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Developing a Methodology for Projecting Intercity Commuting

by

Carol Abel Lewis, Ph.D.
Professor and Director, CTTR
and

Vincent Hassell, Graduate Student Researcher

Veronica Green, Graduate Student Researcher

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Southwest Region University Transportation Center
Center for Transportation Training and Research
Texas Southern University
3100 Cleburne
Houston, Texas 77004

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ABSTRACT

Texas agencies are investigating passenger rail options in several corridors connecting people between the state's major cities. Popular thinking is that there is commuter travel between a number of these markets. In specific, Austin to Houston and Dallas to Houston rank as highly desirable connections to be made by passenger rail. There has been significant study of corridors linking Austin, Dallas and San Antonio; but little research considers the State Highway 290 corridor that would link Houston to Austin. A tool to project the commuter travel between these cities would be beneficial for Metropolitan Planning Organizations (MPOs) and local transit authorities. This research seeks to assess existing methodologies, and then modify, develop and recommend for testing a methodology to determine the volume and frequency of commuter travel between these markets.

EXECUTIVE SUMMARY

Commuter trip lengths are increasing across American communities. Some of this travel is occurring between cities. Of interest to the transportation professional is the capacity to predict these movements and link them with appropriate mobility options. For regions considering high speed rail or lower speed regional rail, these potential commuting trips could be a regular component of daily travel. Literature and data regarding intercity travel are difficult to find. Some studies have been conducted about intercity commuting that apply a gravity model; another study used a GIS based approach. Other researchers adapted the traditional 4-step model and others crafted a series of trip purpose equations.

A significant amount of travel occurs between Texas' major cities, especially those known to be in what's known as the Texas Triangle (Austin, Houston, Dallas, and San Antonio). Previous work looked at the corridor from San Antonio through Austin to Dallas, but the same level of study had not been conducted for the other corridors. Analysis is underway by local governments on a possible passenger rail connection from Austin toward Houston and from Houston toward Austin. A small section in the middle could be completed to connect these two extents. Also, a private company is planning a high speed rail option between Houston and Dallas and the Texas Department of Transportation (TxDOT) is considering a high speed rail line into Oklahoma along IH 35.

This research did not show consistently applied software or a demand estimation process that is in use nationally. It may be that an amalgam of reasonable components should be layered to obtain the most accurate projection of demand for Texas corridors. The traditional four step approach or an activity based method would likely yield useable results, but would be time and resource intensive. The Virginia method, termed sketch planning, would provide a starting point to estimate the potential volume of travelers between Houston and Austin. Successful outcomes would add to the available methods for planners seeking to conduct initial analyses prior to investing larger financial and time allocations.

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Background

The majority of work investigating commuting covers home to work trips within cities. Across the years and observed with increased frequency during the economic downturn of 2008 and 2009 was the tendency for people to commute between cities. Of interest to the transportation professional is the capacity to predict these movements and link them with appropriate mobility options. For regions considering high speed rail or lower speed regional rail, these potential commuting trips could be a regular component of daily travel. Some studies have been conducted examining intercity commuting. Ogura (2010) applies a gravity model to California cities to assess intercity travel between cities with controlled growth policies compared to those with less restrictive growth policies. The author found that growth managed cities tend to attract intercity commuters. Simini et al. (2012) reviewed this research using a tool termed a “radiation model” to project travel between the California cities. The characteristics of their model relied less on distance between the cities (as does the gravity model) and more on densities of the areas. The radiation accounts for people’s job choice as a function of proximity and benefits. It allows for longer commutes if fewer jobs in their own area meet their needs. Still, like Ogura, they confirmed higher volumes of commuters to destinations that have stronger policies restricting residential growth.

In Texas, the Geographic Information System (GIS) was used to predict intercity commuter travel between San Antonio and Austin (Zhan and Chen, 2009). The research examined patterns between rural and urban communities and county to county travel using the 2000 Census Journey-to-Work data as a base data source. The research team found that the GIS-based analysis models are effective for analyzing commuting patterns and travel corridors. Commute flows between urban and rural areas account for about 20 percent of the total commute traffic in the study area and inter-county commute accounts for 13 percent of the total commute traffic.

The previously applied methodologies and potential new methods will be reviewed as a part of this research in order to determine an appropriate strategy for understanding commuter volume and patterns. Literature and data regarding intercity travel are difficult to find. Transportation planners and decision makers would benefit from a greater level of knowledge about the nature, frequency and volume of commuter travel in south and southwest Texas. Greater efficiencies could, then, be sought in short and long term planning for roads, airways, bus or planned high speed rail.

A significant amount of travel occurs between Texas’ major cities, especially those known to be in what’s known as the Texas Triangle (Austin, Houston, Dallas, and San Antonio). Previous studies looked at the corridor from San Antonio through Austin to Dallas, but the same level of study has not been conducted for the other corridors. Analysis is underway by local governments on a possible passenger rail connection from Austin toward Houston and from Houston toward Austin. A small section in the middle could be completed to connect these two extents. Also, a private company is assessing a high speed rail option between Houston and Dallas and the Texas Department of Transportation (TxDOT) is considering a high speed rail line into Oklahoma along IH 35. A tool to project the commuter travel between cities would benefit MPOs and local transit authorities that need to anticipate transfers and mobility once passengers arrive at

these cities. As more intercity connectivity is under discussion around the country, such a tool would benefit other city pairs with significant intercity commuters.

One phenomenon of the past several decades is a change in how Americans view their work trip. As residences and jobs moved further from the urban core, commute trip lengths increased showing that people are willing to live great distances from their jobs (Figure 1). Average trip length during that period increased, as did average travel time, while travel speeds decreased. Texas, while not leading the nation with the longest commutes, exhibits characteristics that show commuters already traveling long distances to work. Figure 2 shows several areas of the state where commuters are mega-commuting, traveling more than 50 miles or taking more than 90 minutes to get to their jobs. Regional rail capable of serving these trips would shorten travel time and bring more jobs within the 90 minute time window.

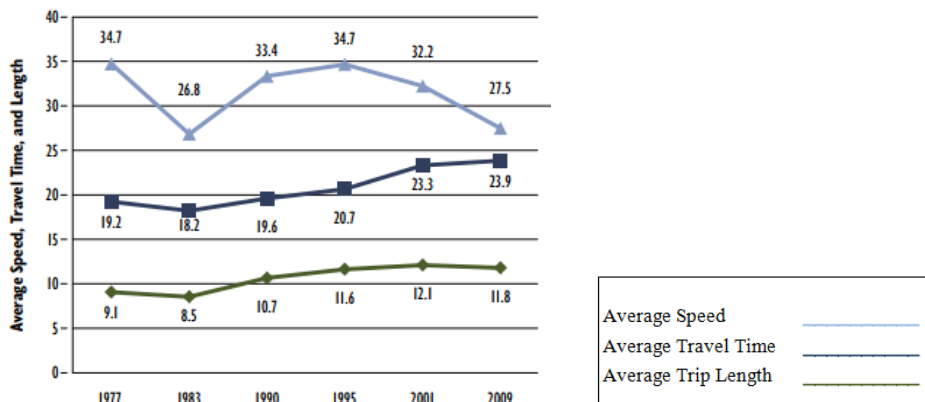


Figure 1. Average Speed, Travel Time and Trip Length
Source: Data from US Census, ACS 2009

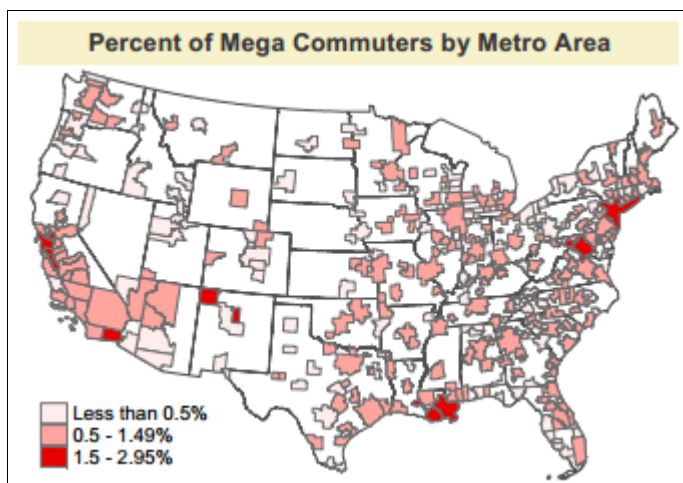


Figure 2. Percent of Mega Commuters by Metro Area
Source: Rapino and Fields (2013)

Persons who commute between cities are the ultimate example of person's accepting mega-commuting. Reasons for intercity commuting are numerous, but may include past years of a lagging economy resulting in more individuals finding available jobs outside their local areas,

the inability to sell a house and/or the two career person households, where both individuals are on upwardly mobile tracts. A casual conversation about intercity commuting often elicits examples of people known personally who travel daily or weekly to a work location beyond the area of their residence. In addition to the regular home to work travel, Texans have biennial work related trips to Austin during the meeting of the Texas legislature. There is undoubtedly a travel spike during the legislative session, but even throughout the year, it is likely a number of residents travel regularly to and from the state capital for business. Austin is also the location of the University of Texas, the state's largest academic institution.

Research Objectives

Literature and data regarding intercity travel are difficult to find. Transportation planners and decision makers would benefit from a greater level of knowledge about the nature, frequency and volume of commuter travel in south and southwest Texas. Greater efficiencies could, then, be sought in short and long term planning for roads, airways, bus or planned high speed rail. The goal of this research is to determine the most suitable methodology to project intercity commuter travel. Specific objectives will be to assess intercity travel between Houston and Austin. Findings can then be applied to continuing study of travel between Texas cities.

Methodology

The process for conducting this work is two-fold. First, literature is reviewed to determine methodologies used in previous intercity assessments, within and outside Texas. Second, the study team compared the characteristics of the city pairs designated for this analysis and identified similarities and differences that might render models identified through the literature suitable or not. Lastly the work was compiled into the final report. There are a number of key questions to address, but a central one is whether a more traditional software series, reflective of the historical 4-step process is best or one that mimics the more contemporary activity based formats. Literature to examine in greater detail include, but are not limited to, reports described below.

Current Travel Between Texas Megaregion Cities

Houston is the fourth largest city in the US and is surrounded by vibrant and growing suburbs. Austin is the seat of Texas government with a legislature that meets biennially. Between 2010 and 2035, the population of the region is projected to increase by 86% to 3.2 million people. The Capital Area Metropolitan Planning Organization (CAMPO), the Metropolitan Planning Organization (MPO) 2035 plan shows a green line commuter service from Austin to Elgin which is 26 miles. There are 165 miles between Austin and Houston. The Houston area's Gulf Coast Rail District is examining options along the US 290 corridor to roughly Prairie View 48 miles. About 90 miles would connect the planned sections between Austin and Houston. Although not necessarily viewed as high speed, the connection is important.

Several studies are currently in progress examining high speed rail for portions of Texas cities in what is known as the Triangle – San Antonio, Austin, Dallas/Fort Worth and Houston. While the rail design is for all trip purposes, if constructed, not only would intercity commuting be accommodated, but rail may serve to incentivize such trip making. Rail corridors, notably along the east coast have served intercity commuters for decades – key among them, the Boston, New York to Washington, DC corridor served by Amtrak. Lessons may be learned from these cities and also from intercity commuting corridors between cities in California.

The previously mentioned Texas Triangle is a part of the international megaregions' discussions indicating the interdependence of these cities from economic, energy, environmental, and infrastructure perspectives (Amekudzi et. al., 2007). These cities may often be viewed in tandem from the perspective of world trade networks. Current travel options between the Triangle cities are the automobile, air, and the long-time intercity bus company, Greyhound. More detailed information about travel volumes requires more intensive investigation, but a view of scheduled service reflects the relative share of travel by mode (Figures 2 through 4). Trip purpose is not reflected, nor is the impact of recent entrance into the market by the company, Megabus. Consideration should be given to how greater attention to the megaregions' concept would impact intercity commutes.

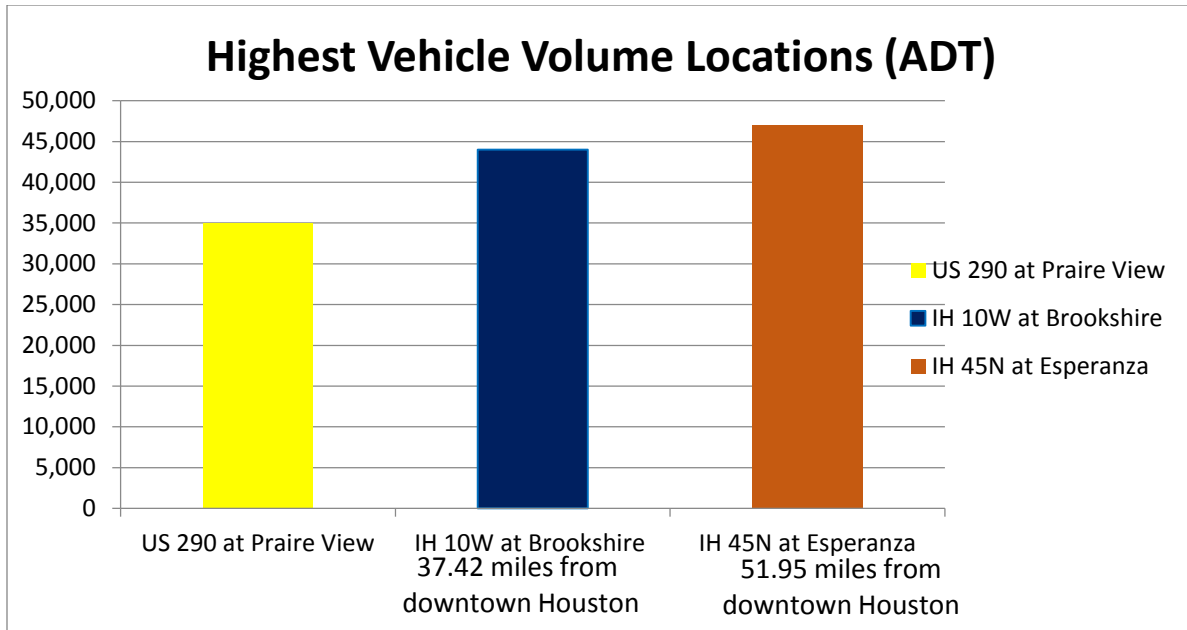


Figure 3. Highest Weekday Volumes on Texas Roadways from Houston
 Source: TxDOT 2013.

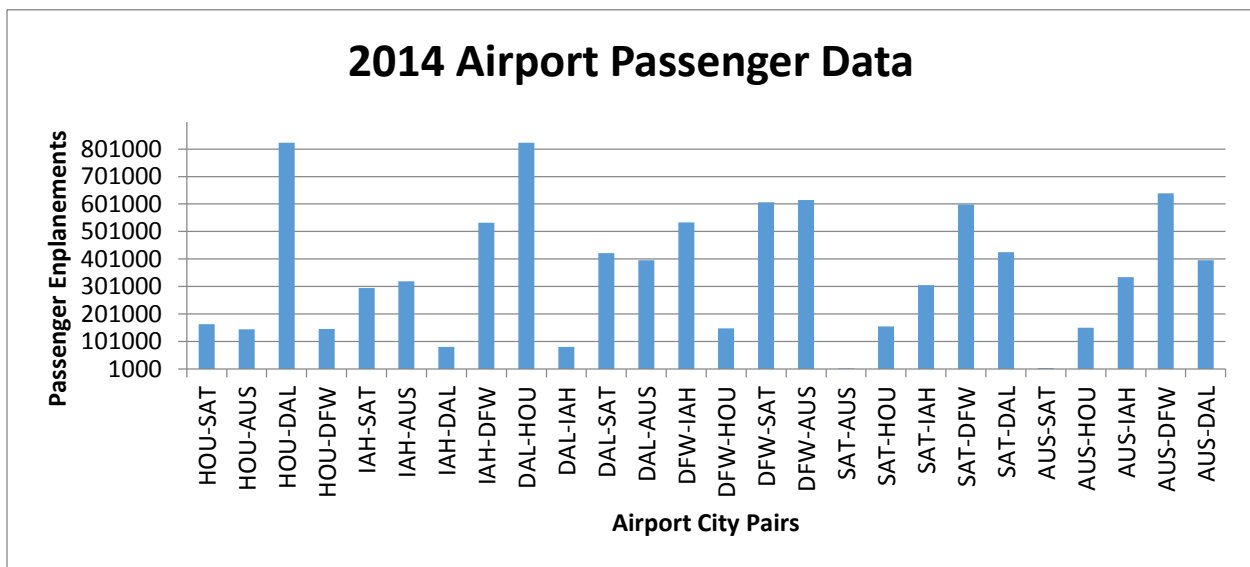


Figure 4. Weekday Scheduled Trips by Air
 Source: Data from BTS, Air Carriers T-100 Domestic Market

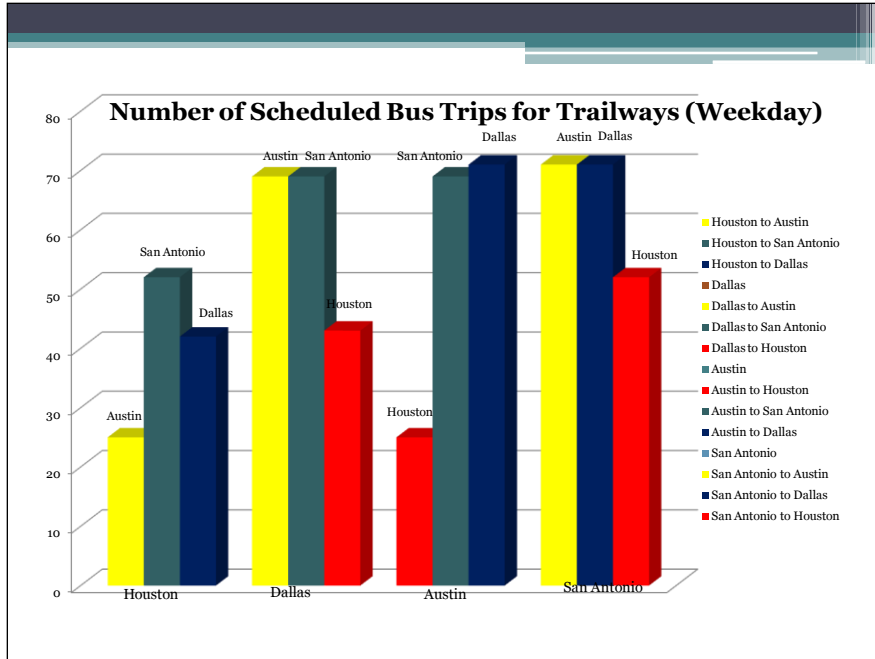


Figure 5. Weekday Scheduled Trips for Greyhound/Trailways Bus Service

Framework of Demand Models

High Speed Rail (HSR) provides an innovative mode choice, allowing passengers to travel significant distances quickly. When effectively utilized, high speed rail transports a multitude of people, promotes regional connectivity, enhances opportunities for citizens while reducing the region's carbon footprint. In many ways, however, the practice of estimating demand is starting anew with the best way to predict intercity travel and why. In general, the prevailing practice has been to apply the 4-step model process largely developed for intracity travel and adapt the model for intercity. Additional investigation is necessary to optimize connectivity and present a more precise and confident demand forecasting method for intercity rail scenarios.

Methodologies of transportation demand estimation are highly evolved from the standpoint of projecting intracity (internal) travel and even intercity highway travel. However, the attention to intercity travel by public transportation for commuting purposes (especially when analyzing by conventional transportation demand software models) has not had extensive vetting. There is a need to explore the application of existing models as they have been utilized to predict intercity commutes and other regular travel to determine the experiences of these models and their potential for application in south and southwestern Texas corridors.

Two approaches of intercity travel demand projections, formed from several foundations, include economical/behavior and psychometric/attitudinal.

- Economical/Behavior Approach - incorporates the utility maximization assumption of neo-classical economics and models travel demand decisions as problems in micro-economic consumer choice among discrete alternative (Domencich & McFadden, 1975).
- The Psychometric/Attitudinal Approach - models travel decisions by incorporating attitudes affecting choices among alternatives (Golob & Dodson, 1974).

The most common methods are stated response, revealed preference and the Delphi technique. The introduction of stated choice modelling, using the set of established discrete-choice modeling tools routinely applied with revealed preference data, widened the interest in stated response methods in the early 1980's.

- Stated Response: Two broad categories of stated response methodology are stated preference and stated choice.
 - Stated preference gives the respondent a set of attributes that defines a service or mode. The respondent ranks his/her preference accordingly. Stated preference methods are widely used in travel behavior research and practice to identify behavioral responses to choice situations not revealed in the market, which is akin to the situation with high speed rail. The principal drawback with stated preference is that individuals stated preferences may not correspond closely to their actual preference or behavior. There may be divergence because of a systematic bias in the stated preference response (Bosnall, 1983). Importantly, stated preference methodology can represent a mode/service not present in the current market which is critical to the analysis in the SH290 corridor.
 - Revealed preference is a more conservative approach to travel demand and does not offer data regarding a mode or service that does not currently exist, so would not be

recommended for new intercity rail options. It is argued that the revealed preference theory couples the concepts of consumer buying behavior with binary logit (BLOGIT) modeling or the multinomial model to reveal an individual's decision process in choosing a travel mode. Revealed preference methodology uses cost and time analysis to determine an individual's modal choice and consumers' actual travel behavior. The essence of revealed performance is in making the choice to drive and get the benefits or not (Shaw, 2005).

Wardman (1988, 2005) argues for a combination of stated preference and revealed preference. He posits that for both the revealed preference and the stated preference analysis, choice is deemed to be based on the neo-classical theory of consumer behavior. Individuals are assumed to maximize utility subject to their available time and income. The external validation test undertaken in transport research includes the comparison of revealed and stated preference models' travel behavior with comparison of market shares/individuals choices predicted by examples of modes currently observed in practice.

The most popular methodology for predicting travel demand is the 4-step process. Underlying the 4 steps is the concept of the gravity model, which theorizes that trips between zones are directly proportional to the attraction of each of the zones and inversely proportional to some function of the spatial separation between zones. Many iterations and upgrades have been done since the concept was first developed in the 1920s (Federal Highway Administration, 1983). The gravity model creates parameters that are based upon reasons people make trips (i.e. work, shopping, leisure) incorporates travel time, costs and other variables.

Quite a few transportation professionals advocate the activity based models for demand estimation. The activity-based approach to travel demand analysis views travel as a derived demand; derived from the need to pursue activities distributed in space (Jones *et al.*, 1990). The approach adopts a framework that recognizes the interactions in activity and travel behavior. This approach is linked to the idea that to participate in activities is more basic than the travel that some of these participations may entail. (Bhat and Koppelman, 1999). The activity based approach requires extensive data scrutiny to construct sequences of activities and travel which may or may not be available for the intercity scenarios.

State of the Practice

In many ways, the best state of the practice for high speed or regional rail in the US is reflected in the analysis and peer review for the California High Speed Rail system. California has published a very detailed approach to modeling for high speed rail. They propose integrating the traditional 4-step model with an interregional model. The interregional model is also comprised of 4 steps, but includes a destination component in recognition of the variation in trip purposes for intercity as compared to intracity trips. Interregional also includes a step for induced trips, important for new transportation markets. The Government Accounting Office (GAO) reviewed the California methodology and despite critiques found the approach to be valid (Outwater, 2010; GAO, 2013).

Virginia developed a multi- step process that began with identification of non-business trips, identification of locations (stations) with anticipated high volume. (In our case an example

might be SH6 where students from Texas A & M would board.) Then, “a singly constrained gravity model was used to estimate the total demand between each station pair. Subsequent equations are used to identify ranges per station (Miller and Thorn, 2009). Table 1 shows a summary of recent models explored to project intercity travel.

**Table 1
Travel Demand Methods to Predict Inter City Commute Travel**

Researcher	Method	Finding	Comment
Ogura (2010)	Gravity Model	Cities with growth management strategies attract commuters	Inference is a jobs/housing imbalance with contribute to inter-city commuting (more jobs in the city than available housing)
Simini et al. (2012)	Radiation Model – Focused more on densities, not on gravity	Cities with growth management strategies attract	
Zhan and Chen (2009)	GIS Based	13% of travel between Austin and San Antonio was inter-county	Not robust enough for longer range city to city travel
BTS (2011)	Connectivity Criteria		To supplement a line haul methodology
GAO-13-304 California High Speed Rail	Traditional 4-Step with Induced Algorithm	Resulted in passenger volumes leading to construction of the line.	Federal review discussed some shortcomings, but method was determined to be solid.
Miller and Barclay (2009)	5-Step Sketch Planning Approach	Joined components of traditional modeling with mode choice variants (include tourist, non-business and college categories)	Enabled forecasting of passenger volumes from station to station.

Connectivity and Distribution to Final Destination

Important to the ultimate demand is the quality and location of the intermodal connections once at the destination. A 2007 nationwide study (Goldberg, 2011) shows that bus is the most frequent vehicle for connecting intermodal services for travelers to reach their destination. In order to optimize connections, links to light rail are desirable, but bus must be viewed as a vital component, as well. The Goldberg study found that a number of Amtrak rail stations are served by Amtrak Thruway, the company’s intercity bus feeder network. When planning for Texas

also important is inclusion of travel by airline. Since Texas is in the position of building in connections from an emerging statewide network, it will be important for the demand estimations to integrate availability of multimodal connections, including air, light rail and bus. Transfers across modes must be available, timely and convenient. Patrons must feel safe and the connecting walk must be pleasant and interesting. Connectivity criteria are established by US Bureau of Transportation Statistics and can likely be integrated into the projection methodology. Table 2 reflects the number of US intercity rail stations and connectivity with other modes.

**Table 2
Intercity Rail Connectivity with Other Modes**

	With connectivity		Connect with one other mode		Connect with two modes		Connect with three modes		No connectivity		Total stations
	No.	Percent	No.	Percent	No.	Percent	No.	Percent	No.	Percent	
Intercity Rail Stations											
All stations served by intercity rail	277	52.4%	243	45.9%	33	6.2%	1	0.2%	252	47.6%	529
Stations w/ intercity only	189	43.2%	181	41.4%	8	1.8%	0	0.0%	248	56.8%	437
Commuter Rail Stations											
All stations served by commuter rail	812	70.0%	734	63.3%	75	6.5%	3	0.3%	348	30.0%	1160
Stations w/ commuter rail only	724	67.8%	672	57.9%	50	4.3%	2	0.2%	344	29.7%	1068
Joint Intercity/Commuter Stations	88	95.7%	62	67.4%	25	27.2%	1	1.1%	4	4.3%	92

SOURCE: Intermodal Passenger Connectivity Database, U.S. Department of Transportation, Research and Innovative Technology Administration, Bureau of Transportation Statistics. Retrieved from <http://www.bts.gov/> on Oct. 8, 2010.

<http://www.rita.dot.gov/bts/sites/rita.dot.gov/bts/files/publications/special_reports_and_issue_briefs/special_report/2011_01_12/html/table_02.html>

Once arriving at the destination, travelers must be able to access a desired location. Options are public transportation, taxi, personal shuttle, rental vehicle or passenger pick up. Clearly, the more robust the available options, the more attractive the intercity service. In the case of Houston to Austin corridor via US 290, Houston METRO and Capital METRO transit authorities would provide the basic connections. On the Houston end, along the US290 corridor connections would be at one or two locations. The nearest would be near the intersection of Hempstead Highway and IH 10. This area would allow transfers to buses traveling west to destinations along IH10 including the Energy Corridor (home to numerous oil companies like Shell Oil, BP, Citgo and others). A link would also be available to a planned bus rapid transit line into the Uptown and Galleria areas. Previous studies indicate that the highest ridership would be achieved if the rail line continued into downtown, although right-of-way options into downtown would be more difficult to acquire. Express bus trips to downtown will also be available from the Northwest or Hempstead transit centers.

Table 3
Percent of Commuter Rail Stations with Connections to
Other Modes in Communities

(Where Both Commuter Rail and the Other Modes Operate)

MODE	Percentage
Transit Bus	86%
Intercity Bus	37%
Intercity Rail	86%
Heavy Rail	61%
Light Rail	65%
Air Service	22%

SOURCE: Adapted from the Intermodal Passenger Connectivity Database, U.S. Department of Transportation, Research and Innovative Technology Administration, Bureau of Transportation Statistics. Retrieved from www.bts.gov, 2011.

SUMMARY

Early research by TSU did not yield consistently applied software or a demand estimation process that is in use nationally. It may be that an amalgam of reasonable components should be layered to obtain the most accurate projection of demand for Texas corridors. Several studies are currently in progress examining intercity rail that connects several of the city pairs known as the Triangle – San Antonio, Austin, Dallas/Fort Worth and Houston. Higher speed rail would provide an innovative mode choice, allowing passengers to travel significant distances quickly. This research seeks to assess existing methodology, and then modify, develop and test a methodology to determine the volume and frequency of commuter travel between these markets. The traditional four step approach or an activity based method would be time and resource intensive, which are not available to these researchers. The Virginia method, termed sketch planning, would provide a starting point to estimate the potential volume of travelers between Houston and Austin. Successful outcomes would add to the available methods for planners seeking to conduct initial analyses prior to investing larger financial and time allocations. A Texas Southern University student, will apply the Virginia Sketch Planning tool to the US 290 corridor as a thesis research project.

Important to the ultimate demand is the quality and location of the intermodal connections. Further study is needed on the design and accessibility of multi-modal distribution options that would be available at intercity terminal locations for the triangle cities. While the national research reports the priority for bus connections, other modes may have a greater role in Texas, largely because of the comparatively less dense (viewed against East Coast cities) metropolitan areas. While the rail design is for all trip purposes, if constructed, not only would existing intercity commuting be accommodated, but rail may serve to incentivize such trip making.

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