Modelling Household Travel Decisions

A Travel Scheduling and Resource Allocation Model for a Mid-Sized Canadian City

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The Household Travel Problem

Each person in a household has a set of **activities** for a typical day, including:
Mandatory Activities, which *must be completed* and are prioritized first

School Work

Discretionary Activities, which *may be deferred* to another day

Service Shopping Recreation Social

Each activity has different: *Location*, *Duration* and *Possible Start Times*

The household also has a set of **shared resources** for travel to activities:

Budget Time Vehicles Independence or Supervision for Dependents

Using available resources, each person must choose one of the following modes to travel to each activity:

Drive Share Transit Bike Walk

A person might *defer* or *cancel* an activity if there are no available resources. Over the long term, if a household continues to defer or cancel activities, it may *move to a new location* or *purchase a vehicle* to change it resource set.

The household must collectively allocate resources and schedule activities so that its members may achieve its activities within the resource constraints. Additional complexity arises if there are dependents (e.g. children or seniors).

Research Objectives and Approach

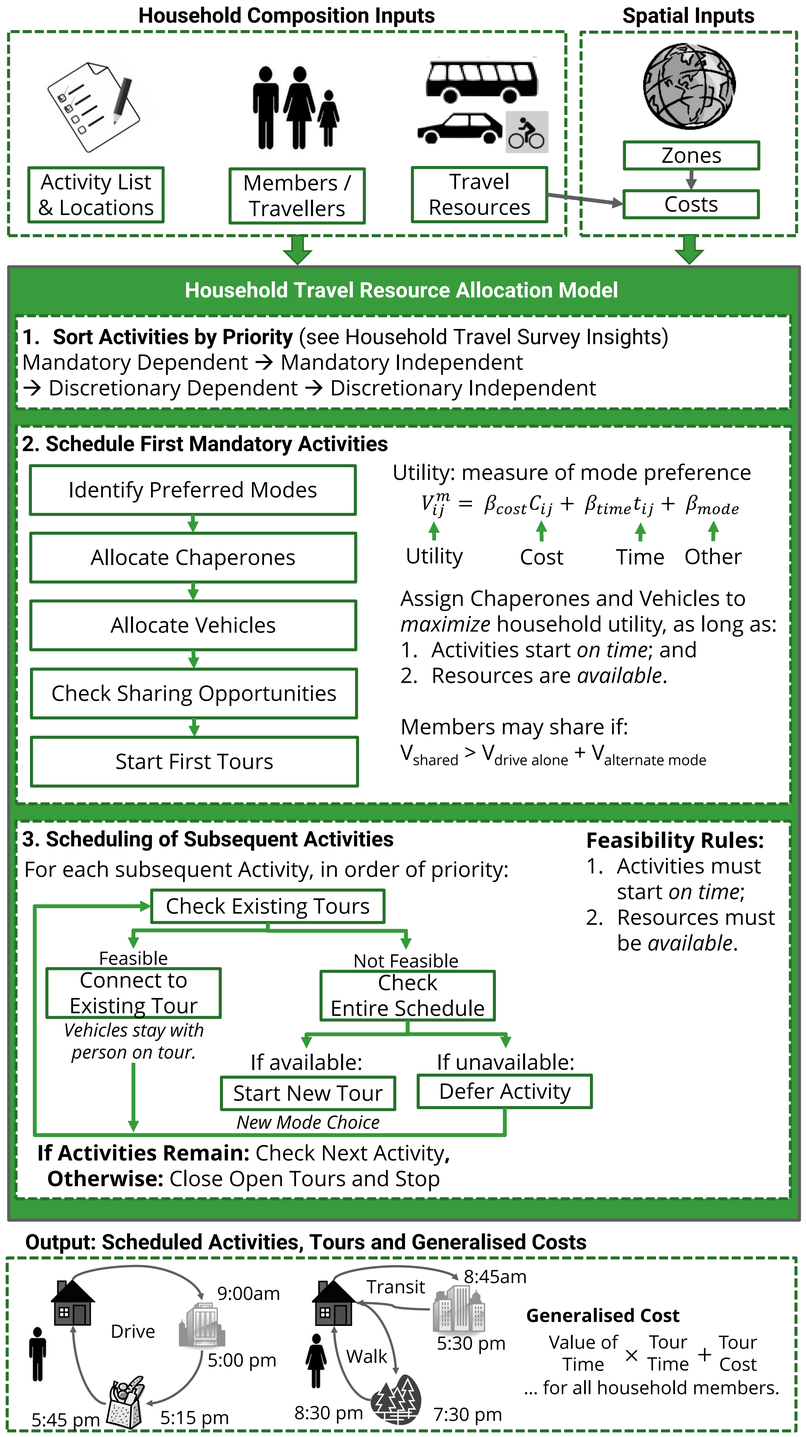
The household travel problem is fundamental to both transport and land use systems. Therefore, we seek to understand and model the household travel decision making process. In particular, we are interested in:

1. How do households allocate resources – vehicles, time, and supervision – to conduct their activities?
2. How do households prioritize their various activities?
3. What factors, other than time and cost, do households consider when making travel decisions?

In this research, we take the following empirical approach:

- Survey households of various demographic backgrounds and compositions
- Establish general rules that reflect the logic and process of travel decisions
- Develop and test the model using actual activity sets from households

Household Travel Resource Allocation Model



Household Travel Survey Insights

Activity Priorities

Activity Type	Avg. Priority
Work / School	1.0
Service	3.0
Grocery Shopping	3.6
Social	3.9
Recreational	4.6
Other Shopping	6.0

Note: If dependent in household, Chaperone activity has priority of 2.

Decision Motivators

Motivation	Avg. Rating
Achieving Activities	1.6
Maximize Flexibility	2.0
Minimize Cost	2.9
Lower Env. Impact	3.0
Achieving Fitness	3.9

Rating 1 (very important)
Rating 5 (not very important)

Calibrating and Validating Model Utility Function

- Based on 2011 Transportation Tomorrow Survey for Kitchener-Waterloo
- Function calibrated with 14,000 trips and validated with 6,800 trips
- Function calculates mode share within +/- 0.2% of actual mode share

Parameter	Estimate	Standard Error	$t_{statistic}$	Significance
β_{time}	-0.0935	0.0031	-29.7470	***
β_{cost}	-1.0698	0.0767	-13.9429	***
$\beta_{mode,\ transit}$	-0.5479	0.0812	-6.7465	***
$\beta_{mode,\ bike}$	-4.7574	0.0983	-48.3965	***
$\beta_{mode,\ walk}$	-0.7249	0.0536	-13.5150	***

Significance codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
Log-likelihood = -7008.2; $\rho^2 = 0.1046$

Model Test Results

- Model tested with 21 persons (9 households) from Kitchener-Waterloo
- Model attempts to schedule activity within 15 min. of reported start time

Metric	Accuracy	Model Limitation
# of Activities	18 / 21	Model only inserts activities at end of tour
# of Tours	14 / 21	Model typically underestimates number of tours.
Mode choice (First Tour)	13 / 21	Model underestimates cost of parking. Model also does not include all mode choice preferences.
Chaperone Assignment	2 / 2	One household with two dependents tested in model. Initial results should be confirmed with more tests.

Model has fast run times and may process 10,000 households in 15 min.

Conclusions

A model to schedule activities and allocate resources was developed for a mid-sized Canadian city. The model was tested with preliminary data with reasonable success to provide initial confidence in the model logic.

This model is part of a broader modelling effort that identifies changes to travel behaviour and residential location patterns in Kitchener-Waterloo.

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