionals should place a high priority on including the needs of vulnerable populations beyond urban boundaries and use tools that better inform decision-making for projects designed to improve mobility in these communities.

Such a challenge, with respect to the mobility gap in interstice communities, has to be addressed through serious coordination at both the state and local levels. However, many local transportation agencies are limited to planning within their own jurisdictional boundaries, leaving a void in addressing the needs of rural communities. In states like Texas, while the Texas Department of Transportation

TxDOT has a small program for rural public transportation; however, its focus on roadway improvements for vehicular traffic often overshadows efforts in this area.

A recent report from TxDOT on statewide public transportation planning highlighted five big needs: expansion and enhancements of transportation services, coordination and collaboration increase, improvement of connectivity and access, building ridership through targeted outreach and engagement, and the pursuit of new funding sources (Miller, Kristie, 2016). More importantly, it emphasizes that transportation is an essential part of public service, especially in rural counties where one must travel miles before reaching major employers.

With ever-changing demographics, the role of public transportation is becoming increasingly vital in connecting people to jobs and services. In this regard, addressing these needs will require collaboration between state and local governments, prioritization of public transportation initiatives, and innovation in developing solutions that address mobility in interstice communities.

The importance of public transportation to enhance the quality of life and access basic resources by the most vulnerable populations in a megaregion's anchor city cannot be overestimated.

As Marcantonio and Karner (2016) highlighted, planners and advocates require methods and metrics to identify those transportation investments which address the challenges of segregation, exclusion from opportunities, and extreme inequality faced by low-income communities of color.

It is important to consider low-income residents themselves, which is often neglected in transportation planning. For instance, Day Cheeseman et al. (2016) found that, on average, rural workers are older than their urban counterparts, and their salaries are lower each year. This reflects the trend of younger, more educated people moving from rural to urban areas. By educational attainment, rural women and men aged 25 to 29, along with rural and urban women, have relatively similar percentages of high school graduates, while urban men have slightly higher rates.

However, there is a marked increase in the percentage of urban college graduates compared to rural counterparts for both men and women at the bachelor's level. This is the reason there is a drift of educated young people from rural areas to urban centers in search of better-paying jobs. Public transportation is vital in connecting rural communities with urban centers where education facilities, employment opportunities, and medical facilities are readily available. Transportation planning initiatives should give special attention to the needs of the most vulnerable members of society and take into consideration the socio-economic factors affecting migration and job opportunities in rural and urban areas. Modal mismatch refers to the inability to reach a desired destination due to lack of appropriate modes of transport, especially

public transportation. This term has recently gained attention in urban planning literature, for instance, in works by Blumenberg and Manville (2004) and Grengs (2010).

This concept emphasizes the fact that even though two regions in a city are separated by a rather short distance, they could be effectively divided due to a lack of adequate or decent public transportation. Foth et al., 2013 Prialakou, Gkrita, and Fricka (2016) remind that the United States has so far paid inadequate attention to the needs of vulnerable and rural residents whose disadvantage is associated with a lack of public transportation and limited economic, recreational, and other opportunities. Their research, which is somewhat of a departure from the demographic-based approach that has dominated the literature to date, proposes a new method called 'moves.' This new approach counts access and travel times for walking and driving, and therefore better captures the nature of transport disadvantage. Public transportation presents an attractive solution to the financial burden of automobile travel for members of interstice communities. While public transportation, on the other hand, is one of the cheapest ways compared to accessing nearby urban areas since one must incur several costs in terms of fueling and parking fees.

Despite challenges on the side of parking availability and cost, some trip purposes will make people have to endure parking costs, for instance, seeking specialized medical care in urban areas. However, parking complications may discourage rural residents from pursuing educational or job opportunities. A study conducted by Shiftan and Burd-Eden in 2001 in Haifa, Israel, analyzed user responses to alternative parking policies. It shows the complexity of the interaction between transportation policies and individual travel decisions. Their findings suggest that workers are less responsive to parking changes than others.

Addressing the transportation needs of vulnerable and rural residents is going to require a multifaceted approach that addresses aspects of accessibility, mobility, and outcome-based metrics. Public transportation has emerged as a key solution to reduce the financial costs of automobile travel and offer urban opportunities in a more equitable and sustainable manner. Presently, there is a public transit service available for the residents of three interstice counties proximate to Travis County, Austin, and provided by CARTS, Capital Area Rapid Transit. The other interstice counties such as Austin, Waller, or Washington Counties do not have any sort of public transportation service. This makes low-cost transportation connections to the nearby anchor cities or destinations along US 290 a key factor in the survival of these residents. The concept links interstice communities to a line-haul transit service in the 290 corridors, providing access to urban opportunities or other interstice communities.

Supporting this transit corridor service are first mile/last mile connections, linking residents to and from their homes to the line-haul service.

A case study in New Jersey found first mile shuttles effective in low-income communities (Deka & DiPetrillo, 2012).

Chapter 3 Research Question and Methodology

Research Question

The research question is whether the gap between vulnerable residents in rural and small urban communities and their county cohorts can be measured using demographic variables. This work combines traditional socioeconomic variables with a perspective of comparing residents of these communities to their cohorts via their county means. The concept encourages thought about the gap of discretionary income for vulnerable people for daily necessities, savings for post high school education or recreation.

Methodology

A multi-step approach led to the identification of block groups that have populations with lower incomes and greater challenges when viewed compared to state and county means. Ten-mile cordon lines from the centerline of each freeway (IH 35, IH45, IH 10 and US 59 south from Houston) formed the parameters of the study area. The initial step took Texas' state poverty rate of 16% and identified each block group with a poverty rate equal to or higher than the state rate. The next step applied the following demographic variables: minority, female head of household, non-English speaking, county percent in poverty, zero automobiles, and people who are seniors. The latter two variables were not carried forward as their representation in the identified blocks was lower than 3% in all block groups. The next step calculated an index of the sociodemographic variables. Next, the sociographic variable means for each representative county was calculated and compared to the vulnerable block group values.

The Corridors in the Texas Triangle and Along the Texas Gulf Coast

Megaregions are aggregations of centers with aligned economic, energy and environmental interests. Two of the US's primary megaregions are in Texas. The Triangle links Houston, San Antonio, Austin and Dallas and the Gulf Coast links Brownsville, Corpus Christie through Houston to the Texas border with Louisiana. Between the major cities are enclaves of rural and small urban residents, who have inadequate access to education, health care and other services that are readily available in their nearest urban centers. Each triangle corridor will be examined by its sociodemographic characteristics with the index applied comparing them to their county cohorts.

The Triangle: San Antonio to Dallas – (IH 35)

The IH 35 section is in two segments along IH 35 -- San Antonio to Austin and Austin to Dallas.

Figure 2. Texas Triangle

Segment 1: San Antonio to Austin – (IH35)

This study segment between San Antonio and Austin captured 120 block groups, representing 3 counties -- Comal, Hays, and Caldwell. Sorted by the poverty percentage of the state of Texas, 43 of these block groups had a poverty percentage above the state's percentage. Table 1 shows the mean of variables of all the block groups and the block groups by county.

Table 1: San Antonio to Austin

Mean of Variables							
COUNTY	**BLK GRP**	**FHH**	**NES**	**MINORITY**	**POVERTY**	**SENIOR**	**ZERO AUTO**
All counties	43	4.82%	30.67%	57.34%	33.17%	9.18%	2.28%
Caldwell	7	6.36%	38.07%	68.10%	35.06%	10.74%	1.59%
Comal	10	4.52%	30.01%	58.96%	25.68%	12.91%	1.82%
Hays	26	4.52%	28.93%	53.83%	35.54%	7.33%	2.65%

The minority and poverty vulnerabilities are notable for the block groups in all three counties. On average, 57.3% of people in these block groups are minorities and 33.2% live at or below the poverty level. The female head of household, senior and zero auto vulnerabilities' average percentages for all the block groups are insignificant because they are below the state's percentages.

At the county level, block groups in Comal and Hays Counties have greater vulnerability by poverty, minority, and non-English status compared to their counties. The poverty percentage of the 10 block groups in Comal County is 7.49% lower, the minority percentage is 1.62% higher than that of the county. Block groups in Hays County are most vulnerable to poverty status. Their poverty percentage is 2.37% higher than that of the county.

Table 2: IH 35 San Antonio to Austin

Socio-Demographic Indexes				
COUNTY	**VBG FHH Index Value**	**VGB Non-English Index Value**	**VBG Mean Minority Index Value**	**VBG Index Value**
Caldwell	2.7	1.0	1.7	1.8
Comal	0.9	2.9	2.5	2.1
Hays	0.8	2.0	1.1	1.3

The data presented in table 2 reveals distinct vulnerabilities among block groups within specific counties, as indicated by socio-demographic indexes. Notably, Comal County stands out with higher Vulnerable Block Group (VBG) Index values, implying a more precarious situation. This trend is reinforced by elevated Female-Headed Household (FHH) and Minority Index Values, alongside greater challenges faced by non-English speakers, all of which collectively point to areas of concentrated vulnerability within these counties.

Segment 2: Austin to Dallas

Along this study segment, 545 block groups, representing 6 counties, were identified. Sorted by the poverty percentage of the state of Texas, 179 of these block groups had a poverty percentage above the state's average. Table 2 below shows the mean of vulnerability variables of all the 179 block groups and the block groups by county—Bell, Ellis, Falls, Hill, McLennan and Williamson.

Table 3: Austin to Dallas

Mean of Variables							
COUNTY	**BLK GRP**	**FHH**	**NES**	**MINORITY**	**POVERTY**	**SENIOR**	**ZERO AUTO**
All counties	179	6.43%	23.68%	57.43%	30.46%	11.31%	3.27%
Bell	35	6.19%	19.67%	53.10%	30.42%	14.26%	4.27%
Ellis	23	5.62%	26.73%	56.00%	26.00%	12.58%	1.95%
Falls	2	2.41%	20.68%	43.46%	21.51%	16.01%	2.74%
Hill	11	6.17%	22.81%	45.33%	23.79%	13.81%	1.99%
McLennan	86	7.01%	23.86%	62.09%	34.27%	10.20%	3.73%
Williamson	22	5.84%	26.91%	54.87%	24.48%	7.98%	1.99%

Like the San Antonio to Austin study segment, the main vulnerabilities within these block groups are minority and poverty. On average, 57.4% of the population in these block groups comprise minorities and 30.5% live below the poverty level. The female head of household, non-English speaking, senior and zero auto vulnerabilities' average percentages for All the block groups are not significant because they are below the state's percentages.

Comparing the block groups to their respective counties, those in Ellis, Williamson, and McLennan Counties are the most vulnerable. The percentage of people living at or below the poverty level is 3.81% higher and the minority percentage is 4.66% higher for block groups in Mclennan County than all the counties.

Table 4: IH 35 Austin to Dallas

Socio-Demographic Indexes				
COUNTY	**VBG FHH Index Value**	**VGB non-English Index Value Index**	**VBG Mean Minor-ity Index Value**	**VBG Index Value**
Bell	0.7	1.8	2.1	1.5
Ellis	0.8	2.6	1.3	1.6
Falls	0.1	1.9	1	1
Hill	0.9	2.5	1.2	1.5
McLennan	0.0	2.3	1.5	1.3
Williamson	1.1	2.4	1.3	1.6

The examination of block groups located along the I-35 corridor stretching from Austin to Dallas demonstrates a consistent trend: apart from Falls County, these groups tend to have an average index above 1, indicating their increased susceptibility compared to their peers. This evaluation emphasizes the importance of socio-demographic indicators in recognizing and describing vulnerable block groups, thereby highlighting areas that necessitate focused assistance to enhance their socio-economic circumstances.

The Triangle: Dallas to Houston – (IH 45)

For this corridor, the sort conducted based on the state's poverty percentage yielded 87 vulnerable block groups within the 11 counties. Table 3 shows the mean of the vulnerability variables of all the block groups and the block groups by county – Freestone, Grimes, Henderson, Houston, Kaufman, Leon, Madison, Montgomery, Navarro, San Jacinto and Walker.

Table 5: Dallas to Houston

Mean of Variables							
COUNTY	**BLK GRP**	**FHH**	**NES**	**MINORITY**	**POVERTY**	**SENIOR**	**ZERO AUTO**
All counties	87	6.29%	22.05%	46.54%	28.18%	14.05%	2.99%
Freestone	6	6.85%	14.27%	45.41%	25.73%	17.34%	3.09%
Grimes	1	9.91%	3.68%	13.28%	35.35%	12.09%	1.62%
Henderson	1	5.02%	12.45%	20.19%	22.64%	11.73%	0.40%
Houston	1	2.25%	4.51%	15.27%	23.53%	32.92%	4.63%
Kaufman	1	3.69%	3.25%	9.54%	41.21%	29.28%	0.00%
Leon	7	4.77%	12.45%	20.34%	23.39%	21.86%	0.86%
Madison	5	5.78%	18.86%	36.28%	21.48%	18.93%	4.30%
Montgomery	33	6.39%	32.09%	54.04%	27.69%	10.66%	1.71%
Navarro	17	6.89%	19.50%	53.89%	28.06%	16.67%	6.72%
San Jacinto	1	1.93%	22.12%	46.52%	19.57%	11.26%	0.25%
Walker	14	6.64%	15.32%	46.33%	35.21%	9.89%	2.63%

Although the non-English speaking, minority, and poverty vulnerabilities account for the highest percentages for all these block groups, compared to the other corridors studied within the Triangle, these percentages are relatively lower. Only poverty vulnerability is significant for these block groups since it is higher than the state's poverty percentage. The minority and non-English speaking average percentages are below the state's averages.

Comparing vulnerability of these block groups to their county's variance shows difference in Kaufman, Montgomery Counties. The vulnerable block group in Kaufman County has a 13.03% higher poverty percentage and a 15.23% higher senior percentage than that of all counties. Block groups in Montgomery County have a 7.5% higher minority percentage and an 10.04% higher non-English speaking percentage.

The female head of household and zero auto vulnerabilities' average percentages for all the block groups are insignificant. In the percentages were slightly above or below those respective counties.

Table 6: IH45 Houston to Dallas

Socio-Demographic Indexes				
COUNTY	**VBG FHH Index Value**	**VGB Non-English Index**	**VBG Mean Minor-ity Index Value**	**VBG Index Value**
Freestone	1	1.7	1.1	1.3
Grimes	0.6	0.1	0.2	0.3
Houston	0.1	0.0	0.2	0.1
Henderson	0.4	1.1	0.2	0.6
Kaufman	0.2	0.1	0.2	0.2
Madison	0.7	1.6	0.9	1.1
Leon	0.7	2.1	0.4	1.1
Montgomery	1.2	2.7	1.2	1.7
Navarro	1.0	1.5	3.5	2
San Jacinto	0.2	2.0	0.7	1.0
Walker	1	1.6	1.1	1.2

The tabulated data reveals varying levels of vulnerability among block groups along the IH45 route from Houston to Dallas, particularly in Montgomery County which shows higher values on the Vulnerable Block Group (VBG) Index due to elevated Female-Headed Household (FHH) and Minority Indexes, along with language barriers. These findings highlight socio-economic challenges in these counties and suggest the need for targeted interventions to address these issues. Navarro County shows the greatest vulnerable block groups showing values three time that of their county cohort.

The Triangle: Houston to San Antonio – (IH 10)

In the IH 10 corridor, 160 block groups were captured along this corridor. Sorting the block groups by the state's poverty percentage, 40 block groups from 7 counties had a higher poverty percentage than of the state. Table 7 below shows the mean of the vulnerability variables of all the

block groups and the block groups by county – Austin, Colorado, Fayette, Fort Bend, Gonzales, Guadalupe and Waller.

Table 7: Houston to San Antonio

Mean of Variables							
COUNTY	**BLK GRP**	**FHH**	**NES**	**MINORITY**	**POVERTY**	**SENIOR**	**ZERO AUTO**
All Counties	40	5.43%	35.83%	64.02%	27.54%	16.08%	2.97%
Austin	5	6.34%	24.03%	52.94%	27.75%	12.53%	1.95%
Colorado	3	4.97%	17.86%	41.06%	33.08%	30.54%	0.86%
Fayette	2	3.31%	32.96%	50.23%	17.65%	25.58%	5.07%
Fort Bend	9	3.80%	53.08%	80.01%	23.52%	11.02%	1.30%
Gonzales	1	2.43%	33.10%	45.54%	25.81%	18.81%	3.99%
Guadalupe	17	6.32%	34.36%	64.69%	30.34%	16.85%	4.38%
Waller	3	6.56%	32.93%	69.04%	24.98%	11.07%	1.97%

The non-English speaking, minority, and poverty vulnerabilities are prominent within the block groups. On average, 27% of people in all 40 block groups live at or below poverty level, 64% are minorities, and 35% cannot speak English. Comparing these block groups to their respective counties shows significant vulnerability in Colorado, Fayette, Fort Bend, and Guadalupe Counties. Block groups in Colorado County have a 5.54% higher poverty percentage and a 14.46% higher senior percentage than that of the county.

The female head of household and zero auto vulnerabilities' average percentages for all the block groups are insignificant. The percentages were slightly above or below those of the respective counties.

Table 8 reflects the indexes for this corridor. Fort Bend shows the highest value for poverty at 3.5, although the mean for all counties, except Gonzales, are slightly above 1.

Table 8: Houston to San Antonio

Socio-Demographic Indexes						
County	**FHH**	**NES**	**Minority**	**Poverty**	**Elderly**	**Mean Index**
Austin	0.5	0.3	1.3	3.0	0.6	1.1
Colorado	0.4	0.8	0.9	3.7	1.4	1.4
Fayette	0.3	1.4	1.7	1.8	1.0	1.2
Fort Bend	0.4	1.7	1.1	3.5	0.9	1.5
Gonzales	0.1	1	0.8	1.9	1.1	1.0
Guadalupe	0.3	1.9	1.2	2.9	1.2	1.5
Waller	0.5	1.2	1.2	2.0	0.9	1.2

Gulf Coast Megaregion: Houston East to Texas State Line

Of the 292 block groups that are within 5 miles either side of the IH 10 East Corridor centerline, 142 are vulnerable by having a poverty mean higher than the 16% Texas mean. Table 9 shows Chambers County with 6 block groups, Jefferson County with 107 block groups, and Orange with 29 block groups. The most prevalent vulnerabilities within the block groups are minority, poverty, and non-English speaking. Of the 142 vulnerable block groups Jefferson County has the highest mean minority and poverty percentages (76% and 33% respectively) and has a 24% non-English speaking population.

When viewing means percentages and ranges Chambers County shows the second highest mean poverty percentage of 26% and has 50% minority and 21% non-English speaking mean percentages. Lastly, Orange County with the lowest mean poverty percentage (25%) has 27% minority and 6% non-English speaking mean percentages. For the least prevalent vulnerabilities (senior population, female headed households, and zero automobile), Orange County has the highest mean percentage of senior population (18%), and Jefferson County has the highest mean percentage of both females headed households (8%) and zero automobile (9%).

Table 9: IH 10 Houston to East to Texas State Line

Mean of Variables							
County	**Number of Block Groups**	**Female Headed**	**NES%**	**Minority**	**Poverty**	**Senior**	**Homes w/Zero Autos**
Chambers	6	4%	21%	50%	26%	17%	2%
Jefferson	107	8%	24%	76%	33%	14%	9%
Orange	29	7%	6%	27%	25%	18%	3%

When viewing indexes for these three counties, all the vulnerable block groups show higher values across the variables than the county averages.

Table 10: IH 10 Houston to East to Texas State Line

Socio-Demographic Indexes							
County	**VBG Non-English Mean**	**% County Non-English Mean**	**VBG Non-English Index Value**	**% VBG Mean Minority**	**% County Mean Minority**	**VBG Mean Minority Index Value**	**VBG Index Value**
Chambers	21	16	1.3	50	28	1.8	1.6
Jefferson	24	20	1.2	76	59	1.2	1.2
Orange	6	5	1.2	27	20	1.4	1.3

Gulf Coast Megaregion: Houston to Brownsville

The study area spanned 328 block groups of 16 counties. Sorted by the poverty percentage of the state, 165 of these block groups had a poverty percentage above the state's average.

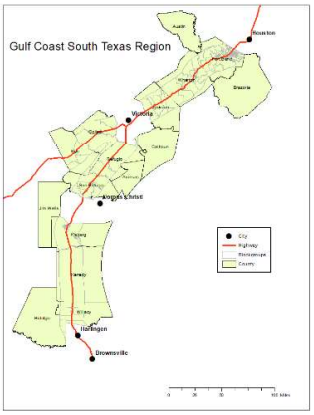

Figure 3. Gulf Coast Megaregion Corridor

Figure 2 reflects this corridor and the affected blocks. Table 11 below shows the mean of variables of all the block groups and the block groups by their respective county – Bee, Fort Bend, Goliad, Hidalgo, Jackson, Kennedy, Kleberg, Refugio, San Patricio, Wharton, and Willacy.

Table 11: Houston to Brownsville

Mean of Variables							
COUNTY	**BLK GRP**	**FHH**	**NES**	**MINORITY**	**POVERTY**	**SENIOR**	**ZERO AUTO**
All counties	165	5.92%	39.67%	73.96%	39.73%	13.17%	2.48%
Bee	2	4.93%	38.07%	65.36%	21.39%	16.80%	2.64%
Fort Bend	89	5.55%	36.47%	69.73%	47.63%	12.03%	1.80%
Goliad	2	3.24%	15.06%	53.55%	24.48%	19.26%	1.41%
Hidalgo	9	5.40%	73.68%	97.7%	36.30%	10.56%	2.31%
Jackson	3	6.77%	27.25%	60.6%	22.13%	10.79%	3.06%
Kennedy	1	6.99%	58.24%	71.3%	22.76%	15.77%	1.97%
Kleberg	14	6.98%	44.41%	87.48%	31.93%	13.71%	4.51%
Refugio	3	7.63%	27.53%	60.8%	27.14%	19.69%	3.58%
San Patricio	10	6.86%	46.80%	80.4%	24.80%	15.23%	3.35%
Wharton	17	6.11%	24.32%	63.0%	29.59%	15.85%	4.16%
Willacy	15	6.56%	53.70%	89.7%	35.26%	14.34%	2.12%

Analyzing the block groups, the poverty, minority, and non-English speaking vulnerabilities are noteworthy. On average, 39.7% of people within these block groups are below the poverty level, 74% of people identify as minority, and 39.7% do not speak English. These three percentages are higher than the state's percentages indicating greater vulnerability within these block groups. The senior, female head of household (FHH), and zero auto vulnerabilities' average percentages are relatively lower than the state's percentages and therefore do not show significant vulnerability.

Further examining the block groups by county, they are still most vulnerable by poverty, minority, and non-English speaking status. The significantly vulnerable block groups are in Fort Bend, Hidalgo, and Willacy Counties. Compared to the entire county, the poverty percentage. of the 89 vulnerable block groups in Fort Bend County was 7.9% higher

The minority vulnerability in the 9 block groups in Hidalgo County is exceptional because it is 23.74% higher than that of the entire county.

Table 12: US 59 Houston to Brownsville

Socio Economic Indexes				
COUNTY	**VBG FHH Index Value**	**VGB Non-English Index Value**	**VBG Mean Minor-city Index Value**	**VBG Index Value**
Bee	0.3	1.5	6.7	2.8
Fort Bend	3.7	1.5	4.1	3.1
Goliad	0.5	1.2	3.6	1.8
Hidalgo	1.7	6.1	2.0	3.3
Jackson	0.2	1.4	0.9	0.8
Kenedy	0.5	2.7	0.8	1.3
Kleberg	0.6	1.7	3.4	1.9
Refugio	0.2	2.3	2.6	1.7
San Patricio	0.3	1.4	5.5	2.4
Wharton	0.3	1.4	5.5	2.4
Willacy	0.2	0.8	10.4	3.8

The analysis of data collected from the US 59 route connecting Houston and Brownsville shows notable disparities among block groups across various counties. These differences are evident when examining socio-demographic indicators, which represent distinct vulnerabilities within each group. The Vulnerable Block Group (VBG) Index values in Fort Bend, Hildalgo, and Willacy are significantly higher than those in other counties. This means these specific block groups have a higher level of vulnerability.

Chapter 5 Summary

The challenge of meeting transportation needs for individuals in non-urban communities is highlighted in the U.S. Department of Transportation's Beyond Traffic 2045 report (USDOT, 2017). The existing ways to define and classify the welfare of a community are vast but are typically comprised of variables that are socio-demographic. This research expands the traditional method of querying the socio-demographic variables by identifying vulnerable communities that align the freeway corridor linkages of Texas' megaregion cities and compares the vulnerable community characteristics with their county cohorts. The question is whether the gap between vulnerable residents in rural and small urban communities and others in their counties can be measured using demographic variables. This work combines traditional socioeconomic variables with a perspective of comparing residents of these communities to their cohorts via their county means. The concept encourages thought about the gap of discretionary income for vulnerable people for daily necessities, savings for post high school education or recreation after funds are expended on housing, food and transportation.

All Counties' Indexes

The compilation of the corridor summaries is shown in Tables 13 through 15.

The Triangle is reflected in the first three tables.

Table 13: Triangle IH 35

Corridor & Counties	VBG Index
IH 35: San Antonio/Ausin to Dallas	
Caldwell	1.8
Comal	2.1
Hays	1.3
Bell	1.5
Ellis	1.6
Falls	1
Hill	1.5
McLennan	1.3
Williamson	1.6

Table 14: Triangle IH 45

Corridor & Counties	VBG Index
IH 45 Dallas to Houston	
Freestone	1.3
Grimes	0.3
Houston	0.1
Henderson	0.6
Kaufman	0.2
Madison	1.1
Leon	1.1
Montgomery	1.7
Navarro	2
San Jacinto	1.0
Walker	1.2

Table 15: Triangle IH 10

Corridor & Counties	VBG Index
IH 10: Houston to San Antonio	
Austin	1.1
Colorado	1.4
Fayette	1.2
Fort Bend	1.5
Gonzales	1.0
Guadalupe	1.5
Waller	1.2

San Antonio through Austin to Dallas, almost all block groups exhibit more of the collective socioeconomic vulnerability traits than cohort in their respective counties. The exception is Falls County where these residents match the meaning of their county. The greatest variance is in Comal County where the blocks show more than double the values on the socioeconomic variables compared to the mean of their county.

From Houston to Dallas, the opposite situation is observed. Four of the counties show that residents proximate to the IH 45 corridor reflect fewer of the socioeconomic variables than their county cohorts. This study did not examine whether an entire county was below the mean, so that question is not answerable through the data pulled here. What is known is that these residents do not show vulnerability characteristics that would warrant mobility attention more

than being viewed for other persons in their county. Of the values that are over one, the highest is Navarro County that shows an index of 2.

Looking at the Gulf Coast megaregion from Brownsville to the Texas State Line shows all counties, with the the exception of Jackson, show index values above 1. The highest two are in Fort Bend and Willacy Counties, both having values in excess of 3 and Willacy at 3.8 approaching 4.

Table 16: Gulf Coast IH 10 East

Corridor & Counties	VBG Index
IH 10 Houston East to Texas County Line	
Chambers	1.6
Jefferson	1.2
Orange	1.3

Table 17: Gulf Coast Houston to Brownsville

Corridor & Counties	VGB Index
IH 59/69: Houston to Brownsville	
Bee	2.8
Fort Bend	3.1
Goliad	1.8
Hidalgo	3.3
Jackson	0.8
Kenedy	1.3
Kleberg	1.9
Refugio	1.7
San Patricio	2.4
Wharton	2.4
Willacy	3.8

The research conducted confirms that many communities of rural residents are in poverty and they have fewer financial resources than the mean in their respective counties. The socio-

demographic data also demonstrate their characteristics known to be associated with systemic societal disenfranchisement. This team identified the block groups for assessment with the concept of recommending line-haul linkages via public or micro transportation enabling better access for less cost than owning a personal automobile for these residents. Increased opportunity to travel to a nearby megaregion urban area, materially increases educational, job, health care and other opportunities for communities are detached from these type of amenities readily available in urban areas. The idea that these persons in these communities are subjected to cyclical, iterative separatism by virtue of distance and lack of public transportation options belies a generational hindrance to advancement.

Potential Remedies

This work only pulled data from block groups within 5 miles of a major interstate highway leading to the proximate urban area. The rational was to investigate communities close enough to result in a line-haul ride from the community to the nearby urban. It is not envisioned that communities deep into a county would yield a positive demonstration for this concept. The emergence of micro-mobility and transportation network companies (TNC) (e.g. Uber, Lyft) offer contemporary concepts that might be modified to meet rural residents' public transportation needs. The TNC model connects people having a travel need with a driver and vehicle that can meet that trip. These new ideas can be merged with more established means to enhance the potential for travel by persons living in the vulnerable rural communities. Because many of the communities are remote distances from the nearby urban, the concepts below are intended to connect travelers to the outer ring of the urban where they would transfer to the urban areas public transit provider. Or, the trips from the rural counties could focus only on connecting the

eligible residents with locations in the urban areas' outer ring. Three conceptual options are described.

County Operated Trip Linkages: A county could mimic the TNC model setting up a computer-based linkage for trips in their county from the studied block groups. The group ride option could be pursued lowering the cost for an individual trip. Passengers would summon a trip as in Uber/Lyft scenarios that would ferry them to the urban. This option would be expensive on a per ride basis. Subsidy could be sought as part of the operational strategy used by many urban transit systems. This option is best suited for medical or occasional trip needs, not as in a daily commute.

Subscription Bus Service: Employers or educational institutions located in an urban area's peripheral boundary or group of employes (as in a mall or regional employment area) could consider a subscription bus service. This option would work for a daily commute needs.

Rideshare Option: A carpool/vanpool option could work well for daily commute needs in a fairly proximate rural area. Employers or educational institution could sponsor networks facilitating connections between riders who reside in the block groups identified in this research. Not only would there be mobility benefits for the users, but suppliers of the service might benefit, as well.

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