2020 UDOT RESEARCH PROBLEM STATEMENT

Problem Statement deadline is March 16, 2020. Submit statements to UTRAC@utah.gov

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Title: Forecasting Travel Time Reliability through Model Uncertainty **No. (Office Use): 20.05.01**

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Select ONE Subject Group ☐ Materials/Pavements ☐ Maintenance ☐ Traffic Mgmt/Safety ☐ Structures/Geotech ☒ Planning ☐ Aeronautics ☐ Public Transportation ☐ Other

1. Write a brief research project objective:

Examine parameter uncertainty in a travel demand model for the Wasatch Front. Investigate the consequences of this parameter uncertainty in the model's forecasts of travel time and compare these forecasts with observed highway reliability statistics.

2. Explain the problem and why this research is important: (*Importance reflects 50% of the statement score*)

Surveys of residents and freight shippers consistently state that travel time *reliability* – the consistency and predictability of travel time is of greater concern than persistent congestion or overall travel time. In spite of its importance, UDOT and the general forecasting community do not have a reliable method of forecasting travel time reliability and examining how proposed projects might improve reliability.

Studying travel time reliability requires analyzing *non-typical* traffic conditions, but the WFRC / MAG travel demand model for the region, like virtually all travel forecasting models, is designed and calibrated to analyze a *typical* travel day. The model does this by representing complicated individual travel behavior parameters – such as the number of work trips made per household, or the perceived costs of in-vehicle and out-of-vehicle travel time – with mean values. When an analyst estimates these parameters, however, the parameters include some level of uncertainty reflecting the variation in travel behavior. The goal of this project is first to recover this parameter uncertainty, and then to examine the consequences of this uncertainty the model's forecasted travel times.

3. Describe how the research results will be implemented and benefit Utah: (*Implementation reflects 50% of the statement score*)

To represent the uncertainty inherent in the WFRC / MAG travel demand model, we will reestimate or otherwise recover the parameter estimates for certain key elements of the model, with their statistical distributions. In the case of cross-classified trip rate estimates, for example, we will compute the mean trip rate from the most recent Utah Household Travel Survey (UHTS) along with the variance in the mean trip rate. We will then conduct several runs of the WFRC / MAG model, drawing a different trip generation rate from the estimated distribution for each run. A mean trip rate of 2.1 trips per day with a standard deviation of 0.4 might use rates of 1.73, 2.06, 2.24, 1.61, and 1.93 in five different runs of the model.

The Boston MPO recently completed an uncertainty analysis of its regional travel demand model [1], which provides a useful template for this study. In the Boston study, the MPO identified uncertain travel model *inputs* – including land use forecasts and behavioral parameters – and examined the consequences of this uncertainty in the resulting project forecast. A major contribution for the perspective of this problem statement is the Boston study's application of Latin Hypercube Sampling [2], a technique which reduces the number of model runs necessary to adequately sample the parameter space.

The outcome of this parameter sampling will be a variation in estimates of the travel time on each highway link in the model network. By comparing this variation with the variation in travel times UDOT measures in IPEMS or from its HERE data, we can determine whether parameter sampling in the travel model is a reasonable technique to forecast travel time reliability for future conditions.

References

1. Gliebe, J. (2019). Use of a Response Surface Model to Quantify Forecasting Error Intervals for Disparate Impacts Analysis. In *TRB Planning Applications Conference*, Portland Or. Retrieved on February 17, 2020 from https://www.trbappcon.org/2019conf/294_JGliebe_TRBAppsConf_2019_v2.ppt
2. McKay, M., Beckman, R., & Conover, W. (1979). A Comparison of Three Methods for Selecting Values of Input Variables in the Analysis of Output from a Computer Code. *Technometrics, 21*(2), 239-245. doi:10.2307/1268522

4. List the major research tasks:

The major tasks of this project:

1. Literature review
2. Review WFRC / MAG model parameters for trip generation, distribution, and mode choice
3. Reestimate model parameters from UHTS with uncertainty distributions
4. Develop a parameter space sampling strategy, and conduct model runs across the parameter space
5. Compare variation in modeled travel times with observed reliability measurements

5. List the expected research deliverables (reports, manual, specification, design method, training, video, etc.):

The primary deliverable will be a research report describing the analysis methodology and results. There will also be a presentation to the WFRC / MAG model users group meeting, and code for our parameter sampling strategy will be supplied to UDOT and the MPO's.

6. Requested from UDOT: $60,000 **Other/Matching Funds:** $ **Total Cost:** $60,000

Briefly explain funding sources:

7. Outline the proposed schedule, including start and major event dates:

2020:

- September: Initial scoping meeting with TAC
- November: Start project, kickoff meeting with TAC and student research assistants

2021:

- February: Complete literature review
- April: Review WFRC / MAG model parameters for trip generation, distribution, and mode choice
- June: Reestimate model parameters from UHTS with uncertainty distributions
- July: Develop a parameter space sampling strategy
- August: Conduct model runs across the parameter space
- September: Compare variation in modeled travel times with observed reliability measurements
- November: Submit draft final report to TAC