Content

• Quick Review of Major Concepts from Last Week
  – Accessibility measures via Gravity Model and Utility-based Model
• Conclusions from Accessibility Lecture
  – “Composite Measures,” Deciding on a “Best Measure”, Accessibility as raison d’etre?

• Travel Demand
  – Basic Characteristics
  – Primary Drivers
  – Influencing Factors
  – International Comparisons
  – Implications for the Future…
• Assignment I
• Other Course Logistic Items

Back to the “Four Step”

Data Inputs
Inventories and forecasts of population, land uses, travel behavior, etc.

Trip Generation
Predicts number of trips produced and attracted in a given zone

Trip Distribution
Produces trip production and attraction for each zone

Modal Split
Predicts mode share typically for auto and public transport (can include walk, bike)

Trip Assignment
Assigns trips to their respective networks

System Outputs
Provides, for each link, data including traffic volumes, speeds, vehicle mix

Evaluation

Accessibility (continued) & Basics of Travel Demand
Day 6
11.953

Gravity-based Measures

• Theoretical origins in physics,
• Improvement over distance-based measures, partly because they attempt to better reflect travel behavior realities through their functional form, generally:

\[ A_i = \sum_j W_j f(c_{ij}, \beta) \]

• where:
  – \( W_j \) represents the opportunities available in a given zone \( j \).
  – \( f(c_{ij}, \beta) = \exp(-\beta c_{ij}) = \) impedance between zones \( i \) and \( j \).
  – \( c_{ij} \) represents the travel cost/distance between zones \( i \) and \( j \); and
  – \( \beta \) is a travel cost sensitivity parameter.

  • generally enters as a negative exponential function
  • the accessibility measure clearly is highly sensitive to this parameter.
  • Should come from empirical analysis

Utility-Based Accessibility: the Logit Model

Example: Car or Bus?

\[ P_a(i) = \frac{e^{\mu V_a}}{\sum_j e^{\mu V_j}} \]

• Potential Influencing factors (variables)
  – In-vehicle travel time
  – Out-of-vehicle travel time
  – Traveler income
  – Age
  – Gender
  – Etc.

Normally, Results used to MAKE PREDICTIONS about choices in some future (or alternative) setting
Utility-Based Accessibility: The “Logsum” and Nested Logit

\[ P_m(d) = P_m|d|P(d) \]

“Logsum” at “the root” represents composite benefit (“Expected Maximum Utility”) of the entire choice process.

\[ V_d \phi \ln \sum_{m} P_m(d) \]

Social Accessibility Levels
Female Adult, Evaluated at Mean Relevant Characteristics for Income Category

“Utility-based” Measures
- Theoretically appealing
  - Basis in behavioral theory and welfare economics
- Not immediately and easily convertible into meaningful and understandable units
  - Convertible into currency, time, but cumbersome
- Assumes utility linear with respect to income
  - Nonpresence of income effect
- Still travel-biased measures
  - Cannot immediately account for non trip-based accessibility (e.g., not traveling; trip-chaining)

“Composite” or “Activity-based” Approaches
- Essentially merging person-based (time-space) with utility-based
- Aims to account for people’s activities throughout the day.
- Directly linked to “activity-based” travel research
  - Reflect activity re-scheduling, work-at-home possibilities, etc.
- Data and computationally intensive

Traffic Analysis Zone (TAZ)

Relative Decline in Recreational Accessibility
Middle Income Female

High Income Middle Income Low Income
**Activity-Based Example: Long-Term Impacts of Congestion Pricing**

- Total effects lower (mean and median) for ABA
- ABA accounts for shifting to non-peak, change in activity pattern (e.g., work at home)

Dong et al., 2005.

**“Best” Measure?**

- No universally-agreed upon criteria
- An “ideal” accessibility measure should reflect:
  - Different preferences among people,
  - Scarcity of people’s time and money,
  - Range of relevant travel (“impedance”) characteristics
    - safety, convenience, comfort, aesthetics, etc.
  - Range of destination (“opportunity”) characteristics:
    - safety, convenience, aesthetics, diversity, etc.
  - Relevant traveler characteristics
    - vehicle availability, age, disability status, etc.
  - And be “operational,” interpretable, easily communicated.

- The composite, activity-based approach approaches the theoretical ideal.

See, e.g.: Ramming, 1994; Bhat et al., 2000; Handy and Clifton, 2001; Steuer and Van Wee, 2004

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**Accessibility: Indicator or Variable?**

- Examples here have shown accessibility as Indicator
  - US Cities accessibility
  - Neighborhood variation (Limanond and Niemeier, 2003)
  - Total User Benefits (Martinez and Araya, 2000)
- Accessibility also used as variable (input)
  - As determinant of some behavior or activity, influencing, e.g., residential choice, mode choice, vehicle ownership, etc.
  - Household/worker(s) commute time(s) influencing residential choice
  - distance to bus stops;
  - “neighborhood accessibility”;
  - “transit accessibility”;
  - number of jobs within certain driving distance;
  - distance to CBD;
  - employment density within certain radii;
  - number of establishments within various radii of home
  - even population density or share of commercial space reflect inherent relative nearness of people, stores, etc.
  - And, of course, in combination: e.g., in integrated LUT models

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**Accessibility as LUT raison d’être?**

- The mobility-for- accessibility perspective implies a largely utilitarian perspective
  - we travel to derive accessibility (e.g., “travel is a derived demand”)
- But, travel is not always a “means” to an “end,”
  - “travel liking” (due to adventure, variety, independence desires, etc.) and not just for leisure trips, but for routine trips and not just for auto sake (see Dry and Mokhtarian, 2005)
  - Extra travel as a means of “information gain” (i.e., better information on products, space, etc.) (Arentze and Timmermans, 2005)
- Travel’s role in social class formation
  - E.g., Vasconcellos (1997) details the role of the car in the “making of the middle class.”

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**Basics of Mobility Demand**

**Relevant Basic Characteristics**

- **Purposes:**
  - Work, Shopping, Social, Recreational, Business, School, Others
- **Origin:**
  - e.g., Home-based work, Home-based school, etc. nonhome-based shopping, etc.
- **Stage:**
  - e.g., Stage 1, 2, etc.
- **Mode:**
  - car, bus, rail, etc.
- **Time of Day:**
  - e.g., AM-Peak, Off-peak, etc.
- **Tour:**
  - combination of trips taken between “anchors” (activity-based modeling); multiple activities in a single tour = “trip chaining”
- **Distance, Time, other?**

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**Sources of Data**

- **Fundamental source**
  - Household Origin-Destination Survey
  - Should be calculated for a given Metropolitan Area
- **National-level Surveys**
  - E.g., Censuses
  - 2001 NHTS: 26,000 households, national-level, 24-hour “travel day” diary, plus 28-day “Travel Period” for long-distance travel (see nhts.ornl.gov)
How do people get around?
US MSAs 2000: Work Trip Mode Share

Santiago (2001)

Range of “Developing World” Cities

Why do we Travel: Trip Purposes?

Travel Demand: Relevant Personal Choices

- **Activity choices**
  - result in the number of tours and trips made by a person for a certain purpose

- **Destination choices**

- **Mode choices**
  - car, train, bus, tram, metro, etc.

- **Time-of-day choices**

- **Route choices**

Travel Demand
(Activity Choice + Destination Choice + Mode Choice) =

\[ f(\text{Socio-Economics/Demographics, Communication Patterns/Time Routines, Travel Costs (generalized), Modal Availability, Land Use Patterns}) \]
Major Socio-Economic and Demographic Drivers

- Household Income
  - Car ownership
    - although elasticities different at different income levels: e.g., S-curve
  - Longer and more trips
  - Higher demand for speed
    - higher value of time

The Stylized “S-Curve”

National Motorization Rate
Where’s the S-Curve?

Figure removed for copyright purposes.
See Willoughby, Christopher. “Managing Motorization.”


Source: RITES, 1995

Household-Based S-Curves...
Autos and Motorized Two-Wheelers in Chennai, India (1993)

Income and the Demand for Trips

Source: U.S. DOE, 2004

Income and the Demand for Trips

**São Paulo 1997**

![Bar Chart]

- Average Household Income (US$1997)
- Trips/Person/Day

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Income and Mode Share - Santiago

![Line Graph]

- % of All Trips
- Walking
- Auto
- Public Transport

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Income and Mode Share - São Paulo

![Line Graph]

- % of All Trips
- Walking
- Auto
- Public Transport

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Income, Motorization Rate & Mode Share – Santiago

![Bar Graph]

- Auto Mode Share
- Vehicles per 1000 Pop.

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The Theory of Constant Travel Budgets

![Bar Graph]

- Hours/Day Spent Traveling
- Travel Cost, Percent of Disposable Income
- Kilometers Traveled/Person/Day
- Source: Updated data based on Schafer (1988).

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What Does Schafer Say About This?
Implies: Increased Income=Increased Travel
Passenger Travel Growth, Past 50 Years.

How Would Schafer Respond?

But, be careful with National to Global Level Averages…