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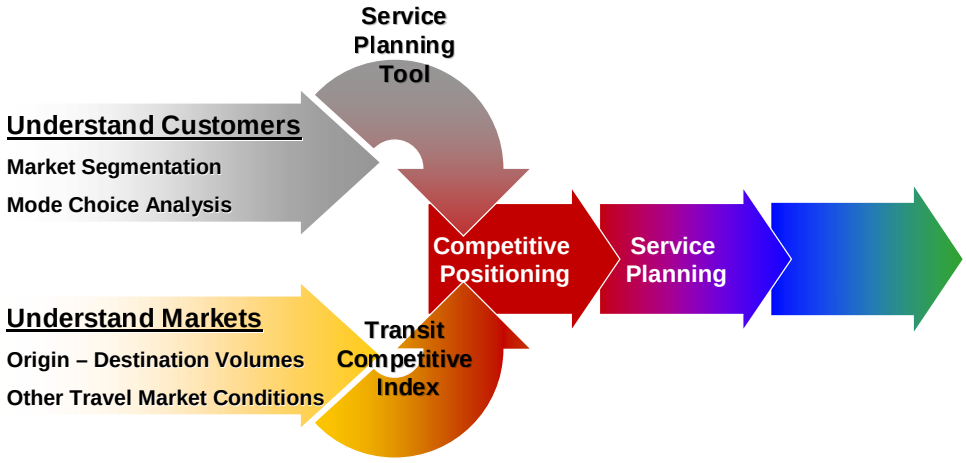
Transit Sketch Planning Tools / MARCH 2009 /

In coordination with local agency staff and transit operators, the Puget Sound Regional Council (PSRC) has been developing new tools to improve the transit analysis and forecasting capabilities for use in the Transportation 2040 plan update process. These new tools are part of an overall integrated modeling framework.

The two new transit sketch planning tools are called the Transit Competitiveness Index (TCI) and the Service Planning Tool (SPT). These tools identify corridors where transit is a highly competitive mode (to understand markets) and then interactively allow users to test the level of service that would produce the highest ridership in that corridor (to understand customers).



The tools were developed to support regional transit planning and also may be useful at the local transit planning level. The three primary purposes of these tools:

1. Understand how to adjust transit service to better serve markets in future year 2040.
2. Identify how to improve transit ridership in congested corridors, e.g. SR 520.
3. Understand transit patterns to Regional Centers, e.g. Bellevue Multimodal Concurrency effort.

The TCI and SPT use multiple sources of demographic, economic, urban form, and traveler attitudinal data. Sources include information from the regional travel demand model and the 2006 attitudinal survey. More details on the data sources are provided on pages 9-12 of the attached document.

1. **Transit Competitiveness Index** – To better understand the market, the TCI analysis compiles dozens of market conditions, weighted in proportion to their relative effect on travel choice (transit, car, etc.). The TCI allows for a transit demand pattern and gap analysis. Step by step details on how to use the TCI model are provided on page 5 of the attached document.

2. **Sketch Planning Tool** - To understand the customer, the SPT contains a series of calculations that predict changes in transit ridership (bus or rail) that will result from changes in level of service characteristics for a set of travel patterns (production – attraction zones). The main functionality of SPT is aimed at predicting the changes in the number of trips for each defined mode based on changes to the existing levels of service. Step by step details on how to use the TCI model are provided on page 7 of the attached document.

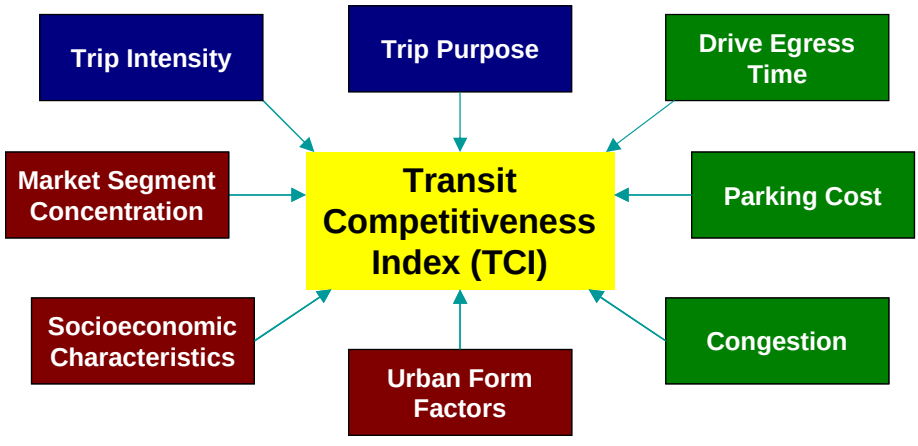
There are a number of advantages to using the new tools, including the speed and interactive nature of the analysis, and the fact that the TCI tool looks at potential markets irrespective of existing service. This provides more opportunities to design effective service.

As with any analytic tools, there are some limitations, including the fact that both the TCI and SPT are based on estimates from the current year (2006) data. In the future, the TCI and SPT tools can be updated with the future travel patterns forecasts from Transportation 2040's preferred alternative when it is developed in 2010. With the future forecasts, the TCI can identify strong future transit travel patterns and provide data for a gaps analysis. The SPT can optimize transit service plans for the preferred alternative in the transportation plan update. Additional details on the advantages and limitations of these tools are provided on page 4 of this document.

Overview

Transit Competitiveness Index (TCI)

The competitive conditions for transit exist through the PSRC region regardless of what kind of transit service is currently deployed or could be deployed, and they have critical consequences on how much capital and operating expense will be needed for an effective transit system to attract riders. PSRC now has a software tool for measuring these conditions in each travel market. The tool calculates a Transit Competitive Index (TCI) for an origin, destination or O-D pair within the region.



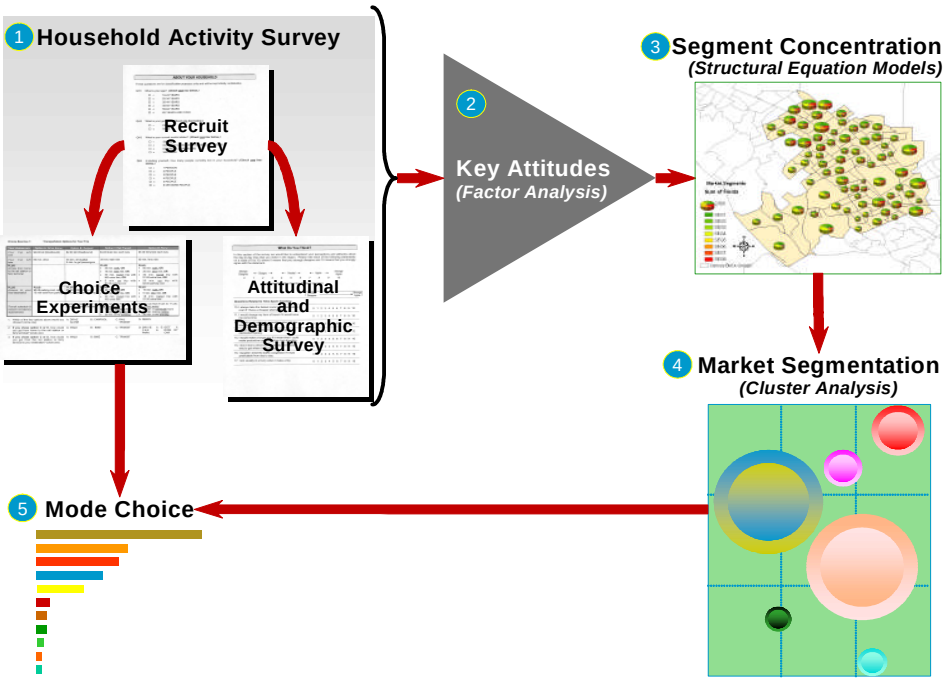
This composite metric provides a single score that is comprised of dozens of specific market conditions that are weighted in proportion to their relative effect on mode choice. This is done using the coefficients in the mode choice models estimated for each market segment.

Service Planning Tool (SPT)

Just as in any private business, most transit providers understand that their potential customers are not all are the same. The service planning tool applies the same market research techniques to drill down into the key attitudes and preference that drive a potential rider's mode choice as have been used in the private sector for many years. There are five steps in the process to understand the customers of our regional transit system using the service planning tool (SPT):

1. Conduct a household activity survey to collect attitudinal, demographic, and preference data on potential customers throughout the region (both riders and non-riders).
2. Use the survey to identify and predict traveler attitudes.
3. Divide the traveler market into eight segments based on three key traveler attitudes (transit receptiveness, travel flexibility, and comfort and time use).
4. Estimate market segments for each census block group in the region.
5. Use the survey to predict mode choices for each traveler based on demographics, traveler attitudes, market segments, and level-of-service characteristics.

This service planning tool process is demonstrated below.



What are the new tools used for?

Regional and local planning agencies

As a regional planning agency, PSRC will use the transit sketch planning tools to support transportation planning activities:

- Identify the strongest transit markets for the transportation plan update (TCI)
- Develop the transit alternatives for these markets (SPT)
- Evaluate transit markets (TCI) and metrics (SPT) for multimodal concurrency
- Evaluate station locations (TCI) and estimate preliminary ridership (SPT) for transit projects (e.g., BNSF rail)
- Optimize transit service plans for the preferred alternative in the plan update (SPT)

Other local planning agencies could use the new tools for similar planning activities.

Transit operators

Transit operators around the region may use the new tools to support transit planning activities, such as:

- Evaluate transit markets to identify under- or over-served markets (TCI)
- Test alternative service plans for short term planning (SPT)
- Maximize ridership for transit projects (SPT)

What are the advantages and limitations of the tools?

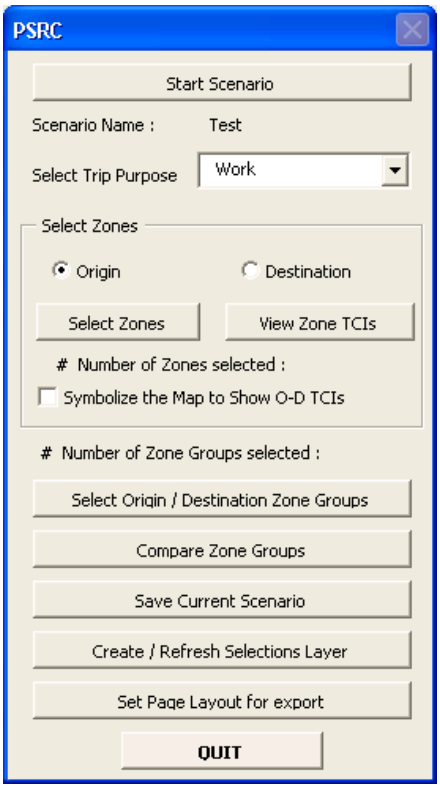
There are a number of advantages to using the new tools:

- The SPT application is faster than running regional or local travel models.
- The SPT is interactive so that multiple service plans can be tested.
- The TCI uses weighting factors that are proportional to each component's ability to generate transit trips.
- Transit markets are defined irrespective of current service in the TCI so that potential markets are not limited by current service patterns.
- Both the TCI and SPT tools are consistent with regional travel model assumptions (times, costs, land use, etc.).
- Both tools account for traveler attitudes on comfort, time use, flexibility, etc. which are not accounted for in our regional travel forecasting models.

And, as always, there are some limitations:

- Both the TCI and SPT are based on estimates from the current year (2006) data; future year applications still need to be constructed.
- The SPT tests individual service plan changes and does not reflect system-wide interactions. As a result, the SPT is not intended to replace regional travel model's estimates of system-wide ridership.
- The TCI methodology does its calculations at a fairly high level of granularity. For example, all work trips are considered similar in their transit competitiveness. In reality some types of trips may be more competitive than others.

How do we use the new tools?



To better understand transit markets

The TCI software is menu-driven and provides options to identify and save scenarios, choose trip purpose (work, other, or all), and select locations to analyze (origins, destinations, or origin-destination pairs). Once these selections are made, the TCI contains a series of calculations to produce the index value and component contributions to that value for a production zone(s), attraction zone(s) or combined production-attraction zone(s)[1]. An index value of greater than 100 is considered to be a market that is competitive for transit, where an index value less than 100 is a market that is considered to be not very competitive.

Step 1. Calculate utilities for bus, rail, and auto travel assuming a base case for the region. The utility equation for each market segment and trip purpose (work, other) includes the following variables:

- Cost ($)
- In-vehicle travel time (minutes)
- Out-of-vehicle travel time (minutes) separated by access, egress, and wait time for transit and terminal time at the origin and destination for auto
- Average workers per household
- Fraction of zero-vehicle households and average vehicles per household
- Fraction of the population with age greater than 75
- Fraction of the population that is college students
- Fraction of the population that is full-time workers
- Fraction of the population that is part-time workers
- Average household income
- Traveler attitudes (environmental consciousness, stress, transit receptiveness, need for flexibility, and time sensitivity)
- Urban form (urban parkland and retail floor area ratios)

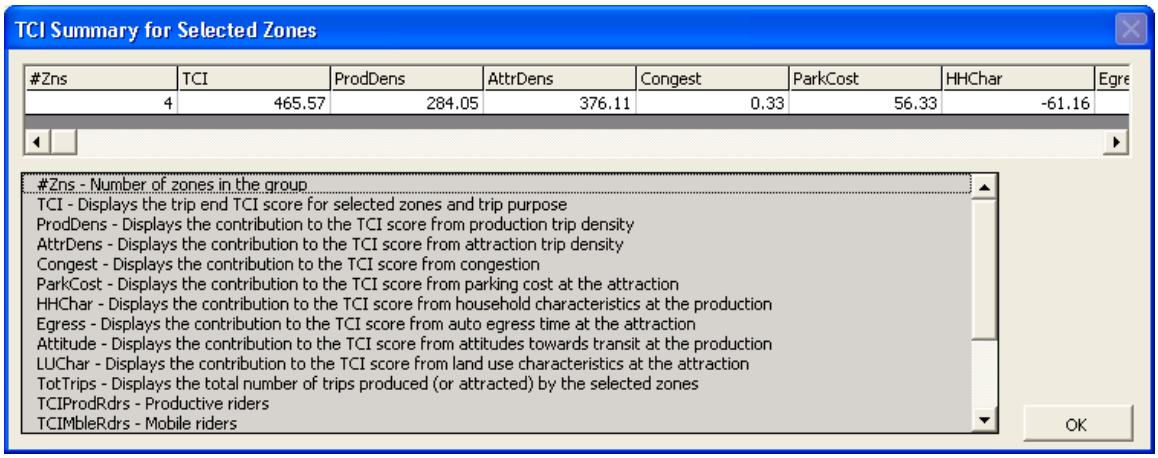
Step 2. Adjust the utilities for location-specific attributes of a set of zones for each market segment and trip purpose.

Step 3. Calculate the probability of using transit (bus or rail) for each market segment and trip purpose (work, other) with the nested logit choice model.

Step 4. Aggregate TCIs for each production-attraction set of zones. TCIs are additive across trip purposes and market segments.

[1] Production zones are the household-related part of trip-making (such as residential neighborhoods); attraction zones are the non-household-related part of trip-making (such as employment centers). These are not the same as origins and destinations, which are the beginning and ending location of a trip.

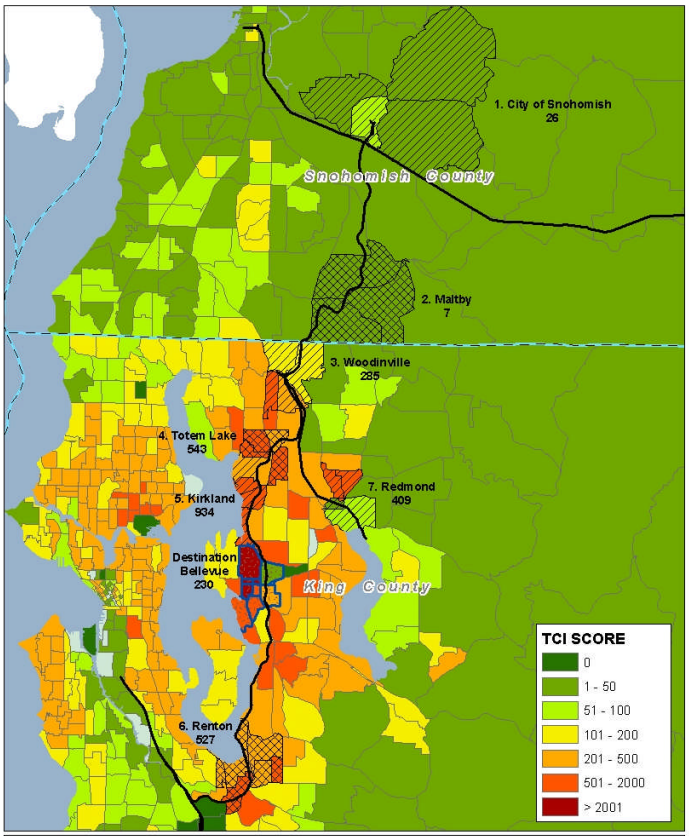
Step 5. Report contributions from different components for each market segment.



Step 6. Scale the TCI for work, other, and all trips such that a TCI score of 100 corresponds to a production zone, attraction zone, or production-attraction zone pair that is at the threshold of being transit competitive.

Additional Notes:

- TCI is proportional to the number of trips so that twice as many trips have twice the potential for transit ridership.
- TCI is inversely proportional to production zone area so that half the area has twice the potential for transit ridership.
- TCI is inversely proportional to attraction zone area so that half the area has twice the potential for transit ridership.

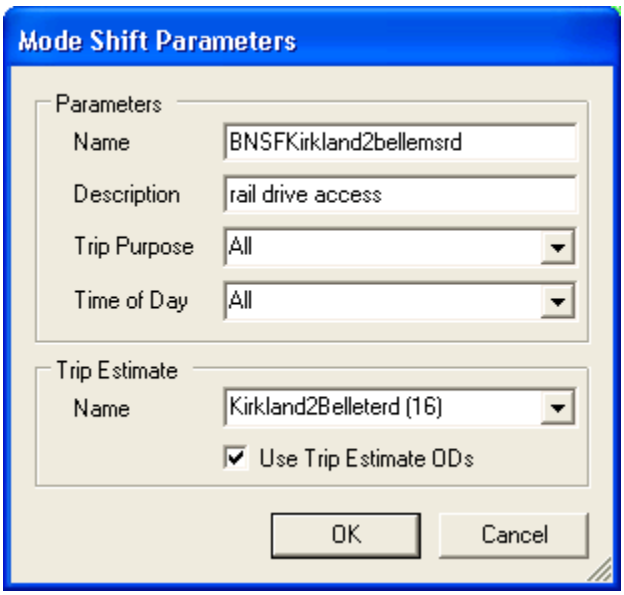


Map : BNSF Eastside Commuter Rail Feasibility Analysis using PSRC's Transit Competitive Index for 8 Major Station Areas PSRC 11/10/08

File Location : Dest-Bellevue-Origin-7Stations-Work.txt

To better understand potential transit customers

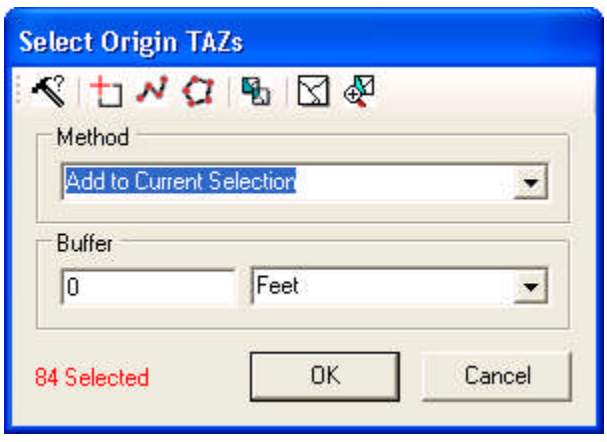
The SPT contains a series of calculations that predict what changes in transit ridership (bus or rail) will result from changes in level of service characteristics for a set of production-attraction zones. The SPT is also menu driven and allows the user to define and save scenarios representing different sets of mode shift and trip estimate parameters.



Step 1. The SPT application applies a pivot point mode choice model to predict changes in ridership. Pivot point analysis is limited to ridership for existing modes, so the tool also provides functionality to allow the number of trips for a new mode to be predicted based upon the most similar existing mode. This is identified as the trip estimate.

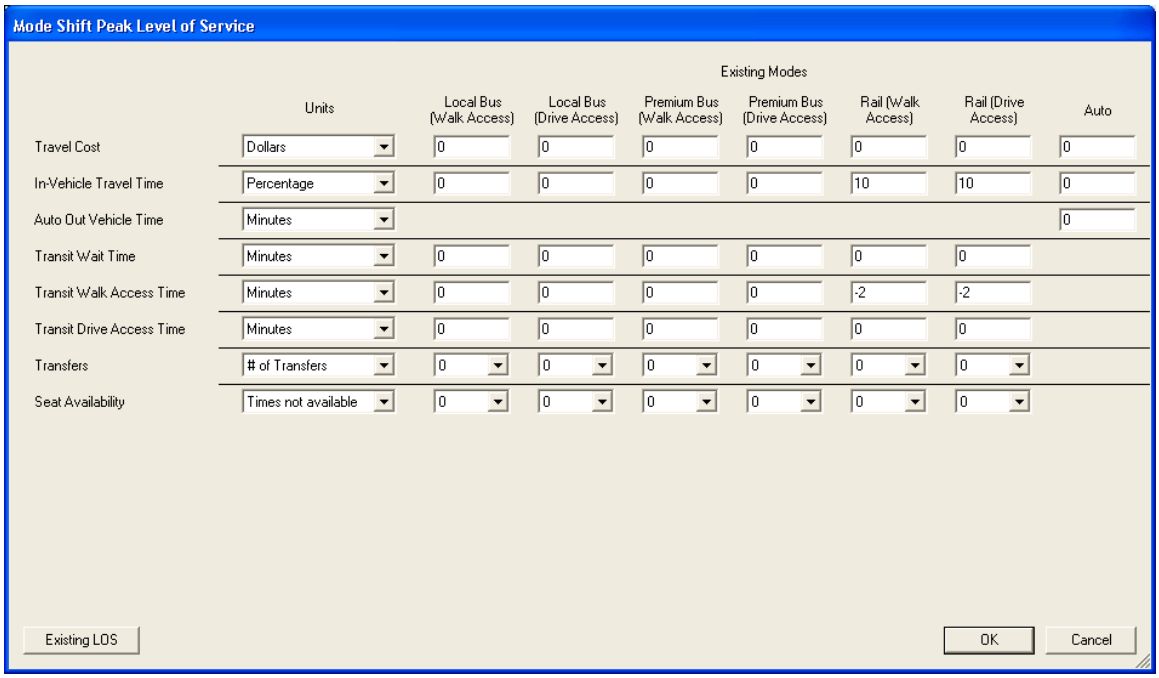
If the trip estimate is desired, a process to identify the origin and destination traffic analysis zones (TAZs) is conducted. There are various means to identify TAZs:

- *Select by Query*. This option is used to select TAZs based on attribution. The 'Select by Attributes' Dialog can be used to build a Where clause based on the attribute fields.
- *User Select.* This option is used to select TAZs by clicking-and-dragging a rectangle on the Map.

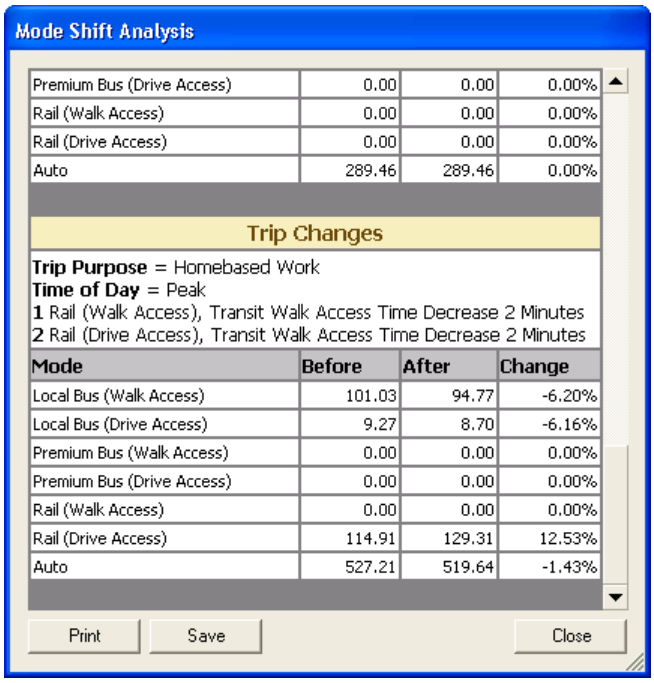


- *Select by Polyline.* This option is used to select TAZs by drawing a Polyline on the Map. The Polyline is drawn by clicking each vertex and double-clicking to finish.
- *Select by Polygon.* This option is used to select TAZs by drawing a Polygon. The Polygon is drawn by clicking each vertex and double-clicking to finish.
- *Select by Feature.* This option is used to select TAZs by selecting features of interest (e.g., Bus Stops, Rail Routes, Counties, etc).

Step 2. The main functionality of SPT is aimed at predicting the changes in the number of trips for each defined mode based on changes to the existing levels of service. These changes can be in either absolute values (e.g., auto travel cost increases by $5 if a congestion charge is applied), or as a percentage of the existing level of service (e.g., premium bus travel time reduces by 10% when a new bus-only lane is introduced). The mode shift scenario allows the user to enter all of the level of service changes for all modes. This scenario is then analyzed using a mode shift algorithm to predict the changes in the number of trips for each mode.



Step 3. The SPT is populated from the results of a regional transit analysis model based on proposed level of service (e.g., travel cost and time) for various modes (e.g., bus, auto, etc.). The resulting trip changes show the change in ridership for each trip purpose (work and other), for each time of day (peak and offpeak) and for each mode (walk and drive access for each transit mode -- local bus, premium bus, rail, and auto). The trip changes are reported as percentage changes and the before and after trips are shown as well. These results can be printed or saved for further analysis.



What data are used in the tools?

Demographics and Economics

The person and household characteristics data are used to apply the Structural Equations Model (SEM) that is used to determine the traveler attitudes and subsequently the market segments.

Person and Household Characteristics

Age
- Ages 18-24
- Ages 25-34
- Ages 35-44
- Ages 45-64
- Ages 65+

Gender
- Male
- Female

Education Level
- Less than high school or high school
- Vocation/technical training/some college
- College
- Graduate/post-graduate degree

Employment Status
- Part time employee
- Full time employee
- Retired or not working

Housing and Development Type
- Urban multi-family
- Urban mixed development
- Urban single family/Suburban multi-family
- Suburban mixed development
- Suburban single family
- Exurban-rural areas

Resident Location
- Not a residence of King County
- Resident of King County but not Seattle
- Resident of the City of Seattle

Number of workers in the Household
- Zero worker
- One worker
- Two or more workers

Household size
- One person
- Two persons
- Three persons
- Four or more persons

Vehicle Ownership in the Household
- No vehicles
- One vehicle
- Two vehicles
- Three or more vehicles

Vehicle Availability
- Less than 0.5 vehicles per driver in the HH
- 0.51 to 0.75 vehicles per driver in the HH
- 0.76 to 1.33 vehicle per driver in the HH
- 1.34 to 2.0 vehicles per driver in the HH
- More than 2.0 vehicles per driver in the HH

Licensed Drivers in the Household
- One licensed driver
- Two licensed drivers
- Three licensed drivers
- Four or more licensed drivers

Household Income group (2006$)
- Under $50,000
- $50,000 to $100,000
- Over $100,000

Note: Household income is assumed to increase with inflation. In the TCI, household income is coded as the income in $10,000 for the production zone.

Urban Form

There are two urban form variables used in the models:

- Ratio of urban parkland to total area for the attraction zone
- Ratio of retail floor area to building area for the attraction zone

Traveler Attitudes and Market Segments

There are 21 attitudinal characteristics derived from the 2006 household survey that are combined to produce six *traveler attitudes.*

Traveler Attitudes

Environmental Consciousness
- I would be willing to pay more when I travel if it would help the environment
- I would switch to a different form of transportation if it would help the environment
- People who drive alone should pay more to help improve traffic congestion situation
- Use of transit can help improve the environment

Travel Stress
- Driving on Puget Sound freeways is stressful for me
- I am usually anxious and unsettled when traveling
- I avoid making certain trips at certain times because it is too stressful to make the trip
- Having a stress-free trip is more important than reaching my destination quickly
- I don't like to drive but it is usually the fastest way to get where I need to go

Transit Receptiveness
- I am comfortable riding a bus
- I prefer not to make trips alone because I like time to myself
- I know how to reach my destination using public transportation
- I wouldn't mind walking a few minutes to get to my destination

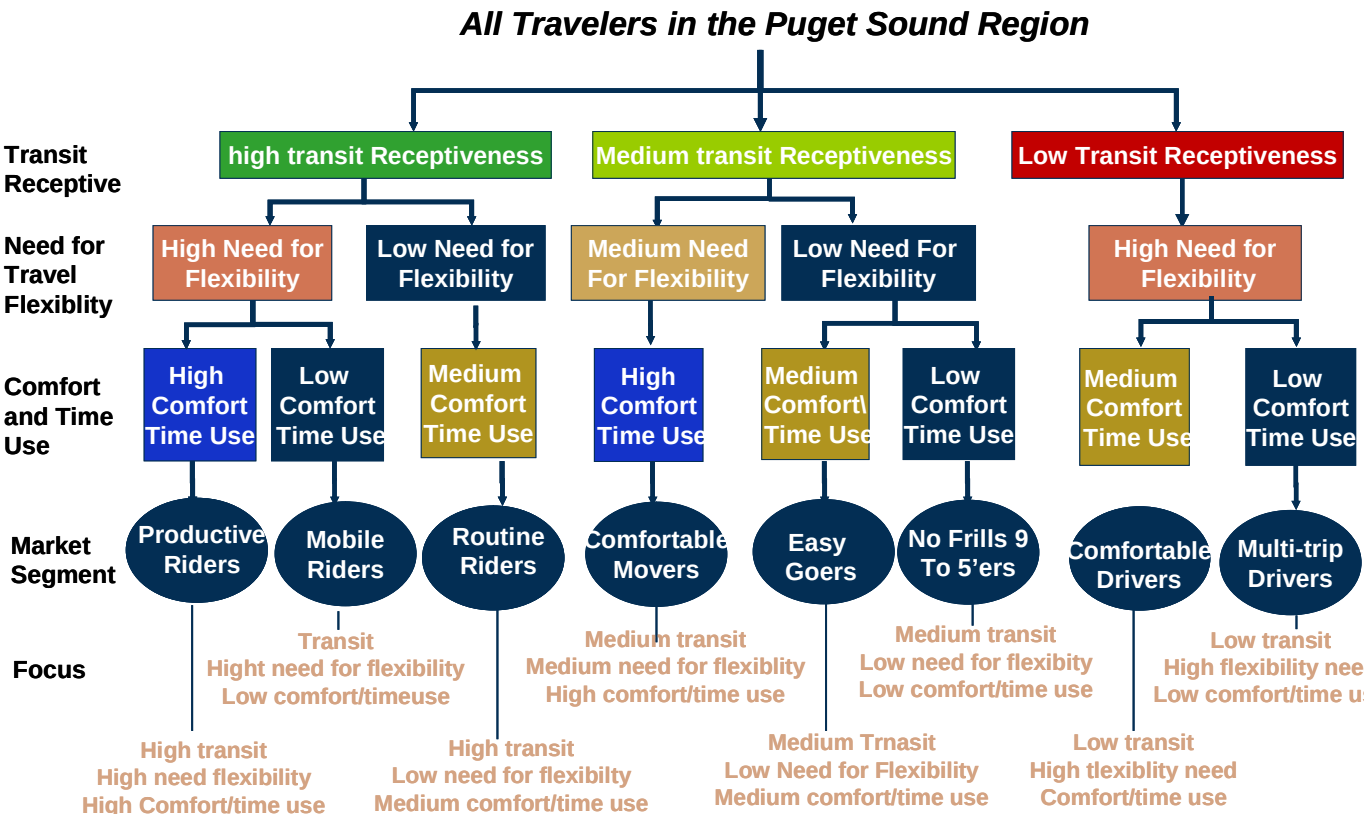
Need for Travel Flexibility
- I don't know how to reach my destination using public transportation
- I need to make trips to a wide variety of locations each week
- I need to have the flexibility to make many trips during the day if necessary
- I am usually in a hurry when I make a trip
- I use the most convenient form of transportation regardless of cost

Time Sensitivity and Schedule Constraints
- I would change my form of travel if it would save me some time
- I always take the fastest route to my destination even if I have a cheaper alternative
- I am usually in a hurry when I make a trip
- I need to make trips according to a fixed schedule
- I use the most convenient form of transportation regardless of cost
- I don't mind delays as long as I am comfortable

Comfort and Time Use
- I don't mind delays as long as I am comfortable
- I wouldn't mind the traffic congestion if it was predictable from day-to-day
- I don't mind taking a longer trip if I could make productive use of my time when I travel

The six traveler attitudes are used to segment the travel market into eight *market segments*, based on their attitudes on transit receptiveness (high, medium or low), travel flexibility (high or low need), and comfort and time use (high, medium or low need).

Market Segments



Travel Characteristics

Travel is classified by purpose, mode and time period in the travel demand forecasting models.

Trip Characteristics

Time Period
- Peak (6-9am and 3-6pm)
- Off-peak (12-6am, 9am-3pm, 6pm-12am)

Modes
- Auto
- Local bus (walk and drive access)
- Premium bus (walk and drive access)
- Rail (walk and drive access)

Trip Purpose (Origin and Destination)
- Home-based work and college
- Other

Level of Service
- Travel cost ($)
- In-vehicle time (minutes)
- Wait time (minutes)
- Access time (minutes)

Egress time (minutes)

Travel Costs

There are four types of direct costs in the travel demand forecasting models: auto operating cost, parking costs, tolls, and transit fares. Auto operating costs at 12 cents per mile (in 2000 year dollars) are applied to all auto modes and to the auto-access to transit modes. Daily standard and carpool parking costs are used in the work model. Non-work models use hourly parking costs. Ferry fares paid when crossing the Sound with a vehicle also are considered as auto operating costs. In 2006, there was only one toll bridge, the Tacoma Narrows Bridge, which charges $3.00 in one-direction. All occupants of shared-ride modes share the auto operating costs and parking costs equally. A zone-to-zone transit fare matrix representing the fares for each transit mode also is used as input to the model. A bi-directional averaging procedure is used for cost. All travel costs are assumed to increase with inflation. A separate analysis of the impacts of increasing gas prices on travel behavior is being conducted to demonstrate the sensitivity of vehicle miles traveled to changes in cost.