A Combined Quantitative and Qualitative Approach to Planning for Improved Intermodal Connectivity at California Airports (TO5406)

(Quarterly Meeting)

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Outline

• Objective
• Project Status
  – Progress on Current Tasks
  – First Year Report
• IAPT Development
• IAPT Demonstration
• Next Steps
• Discussion
Objective

– Develop techniques for analyzing the effectiveness of alternative strategies for improving intermodal connectivity at airports using a combined quantitative and qualitative approach
  
  • Quantitative: Analytical models of airport traveler and transportation provider’s behavior, traffic networks
  
  • Qualitative: Descriptive case studies and analysis of agency decision making processes

– Research products:
  
  • Case studies of intermodal access projects at California airports
  • Develop prototype Intermodal Airport Ground Access Planning Tool (IAPT)
  • Using IAPT to evaluate selected case study projects at California airports
  • Policy recommendations and planning guidelines
Project Status – Progress on Current Tasks

- Develop prototype user interface module for the Intermodal Airport Ground Access Planning Tool.
  - Preliminary screen design distributed for review
  - Programming of user interface commenced

- Develop mode choice analysis module for the prototype Intermodal Airport Ground Access Planning Tool and calibrate on data for selected region
  - Define mode choice model structure
  - Define mode choice analysis module data structure and interfaces with other IAPT modules
  - Review recent airport access mode choice models developed in other studies
  - Assemble airport ground transportation service data for calibration region
  - Assemble air passenger survey data for the model calibration region and geocode to analysis zones
  - Review and clean the air passenger survey response data
  - Assemble mode choice model estimation input files and perform iterative model estimation runs to develop mode choice model utility functions and parameter values
Project Status – Progress on Current Tasks

- Developing model of transportation service provider behavior
  - Selection of modeling paradigms (Nash game and elasticity-based)
  - Mathematical modeling and analysis
  - Algorithm development and programming in C code
  - Definition of example case for a single zone with multiple modes to test convergence
  - Generalize approach to multiple zones for all the modes

- Developing interface between sub-modules
  - Explore software language/application interface
  - Continue development of data table specifications
  - Commence programming module interface code

- Explore intermodal connectivity considerations in airport ground access
  - Review connectivity issues in transit network planning
  - Measuring connectivity in airport ground access
  - Integration with IAPT performance measures
Project Status – First Year Report

- Initial drafts of all chapters completed
- Appendices A and B completed, Appendix C in preparation
- Work in progress to refine/expand several chapters
  - Chapter 5: Mode choice model
    - Expand discussion of estimate dataset
    - Include initial model estimation results
  - Chapter 6: Transportation provider behavior model
    - Complete description of modeling approach
    - Revise material to improve clarity of explanation
  - Chapter 7: Measuring airport intermodal connectivity
    - Revise material to better relate to scope of research project
- Need to prepare Executive Summary
- Anticipate submittal of draft report by December 20th
IAPT Development

• Overall structure of the software
• Graphical user interface
• Mode choice model
• Data preparation for model development
• Transportation provider behavior
• Project evaluation: measures of performance
IAPT Software Components and Data Flow

- Ground Access System Configuration
- Graphical User Interface
- Analysis Control Program
- Transportation Service Characteristics
- Mode Choice Model
- Scenario Performance Measurement
- Analysis Results

Data Flow

Control
Graphical Use Interface (GUI)

- **Provides user with consistent approach to problem specification and data entry**
  - Regional data
    - Highway and transit network
  - Airport data
    - Available ground access/egress modes
    - Airport traffic level and air passenger characteristics
  - Project definition
    - Hierarchical structure
    - Available modes and time frame for analysis

- **Interacts with underlying relational database**
  - Contains all input data and outputs from IAPT model runs

- **Design of GUI functionality and screen layouts largely complete**
  - Model specification and modal service level data entry screens still need to be designed
    - Dependent on mode choice model development
Mode Choice Model Development

• **Role of mode choice model**
  - **Predict patronage on each ground access mode**
    - Response to changes in ground access service levels
    - Implications for transportation provider revenue
    - Changes in vehicular traffic levels
  - **Response to introduction of new services or modes**
    - Enhanced intermodal connectivity

• **Considerations**
  - **Need to reflect the factors that influence air party mode choice**
    - Travel time, service frequency (waiting time)
    - Cost
    - Accessibility, transfers, etc.
    - Air party characteristics (party size, trip duration, trip purpose, luggage, etc.)
  - **Need to distinguish between different market segments**
    - Residents vs. visitors
    - Business vs. personal trips
    - Type of trip origin (residence, hotel, other)
Mode Choice Model Development

- **Model estimation data requirements**
  - Air passenger access mode use and travel party characteristics
    - MTC Air Passenger Survey at Bay Area Airports
      - August/September 2001 (pre 9/11)
      - Approx 5,300 unique records (1,600 OAK, 2,260 SFO, 1,440 SJC)
  - Airport access mode service data for survey period
    - MTC 2000 Base Year highway and transit network
    - Airport parking rates from communication with airport staff
    - BART, Caltrain and VTA light rail schedules and fares from operator staff
    - Airport ground transportation service data
      - Information publications on file with airport staff and others
      - Discussions with operators
      - Estimated from 2005 service levels

- **Model estimation process**
  - Merge access mode service data with air party characteristics
    - Air passenger survey responses geocoded to MTC traffic analysis zone
  - Use maximum likelihood model estimation software (WinBiogme) to determine values of mode utility function coefficients
Data Preparation for Model Development

- Data describe service characteristics for ground access modes to SFO, OAK and SJC in 2001, 2002 and 2005
- Nine primary modes are listed in the table. Parking service characteristics are trip duration based, all others are based on MTC 1454 Transportation Analysis Zone (TAZ) system.
- The main variables of TAZ-based service levels are described in the following two slides

<table>
<thead>
<tr>
<th>Mode</th>
<th>SFO</th>
<th>OAK</th>
<th>SJC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auto Drop-off</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Parking</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Taxi</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Door-to-door Van</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Scheduled Airport Bus</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Public Transit</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>BART</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Caltrain</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>VTA Light Rail</td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>
## Data Preparation for Model Development

<table>
<thead>
<tr>
<th>Mode</th>
<th>Attributes</th>
</tr>
</thead>
</table>
| Auto                     | Travel Distance  
|                          | Travel Time (AM Peak)  
|                          | Travel Time (PM Peak)  
|                          | Travel Time (Off Peak)  |
| Taxi                     | Fare       |
| Door-to-Door Van         | Fare for the first person  
|                          | Fare for the second person  
|                          | Frequency  
|                          | Circulation time to pick up passengers  |
| BART                     | Access time to the nearest BART station from origin TAZ  
|                          | Access distance to the nearest BART station from origin TAZ  
|                          | Headway  
|                          | Ride time on train  
|                          | Fare |
## Data Preparation for Model Development

<table>
<thead>
<tr>
<th>Mode</th>
<th>Data Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caltrain</td>
<td>Access time to the nearest Caltrain station from origin TAZ</td>
</tr>
<tr>
<td></td>
<td>Access distance to the nearest Caltrain station from origin TAZ</td>
</tr>
<tr>
<td></td>
<td>Headway</td>
</tr>
<tr>
<td></td>
<td>Ride time on train</td>
</tr>
<tr>
<td></td>
<td>Fare</td>
</tr>
<tr>
<td>VTA Light Rail</td>
<td>Access time to the nearest VTA light rail station from origin TAZ</td>
</tr>
<tr>
<td></td>
<td>Access distance to the nearest VTA light rail station from origin TAZ</td>
</tr>
<tr>
<td></td>
<td>Headway</td>
</tr>
<tr>
<td></td>
<td>Ride time on train</td>
</tr>
<tr>
<td></td>
<td>Fare</td>
</tr>
<tr>
<td>Scheduled Airport Bus</td>
<td>Access time to the nearest scheduled airport bus stop from origin TAZ</td>
</tr>
<tr>
<td></td>
<td>Access distance to the nearest scheduled airport bus stop from origin TAZ</td>
</tr>
<tr>
<td></td>
<td>Headway</td>
</tr>
<tr>
<td></td>
<td>Ride time on train</td>
</tr>
<tr>
<td></td>
<td>Fare</td>
</tr>
<tr>
<td>Public Transit Bus</td>
<td>Headway of transit</td>
</tr>
<tr>
<td></td>
<td>Ride time on bus</td>
</tr>
<tr>
<td></td>
<td>Fare</td>
</tr>
</tbody>
</table>
Data Preparation for Model Development

• **Highway travel times and distances**
  – Obtained from MTC Base Year 2000 highway network skim tree tables
    • From each zone to TAZ for each airport

• **Public transit bus travel times and fares**
  – Obtained from MTC Base Year 2000 transit network skim tree tables
    • From each zone to TAZ for each airport

• **Calculation of access times and distances to rail stations/bus stops**
  – Identified TAZ for each station/stop
    • Geocoded from station/stop address
  – Calculated distance to each station/stop TAZ for each zone
  – Selected closest station/stop for each zone
  – Obtained travel time and distance from MTC skim tree tables
Transportation Provider Behavior

- Two approaches to modeling transportation provider response to changes in competing modes or introduction of new service
  - Elasticity
  - Generalized Nash game

- Elasticity approach
  - Iterative procedure to represent transportation provider decisions based on patronage changes in response to changes in price and service levels
    - Using calibrated mode choice model for calculation
  - Indirect representation of competition between providers
  - Approach previously applied to transit networks
  - Fare changes as primary decision factor
    - Adjust service frequency to achieve reasonable load factor
Transportation Provider Behavior

• Generalized Nash game approach
  – Each mode is considered as a player, thus competition happens across modes
  – Full competition between modes assuming each mode knows the service levels of other modes
  – Consider access/egress path instead of whole transportation network
  – Use price as decision parameter but consider service frequency changes in discrete increments
    • Service frequency primarily concerns shared ride van and scheduled bus
    • Service frequency for other modes either not relevant (e.g. taxi) or not sensitive to changes in use for airport access trips (e.g. BART)
  – Assume rates/fares change by a uniform percentage, greatly simplifying the problem – avoiding the need to vary price structure across zones, etc.
Illustration of Access/Egress Paths

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Transportation Providers Behavior

• **Implementation in IAPT**
  – Elasticity approach as short term goal
  – Generalized Nash Game approach as longer term goal
Project Evaluation – Measures of Performance

- Measures of performance defined by users from output measures generated by post-processing mode choice model results
  - Number of passengers
  - Number of air parties
  - Revenue
  - Vehicle trips
  - VMT
  - Emissions
  - Passenger travel time

- A measure of performance (MOP) consists of an output measure applied to a set of modes
  - e.g. Ridership (passengers) on all shared-ride modes
    - Revenue from on-airport parking
    - Emissions from all modes

- Output measures calculated by summation of mode use by each air party
  - Known trip origin allows access trip length calculation
Project Evaluation – Feasibility of Improved Access Services

• Evaluation of proposed projects to improve intermodal connectivity
• Considerations
  – Ridership and fare revenue changes (if any) from service enhancement
  – Capital and operating costs for service enhancement
  – Impact on use of other modes
    • Reduction in vehicle trips, VMT and emissions
    • Airport and operator revenue implications
• Capital and operating costs
  – User provides unit costs
    • Capital cost per route mile
    • Capital cost per vehicle
    • Operating cost per year (fixed cost)
    • Operating cost per vehicle-mile (variable cost)
  – IAPT calculates total capital and annual operating costs
    • Varies with service frequency defined for project
      – Determines number of vehicles required
      – Determines vehicle-miles per year
IAPT Demonstration

- Prototype version of IAPT is being developed in Visual Basic
- Initial focus on functionality of GUI
  - Layout of GUI screens needs to be modified for consistency with IAPT design
  - Current work is refining interaction with IAPT database
- Demonstration of current status of software development
Next Steps – Continued Development of IAPT

- **GUI development**
  - Modify screen layouts for consistency with IAPT design
  - Complete interface with database, data files and other modules

- **Calibration of mode choice model**
  - Complete preparation of Bay Area service data
  - Model estimation and development

- **Transportation provider modeling and algorithm**
  - Modeling constraints to generate realistic results
  - Refining representation of transportation provider decision making
  - Testing alternative optimization software
  - Convergence issues

- **Development of project evaluation module**
  - Calculating measures of performance
  - Interface with mode choice model results