ABM Progress Update

Mohamed Kamel, PhD

Modeling & Forecasting,
Research & Analytics

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Outline

- Why an Activity-Based Model?
- Phase 1: Development Journey
    - Model Estimation
    - Model Calibration
    - Model Validation
    - Sensitivity Testing

Why an Activity-Based Model?

Why Evolve? The Need for a More Detailed Approach

- **Today's Planning Context:**
  - Understanding complex households (multi-worker).
  - Modeling modern work patterns (work from home).
  - Analyzing the full spectrum of travel (interest in non-commuting travel).
  - Assessing detailed equity impacts of projects and policies.
  - Evaluating the effectiveness of demand management (e.g., pricing).

- **For more information, please revisit last year's presentation:**
  - ABM_Update, 2024

Why Evolve? The Need for a More Detailed Approach

- **Activity-Based Models (ABM):**
  - **Person/Household Focus:** Simulates individuals and their complete daily activity schedules, capturing some of the intra-household interactions.
  - **Tour-Based:** Understands travel as chains of trips (tours) with specific purposes and constraints (time, vehicles), allowing better analysis of trip chaining and non-commuting travel patterns.
  - **Disaggregate Detail:** Provides insights at the level of unique individuals and households, essential for granular equity analysis and understanding varied responses to travel demand management.
- **Result:** A modeling approach better equipped to answer: “who travels, why, when, where, and how throughout their entire day?" in the context of today's complex challenges.

What ABM Means for Planning: Answering Key Questions

- **How the ABM's Detail Translates to Planning Benefits:**
  - **Targeted Equity Analysis:**
    - **Question:** How does a new transit line or road toll affect low-income households vs. high-income, or seniors vs. younger adults?
    - **ABM Advantage:** Simulates individuals, allowing direct analysis of impacts by detailed demographics.
  - **Effective Demand Management:**
    - **Question:** Will time-of-day pricing, parking charges, or promoting flexible work hours successfully reduce peak-period demand? By how much?
    - **ABM Advantage:** Models trip scheduling and time constraints, providing realistic sensitivity to policies aimed at shifting travel times.

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What ABM Means for Planning: Answering Key Questions

- **Realistic Transit & Active Transportation Planning:**
  - **Question:** How do factors like transit accessibility, fare changes (including pass ownership), or improved bike lanes influence mode choice for the entire journey?
  - **ABM Advantage:** Considers the full tour context and detailed person/household factors influencing mode choice.
- **Understanding New Trends:**
  - **Question:** What are the network impacts of increased work-from-home? How might new mobility services be used? How do households coordinate complex trips (e.g., school drop-offs)?
  - **ABM Advantage:** Flexible structure allows adding models for these complex, evolving behaviors directly into the decision framework.

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Phase 1 : Development Journey

Phase 1: Objectives

- **Develop Pre-COVID Baseline Model:** Implement ActivitySim using the 2017 trip diary to establish a pre-pandemic reference point.
- **Confirm RTM-Level Capabilities:** Validate that the initial ABM capabilities achieve RTM level analysis and benchmark ABM against the RTM.
- **Achieve In-Depth Model Insight:** Develop a strong understanding of the ActivitySim platform via:
  - Rigorous sensitivity analysis.
  - Thorough software evaluation.
  - Comparative benchmark analysis with RTM outputs.

Phase 1: Model Estimation

- **Building the ABM involves developing a complex ecosystem of interconnected models.**
- **Illustrative Scale of Phase 1 Effort:**
  - The ActivitySim ABM framework consists of ~26 distinct, interdependent modules,
  - 11 core modules were fully estimated for phase I
  - 20 modules calibrated to the weighted 2017 targets for phase I
  - Many modules handle multiple travel purposes (Work, School, Shop, etc.) and numerous choice alternatives (e.g., dozens of modes/submodes, thousands of potential locations).
  - Dependencies are critical: Outputs from one module (like auto ownership) directly feed into others (like tour mode choice), requiring careful, sequential development.

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Phase 1: Model Estimation

- **Prepared 2017 Trip Diary for ABM Estimation:**
  - Transformed raw survey data into analysis-ready format.
  - Key tasks: robust tour formation, coding non-modeled behaviors, variable recoding
- **Developed ActivitySim Model Structures:**
  - Estimated core modules (e.g., workplace, school location choice, mode choice).
  - Borrowed module structures as placeholders to enable end-to-end testing.
- **Refined Models Through Iterative Debugging:**
  - Systematically identified and resolved initial model issues.
  - Focused on addressing inconsistencies between observed survey behaviors and modeled outputs.

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Phase 1 Methodology: Building a Robust Foundation

1. **Guiding Principles for Estimation:**
    - **Unbiased & representative:** Models reflect observed 2017 behaviors without overfitting; parameters are behaviorally sound.
    - **Forecast capability:** Focused on underlying relationships, not just replicating base-year totals, to ensure future-year applicability.
    - **Policy sensitivity:** Ensured core models respond logically to key regional levers (e.g., travel time/cost, accessibility) to enable future testing.
2. **Systematic Module Development:**
    - Ensured logical information flow where feasible in the model:
        - **Example 1:** people not old enough to drive can’t "drive alone"
        - **Example 2:** Workplace Location choice considers not just job attributes and income, but also the overall commute accessibility (using mode choice "logsums")

Phase 1 Calibration & Validation

- **Calibration Process:**
  - Developed weighted survey targets for travel choices (e.g., mode shares, trip rates by purpose).
  - Systematically adjusted model parameters (primarily Alternative Specific Constants) to align model outputs with these targets.
  - Developed automated scripts for efficient and repeatable calibration adjustments.
- **Validation Process (Out-of-Sample):**
  - Assigned simulated ABM trip outputs to the network.
  - Compared resulting traffic volumes against observed Auto and Transit Screenline counts.
- **Diagnostic Check:**
  - Separately assigned the weighted 2017 Trip Diary demand to the network.
  - Helped understand the sources of variation between simulated demand and observed counts.

Phase 1: Model Estimation & Calibration Summary

Core Modules	Estimation	Calibration
School Location	✓	✓
Workplace Location	✓	✓
Work From Home	⊘	✓
Telecommute Frequency	⊘	✓
Auto Ownership	✓	✓
Transit Pass Ownership	✓	✓
Coordinated Daily Activity	✓	✓
Tour Frequency	⊘	✓
Tour Destination	⊘	⊘
Tour Scheduling	✓	✓
Tour Mode Choice	✓	✓
Stop Frequency	⊘	✓
Trip Purpose	⊘	⊘
Trip Destination	⊘	✓
Trip Scheduling	✓	✓
Trip Mode Choice	✓	✓

Legend

Completed ✓

Deferred ⊘

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Phase 1 Estimation Challenge: Transit Pass Ownership

- **Challenge:**
  - **Need:** Ability to test future policies involving transit pass price changes.
  - **Data Limitation:** 2017 survey data showed no variation in pass prices, preventing direct measurement of price sensitivity.
- **Our Approach:** Leveraging related knowledge
  - We know from the Mode Choice model how sensitive travelers are to daily travel costs.
  - **Assumption:** A similar sensitivity applies when travelers consider the value of purchasing a monthly transit pass relative to its price.
  - **Method:** Introduced price sensitivity by relating the pass price to traveler utility using the cost coefficient transferred from the Mode Choice model.
- **Implementation:**
  - Integrated the price sensitivity into the Transit Pass Ownership model structure.

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Phase 1 Sensitivity Testing

- **Next Step:** Rigorous Sensitivity Testing marks the final validation of the Phase 1 model.
- **Purpose:** Confirm the foundational model responds logically and realistically to changes before initiating Phase 2 estimation with 2023 data.
    - Confirm RTM-Level Capabilities
- **Our Approach:**
    - **Comparative Testing:** Execute identical test scenarios on both the ABM and the RTM to benchmark performance and understand differences.
    - **'Before & After' Analysis:** Simulate specific known changes (e.g., a past network update or policy introduction) and compare ABM's simulation against observed real-world data changes.
- **Outcome:** A thoroughly vetted baseline model, providing confidence to proceed with Phase 2 development using the 2023 Trip Diary.

Thank you