2016 UDOT RESEARCH PROBLEM STATEMENT

****** Problem statement deadline is March 14, 2016. Submit statements to Tom Hales at tahales@utah.gov. ******

Title: Connected Vehicle Dilemma Zone Awareness **No. (office use):** 16.03.06

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Select One Subject Area

- ☐ Materials/Pavements
- ☐ Maintenance
- ☒ Traffic Mgmt/Safety
- ☐ Preconstruction
- ☐ Planning
- ☐ Public Transportation

1. Describe the problem to be addressed.

When approaching signalized intersections, motorists oftentimes find themselves within a dilemma zone at the time of the phase change from yellow to green – an area where the driver must make a non-obvious decision between continuing through the intersection, or to begin braking. Due to the imprecise nature of driver behavior (e.g., reaction times, time-speed-distance assessment, yellow time estimation, degree of driving aggressiveness, etc.) individual drivers behave quite differently when faced with the same decision. Without external information to support these decisions, this can lead to red light running or hesitation before hard braking, ultimately resulting in angle and rear-end collisions stemming from such misjudgments. To address this problem, this research proposes to examine driver behavioral responses to a connected vehicle dilemma zone awareness (CVDZA) application through the use of the University of Utah's driving simulator, in order to assess the potential effectiveness of such systems. This application will consist of two main components, examining the potential effectiveness, limitations and risks of (1) a red light warning application (to recommend that drivers brake), and (2) an optional added intersection clearance application (to recommend that drivers proceed with caution).

2. Explain why this research is important.

Angle and rear-end collisions are some of the most common crash types observed at signalized intersections, and injury outcomes can oftentimes be severe, particularly for angle collisions. Many of these crashes stem from driver misjudgments as to whether to brake or continue through the intersection when the signal indication changes from green to yellow. While it will soon be possible to assist drivers in making these braking or proceeding decisions through new connected vehicle and connected infrastructure systems, the potential effectiveness of such applications are broadly unknown. Existing research to date has focused on how to apply red light warning systems and when to target individual vehicles based on distance from an intersection, vehicle speed, and signal timing parameters. Ultimately, however, the breadth and speed of deployment of such systems should depend on the effectiveness of the application, which this research work will seek to investigate.

3. List the research objective(s):

1. Identify how best to implement a CVDZA application.
2. Estimate the effectiveness of CVDZA applications on reaction times, hard braking, driver compliance (avoidance of red light running) and other factors influencing intersection safety, across multiple intersection contexts.

4. List the major tasks:

1. Synthesize literature. Identify, review, and critically synthesize relevant published literature regarding red light running warning applications, connected vehicle driving simulation methodologies, and other relevant literature to the research topic.
2. Scenario design and development. Design a set of driving simulator scenarios, with the consideration of key simulation factors such as communication method (audible, heads-up in-vehicle display, etc.), application settings (red light warning only, or combined with intersection clearance option), roadway speeds, congestion levels, and surrounding vehicle behavior, as well as other study design factors such as number of participants, simulation duration, and number of intersections that each participant will drive through. The scenarios will include intersections with and without the connected vehicle dilemma zone application. After consultation with the Technical Advisory Committee (TAC), selected driving simulator scenarios will be developed in detail and thoroughly tested.
3. Participant recruiting and simulation. Driving simulator participants will be recruited to partake in the developed scenarios. A small monetary incentive (e.g., $20 per participant) will be used to assist with recruiting. Limited screening will be used as necessary to ensure a reasonable distribution of participant ages and gender in the overall sample. Participants will drive through developed scenarios using the University of Utah's driving simulator, while research team members record vehicle

operation. Coordination with the University of Utah's Institutional Review Board (IRB) will help ensure that all human subject research conducted in this study is in compliance with federal standards and regulations.

4. Analysis and evaluation of results. Collected simulation data will be reviewed and compared to default (non-connected) intersection settings. Using this information, the research team will estimate the impact of CVDZA applications on driver compliance (red light running avoidance), hard braking, reaction times, and other factors influencing intersection safety. If present, differences in effectiveness across intersection contexts (e.g., number of lanes, speed, traffic volumes, etc.) will be identified.
5. Final reporting. A Final Report will be prepared and submitted that documents the entire research effort, including preliminary literature synthesis, scenario design, development, application, and evaluation, and participant recruiting process, while also incorporating feedback received from the TAC. Task 5 activities will follow UDOT Research Division's Final Report Process.

5. List the expected results:

1. Assessment of CVDZA application effectiveness, across metrics noted in Task 4, and across tested intersection settings.
2. Identification of preferred CVDZA implementation, (e.g., whether to include the intersection clearance application, and the effectiveness of audible vs. in-vehicle heads-up display messages).

6. Describe how this research will be implemented.

Findings will be presented to UDOT transportation safety and operations staff. These individuals may use the information stemming from this research in order to better anticipate how and where such CV dilemma zone awareness systems might be best implemented, as well as the anticipated effectiveness of such systems which could have an impact on the speed and breadth of such deployments. Research findings will also be shared with automotive manufacturers through the PI's contacts, such as Toyota and Ford.

7. Requested from UDOT: $50K **Other/Matching Funds:** $40K* **Total Cost:** $90K

*A proposal for the $40K in matching funds will be submitted to the Mountain Plains Consortium, the U.S. DOT Regional University Transportation Center for Federal Region 8, which shall be used to supplement scenario evaluation activities.

(or UTA for Public Transportation)

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

- Task 1 Synthesize literature (2 months): Sept. 1, 2016 – Oct. 31, 2016
- Task 2 Scenario design and development (5 months): Nov. 1, 2016 – March 31, 2017
  - Meeting with TAC around Dec. 15
  - Technical memorandum detailing outcomes of first two tasks March 31
- Task 3 Participant recruiting and simulation (2 months): April 1, 2017 – May 31, 2017
- Task 4 Analysis and evaluation of results (3 months): June 1, 2017 – Aug. 31, 2017
  - Meeting with TAC around July 15
  - Technical memorandum detailing outcomes of Tasks 3 and 4, Aug. 31
- Task 5 Submit final report (2 months): Sept. 1, 2017 – Oct. 31, 2017