A Travel Time Reliability Estimation and Valuation Approach for Transportation Planning Applications

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Overview

- Introduction
- Literature
- Methodology
- Data
- Results and Discussion
- Conclusion and Future Research

Introduction

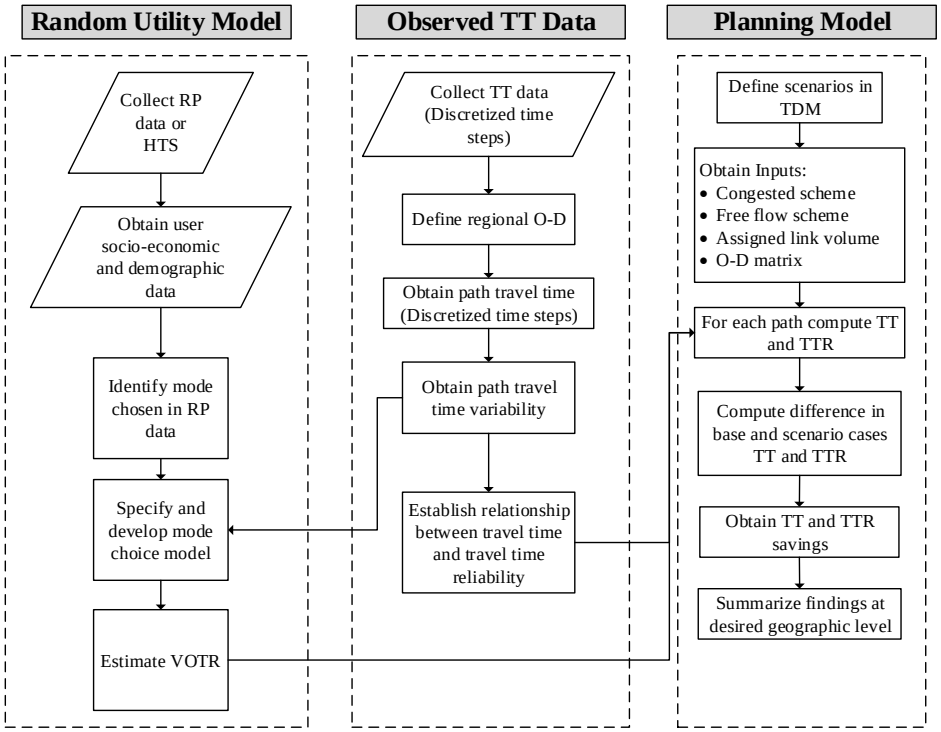
- Value of Travel Time (VoT) and Value of Travel Time Reliability (VoTR) are two important parameters
- VoT
  - monetary value travelers place on reducing their travel time or savings
- VoTR
  - monetary value travelers place on reducing the variability of their travel time or improving the predictability
- Key question:
  - How to incorporate reliability in transportation planning process
  - What is the valuation of reliability for transportation planning applications
  - How planning agencies can utilize reliability as a measure in the decision making process

Literature

- Performance driven reliability
  - Derived from observed data
  - Used for application purposes (congestion, delay etc.)
- Traveller's response based reliability
  - Choice based behavior
  - Requires significant time for development
- Measures of reliability
  - 90^{th} or 95^{th} percentile travel time,
  - buffer index,
  - planning time index,
  - percent variation,
  - percent on-time arrival
  - standard deviation

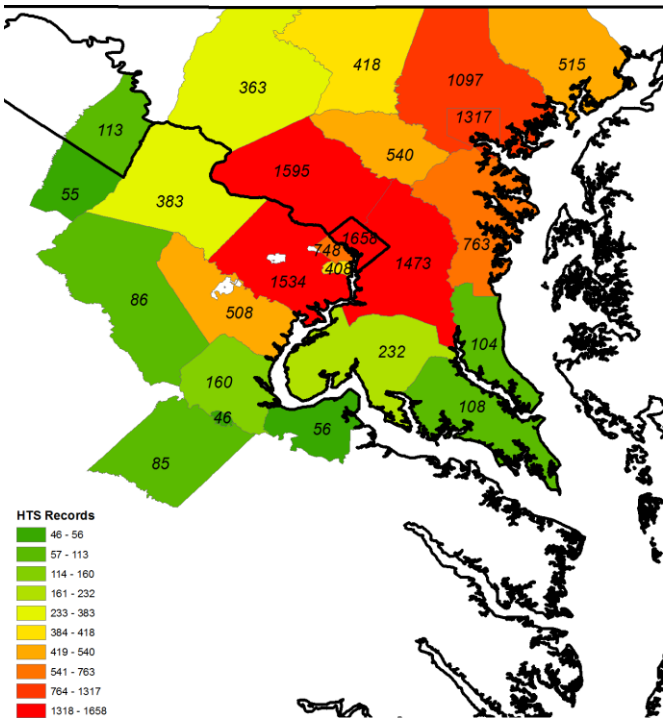
Methodology

- 3 Step Process
  - Random utility model
  - Reliability and travel time relationship
  - Application in planning models



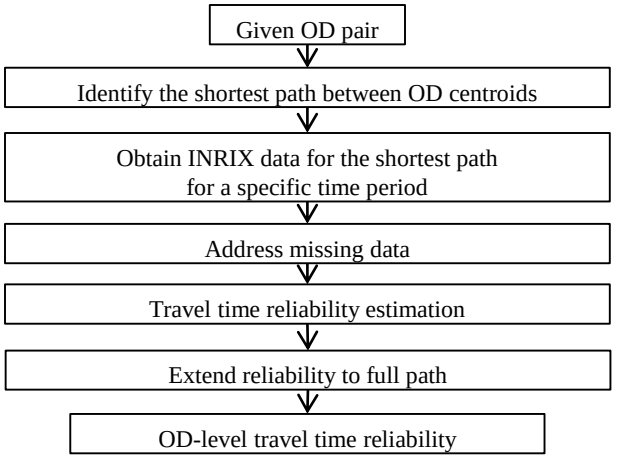
Household Travel Survey

- Survey conducted between May 2007 and December 2008
- Interviewed 14,365 households
- 108,110 trips were reported



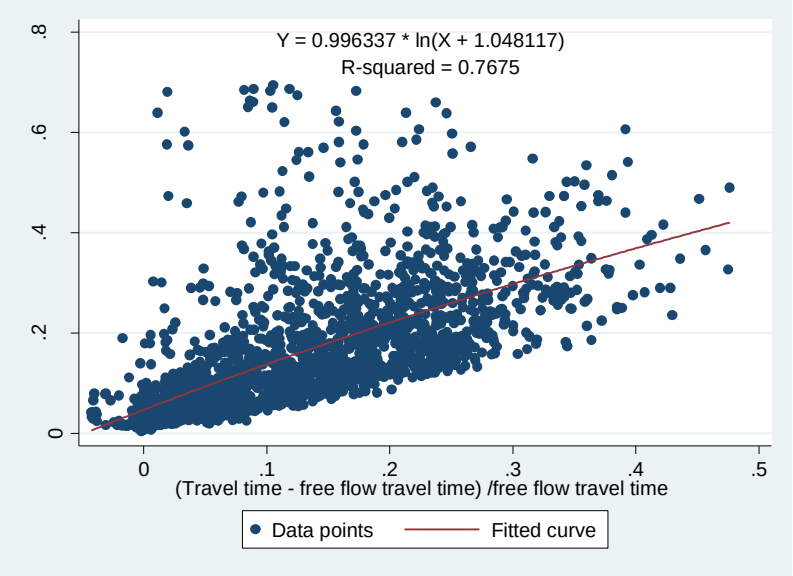
Obtaining Path Travel Time

- Travel time data for various paths are obtained from INRIX TMCs
- Data obtained for the whole year in five minute increments
- Path specific travel times are aggregated to one hour
- Various reliability measures are obtained
  - Standard deviation
  - Coefficient of variation



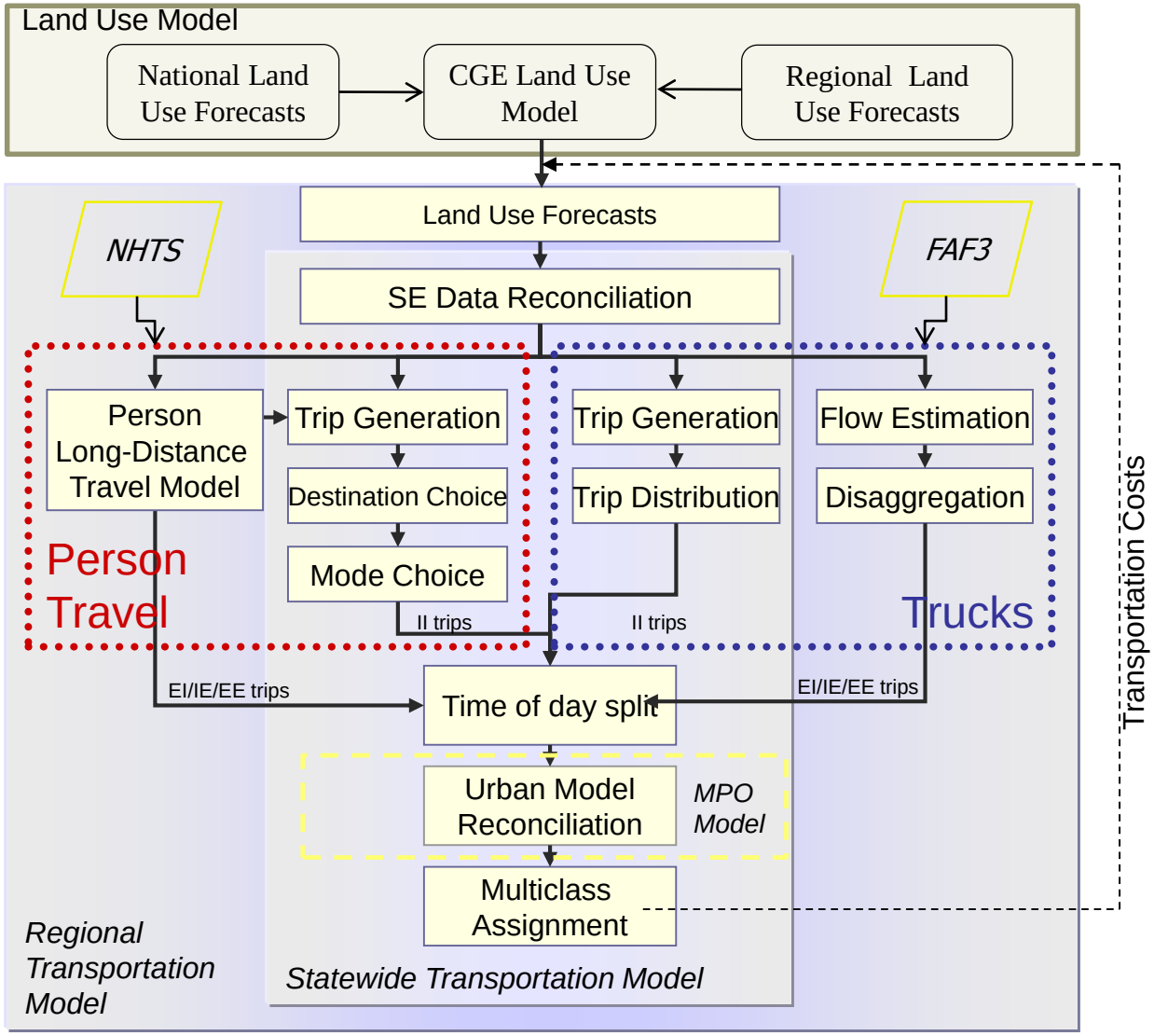
Estimating Reliability Measure

- Obtain travel time data for a region on selected O-D pairs
- Designed path travel times
- Variation on path travel times
- Develop relationship between path travel times and variation in path travel times



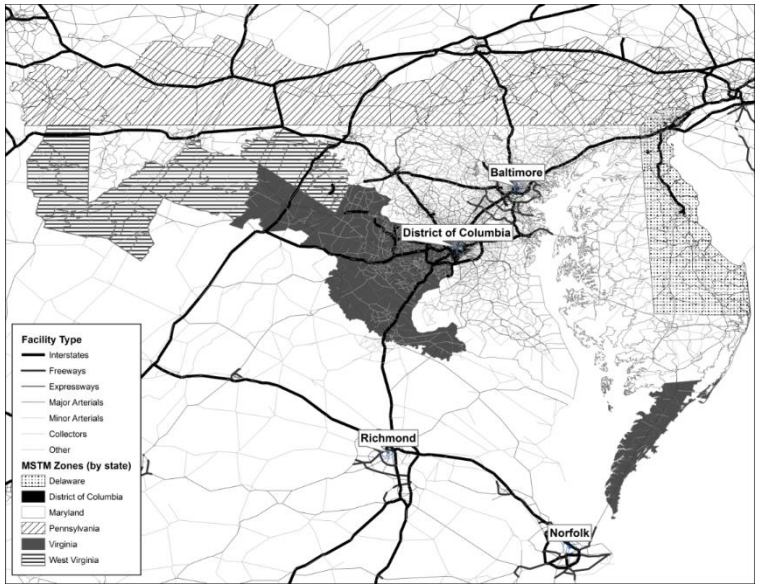
Travel Demand Model

- Trip based model
- Separate component for passenger and freight
- Long and short distance aspects
- Interfaces with land use model
- Model validated per FHWA guidelines

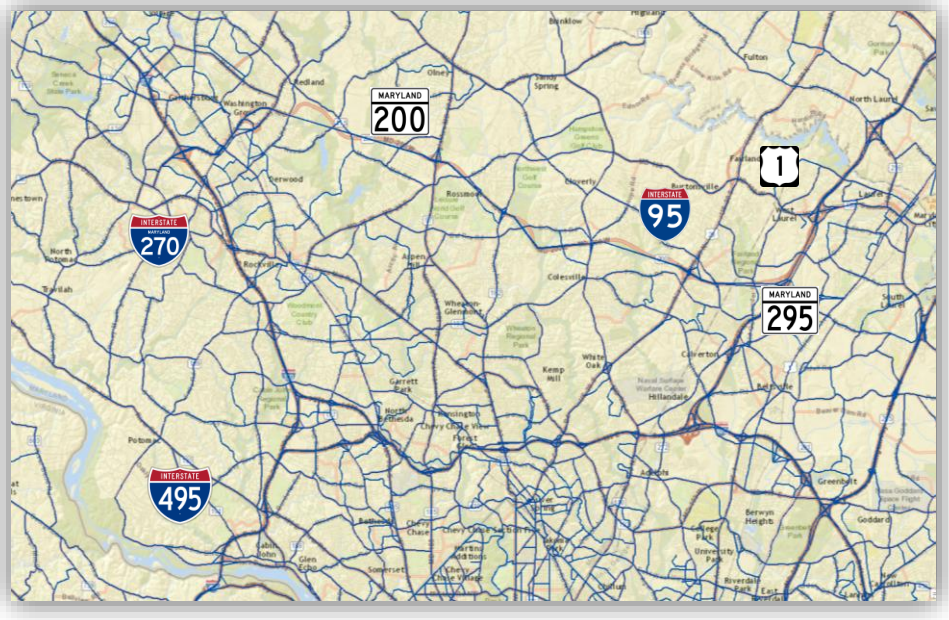


Study Area

- Maryland Statewide Transportation Model Area



ICC and I-270 (Case Study Locations)



Reliability and Mode Choice (1)

- Regional Household Travel Survey
- The survey provides activity scheduling process
- Given a time varying network G = (N,A)
  - N: finite set of nodes
  - A: finite set of directed links
- The time dependent zonal demand represents
  - number of individual travelers of an O-D pair
  - at departure time t
  - From available set of modes M

Reliability and Mode Choice (2)

- The choice probability for each mode can be given by

$$U(m) = \alpha TT_r^{qtm} + \beta TC_r^{qtm} + \gamma TTR_r^{qtm} + \theta_i DC_i +$$

Where,
TT = path travel time
TC = Travel cost
TTR = Travel time reliability (example: coefficient of variation)
DCi = Decision maker's *ith* characteristics
α = coefficient of travel time
β = coefficient of travel cost
γ = coefficient of reliability
θ_i= coefficient of decision maker's *ith* characteristic
α / β = value of time
γ / β = value of travel time reliability
γ / α =reliability ratio

Mode Choice Model Results

Variable	Coefficient	P-value
Constant (Auto)	0.352	0.02
Veh0	-2.71	0
Veh3	0.645	0.02
Time	-0.009	0.05
Reliability	-0.113	0.01
Number of observations	520	
Log likelihood at convergence	-328.515	
ρ^2	0.089	

Note: Rail is reference category

$$RR = \frac{VOR}{VOT} = \frac{\partial U / \partial TTR}{\partial U / \partial TT} = \frac{\beta_{TTR}}{\beta_{TT}}$$

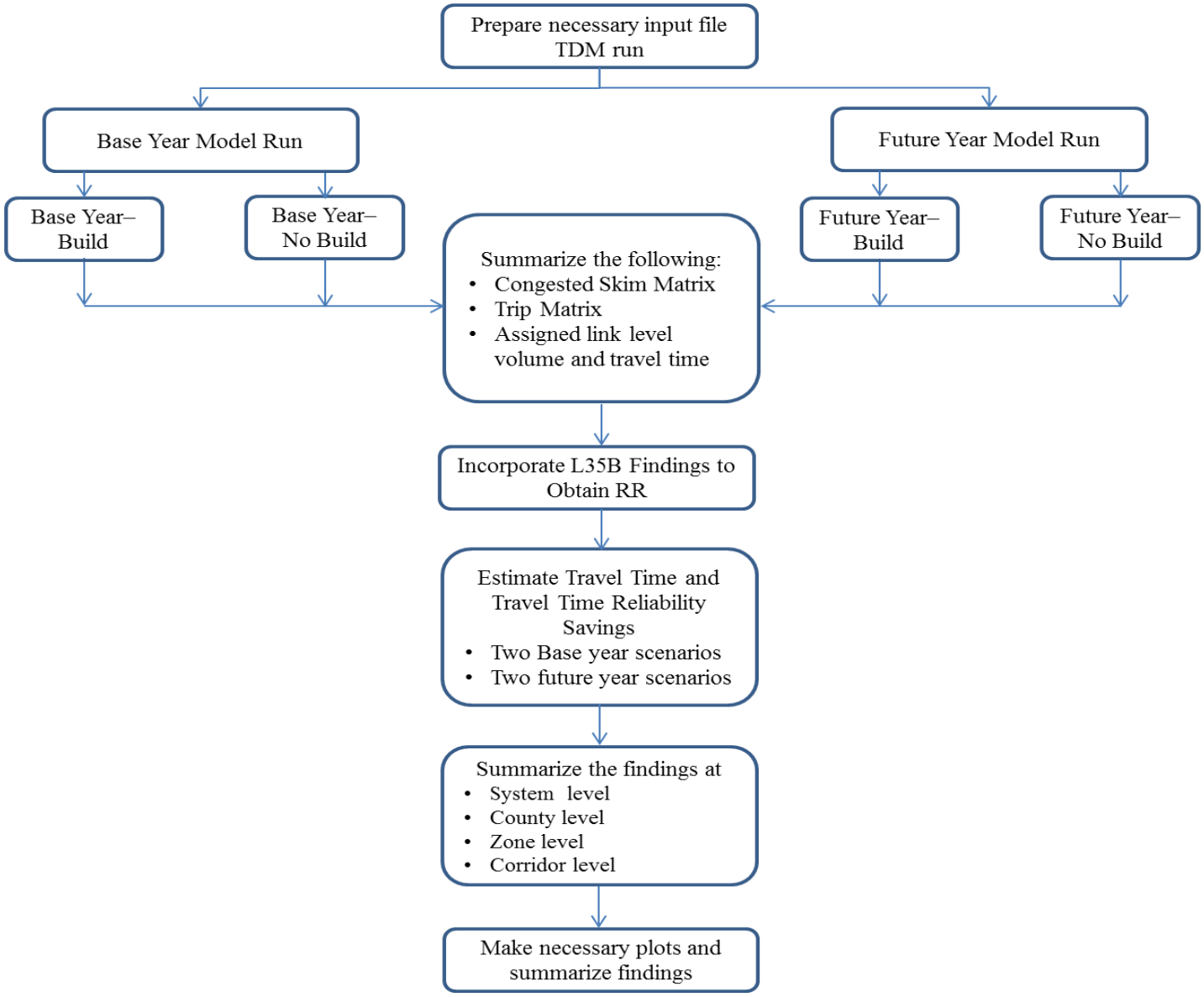
RR = -0.113/-0.009 = 13.25
Assume VoT = 14 $/hr
VoTR = 13.25*14= 185.5 $/hr

Quite High

Rationale and Reconciliation

- The estimated RR is high. Reported in literature range is 0.1 ~ 2 .51
- The discrepancy is caused by following reasons
  - First, RR is estimated based on mode choice problem between auto and rail, while other modes exist in reality (bus, express bus, light rail, and non-motorized transport)
  - Second, travel cost and travel time variance of rail is not included in the utility function because of data limitation.
  - Third, travel time reliability is calculated by using Maryland specific data (variation may occur using RP or SP data)
  - Fourth, since 1h time interval is used in this study, the travel time reliability measures estimated will be much lower than using smaller time intervals, thus leads to a higher estimation of reliability ratio
- We have used RR as 0.75 considering to improve the model to obtain realistic RR in the future

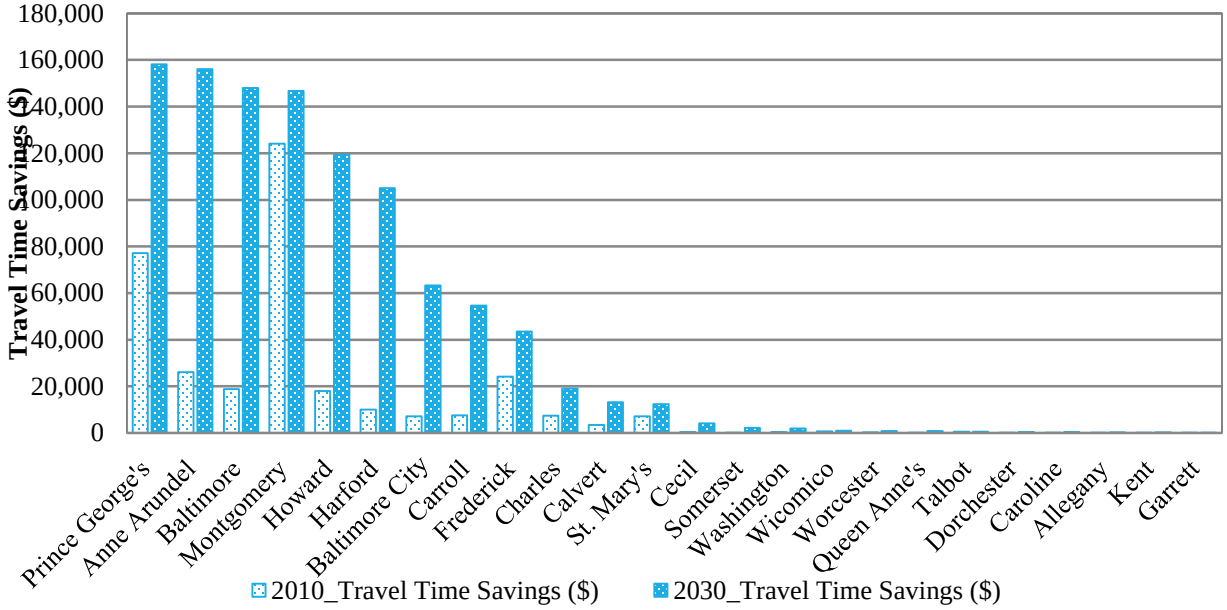
Application Methodology

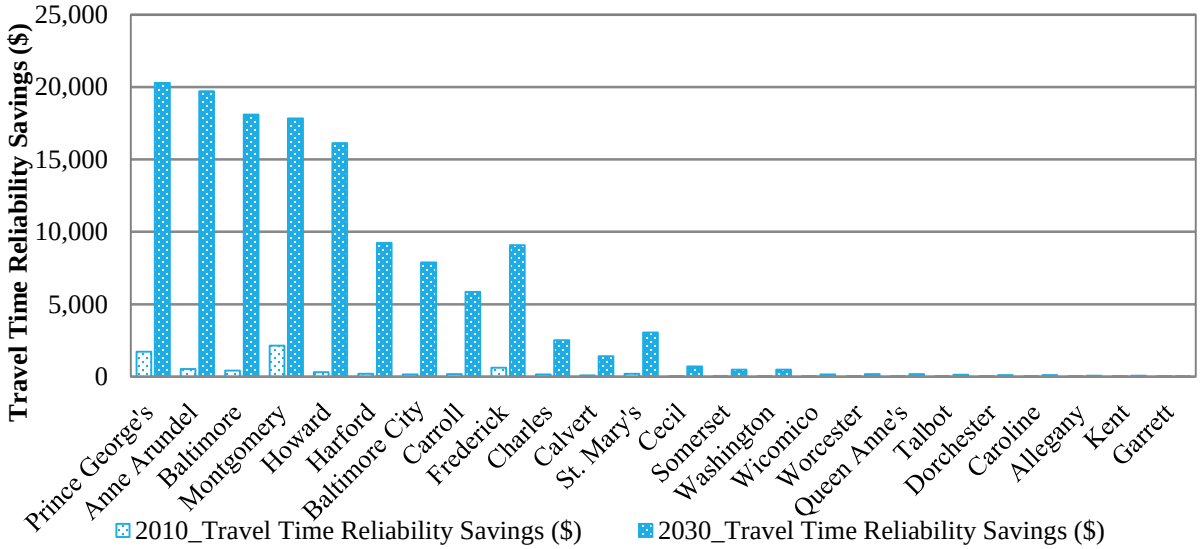


Statewide Findings

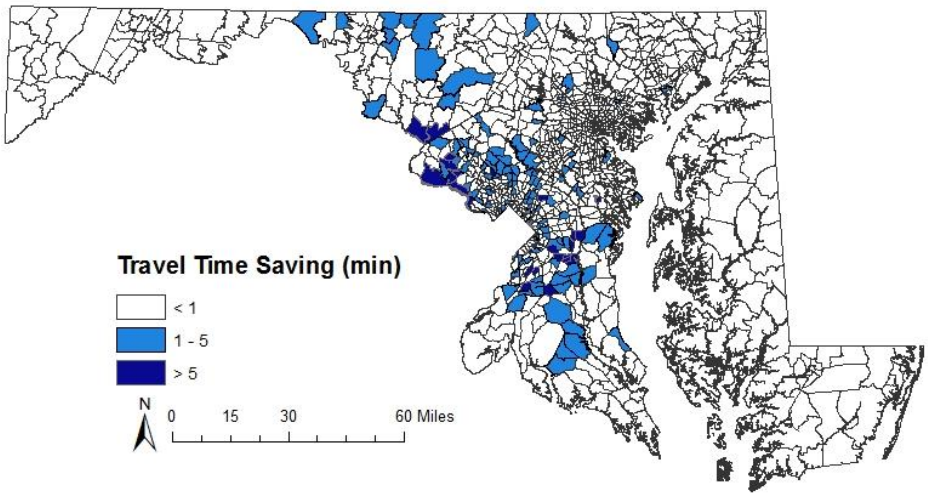
Year	Total Savings	Travel Time Savings (Minutes)	Travel Time Savings ($)
Base Year	Travel Time	1,434,002	334,552
	Travel Time Reliability	144,255	33,774
Future Year	Travel Time	4,512,147	1,052,682
	Travel Time Reliability	454,639	106,214

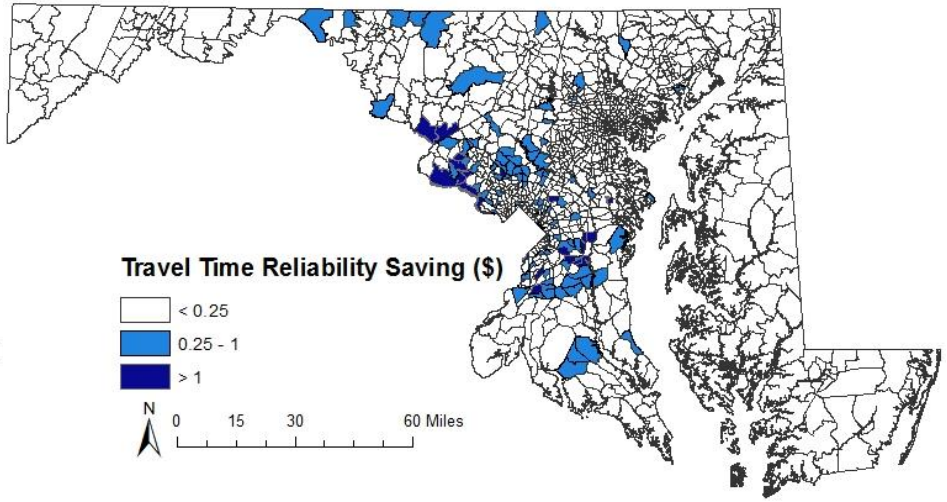
County Level Findings





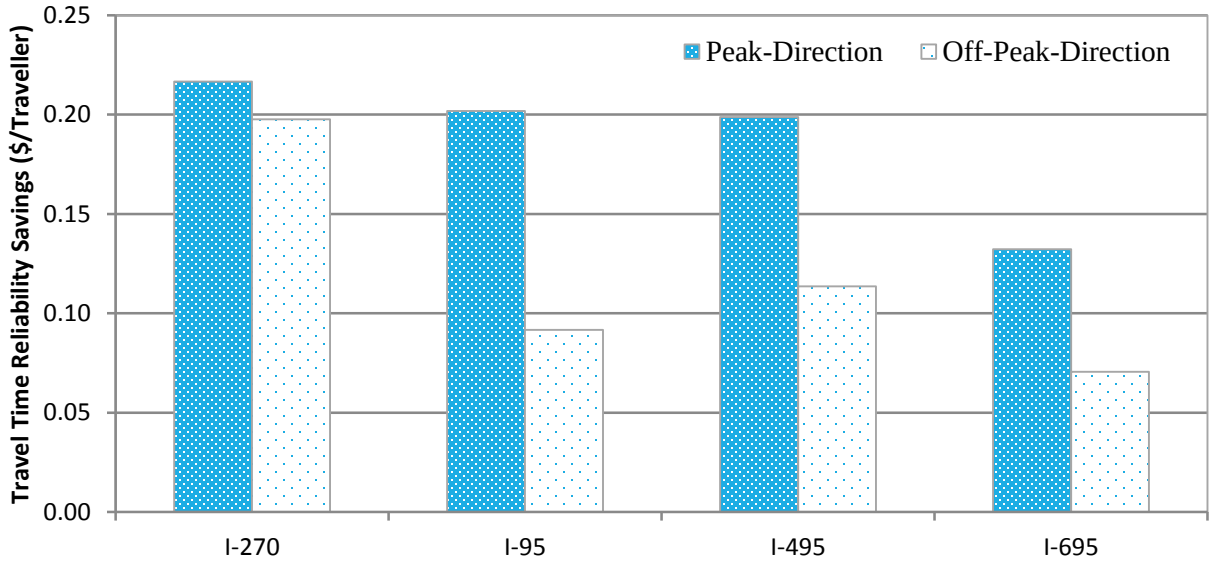
Zone Level Findings





Corridor Level Savings

Scenario	I-270 Travel Time (Min)		I-270 TT Savings (min/ Traveler)		I-270 TTR Savings ($ / Traveler)	
	NB	SB	NB	SB	NB	SB
Base-No Build	20.2	23.8				
Base-Build	18.6	21.8	1.6	1.9	0.19	0.21
Future-No Build	21.6	25.7				
Future-Build	19.8	23.7	1.8	2.0	0.22	0.20



Summary and Conclusion

- The paper proposes a unified approach for determining VoTR savings in transportation planning models.
- The approach is designed for estimating the following in a planning model
  - reliability ratio,
  - VoTR,
  - benefits received from new network investments, and
  - reliability measures because of newly suggested improvements
- The approach is applied to estimate travel time reliability savings from no-build to build scenarios for both base and future year
- Reliability savings are found to be 10% of the travel time savings

Limitations and Future Explorations

- The mode choice model developed in this research is preliminary and can be improved
- More modes can be integrated in the choice model
- Reliability savings are obtained as a post processor in the planning model
- In the future, reliability can be incorporated in the travel demand mode itself for more realistic behavioral implications

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Thank You

Q & A