TCRP H-37 CHARACTERISTICS OF PREMIUM TRANSIT SERVICES THAT AFFECT MODE CHOICE: SUMMARY OF PHASE 1

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ABSTRACT

This research seeks to improve the understanding of the full range of determinants for mode choice behavior and to offer practical solutions to practitioners on representing and distinguishing these characteristics in travel demand forecasting models. The principal findings were that the representation of awareness of transit services is significantly different than the underlying assumption of mode choice and forecasting models that there is perfect awareness and consideration of all modes. Furthermore, inclusion of non-traditional transit attributes and attitudes can improve mode choice models and reduce bias constants. Additional methods and analyses are necessary to bring these results into practice.

The work is being conducted in two phases. This report documents the results of Phase I, which included data collection for one case study city, research and analysis of non-traditional transit attributes in mode choice models, awareness of transit services, and recommendations for bringing these analyses into practice. Phase II will include data collection for two additional case study cities with minor modifications based on limitations identified in Phase I, additional analyses where Phase I results indicated a need, and a demonstration of the research in practice for at least one case study city.

1. INTRODUCTION

The purpose of the research was to identify and measure the characteristics of premium transit services that affect choice of mode. This led to three primary goals:

- To describe the most important factors that differentiate premium transit services from standard transit services;
- To provide methods to measure the impact of these distinguishing features; and
- To propose ways to incorporate these measurements into regional planning activities.

The factors that differentiate premium service on the decision to choose one mode over another fall into three categories: awareness of transit services, non-traditional transit service attributes (such as real-time information, station and on-board amenities), and traveler attitudes.

This project (Phase I) included a literature review; personal travel and stated preference surveys conducted in Salt Lake City; analysis of awareness, transit attributes and attitudes; and recommendations for bringing these results into practice. This paper discusses each of these activities and their contribution to the overall research. In addition, the paper presents the next phase of work (Phase II), which will include additional surveys for two cities, models to quantify the impact of awareness on mode choice, additional work on transit attributes and attitudes, and an application of the methods for a demonstration city.

2. LITERATURE REVIEW

The literature review is based on a standard academic literature search, interviews with five transit practitioners at agencies around the country, and project examples from the project team, not all of which are published. The literature review centered on the following topics:

- Transit awareness and familiarity
- Identification of transit service attributes
- Applied models

Transit Awareness, Familiarity, and Consideration

The lack of transit awareness and familiarity with transit seems to be significant, though there is not yet abundant research on this topic. For TCRP Report 63 *(1)*, individuals in a variety of transit markets were asked their perception of transit availability; and while all respondents contacted in this study lived in an area with readily available transit alternatives, 21% did not know that transit was available. More than twice that number, 44%, reported being either “not very familiar” or “not at all familiar” with public transportation services in their area. A study for the Regional Transportation Authority for Chicago *(2)* found that 38% of randomly selected residents in the transit service area had not ridden transit in the past year, with 19% reporting they were “somewhat unfamiliar” with transit services and an additional 36% “very unfamiliar” with transit.

An interesting social experiment was conducted at UCLA in the summer of 2008 to get employees to try public transit *(3)*. UCLA provided a free transit pass for 12 weeks in return for turning in their employee parking pass. Researchers found that gaining familiarity with using transit over the 12-week period contributed to the program's success because 62% of former auto drivers were able to become comfortable with routes and schedules, became more relaxed with the experience, and ultimately found the bus less stressful than driving.

Other aspects of awareness include facts such as the introduction of premium transit is often accompanied by targeted marketing campaigns. Marketing has been shown to significantly improve ridership, and while a portion of riders who become aware due to marketing may ultimately choose to ride because of the improved comfort and convenience, the simple awareness of the service likely plays a role in increased ridership. Brog and colleagues *(4)* in particular have detailed the impact of targeted marketing—specifically the Individualized Marketing (IndiMark®) program—on ridership increases. Results from two projects ("Saarbahn," a light rail system in the Saarland region in Germany and the MAX light-rail line in Portland, Oregon) show that soft policies, such as IndiMark, can in fact double ridership.

Lack of awareness, therefore is an important issue that needs to be further researched and explored, as the consequences of assuming all people fully aware of their choices (which is made in forecasting models) means that forecasts can be substantially incorrect. This problem typically gets "solved" by creating very large calibration constants, which greatly diminish the power of the forecast models.

Identification of Transit Service Attributes

There are several attributes known to be important in mode choice decisions and transit customer satisfaction that are not traditionally included in mode choice models. These nontraditional attributes tend to either be qualitative (e.g., comfort and safety) or quantitative but difficult to measure (e.g., reliability). The literature review describes eight studies incorporating nontraditional attributes into transit mode choice studies to understand the techniques being used to estimate these variables. The results of the eight studies yielded the four most important attributes:

- **Reliability -** One study conducted in Australia *(5)* used a stated preference exercise to quantify the impact of various bus stop and onboard service attributes, including reliability. Results showed that the cost from an additional minute of delay was equivalent to 2.1 additional minutes of IVTT. Litman (2008) estimated an additional minute of unexpected delay at 3.7 times the cost of an additional minute of IVTT *(6).* Another study reported that travelers accessing John F. Kennedy International Airport have a value of unreliability ranging from 0.5 to 1 minute of equivalent IVTT per minute of delay incurred 10% of the time *(7).*
- **Station/stop Comfort –** There are several aspects to station/stop amenities: cleanliness *(8), (9), (10);* shelter and seating *(5) (10);* and station building *(9) (10).* One estimate *(10)* values a 10% improvement in on-board time with station amenities at 19% increase in cleanliness, 17% increase for station building, 7% increase for shelter, 5% increase for seating and 5 % increase for the platform surface.
- **On-board Amenities** – Pepper et al (2003) reported that travelers do have a preference for seating with more capacity *(11),* and more comfortable seating *(10).* In Chicago, seatless buses were preferred only on crowded buses *(12).* Douglass et al (2006) found that a train at full capacity (200% load factor) increased the cost of IVTT by 74% *(10).* Litman (2008) found that standing for 20 minutes or longer increased the IVTT cost by 81% *(6).*

- **Real-time Information -** Many studies have examined the ability of real-time service information to mitigate the costs associated with wait time, unreliability, and transfers since it is the uncertainty of arrival that increases the perceived time and therefore the cost of waiting *(13).*

The literature review demonstrates that there is significant research that has been conducted on quantifying and modeling nontraditional attributes. However, the techniques to do so vary considerably and the research is new enough that no standards currently exist on how best to estimate these variables. It is expected that as this research progresses, best practices will emerge on how to most efficiently estimate these variables.

Applying Nontraditional Attributes into the Forecasting Process

Beyond the eight studies reviewed for estimating nontraditional attributes, a different set of eight case studies are described in the literature review on applying nontraditional attributes. These application examples were chosen to represent a cross section of practitioners' efforts to date. Within these eight application studies, nontraditional attributes were applied in the travel forecasting model in seven of the cases *(14), (15), (16), (17), (18), (19), (20), (21).* Two case studies are guidance on accounting for nontraditional attributes in forecasting models *(14), (15).*

The TCRP Report 118—Bus Practitioner's Guide notes that new BRT systems in six cities experienced higher ridership increases than their traditional attributes would normally indicate *(15).* The reasons behind underestimates of premium transit services are not usually known but have been speculated to be related to public perception of safety, heightened awareness, brand visibility, and various service attributes that are measurable but not typically included in most forecasting models.

Given the uncertainty about modal preference and the difficulties of quantifying the underlying factors, practitioners trying to match observed transit usage typically use simplified approaches that try to represent a general preference toward certain modes without explicitly representing the reasons that these preferences might exist. Often this is done by introducing transit mode-specific constants favoring premium modes within the mode choice utility function. The purpose of these constants is to represent the sum of all nontraditional attributes that accrue to travelers who elect to use the premium service during the course of their trip. The value of the incremental mode-specific constant generally varies between 10 and 15 minutes of equivalent transit in-vehicle travel time and reflects the perceived difference between conventional bus and premium modes *(14).*

3. SURVEY

The study's analytical approach involved a three-part survey that was conducted in Salt Lake City, UT for both transit and non-transit users. For the purposes of this study, a frequent transit user was someone who used transit at least once within the last month and an infrequent transit user was someone who used transit at least once in the last year. The **first part** of the survey was designed to gather data on awareness of transit options. The **second part** of the survey presented choice based conjoint (CBC) stated preference mode choice experiments to travelers where they were asked to choose a mode based on different levels of attributes, including some attributes that were constructed as "bundles." The **third part** of the survey used MaxDiff conjoint techniques, which was used to evaluate the individual attributes that make up the bundles. The second and third parts of the survey instrument were designed for the study to use conjoint analysis to measure preferences among transit features. The survey was intended to gather information to research awareness as well as nontraditional attributes.

Response

The survey administration effort yielded an overall dataset with just over 2,000 respondents (total 2,017). The survey responses came from the following sources:

- 272 intercepts in Salt Lake City
- 1,445 Utah Transit Authority email database of riders/non-riders
- 300 purchased sample of non-transit users

The survey had three main parts with six specific sections: background, awareness/consideration, specific trip, stated preference experiments, most/least preferred options for transit users, and demographics.

Transit Awareness and Consideration

If respondents identified transit options within walking distance of home, they were asked if they had used those transit types within the last month, the distance (in minutes) to the stop nearest to their home, and the actual location of the closest transit stop. If respondents identified transit options close to home, but had already been determined to be transit non-users (had not used transit in past 12 months), they were asked about their familiarity with the transit schedules, routes available, fare payment options and costs, and whether they knew how to get to their destination using transit even though they chose not to.

If respondents had a car available, they were asked about transit options available at a convenient park and ride. They were then asked whether they had used different transit types within the past month and the locations of the park and ride lots. From this data, the survey was able to determine respondents who identified transit options at a convenient park and ride, who are aware of the transit options, whether or not they use those options, and whether they consider the park and ride convenient. In the next phase, the use of the term “convenient” was dropped because this may be interpreted differently by different people and these questions about awareness and consideration were revised to ask the same questions of all respondents.

Finally, respondents were asked about the transit stop closest to their destination (primarily work and school) and the location of that destination. Transit users were also asked about their familiarity with transit stops and services around their work location.

Stated Preference Experiments and Maximum Difference Scaling

Respondents were next sent through eight stated preference experiments with varying travel time, costs, and transit service features to force choices among three options shown on each page. An experimental design was created that would allow the calculation of value in terms of time (minutes) or in cost (dollars) for all the traditional variables used in demand forecast modeling. Additionally, because the goal of this research was to determine the effect premium vs. standard transit features have on people’s choices and to improve estimations of mode choice models and transit path-builders, bundles of nontraditional variables (premium transit vs. standard transit features) were included in the design to allow calculation of a specific value for each bundle. To ensure respondents would understand exactly what differences exist between premium transit features vs. standard transit features, a clear definition of the features was presented. The bundle definitions used in the survey are shown in Table 1. Following the stated preference section, there was an extensive debrief section to probe for reasons why respondents who never chose a transit option answered as such.

TABLE 1. Bundle Definitions of Premium Transit Variables versus Standard Transit Variables

Bundle Definitions		
On-Board Amenities	Premium	
	1	Vinyl seats
	2	Transit has efficient air-conditioning & heating
	3	Your trip is uncrowded and you have a seat
	4	Train/bus is new & very clean
	5	Seats are comfortable with back and neck support
	6	Transit ride is smooth & quiet
	7	Clear announcements indicate next stop & any delays
	Standard	
	1	Cloth seats
	2	Transit has some air-conditioning & heating
	3	Your trip is crowded and you may or may not have a seat
	4	Train/bus is maintained, but not new.
Station/Stop Amenities - DESIGN	Modernized Station/Stop	
	1	Has bicycle storage
	2	Is well lit and safe
	3	Is well maintained & clean
	4	Has comfortable benches
	5	Is spacious, with good visibility & open sightlines
	6	Has modern looking shelter to protect from bad weather
	7	Has been recently renovated with high-quality materials
	8	Has retail services such as coffee shop, dry cleaners, etc.
	Standard	
	1	Is maintained
	2	Graffeti and vandalization are NOT present
	3	Has some benches
	4	Is safe
Station/Stop Amenities - INFORMATION	Informative Station/Stop	
	1	Signs show minutes until next arrival/departure
	2	Transit routes & schedules are clearly posted
	3	Service change information is posted & announced
	4	Posted routes & schedules are easy to understand
	5	Posted routes & schedules are always accurate
	6	Neighborhood map with streets is clearly posted
	Standard	
	1	Transit routes & schedules are posted
	2	Name of station/stop is visible

All transit respondents were asked to select their most preferred and least preferred transit option of the three options shown on each page. Transit non-users were not directed through this section in this phase of the project, but this was identified as a limitation and so in subsequent surveys conducted in Phase 2, all respondents will respond to these questions. An example of a stated preference experiment and maximum difference (MaxDiff) options are shown in Figure 1. There were a total of 21 premium service attributes. To make the design reasonable for respondents to evaluate, only three of these attributes were shown at a time.

SALT LAKE CITY TRAVEL STUDY

If these were your only choices, which transit option are you MOST LIKELY to use and which are you LEAST LIKELY to use?

Please assume all other aspects of transit service are the same across all of the options.

	Option #1	Option #2	Option #3
Time Riding on Transit	12 mins.	9 mins.	11 mins.
Transit Fare	$0.80	$1.20	$1.00
Station/Stop Distance	More than 10 mins. walk of your home/work	Within 10 mins. walk of your home/work	More than 10 mins. walk of your home/work
Station/Stop Shelter	Effectively protects you from bad weather	Effectively protects you from bad weather	Limited or no shelter
Route Name/Number Identification	Easy to immediately identify on outside of transit vehicle	Difficult to immediately identify on outside of transit vehicle	Difficult to immediately identify on outside of transit vehicle
MOST Likely	○	○	○
LEAST Likely	○	○	○

(Question 1 of 8)

SALT LAKE CITY TRAVEL STUDY

Which option are you MOST LIKELY to choose and which are you LEAST LIKELY to choose for your trip to work?

Please look at each option carefully because choices will change from screen to screen.

Please select one option in each row.

To see a definition, please put your mouse over the ⓘ.

	Option #1: Take the BUS	Option #2: DRIVE	Option #3: Take the TRAIN
Transit Service Features ⓘ	• STANDARD on-board features • STANDARD station/stop • REAL-TIME arrival/ departure info available		• STANDARD on-board features • MODERNIZED station/stop • REAL-TIME arrival/ departure info available
Travel Time	• Walk 5 mins. to station/stop • Wait time: 10 mins. • 10 mins. ride on bus • 1 transfer • 1 in 10 trips experience delay of 5 mins. or more	• 13 mins. drive • 1 in 10 trips experience delay of 2 mins. or more	• Walk 5 mins. to station/stop • Wait time: 20 mins. • 10 mins. ride on train • No transfer • 1 in 10 trips experience delay of 10 mins. or more
Cost	• Transit: $5.50 one-way	• Parking: $11.00 a day • Gas: $4.50 a gallon	• Transit: $9.00 one-way
MOST Likely	○	○	○
LEAST Likely	○	○	○

(Question 1 of 8)

FIGURE 1. Sample Screens from Salt Lake City: Stated Preference Experiment and Maximum Difference Scaling

4. QUANTIFYING PREMIUM TRANSIT ATTRIBUTES

The method to quantify premium transit attributes was to estimate mode choice models and then review the coefficients to determine the weight of the premium transit attributes compared to in-vehicle time. In this manner, transit attributes can be reported in equivalent minutes of in-vehicle travel time, as shown in Table 2 for work trips (non-work trips were also estimated, but not included for brevity). All of the transit attributes identified in the literature review were tested in the mode choice models, except fare payment (which will be tested in the next phase). The mode choice models were developed separately for work and non-work trip purposes so the quantification of transit attributes is separated by trip purpose as well. The mode choice models were nested logit choice models with bus and train as a nested choice and auto as the other choice.

Traditional Attributes

The mode choice models included traditional attributes of level of service, such as in-vehicle travel, access and egress, and wait time, gas cost, parking cost, fares and number of transfers. A review of these traditional attributes shows that the signs are in the expected direction and that the relative values are within expected ranges. These traditional attributes do not necessarily distinguish premium transit services from standard transit services, unless these premium services have different times or costs. In current mode choice models, these attributes are adequately represented.

Non-traditional Attributes

One focus of this study was on incorporating non-traditional transit attributes that can be used to describe premium transit services. The non-traditional attributes that are significant in determining a person's mode choice are reliability, real-time transit information, stop/station amenities and on-board amenities. These attributes were quantified in the mode choice models and are presented in Table 3. Reliability is measured as 1 in 10 trips are delayed.

For purposes of this study, the term "stop" and "station" are used interchangeably and are distinguished by their attributes, which included safety (like lighting and police presence), shelters, proximity to services (like coffee shops, dry cleaners, grocery, restroom, etc.), clean and well-maintained station, clean and comfortable benches, and enhanced security measures (emergency call buttons, surveillance cameras, and security personnel). These amenities were analyzed using maximum difference scaling data from the survey, where respondents make choices between options to show the relative importance of each item. This analysis quantified station amenities as a portion of the total equivalent minutes 5 and 6.4 minutes for work and non-work trips, respectively, as presented in Table 3.

On-board amenities were also quantified based on specific attributes of the transit vehicles: the presence of wireless internet (WiFi), seating availability, seating comfort, effective air-conditioning and heating, and cleanliness of the transit vehicle. These amenities are further quantified as a portion of the total equivalent minutes 3.1 and 5 minutes for work and non-work trips, respectively, also presented in Table 3.

TABLE 2. Mode Choice Model Estimation for Work Trips

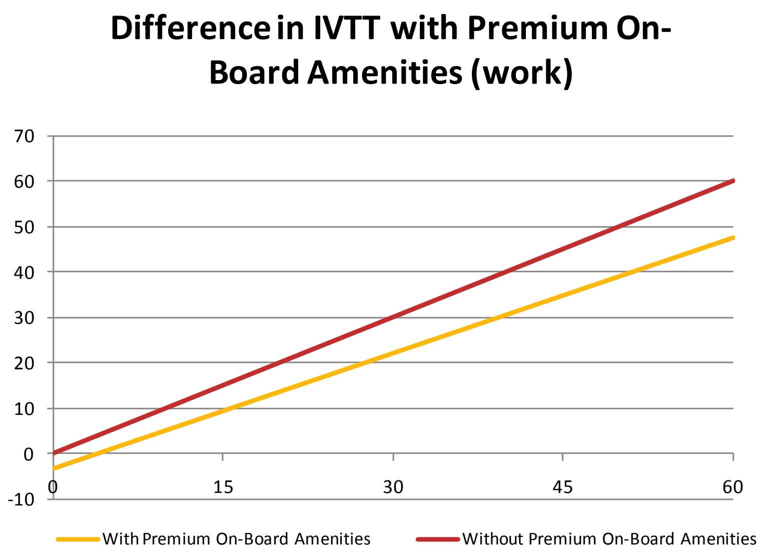
Attribute	Mode Utility Eqn.	Coefficient	Std. Err	t-stat	Value	Notes
IVTT_A (min)	Auto	-0.033	0.005	-6.329		
IVTT_Transit (min)	Bus,train	-0.039	0.006	-6.897	1.165	times IVTT_A
Access time (min)	Bus,train	-0.054	0.009	-6.237	1.610	times IVTT_A
Wait time (min)	Bus,train	-0.053	0.004	-12.212	1.583	times IVTT_A
Trip Gas Cost ($)	Auto	-0.175	0.026	-6.679	11.396	$ per hour
Fare ($ one-way)	Bus,train	-0.405	0.020	-20.488	4.930	$ per hour
Parking Cost ($/day)	Auto	-0.235	0.007	-32.836	8.520	$ per hour
Reliability	All modes	-0.018	0.006	-2.969	0.537	
Transfers (0 = no, 1 = yes)	Bus,train	-0.351	0.043	-8.170	10.527	minutes
Transit Info (0 = no real-time, 1 = real-time)	Bus,train	0.185	0.055	3.363	5.541	minutes
Stop design (0 = standard, 1 = modern)	Bus,train	0.167	0.043	3.846	5.003	minutes
On-board amenities (0 = standard, 1 = modern)	Bus,train	0.125	0.052	2.414	3.740	minutes
IVTT (min) with modern on-board amenities	Train	0.005	0.002	2.156	0.146	times IVTT_A
Wait time (min) with real-time information	Train	0.014	0.006	2.476	0.411	times IVTT_A
Option to work from home (0 = no, 1 = yes)	Train	0.905	0.230	3.932	27.181	minutes
Male (0 = no, 1 = yes)	Auto	-0.121	0.067	-1.800	3.625	
HH income less than 125K (0 = no, 1 = yes)	Auto	-0.236	0.099	-2.381	7.086	
HH income 125K or more (0 = no, 1 = yes)	Train	0.192	0.067	2.859	5.765	
Origin TAZ is rural (0 = no, 1 = yes)	Auto	-0.965	0.495	-1.947	28.955	minutes
Origin TAZ is rural (0 = no, 1 = yes)	Train	0.855	0.385	2.224	25.667	minutes
Transit users inclination factor	Auto	-0.115	0.040	-2.855	3.438	minutes
Transit users service availability factor	Auto	-0.505	0.048	-10.452	15.157	minutes
Auto constant		0.710	0.158	4.484	21.316	minutes
Train constant		0.002	0.061	0.031	0.058	minutes
Bus constant		0.000	fixed			
Auto Nest (Auto)		1.000	fixed			
Transit Nest (Bus, Train)		0.651	0.054	12.129		
Number of observations		32616				
Log likelihood		-5839.594				
Log likelihood (no coefficients)		-10709.120				
R-sqrd		0.455				
RsqAdj		0.454				

TABLE 3. Value of Non-Traditional Transit Service Attribute Measures

	Equivalent In-Vehicle Travel Time Minutes		
Attribute	**Mode**	**Work Trips**	**Non-Work Trips**
Reliability	All modes	0.5	0.8
Transit Real-Time Information	Bus,train	5.5	6.4
Station amenities	Bus,train	5.0	6.4
Station/Stop Lighting/Safety		1.0	0.8
Station/Stop Shelter		1.2	1.5
Proximity to Services		0.9	1.9
Cleanliness of Station/Stop		0.5	0.6
Station/Stop Benches		0.5	0.6
Station/Stop Security		1.0	0.9
On-board amenities	Bus,train	3.1	5.0
WiFi *		0.6	1.0
On-Board Seating Availability		1.3	1.8
On-Board Seating Comfort		0.5	0.5
On-Board Temperature		0.9	1.1
Cleanliness of Transit Vehicle		0.5	0.5
Subtotal		**14.2**	**18.6**
Amenities Interacted with Time Components			
IVTT (min) with modern on-board amenities	Train	0.2	n/a
Wait time (min) with real-time information	Train	0.4	n/a
Traveler Attitudes			
Transit users inclination factor	Auto	3.4	
Transit users service availability factor	Auto	15.2	4.5
Bus users inclination factor (Train Only)	Train		6.5

These transit attributes are assessed as either present (in the case of premium transit service) or not present (in the case of standard transit service). For example, premium transit service that included real-time information, shelters and comfortable seats would provide a 7.3 minute advantage for work trips over standard transit services in the mode choice model that do not include these attributes. If premium transit services included all the above premium service attributes, there would be a 14.2 minute advantage for work trips over standard transit services and 18.6 minute advantage for non-work trips.

There are some transit attributes that are also a function of travel time: on-board amenities as a function of in-vehicle travel time and real-time information as a function of wait time (Table 3). These were not significant for non-work trips. These attributes increase with longer travel trips, as shown in Figure 2. This shows that for a 30 minute in-vehicle time, there would be an advantage of 7.8 minutes for premium on-board amenities and for a 10 minute wait, there would be an advantage of 4.7 minutes for real-time information. This could result in a total of over 26 minutes of equivalent in-vehicle time for a 30 minute trip, with a 10-minute wait, and the full spectrum of premium transit service attributes.



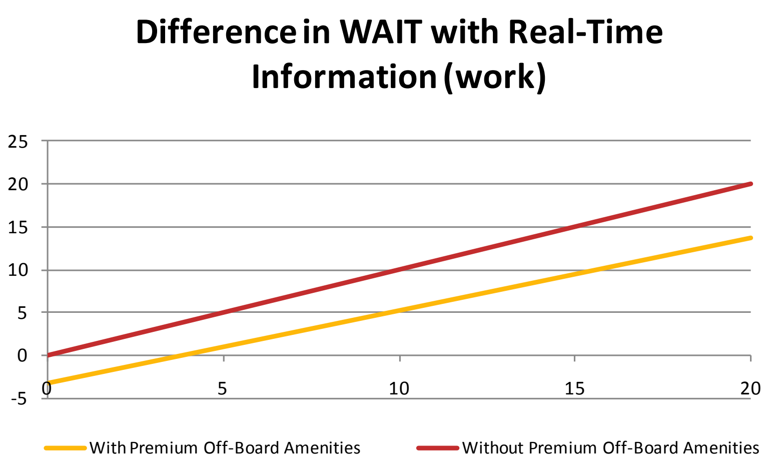


FIGURE 2. Travel Time Interacted with Premium Amenities

Traveler Attitudes

A factor analysis was completed to correlate traveler attitudes from the survey with factors for two groups of respondents: transit users and non-transit users. These were tested in the mode choice models and the two transit user factors were found to be significant for modal choice decisions (the non-transit user factors were not significant and therefore not included). The convenience/inclination factor was for people who currently make an effort to take transit, think the transit system is easy to purchase a fare, and know when the next bus or train will arrive. The service availability factor for people who could use transit more frequently, are able to take transit from home to downtown Salt Lake City, and are able to take transit to useful destinations (like where they work, shop, or go to school). The factor analysis is not presented in detail here for brevity.

These factors were included in the mode choice to quantify the effects that these attitudes would have on mode choice (Table 3). It may appear that the attitudinal factors also capture some transit service attributes that are already present in the mode choice model. For example, the convenience/inclination factor includes the extent to which a traveler knows when the next bus or train is scheduled to arrive. However, there is an important distinction between the attitudinal factors and the objective transit service attribute measures included in the model specification. The attributes that are directly included in the model measure the actual or true service characteristics; these are the real attributes associated with the transit service. However, these variables do not capture what the user “subjectively” thinks, perceives, or feels about the service attributes. The attitudinal factors are therefore capturing the effects of people’s perceptions, beliefs, and feelings about the transit service, regardless of what the true objective service attributes may be. The fact that these factors are statistically significant, even after controlling for objective service measures, supports drawing a distinction between actual and perceived transit service attributes in the model specification.

Socioeconomic Characteristics

Mode choice models also typically include measures of the socioeconomic and demographic characteristics of the population. In these models, the following characteristics of the population were included: gender, household incomes, household locations, age and people with an option to work from home. People with an option to work from home were more likely to choose train for work trips. This represents flexibility in the workplace applied to a limited population and will be explored further. It also represents a potential policy option for travel demand management strategies applied by some employers. Females were found to be more likely to choose autos than males. Lower income households choose transit over auto and higher income households choose train over bus and auto. These income effects will be explored further. While these characteristics of the population will vary by city, some aspects of the population are included in traditional mode choice models and are not the focus of this study.

Alternative Specific Constants

One objective of the study was to reduce the size and significance of the alternative specific constants in the mode choice models. To assess this reduction, we compared the equivalent in-vehicle travel time of the alternative specific constants for mode choice models estimated with the non-traditional and attitudinal variables against mode choice models without these variables. Both the work and non-work models result in smaller reduced equivalent in-vehicle minutes for the alternative specific constants with the additional variables compared to models without these non-traditional and attitudinal variables (20% reductions for auto and 98% reduction for train for work trips and 40% reduction for auto and 19% reduction for train for non-work trip equivalent in-vehicle time).

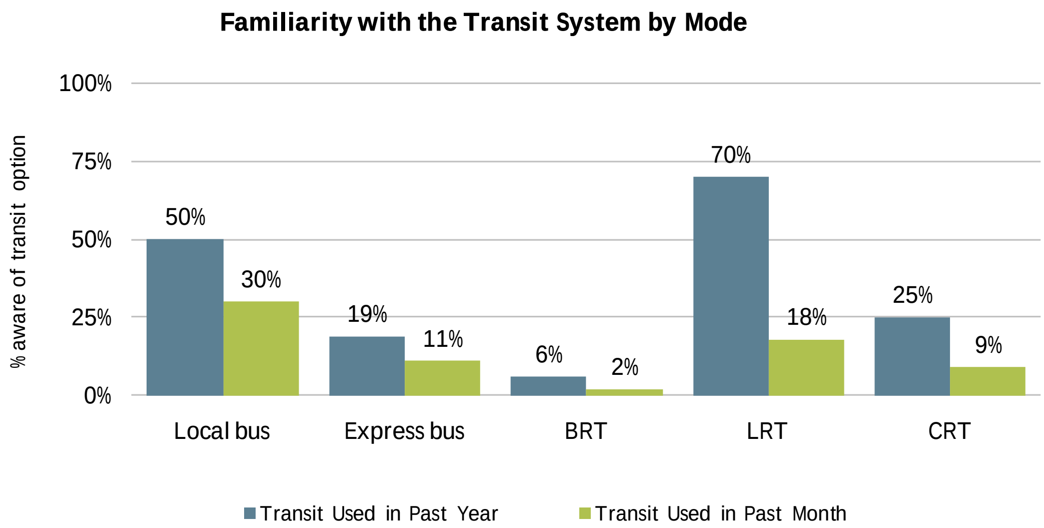
5. TRANSIT FAMILIARITY AND AWARENESS

Transit familiarity and awareness requires that we better define the meaning of these terms so that we can distinguish among the possible interpretations:

- Familiarity with the transit system is defined as someone that has used transit at least once in the last year or in the last month.
- Awareness of the transit system is defined as someone who has identified one or more modes of public transit within walking or driving distance from their house. In the survey, these were not

specifically numerated so for comparisons with other data sources, specific distances were selected for walking distance (1/2 mile or 1 mile) and for driving distance (3 miles or 6 miles).

Transit familiarity and awareness impact the choice of mode in different ways. One must not be previously familiar with public transit to choose it, but transit operators have conducted demonstration projects where new transit services are offered free of charge for a short period after opening to entice travelers to try the system and gain this familiarity, which they believe will contribute to their willingness to use the new system after the demonstration period is complete. Awareness of the transit system is based on whether a traveler's knowledge of transit available near their home is consistent with the actual availability of transit near their home. Data collected in Salt Lake City on familiarity and awareness by mode is shown in Figure 3.



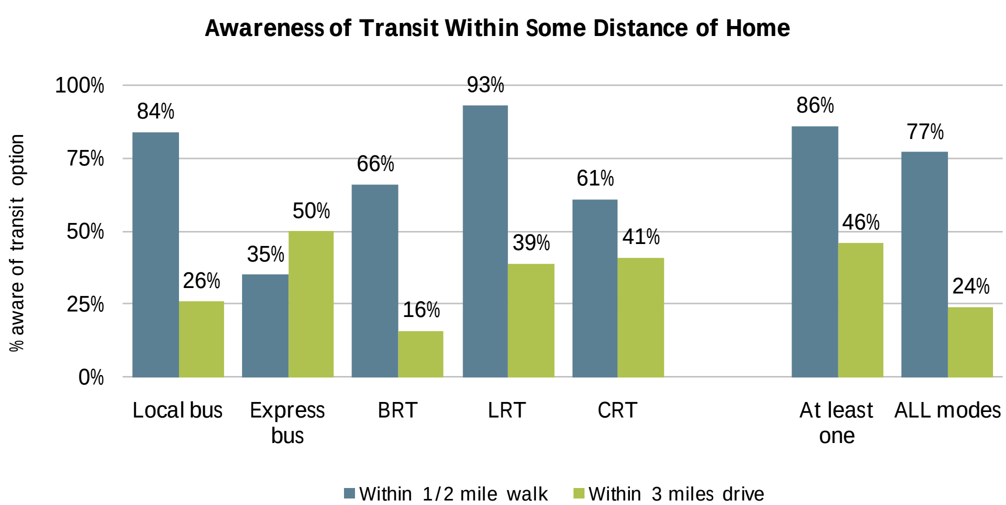


FIGURE 3. Familiarity and Awareness with Transit Systems by Mode

Awareness of the transit system was also explored to find out whether travelers were aware of alternate modes of travel for a particular trip (Figure 4). Although the specifics for each mode vary, all of the responses show that travelers report fewer modes being available than the modeled representations of choice availability. Figure 4 demonstrates that familiarity and awareness of modes available for travel are not accurate and in fact, underestimate the number of available options. Current travel forecasting models assume that travelers have perfect awareness of all travel modes and that familiarity of transit modes has no impact on modal choice. This analysis has identified that familiarity and awareness of modes available should be considered in mode choice models and has identified that choice set models will need to be developed to address this deficiency. The choice set models will allow us to quantify the impact of familiarity and awareness of modes available for travel. The results of this analysis have also shown that select modifications to the survey questions will provide more definitive results for both familiarity and awareness.

The survey also included questions on traveler's willingness to consider alternate options once they were made aware of another alternative. The most common responses for transit users who would not consider taking a transit option was the time and cost associated with this option (53%), the weather and the environment (12%), and a general modal bias (8%). Although these questions were focused on a single trip, responses included the need to make multiple stops, such as work-related trips or picking up the kids (2%). The most common responses for all users who would not consider taking a transit option was that they need their car (46%), of which 22% was to make multiple stops. The responses provide insight on the underlying reasons for each traveler selecting a certain set of modal options to consider.

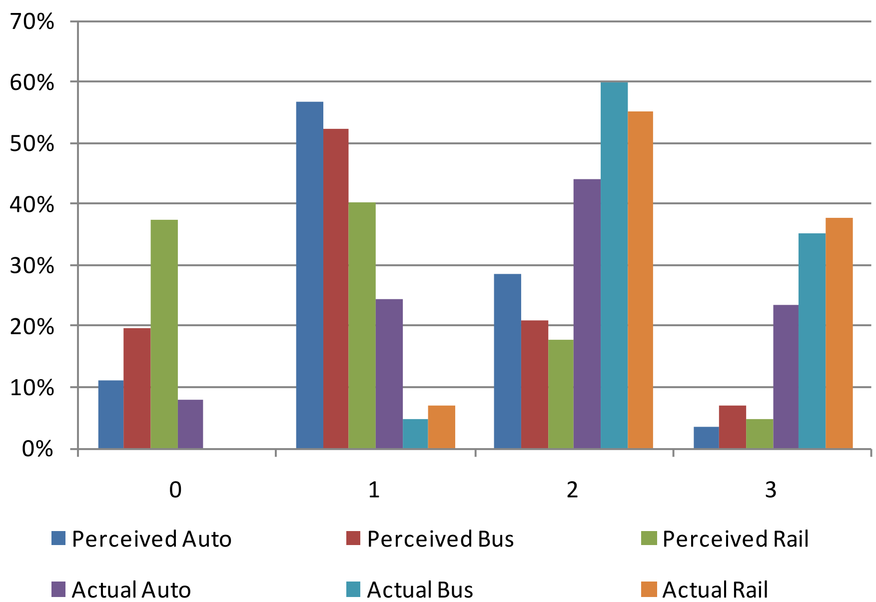


FIGURE 4. Awareness of Alternate Modes of Travel for a Particular Trip

6. PERCEIVED TRAVEL TIME OF MODAL OPTIONS

Virtually all mode choice models are predicated on the concept of using time and cost for all available options to evaluate the share of travel that each mode attracts. The Salt Lake City survey asked respondents about travel times for their trip and we compared this to the travel demand forecasting model's estimate of travel time for that trip. This comparison can help us understand whether the travel demand forecasting model is representing the traveler's perception of travel time sufficiently, but it does not address the question of whether the model or the traveler is accurate. The results of this analysis indicate the following comparisons:

- Local bus riders typically underestimate travel times compared to the model by 27%.
- Express bus riders underestimate travel times compared to the model by 12%.
- Light rail riders are within 2% of the travel times compared to the model.
- Commuter rail riders overestimate travel times compared to the model by 5%.

Traveler estimates of rail and express bus riders are generally consistent with representations of time from the travel forecasting models, while local bus riders are underestimating travel times. Further analysis of the different components of travel time (wait, walk or drive access and egress transfer, in-vehicle) will provide a better understanding of the underlying causes for local bus riders to underestimate travel times may indicate a direction for modification to travel model representations of travel times.

7. CONCLUSIONS

One significant finding from this research was the degree to which awareness of transit services differs from actual transit services. Overall, 77% of travelers are aware of the full set of transit services within ½ mile of their home (walking distance) but only 24% of travelers are aware of the full set of transit services within 3 miles of their home (driving distance). Current travel demand forecasting models assume that 100% of travelers are aware of all transit services within walking and driving distance from their home. One objective of the next phase of work on this project is to develop choice set models that can capture this awareness and limit choice sets that are considered in mode choice models to those that better represent reality. We believe that this will change the mode choice model estimation process as well.

Additional findings from this research were the degree to which non-traditional transit attributes affect choice of mode. The following transit attributes were found to be significant for distinguishing premium transit services in mode choice: reliability, real-time information, transit stops with modern amenities, and on-board amenities. If premium transit services included all the premium service attributes, there would be a 14.2 minute advantage for work trips over standard transit services and 18.6 minute advantage for non-work trips. There were also some transit attributes that are also a function of travel time: on-board amenities as a function of in-vehicle travel time and real-time information as a function of wait time.

There were also transit attitudes that had a significant effect on mode choice: the convenience/ inclination factor and the service availability factor. These attitudes capture the perceived responses to service attributes that go beyond the actual responses to service attributes identified in other parts of the model.

All of these findings are based on data collection from one city and so should not be taken as conclusions that can transfer to other cities. One objective of the next phase is to collect additional data so that broader conclusions are possible.

8. NEXT PHASE

A second phase of the research is currently underway. This phase is focused on collecting additional data in two cities to confirm and/or enhance the results from the current data collected in Salt Lake City. The additional two cities will be chosen to represent diverse geographic areas and an older, more established multimodal transit system as well as a system where premium transit services have had a significant impact on transit ridership.

We propose to develop choice set availability models that can replicate the modal options travelers perceive to be available to them rather than all transit services. These choice set models will then be used to limit choices available to travelers in mode choice models. They may also provide insight on the specific reasons that travelers perceive fewer options than are available. Mode choice models estimated during Phase I will be refined and re-estimated using the choice set limitations for the two new case study sites to show the impact of non-traditional transit attributes on modal choice. The final products will provide insight on the characteristics of premium transit services from each of the three case study sights, thus representing a range of reasonable values.

One of the three case study sites will be selected for a demonstration project. We propose to calibrate and apply the new mode choice model for this demonstration to determine the final bias constants and the validity of the new models in replicating observed behavior. This test will demonstrate that the new methods can be put into practice.

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