2020 UDOT RESEARCH PROBLEM STATEMENT

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

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Title: Methodology for analyzing and forecasting long-term travel time reliability **No. (Office Use): 20.05.03**

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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:

Predicting travel time reliability (TTR) is a crucial task for supporting decision makings of transportation agencies such as UDOT. In the literature, TTR forecasting can be classified into long-term and short-term categories. Long-term TTR forecasting often require the investigation of external impact factors in the long run, such as social-economics, weather, accidents, road constructions, and geographical topology. This study aims to address the long-term TTR forecasting issue which can cover 10-20 years' time window. The proposed research tasks will derive descriptive statistics and intuitive visualization for better understanding the historical and current consistency or dependability in travel times across various scenarios. The quantified TTR measures are planned to be computed for the performance evaluation and the convenience of the public. The widely-used measures, defined by FHWA, include 90th or 95th percentile travel times, buffer time index, planning time index, and frequency that congestion exceeds some expected threshold. These outputs are informative and helpful for portrait, diagnosis and improvement of TTR across the existing transportation network.

In summary, the objective of this study is to develop a systematic approach to analyzing and forecasting the long-term TTR on roadway segments, where both historical traffic sensor data and social-economics data will be utilized for model development.

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

Long-term TTR forecasting is a challenging task due to the large number of impact factors, such as increasing of travel demand. In recent years, data-driven techniques, such as machine learning models, for TTR forecasting are developed since they do not require strong explicit theoretical assumptions and have a low computational cost in the testing phase. The proposed method is designed to avoid the error-prone stochastic assumptions and leverage the data-driven framework, which also has remarkable performance in scare data situations and partially dysfunctional detectors. This study aims to apply a bivariate econometric modeling approach, such as Bivariate Tobit Model to identify and quantify significant factors on expected travel time and travel time standard deviation. Based on data availability, specific factors included in model development are holidays; weather conditions; and road construction and topology. In comparison to the pure data-driven model, the proposed hybrid method is more robust under the condition of the noisy/flawed dataset and is more explainable in terms of the model performance in estimation accuracy.

Travel time reliability measures the extent of this unexpected delay. A formal definition for travel time reliability is: the consistency or dependability in travel times, as measured from day-to-day and/or across different times of the day. Travel time reliability is significant to both DOT agencies and transportation system users. More specifically, transportation planners in state DOTs can benefit from considering travel time reliability as a key performance measure in project decision-makings. This research would provide UDOT an innovative methodology and a useful tool to conduct data fusion and analysis, quantify the expected delays, provide long-term TTR forecasting, and identify the areas where a capacity project could potentially help alleviate congestions.

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

In the proposed method, the inputs would be extracted from the existing traffic state databases (i.e. PeMS, iPeMS): (a) PeMS covers an aggregated instant speed and section traffic flow in a wider area, however, needs average travel time estimation process; (b) iPeMS shows accurate average travel time from floating vehicles, however, the data is collected in low sampling rate. During the past few years, our research team at the University of Utah has been using both database for over 5 UTRAC projects and has a deep understanding to their associated data issues. In this study, data screening and fusion techniques are to be investigated to take

advantage of both data sources. This study would introduce a hybrid probabilistic machine learning method to predict the probability distribution of travel time on a route in a road network in future 10 years or longer, involving PeMS/iPeMS data. Besides the historical travel time reliability pattern, this study would also investigate the external impact factors in the long run, such as social-economics, weather, accidents, road constructions, and geographical topology. This method gives informed predictions for parts of the road network with little data, and is computationally efficient, even for very large road networks and datasets. The results can also be integrated with UDOT travel demand models. The research results can be built on the existing PeMS and iPeMS systems, and be integrated with the existing travel experience report system. The forecasted TTR indicators can be further distributed via webpages or smartphone interface for the travelers' reference with minimal additional efforts.

The advanced travel experience analysis report system would help identify the latten problem regarding TTR induced reduction of level of service and the improvement of traffic demand modeling. Then such long-term TTR forecasting would benefit the planning group of UDOT to understand the current TTR problem, predicting the future TTR patterns, and identify the locations that require an increased capacity for congestion mitigations.

4. List the major research tasks:

1. Conduct literature review to examine existing models, tools, and software that can assess TTR and related travel experience.
2. Determine the TTR indicators, such as 90th or 95th percentile travel times, buffer time index, planning time index, and frequency that congestion exceeds some expected threshold.
3. Develop probabilistic machine learning models for long-term TTR forecasting based on the historical data from both PeMS and iPeMS and other data sources.
4. Case studies - review specific freeway and arterial corridors identified through other ongoing research projects and implement the developed models for TTR forecasting and evaluations.
5. Develop a toolkit for identifying areas where a capacity project could potentially help alleviate a congestion-related reliability problem.
6. Prepare the final project report.

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

1. Report of literature review on the targeted research issue.
2. A document to UDOT that explains the travel time reliability indicators and formulas.
3. A set of probabilistic machine learning models for long-term TTR forecasting.
4. Case study report for the key corridors.
5. A software package for identifying suitable areas for a capacity project.
6. Methodology for evaluating the travel experience with the yielded indicators and suggesting potential improvement methods.

6. Requested from UDOT: $50,000 **Other/Matching Funds:** $40,000 **Total Cost:** $90,000

Briefly explain funding sources: Potential match from the University Transportation Center - MPC

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

The research is proposed to start at Sep. 2020 and last 1.5 years long.

Month 1: project kick-off meeting;
Month 2-4: Task 1;
Month 5-7: Task 2;
Month 8-10: Task 3;
Month 11-13: Task 4;
Month 14-16: Task 5;
Month 17-18: final report preparation.