Exhibit D – Research Project Requirement Template

A Virtual Reality Framework for Analyzing Pedestrian Crossing Behavior and Decision-Making Factors

Recipient/Grant (Contract) Number: The University of Texas at Austin/Grant # 69A3552344815 and 69A3552348320

Center Name: National Center for Understanding Future Travel Behavior and Demand (TBD)

Research Priority: Improving Mobility of People and Goods

Principal Investigator(s): Chandra R. Bhat

Project Partners: N/A

Research Project Funding: $150,000 ($75,000 Federal + $75,000 matching funds)

Project Start and End Date: 6/1/2025 – 5/31/2026

Project Description: Pedestrian safety remains a critical concern, with a significant rise in pedestrian fatalities in recent years. In 2022 alone, 7,522 pedestrians died in crashes, marking a troubling 57% rise from 2013 (Smart Growth America, 2024). However, traditional safety research focusing on crash outcomes and infrastructure factors has failed to capture the nuanced behavioral aspects that influence pedestrian risk-taking, such as hesitation, jaywalking, and split-second decisions that do not necessarily result in crashes but still pose significant risks.

Virtual Reality (VR) has emerged as a valuable tool for studying pedestrian behavior in controlled environments, allowing researchers to safely replicate high-risk scenarios. Recent VR studies have begun exploring social influence on pedestrian decision-making, showing how social conformity and inter-individual interactions affect crossing behaviors. Despite these advances, critical research gaps remain. Most studies examine uncontrolled mid-block crossings rather than complex signalized intersections where pedestrian walk light violations occur. There is also insufficient integration of sociodemographic variables with environmental and social factors to explain safety differences across communities and population groups. In addition, research on social influence typically employs simplified scenarios without exploring psychological mechanisms of observational learning and risk tolerance in realistic urban environments. These limitations limit our understanding of why certain populations (e.g., low income groups) face higher crash risks and how social dynamics influence pedestrian decision-making in high-risk situations. This project aims to comprehensively investigate the interplay of factors influencing pedestrian crossing decisions, with particular focus on behaviors such as hesitation, jaywalking, and risk assessment. Our primary objectives are to:

- Identify how social dynamics, including group behavior and the presence of jaywalkers, influence individual crossing decisions
- Measure the relationship between perceived time pressure and risk-taking behaviors
- Evaluate how different traffic conditions and infrastructure designs affect pedestrian stress (including biometric stress markers) and decision-making
- Analyze how sociodemographic factors and prior experience with different traffic environments modify pedestrian behavior
- Develop evidence-based recommendations for urban planners and policymakers to improve pedestrian safety

This research project employs VR to create controlled yet realistic urban crossing scenarios, allowing systematic manipulation of variables that would be unsafe to test in real environments. This research project

will generate key insights into how social influence affects pedestrian risk-taking and how demographic and environmental factors modify these responses. By identifying which environmental elements and social cues most significantly impact crossing decisions, we will develop evidence-based recommendations for urban design that account for psychological factors in pedestrian behavior. Additionally, the proposed VR methodology will establish new standards for studying pedestrian behavior in controlled yet realistic settings, ultimately contributing to safer urban environments for everyone.

US DOT Priorities: The project aligns with the USDOT's RD&T Strategic Plan by providing Data-Driven Insight (pp.58-59) through the use of advanced data collection and data processing capabilities to create information to support transportation operations and decision-making. Also, the use of VR for data collection aligns with the effort to use New and Novel Technologies (pp.59-60) for the purposes of developing safety assessment frameworks for automated systems across all modes of transportation.

Technology transfer efforts (pages 63-68) will encompass publishing findings in relevant pedestrian safety and behavior journals, presenting at conferences to reach industry professionals and policymakers, utilizing online professional networks to disseminate summaries to a wide audience, and establishing an open-access GitHub repository for data and models for community use and contribution. These efforts align with USDOT's priorities to make "R&D results … widely available to other scientists, to the public to facilitate understanding and decisions, and to innovators and entrepreneurs who can translate them into the businesses and products that will improve all of our lives" (Page 64).

Outputs: The proposed research study shall result in a paper that will be submitted to a relevant journal. Also, the paper will be submitted to and presented at relevant conferences and meetings. The dataset compiled for this project as well as detailed formulations of the analytic models used will also be appropriately documented and made available for public use. The results will be presented to pedestrian-focused divisions at city agencies, metropolitan planning organizations, and state departments of transportation. Data collected from the VR experiment will be made available to the public one year after completion of the project.

Outcomes/Impacts: This research will produce actionable insights to improve pedestrian safety through multiple avenues. Transportation agencies will gain evidence-based recommendations for intersection design elements that mitigate social influence on risky behaviors. Our results can also provide guidelines for creating pedestrian environments that better serve everyone. The findings will inform targeted educational campaigns addressing social conformity in pedestrian decision-making. Additionally, the VR methodology will establish standardized protocols for future pedestrian behavior research, expanding the toolkit available to transportation professionals studying safety interventions in controlled, realistic environments.

By identifying key social and environmental factors influencing pedestrian decision-making, the project will contribute to reduced pedestrian fatalities and injuries. Additionally, the integration of sociodemographic variables with behavioral data will advance safety outcomes across communities. The project will also expand scientific knowledge by establishing causal connections between social influence mechanisms and risk-taking behaviors, filling critical gaps in understanding pedestrian psychology at signalized intersections. The innovative VR methodology will create new research standards for studying behavioral factors in controlled yet realistic settings. By so doing, the project will immediately contribute to impact on the ground in terms of urban design, but also establish a set of VR protocols and standards for testing different pedestrian scenarios in the future.

Final Research Report: A URL link to the final report will be provided upon completion of the project.