STRIDE | Southeastern Transportation Research, Innovation, Development and Education Center

Technology Transfer Final Report

STRIDE Project I3

Evaluation of Work Zone Mobility by Utilizing Naturalistic Driving Study Data, Phase II

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1. Project Overview

The objective of this research is to study work zone mobility by utilizing the second Strategic Highway Research Program (SHRP2) Naturalistic Driving Study (NDS) data. The NDS data provides a unique opportunity to study car-following behaviors for different driver types in various work zone configurations, which cannot be achieved through traditional field data collection. The complete NDS work zone trip data of 200 traversals by 103 individuals, including time-series data, forward-view videos, radar data, and driver characteristics, was collected at four work zone configurations (two-to-one and three-to-two lane closure, and two-to-two and three-to-three shoulder closure), which encompasses nearly 1,100 vehicle miles traveled (VMT), 19 vehicle hours traveled (VHT), and over 675,000 data points at 0.1-s intervals.

First, the gap and headway were analyzed for different drivers (gender, age group, and risk perceptions) to develop the gap and headway selection tables. Furthermore, the speed profiles for different work zone configurations were established to explore the speed change through the entire work zones. The generalized additive model (GAM) was used to develop the best-fit curves of time headway and speed distributions. The change point detection method was used to identify where significant changes in mean and variance of speeds occur. The research results provided additional information on potential impact of human factors on car-following models at work zones that have been implemented in current work zone planning and simulation tools. Additionally, the findings of this work can also be helpful to the automotive industry to improve Adaptive Cruise Control (ACC) gap spacing setting at work zones.

2. Research Goals

1. Develop gap and headway selection tables based on different driver characteristics (i.e., gender, age group, and risk perception) at four work zone configurations; and
2. Perform a speed analysis to develop speed distribution models and identify key speed change points at work zones.

3. Findings

1. Gap and headway selection tables revealed that car-following behaviors are significantly different among different driver characteristic groups at different areas of work zones.
2. Speed distribution analysis indicated that speeds decrease at the transition area and increase near the termination area for lane closure conditions, while for shoulder closure conditions, significant speed reduction was only found at locations where concrete barriers appeared and narrowed shoulder clearance.

4. Performance Metrics

Metric	# Completed
OUTPUTS	
Product(s): Number of new or improved tools, technologies, products, methods, practices, and processes created or improved	1 (4 gap and headway selection tables at four work zone configurations)
Technical Report: Number of client-based technical reports published	STRIDE Final Report

OUTCOMES	
Body of Knowledge: Number of trainings for transportation professionals	2
Professionals Trained: Number of professionals participating in trainings	100
IMPACTS	
Stakeholders: Number of stakeholders you met with to encourage adoption or implementation of product(s)	2
Adoption/Implementation: Number of incidences outputs of research have been implemented or adopted	0

5. Product

Gap and headway selection tables

Gap and headway selection tables before, during, and after work zone by different driver types at four selected work zone configurations (LC 2-1, LC 3-2, SC 2-2, and SC 3-3) were developed.

The time and space gap distributions from different drivers traversing various work zones can improve ACC spacing policies for automotive industry. Taking driver characteristics into consideration when developing spacing policies contributes to the similarity of human driver's spacing behavior in the ACC systems, and thus, would be able to enhance comfort for drivers. It can further improve driver's acceptance and system utilization by introducing driver characteristics.

The headway distributions from different drivers traversing various work zone can improve work zone capacity models. The desired time headway parameter (CC1) in VISSIM is static through all work zone consecutive sections, although it was suggested that desired time headway should be modeled as a distribution rather than a static value when data are available. Thus, if headway distribution models built for different driver characteristics are used in lieu of a static value in VISSIM, a more accurate capacity estimation can be captured.

Technical Description

The gap and headway selection tables revealed that car-following behaviors are highly variable among different drivers. The time and space gap distributions from different drivers traversing various work zone areas can be useful to improve ACC spacing policies for automotive industry. Further studies are needed to understand driver's acceptance of current ACC gap setting at work zones. This study found that mean headways vary among the different component parts of a work zone. These findings suggest that separate headway distributions should be used for different work zone areas when modeling work zone traffic control using simulation or planning tools.

6. Who benefits/will benefit from your product?

- Departments of Transportation
- transportation agencies
- transportation researchers

7. Body of Knowledge & Professionals Trained

1) **TRB ACH40 Committee:** On 1/12/2021, Dr. Hugo Zhou and Dan Xu presented the Best Paper "Analysis of Headway and Speed based on Driver Characteristics and Work Zone Configurations Using Naturalistic Driving Study Data" at TRB Annual Meeting selected by ACH40 committee. There were over 70 participants during the committee meeting.
2) **STRIDE Webinar:** On 10/6/2021, Dr. Hugo Zhou and Dan Xu presented "Evaluation of Work Zone Mobility by Utilizing Naturalistic Driving Study Data, Phase II" at the STRIDE Webinar. There were over 30 participants during the webinar.

8. Stakeholder Engagement

MEETING DETAILS		NARRATIVE DESCRIPTION
STRIDE rep.	Dr. Huaguo Zhou	Presented "Application of Naturalistic Driving Study Data to Study Work Zone Mobility" at Alabama Roadway Safety Conference.
Date of Activity	9/25/2019	
Type of Activity	in-person meeting	
Location	Point Clear, AL	
Stakeholder(s)	John Michael Walker, State Safety Operations Engineer, ALDOT	
STRIDE rep.	Dr. Huaguo Zhou	Discussed the potential use of the results of this study for the simulation model at the Automated Vehicle Symposium in Orlando, FL. Dr. Ma mentioned that the current headway table in the VISSIM model was outdated.
Date of Activity	7/15/2019	
Type of Activity	in-person meeting	
Location	Orlando	
Stakeholder(s)	Dr. Jiaqi Ma, Director of Advanced Transportation Collaborative, University of Cincinnati	

9. Adoption/Implementation

The gap and headway selection tables have not yet been adopted. They will undergo further validation of different driver types and work zone configurations.

10. Broader Impacts

The second Strategic Highway Research Program (SHRP2) Naturalistic Driving Study (NDS) data provides a unique opportunity to study car-following models for different driver types under different work zone configurations. However, driver characteristics, such as gender, age group, and risk perception are typically not available using the traditional roadside data collection methods. Current work zone mobility studies (simulation-based methods or field study) generally do not consider driver characteristics. Driver characteristics can be a very important factor contributing to work zone capacity because different types of drivers react differently to work zones. Although there have been several work zone studies that applied NDS data, none of them have focused on work zone mobility. The gap and headway selection tables, and speed profiles, were developed for different types of drivers in four freeway work zone configurations. This is the first study that applies SHRP 2 NDS data to study the

impact of driver characteristics on gap and headway selection and speed distribution during the entire work zone areas. Current SHRP 2 NDS database contains limit trips and work zone configurations. It is suggested to collect more NDS data to further validate the headway selection and speed distribution by different driver types for more work zone configurations.